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JAKÁ JE ROLE UČITELE V E-LEARNINGU?

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Úvod

Vstup technických zařízení do vzdělávání lidí, tj. situace, kdy vyučování již není výhradní činnosti živého profesionála-učitele a učení jen záležitostí živého studenta (učí se i počítačové systémy), mění dosavadní podobu vyučování a učení a tím i role jejich hlavních aktérů. Už v r. 2004 prohlásili Bennet a Lockyer, že nastal čas **redefinovat roli edukátora** pro specifický případ, kdy výuka studentů probíhá ve virtuální prostředí.

Nás v této studii bude zajímat, jak se **mění role učitele** v situacích e-learningu. Je zřejmé, že některé tradiční role učitele zůstanou do jisté míry zachovány (facilitovat studentovo učení), jiné ustupují do pozadí (být hlavním zdrojem informací pro studenty), další nově přibývají. Někteří autoři (např. Yu, Chang, 2011) tvrdí, že se role učitelovy značně rozšiřují. Srovnávání učitelských rolí v tradičním vyučování a v e-learningu je zatím vzácností (viz např. studii Díazová, Entonado, 2009). Posledně zmínění autoři dospěli k závěru, že významné rozdíly nejsou. Důkladný systematický přehled mnoha důležitých učitelských rolí v e-learningu (s výjimkou studie Muñoz-Carril et al., 2013) nebyl dosud podán.

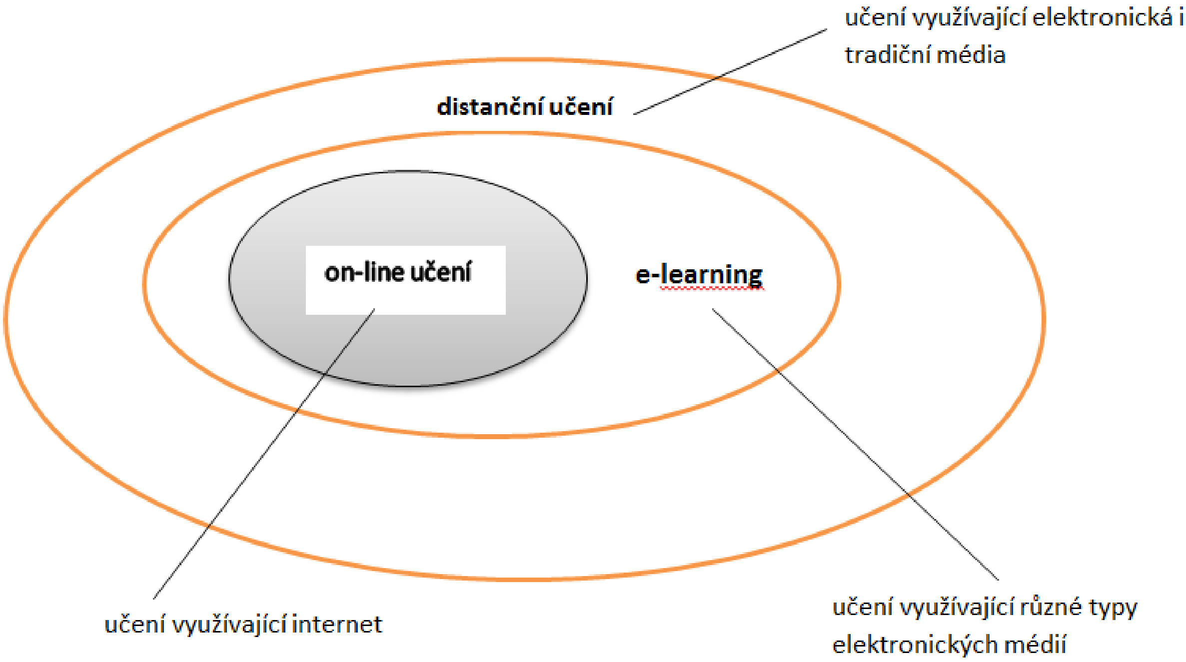
V situacích e-learningu se – oproti tradičnímu vyučování – na učitele kladou **nové požadavky.** Zatím naznačíme jen některé změny. Mění se sociální situace, neboť učitel už nemusí být v osobním, živém kontaktu se svými studenty, nesetkává se s nimi „tváří v tvář“: Vzájemný kontakt bývá zprostředkován technickými zařízeními (viz e-mail, videokonference, Skype apod.). Mění se způsob řízení studentova učení, neboť mnohé činnosti přebírá počítačový program, jehož autorem může být (ale také nemusí) daný učitel. Mění se podoba diskuse mezi studenty a učitelem, neboť účastníci již nemusí být společně fyzicky přítomni na jednom místě, nýbrž obvykle diskutují „na dálku“. Mohou být vzdáleni stovky kilometrů a jejich vstupy jsou zprostředkovány technickými zařízeními. To vše rozšiřuje požadavky na učitele, na jeho pregraduální i postgraduální vzdělávání: musí velmi dobře zvládnout práci s informačními a komunikačními technologiemi.

Mnohost podob e-learningu

Pokud uvažujeme o tom, nakolik se mění role učitele v situacích e-learningu, musíme nejprve zpřesnit, o které situace půjde. Zde narážíme na značné potíže, protože se setkáváme s velmi různorodou terminologií. Různorodost signalizuje, že existují i problémy věcné: to, co se se v různých pracích označuje pojmem e-learning, může mít (a také mívá) mnoho různých podob.

Existují sice pokusy o vymezení hierarchičnosti vztahů (viz obr. 1), ale ty jsou pro naše účely příliš hrubé.

Obr. 1 Základní vztahy mezi pojmy distanční učení, elektronické učení a on-line učení (Anderson, 2005, s. 5)



V české odborné literatuře se pracuje s pojmem **kombinovaná forma** výuky, v níž se propojuje distanční forma (využívající elektronická média) s tradičními prezenčními formami výuky, tj. s živou interakcí učitel-studenti.

V zahraničí literatuře se v případě, že jde o výuku, v níž dominují elektronická média, používá jako základ pojem **prostředí**. Např. elektronické prostředí pro učení (*e-learning environment*) nebo virtuální vyučovací prostředí (*virtual teaching environment*).

Trochu užší pojetí staví na adjektivu **elektronický**: elektronické vyučování (*e-teaching*), elektronické tutorování (*e-tutoring*), elektronické moderování výuky (*e-moderating*), elektronické facilitování učení (*e-facilitating learning*).

Nejužší pojetí se opírá o výuku, která probíhá v reálném čase, což lze vyjádřit výrazem **on-line**: on-line výuka (*on-line instruction*), on-line vyučování (*on-line teaching*), on-line konferování (*on-line conferencing*).

Elektronických médií už je pro výukové účely k dispozici mnoho: osobní počítače, notebooky, tablety, laptopy, smartphony, počítačové sítě apod. Pokud je propojíme s různými formami výuky (asynchronní on-line kursy, synchronní on-line kursy, on-line konference, asynchronní kooperativní on-line učení, synchronní kooperativní on-line učení, kombinovaná forma učení - *blended learning*), dostáváme řadu **různých pedagogických situací**. V každé z takových situací učitel zaujímá poněkud odlišnou roli, plní rozdílné funkce. Přitom se v zahraniční literatuře obvykle mluví o elektronické výuce (*e-instruction*), elektronickém vyučování (*e-teaching*) či elektronickém učení (*e-learning*) ve velmi obecné rovině, což není příliš korektní a komplikuje to hlubší analýzu.

Nemění se jen technické podmínky učitelovy práce. Ukazuje se totiž, že generace současných studentů se výrazně odlišuje od generací předchozích. Je mnohem lépe připravena na pedagogické situace, které navozuje e-learning; ba zvládá je snáze, než většina jejich učitelů.

Nový typ studentů

Sociologové a psychologové upozorňují, že do škol nyní vstoupila jiná generace. Liší od těch předchozích svými zkušenostmi, neboť odmalička pracuje s digitálními zařízeními; bere je jako samozřejmost. Má příslušné dovednosti a dokáže využít předností těchto zařízení. Je tedy technologicky dál, než generace jejich rodičů a také většiny jejich učitelů.

Pro výstižné pojmenování této nové generace se v literatuře používají metaforická označení typu: digitální generace (Tapscott, 1998), Net-generace, tedy síťová generace (Tapscott, 1998), digitální domorodci (Prensky, 2001 a, b), lišící se novými dovednostmi od digitálních imigrantů, tj. svých rodičů a učitelů. Objevila se též vtipná parafráze známého termínu *Homo sapiens*: Veen a Vrakking (2006) přišli s termínem *Homo zappiens*, tedy člověk klikající. Zvláštnosti tohoto nového člověka, pokud jde o učení, shrnuje tab. 1.

Tab. 1 Rozdíly mezi Homo sapiens a Homo zappiens (podle Veen, 2007, s. 3; Veen, Stalduinen (2010)

Homo zappiens	Homo sapiens
rychlé pracovní tempo	konvenční pracovní tempo
řešení více úkolů najednou (multitasking)	řešení jednoho úkolu
nelineární přístup	lineární přístup
primární jsou ikonické dovednosti	primární jsou čtenářské dovednosti
tendence pracovat s druhými lidmi	tendence pracovat sám
tendence spolupracovat	tendence soutěžit
učení vyhledáváním informací	učení vstřebáváním informací
učení hrou (tj. spojování učení a hry)	oddělování učení od hry
učení externalizováním (projevováním se navenek)	učení internalizováním (zvnitřňováním)
používání fantazie	soustřeďování se na realitu
preferování zkratek	vyjadřování se celými slovy
preferuje komunikování s lidmi na sítích	preferuje komunikování s lidmi při živém osobním setkání, „tváří v tvář“
hledá odpovědi na otázky na síti nebo u vrstevníků	hledá odpovědi na otázky v knihách, ve slovnících, u dospělých osob
jedinec může mít více identit	má jednu identitu
udrží pozornosti jen po krátkou dobu	umí udržet pozornost po delší dobu
má vysokou sebedůvěru	má nízkou sebedůvěra

S oporou o odbornou literaturu můžeme konstatovat, že generace současných studentů je jiná; při učení postupuje poněkud odlišněji, než generace předchozí. Mnohem snadněji při svém učení využívá digitálních technologií. Výraznější zapojení digitálních technologií do vzdělávání lidí proměňuje (oproti tradičnímu vyučování) také sociální role učitele. Jak se s novou situací vyrovnávají učitelé? Dříve, než podrobněji rozebereme změny rolí, funkcí a kompetencí učitele, vyložíme tyto tři základní pojmy.

Pojmy: role, funkce, kompetence

V zahraniční odborné literatuře se setkáváme při charakterizování toho, co všechno má učitele v e-learningu zastat, které typy činností má vykonávat, se třemi odbornými výrazy: (sociální) role učitele, (sociální) funkce učitele a kompetence učitele. Někteří autoři je dokonce používají jako „téměř synonyma“ (např. Guaschová, 2010), ale měli bychom mezi nimi rozlišovat.

Role (sociální role) je sociologicky definována jako očekávaný způsob chování, který je vázán na sociální status jedince. Zprostředkovává vztah mezi reálně prováděnými činnostmi a jejich vymezením nadindividuálně platnými normami (Petrusek et al., 1996, s. 943). V instituci (tedy i ve škole) role identifikují činnosti a vztahy; vymezují sociální kategorie a jsou indikátorem skupinového příslušenství (např. k učitelskému sboru). Zajišťují praktickou aplikaci norem v určité oblasti chování. Vykonávání role mívá často charakter vyslání a přijetí určitých požadavků. Role umožňují všem zúčastněným předjímat určitý typ chování a recipročně na něj reagovat.

Sociální role je psychologicky definována jako *chování*, které je pro jedince v určitém postavení či určité situaci *vhodné a žádoucí*. Takový typ chování je od něho okolím očekáván, příp. pro ono chování existuje sociální norma (Hartl, Hartlová, 2010, s. 504). Sociální role učitele je tedy vázána jednak na jeho formální či neformální postavení ve škole a z něho plynoucí pravomoci, jednak na určitou sociální situaci.

V psychologii je pojem **funkce** chápan jako *způsob chování* zaměřený k nějakému účelu. U člověka se může jednat o funkce vegetativní, senzorické, motorické, psychické (Hartl, Hartlová, 2010, s. 159). Sociologie se na tento pojem dívá jinak. Říká, že ve společnosti musí docházet k provádění určitých činností, které jsou nezbytné pro existenci, fungování a vývoj společnosti, a právě takové **činnosti** označují jako **funkce**. Aplikováno na oblast edukace by tedy funkce učitele byly ty *činnosti*, které jsou nezbytné pro existenci školy, pro vyučování a učení lidí.

Pojem **kompetence** bývá v odborné literatuře chápán dvěma rozdílnými způsoby. Jednak jak osobnostní charakteristika, zvláštnost jedincovy osobnosti. Jedinec disponuje specifickým souborem schopností a dovedností, který ovlivňuje účinnost jeho jednání. Druhý přístup říká, že jde soubor znalostí a dovedností, které jedinec získal vzděláním, výcvikem a zkušenostmi. Jde o strategické jednání, které mu dovoluje přizpůsobovat výkon profese měnícím se požadavkům sociálních situací.

V našem kontextu volíme druhou možnost. Kompetence **učitele** chápeme jako soubor „vědomostí, dovedností, postojů a hodnot důležitých pro výkon učitelské profese. Vztahují se k profesní, obsahové a osobnostní složce standardu učitelství. Patří k nim kompetence pedagogické a didaktické; oborově předmětové; diagnostické a informační; sociální, psychosociální a komunikační; manažerské a normativní; profesně a osobnostně kultivující“ (Průcha et al. 2013, s. 130). Kompetence je tedy učitelova dovednost profesionálně jednat určitým způsobem.

V tomto oddíle jsme mluvili výhradně o profesionální roli učitele. Nesmíme ovšem ztrácet ze zřetele skutečnost, že má-li být někdo učitelem, musí být někdo další žákem/studentem. Role učitele a studenta jsou rolemi komplementárními, navzájem se ovlivňují. Čím větší prostor v řízení učení ponechává učitel studentovi, jeho autoregulaci při učení, tím více musí učitel ustupovat do pozadí a delegovat na studenta i odpovědnost za průběh a výsledky učení. Ne vždy dělba práce, spolupráce a názor na to, co by měl dělat ten druhý, probíhá hladce. Může docházet (a také dochází, jak říkají Yu a Chang, 2011) k nesouladu očekávání a reality - a tím i ke konfliktům mezi učitelem a studenty. Uvádějí tento příklad: e-učitel může chápat svoji klíčovou roli tak, že stačí, aby byl editorem studijních materiálů nebo technickým operátorem, zatímco studenti očekávají, že bude vytvářet přátelskou atmosféru při učení; pokud jejich očekávání neplní, jsou s jeho činností nespokojeni.

Rozdílné označování člověka v roli učitele při e-learningu

V publikacích, které se věnují úvahám o roli učitele v situacích e-learningu, nebo se zabývají empirickým výzkumem rolí v e-learningu, se setkáváme se třemi různými typy označení učitelů.

První typ nezdůrazňuje, že se jedná o případy, kdy učitel funguje v situacích e-learningu a autoři používají **konvenční označování** vyučujících podle toho, které činnosti především provádějí, které role ve výuce zastávají.

Druhý typ už samotnou **specifickou předponou** upozorňuje, že jde o pedagogické situace, které se liší od vyučujících v tradiční výuce.

Konečně třetí typ je poněkud matoucí, neboť také užívá specifickou předponu anebo specifické adjektivum, ale věcně **nejde o živého učitele**, ale o počítačový program, který plní některé funkce živého učitele v e-learningu, diagnostikuje a řídí studentovo učení.

Všechny tři typy shrnuje tab. 2.

Tab. 2 Různé typy označení pro učitele v situacích e-learningu

Typy	Anglický termín	Český termín
Konvenční označení učitele v situacích e-learningu	educator	edukátor
	teacher	učitel
	co-teacher	spoluvyučující, týmový učitel
	instructor	instruktor
	tutor	tutor
	moderator	moderátor
Specifické označení živého učitele v situacích e-learningu	educator in e-learning	edukátor v e-learningu
	e-teacher	e-učitel
	e-tutor	e-tutor
	e-moderator	e-moderátor
	online teacher	online učitel
	online instructor	online instruktor
	online moderator	online moderátor
Označení počítačového programu, který plní některé funkce učitele v situacích e-learningu	eTeacher (Schiaffinová et al. 2008)	eUčitel
	virtual teacher (Loveová, Simpson, 2005)	virtuální učitel

Nejde však pouze o terminologii. Podstatnější je změna rolí, které učitel v e-learningu zastává.

Teoreticky stanovené učitelské role v e-lerarningu

Nové sociální role učitele při e-learningu se řada badatelů pokoušela vyjádřit pomocí metafor. Např. Clark (2002) napsal, že skončila doba, kdy učitel vystačil s křídou, tabulí a slovním výkladem (*chalk and talk*). Collison se spolupracovníky se proslavil úslovím, které se však těžko překládá do češtiny: *sage on the stage → guide on the side*. Volně řečeno: nastává posun od situace, kdy se moudrý člověk stával hercem, aby studenty poučil, k situaci, kdy se stává studentovým průvodcem na stránce textu, určeného ke studiu (Collison et al., 2000). Mazzoliniová a Maddisonová (2003) přišly s metaforou *ghosts in the wings* tj. jakýchsi „duchů za kulisami", kteří zasahují do děje jen výjimečně.

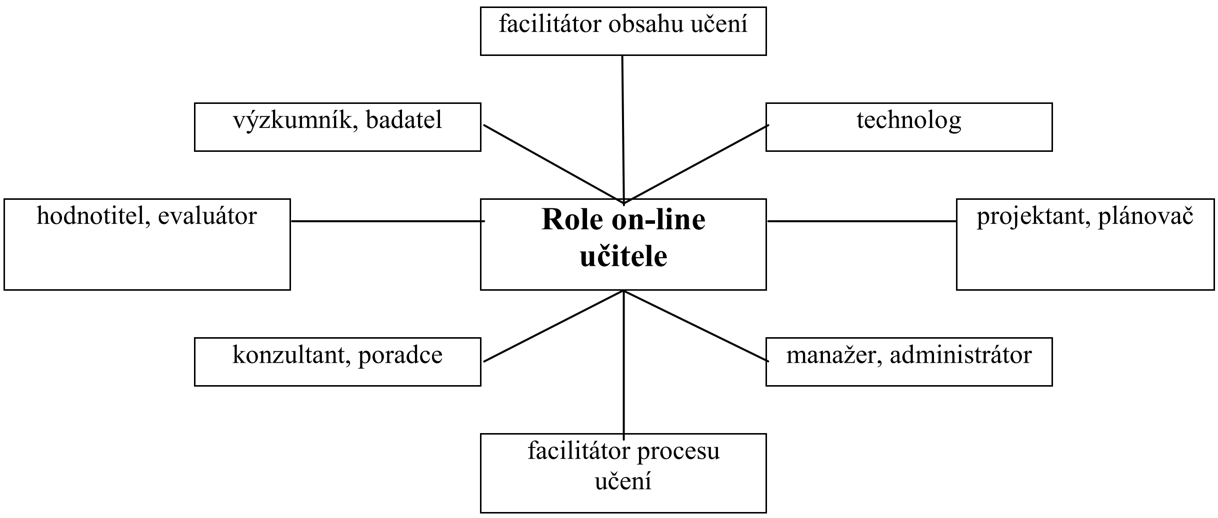
Mezi nejčastěji citovanými taxonomiemi různých sociálních rolí, které učitel zastává v e-learningu, nalezneme dvě: Američana Bergeho a Angličana Goodyeara.

Berg (1995 a, b) se zamýšlel nad důležitými sociálními rolemi, jež plní učitel při počítačových konferencích, a stanovil čtyři:

- pedagogicko-didaktickou (tj. intelektuální, procedurální, tutorskou, facilitační)
- sociální (tj. vytvářející příznivé sociální prostředí pro diskusi)
- manažerskou (organizační, procedurální, administrativní)
- technickou (zajistit komfortní práci s počítačovým systémem a softwarem).

V roce 2000 proběhla ve Velké Británii mezinárodní konference, jejíž účastníci diskutovali o rolích a kompetencích učitele při on-line vyučování. Výsledkem speciálního workshopu byl konsensuální model 8 rolí učitele (obr. 2).

Obr. 2 Konsensuální model osmi rolí učitele při on-line výuce (Goodyear et al., 2001, s. 69)



Je zřejmé, že počet rolí učitele v e-learningu a jejich označení záleží na kritériích, která autor typologie zvolí. V odborné literatuře se setkáváme s případy, kdy rolí není mnoho (viz 4 role v případě Bergovy typologie), ale též s případy, kdy jejich počet se pohybuje v řádu desítek, např. 43 rolí v práci Shaikh, Khoja (2012). Potíž je v tom, že pak dochází k porušování jednotlivých úrovní obecnosti a autoři typologií „od zeleného stolu" ve snaze po originalitě přicházejí s konglomerátem málo funkčních kategorií.

Empiricky stanovené učitelské role v e-learningu

Stanovení učitelských rolí v e-learningu není jen záležitostí teoretických úvah a pokusů o různé klasifikační systémy. V poslední době přibývá konkrétních výzkumů, které se snaží induktivní cestou (pomocí kvalitativního přístupu) či deduktivní cestou (pomocí kvantitativního přístupu) dospět k určitým typům sociálních rolí učitele v situacích e-learningu. Přitom ještě v r. 2003 si Eastonová povzdechla, že role učitele v e-learningu je zatím vágní a empiricky není příliš prozkoumána. Nyní už druhá část jejího tvrzení neplatí.

Podívejme se nyní na některé empirické výzkumy různých rolí, které může učitel v situacích e-learningu zastávat. Výzkumy jsou řazeny podle roku svého publikování.

Tab. 3 Empirické výzkumy různých rolí učitele v situaci e-learningu

Autoři	Typ výzkumu	Zkoumaný soubor	Použité metody	Hlavní výsledky	Poznámky
Eastonová (2003)	kvalitativní	18 vysokoškolských učitelů (věk 25-55 let) a 6 akademických funkcionářů	zúčastněné pozorování, individuální hloubkový rozhovor, diskuse v ohniskové skupině, analýza dokumentace, analýza dat o hodnocení kvality výuky; verbální protokoly byly analyzovány pomocí zakotvené teorie	Učitelé musí věnovat výuce více času, než při tradiční výuce a pociťují větší pracovní zátěž. Museli se naučit komunikovat virtuálně, poskytovat studentům častěji zpětnou vazbu. Změnily se jejich postoje ke studentům, učitelé se stali vstřícnějšími a snaží se studenty více vtahovat do učení.	
Aydin (2005)	kvantitativní	53 vysokoškolských učitelů (většina ve věku 25-29 let)	originální dotazník OTRCRQ - Online Teaching Roles, Competencies and Resources Questionnaire; 78 položek, odpovídá se pomocí pětistupňové škály	Dotazník předpokládá existenci 8 rolí učitele: expert na obsah, facilitátor procesu učení, projektant/ konstruktér výuky, poradce/ konzultant, technolog, hodnotitel/ arbitr, tvůrce studijních materiálů, administrátor	
Díazová, Entonado, (2009)	smíšený	3 vysokoškolští učitelé, 2 experti, 250 studentů (121 mě-lo tradiční vý-ku a 129 on-line výuku)	dotazník pro studenty (20 položek); diskuse v ohniskových skupinách studentů; polostrukturovaný rozhovor s učiteli; diskuse v ohniskových skupinách složených z učitelů i studentů (jedna diskutovala o tradiční výuce, druhá o online výuce); polostrukturovaný rozhovor s experty; doslovné protokoly rozhovorů byly analyzo-vány pomocí tematické analýzy	Neexistuje významný rozdíl ve funkcích učitele při tradiční výuce „tváří v tvář" a při on-line výuce. V obou případech učitel facilituje studentovo učení, kombinuje vysvětlování teoretického učiva s aktivitou studentů, navozuje a rozvíjí interakci. Pokud se přece objevují rozdíly, jsou dány spíše rozdíly mezi školami a učiteli: některé školy se více starají o kvalitu softwaru řídícího učení; někteří učitelé se s nadšením věnují on-line výuce.	
Ayachi-Ghanouchi et al. (2010)	kvantitativní	43 studentů	dotazník Experience-related to the *Unified Modeling Lauguage Course* (35 položek); vývojové diagramy každé ze šesti učitelových funkcí v distan-čním vzdělávání	Učitel v distančním vzdělávání plní 6 funkcí: pedagogickou, organizační, technickou, socio-motivační, metakognitivní, evaluační.	
Yu, Chang (2011)	smíšený	8 vysokoškolských učitelů, 29 studentů	polostrukturovaný rozhovor (živý nebo zprostředkovaný digitálním zařízením), nahrávka, protokol; dotazník pro učitele, dotazník pro studenty; doslovné protokoly rozhovorů byly analyzo-vány pomocí zakotvené teorie	Role učitele v e-learningu nejsou jen instruktor, manažer a mentor, ale také učící se jedinec (žák) a odborník na technologie.	
Muñoz-Carril et al., (2013)	kvantitativní	166 vysokoškolských učitelů	dotazník s 9 položkami; obsah každé položky respondenti posuzovali ze dvou hledisek: a) podle úrovně zvládnutí své kompetence praco-vat v e-learningu, b) podle náhledu, zda potřebují v této oblasti ještě nějaký výcvik	Učitelé si uvědomují změ-ny, které do výuky přináší e-learning a jsou ochotni zvyšovat svoji kompetentnost ve speciálních kursech. Nejvíce si jsou jisti rozplánováním učiva, nejméně pak v roli člověka zkoušejícího a hodnotícího.	

Závěr

Zatím se v úvahách odborníků postupuje tak, že ze znalosti výsledné podoby interakce učitel-studenti, jež je výsledkem určitých technických podmínek, se odvozuje, které role za této konstelace asi může učitel plnit.

Lze však uvažovat i jinak: už ve chvíli, kdy navrhujeme počítačový systém, který je určen pro vzdělávání lidí, bychom měli *předem stanovit*, které role v reálném čase má za této konstelace učitel plnit. Goodyear a Dimitriadis (2013) upozorňují, že obvykle vznikají dvě situace:

1. projekt počítačového systému pro učení se studentů je neúplný, nedostatečně specifikovaný; autoři systému předpokládají, že živý učitel bude po ruce a sám bude „za pochodu" řešit problémy, které během fungování systému studentům vznikají. Učitel v takových případech improvizuje, pomáhá napravovat nedostatky počítačového systému; vysvětluje studentům podrobnosti, doplňuje to, na co autor systému nepamatoval.
2. situace, kdy autor počítačového systému pro učení studentů explicitně definuje roli/role učitele v daném systému a to role v reálném čase. Je předem jasně stanoveno, co všechno bude dělat počítačový systém a co případně přísluší učiteli. Citovaní autoři říkají, že stanovení hranice je snadnější, když si tvůrce konkrétního počítačového systému položí otázku: jak by fungoval můj systém úplně bez učitele, bez jeho intervencí v reálném čase. Jinak řečeno: učitel je zde brán jako expert, aktér, který zasahuje jen v jasně definovaných případech. Můžeme dodat: „nehasí" cokoli, co nefunguje.

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BRIGHT&DARK SIDE OF BEHAVIOURISM

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Abstract

In this publication, the author is concerned in a wide range of important psychological experiments that relate to behaviourism including those of B.F. Skinner. The experiments are focused especially on the information which was obtained thanks to historical behaviourists' experiments not only in the field of programmed learning but also within social sciences. Consequently, he tries to describe also negatives which appeared during researches focused on registration and modification of human beings' behaviour, respectively of experimental animals' behaviour. Consequently, the questions are discussed from a point of view of today's ICT facilities which offer more detailed and sensitive data on human beings' behaviour than it was possible to obtain at the beginning of behaviourism. They also offer data how this knowledge may influence researched individuals life. The author has the aim to provoke thoughts on ethical boundaries in which we occur nowadays while researching and utilization of human beings' behaviour including the facts how ICT facilities participate in it.

Keywords

Behaviourism, ICT pros and cons, humanity, history, future, psychology

Introduction

Behaviourism is an approach to psychology which was founded by J. B. Watson at the beginning of the 20th century. However, American behaviourism is primarily associated with I.P. Pavlov theory. He, in his experiments with dogs, introduced conditioned reflex in public knowledge. It was one of the basic elements utilised during experiments made by psychologists who were oriented to behaviourism. Although I.P. Pavlov is termed as a predecessor of behaviourism, he himself proceeds from I.M. Sečenov theory. I. M. Sečenov was the first scientist who worked with functioning of higher nervous system and motor reaction. That time, from a physiological point of view, he described them as "a reflex arc". Pavlov's contemporary was also E.L. Thorndike. They both worked on very similar objectives which fact was found out post facto. I. P. Pavlov said: „Later I acquainted myself with American studies more comprehensively and I must acknowledge that honour belongs to Thorndike who was the first one who started a new approach of behaviourism. Thorndike started his experiments two or three years earlier than me…“ (Pavlov, 1953, pg. 12). History of behaviourism is longer and more interconnected than it appears for the first sight. It is well known that scientists were interested in registration of individuals' behaviour already before creation of this official approach to psychology.

This approach to psychology is especially characteristic by the fact that it underlines quantification and creates mathematical models. It is a strictly scientific approach which reduces human's mental demonstrations on his behaviour only (Hofmanová, 2010, pg. 26). From behaviourists point of view all human manifestations that might be empirically registered, measured and recorded are called behaviour. Some behaviourists consider behaviour even more closely. They understand it as an observable organism's activity – in principle as muscles and glands activity (Hyhlík, Nakonečný, 1973, in Förster, 2005, pg. 86). The basic objective of behaviourism is a prediction and behaviour monitoring (Hughes, Hall, 1989, pg. 16).

Of course, from the 2nd half of 19th century to 1930's nearly all measurements were direct while using converters on mechanical or pneumatic level. Recorders of big size were very complicated as regards their control. For every measured variable there was special equipment used. If psychologists wanted to observe ability to memorize a text which was presented by the same way to experimental persons, they would have had to use a tachistoscope (it enabled regulation of time period of representation words that should have been memorized) and further they would have had to use also a kymograph that was switched on by an acoustic key and recorded reaction courses during words reproduction (Vobořil, Květon, Jelínek, 2008, pg. 72-75, 49-57). Nowadays when there are IT facilities available, the same questions might be observed by a current notebook (PC) with a microphone equipped by the appropriate SW which would present words on the screen in periods selected by ourselves. During questioning the SW would record verbal answers on a time axis. If the notebook is equipped by a special SW for recognition of spoken text, it can work practically automatically and interpret correctness of the answers.

Because according to Watson immeasurable variables are indemonstrable, it is absolutely pointless to study the soul or any inner human's life. And because they are absolutely indemonstrable and impervious to human observation, they must be considered as so called black box. So it is a definite existence of the inner human world but without a possibility to claim its observation. Inter alia it was the reason why J.B. Watson denied a psychological method of introspection as unscientific. By then introspection was a favourite method of psychologists which dealt with one's own mental manifestations and their description. So behaviour became the only basic element of the observation.

Association of stimulus (S) and response (R) are basic elements of behaviour (Plháková, 2003, pg. 20). On the base of progressive researches, classical S-R (stimulus – response) model of behaviourism was later enlarged by another conditioning element what personality was. Neo-behaviourists who were rather oriented socially had to admit this element because for such complicated organism as human being is, responses could not have been precisely defined on the base of stimulus only. So the final equation was the following: Stimulus-Personality-Response (S-P-R). We try to apply this theory on today's situation when a user logins to Internet and we consider an advertising banner as a stimulus. If the user clicks on the banner, it is his response. From a psychological point of view, it is a demonstration of the fact that the stimulus was processed by the user and that the response corresponds to user's personality. If the stimulus was not important for the given person, there would be no response to this stimulus.

The behaviour might be both a visible demonstration of the organism as well as invisible but measurable. So the behaviour is a manifestation of enjoyment or bad temper. Increase or decrease of blood pressure but also sweating, salivation or muscle tonus inform on it. In an extreme case we are informed on it also by liberation of stress-related or other hormones, by pupil dilatation or constriction, by tremor, by vascular skin, by heart rate or by palpebration frequency. At the beginning, even behaviourists speculated about on the fact that thinking is caused by invisible movements of vocal cords (Watson, 1929, pg. 9 in Plháková, 2012, pg. 157). The truth is that if a human being does not have a feed-back on his vocal chords activities e.g. from a reason of secondarily created deafness, he can draw growling sounds that precisely correspond to read text melody during text reading.

A typical method of behaviourism is also observation of responses by means of studying increments in learning. It means that we are able to register stimuli results by calculation of the desired responses frequency, respectively by recording the times. Both, the frequency and the time are measurable variables and by acting as feedback, we are able to intervene in the other activities during learning.

Bright and Dark Side of Behaviourism

The same as in a case of every human activity, also research and application of obtained results into practice have their bright and dark sides. It is not any different in behaviourism and in work of its representatives and descendants. Facilities of the early period for the experiments with learning were, from today’s point of view, primitive because they worked on mechanical basis. It was impossible to handle masterly and sensitively with variables as it is enabled nowadays during computer controlled processes. It is necessary to take into account that even if you have to face the negative consequences of the testing on animals, this testing had very positive consequences for the future. From today’s point of view, all the tests on animals made within behaviourism experiments together with preliminary I.P. Pavlov’s experiments must be classified as cruel and unethical. However if they were not realised, we would not occur in the situation when we are at least aware of the facts which result from them and we would lack the basic building stones. It is the objective of the future to evaluate whether benefits which the experiments brought may balance all the cruelties that were commited.

I.P. Pavlov

I.P.Pavlov during his experiments on dogs poured acid to dogs’ mouth by force. The aim was to induce salivary secretion which would weaken the chemical action of the acid. It dealt with utilisation of the self-preservation reflex (Pavlov, 1953, pg. 45). Later Pavlov reports on the following: „During Dr. Gejman's experiments which were realised in my laboratory in an acute form, that is on intoxicated animals which were operated without delay, chemical properties of food which touched oral cavity did not induce salivary secretion.“ (Pavlov, 1953, pg. 40).

I.P. Pavlov also evoked nervous breakdown to the dogs by a well-thought-out way when he tried to evoke a conditioned reflex by means of a reward while presenting a circle whereas there was not reward while presenting an ellipse. Consequently he kept changing ratio of sides for so long time up to the state when it was not clear if the picture is a circle or an elipse. In this unclear situation the dogs were not able to response the stimuli and their nervous system broke down. Other Pavlov’s activites were interventions to the nervous system. They dealt with decortication of brain parts or fistulae insertion (artificial outlets) into animals’ stomachs to be able to measure salivary secretion.

Pavlov made researches on reflex activities by strictly scientific approach. It means that he made experiments how to control them in the most effective way, which interferences affect them and how to repress the given response. During the experiments, unbelievable amount of quantities may affect irritatingly learning of that specific conditioned reflex which the researches want to observe. Unusual noise, fluctuation of lighting intensity in the room, a new smell, a whiff of cool air or even a subject that touches the skin as an inconsiderable piece of the plaster which falls from the ceiling might influence it (Pavlov, 1953, pg. 93).

Even if on the base of previous facts we cannot have oversized illusions on experimental animals’ quality of life, the results dealing with the interferences on creation of the conditioned reflex are very interesting. This information becomes even more interesting these days because there is a huge amount of interferences. If we try to extrapolate consequences of simple reflex activity on more complicated activity that is called learning, the results are quite extensive. There are questionnaires which work with learning styles. Within them there are also enquiries made concerning the activities which we prefer during learning. A typical questionnaire is LSI in which enquiries are made concerning learning and parallel food consumption or preference of a certain temperature in the room or similar (Mareš, Skalská, 1994).

So, it is obvious that during learning people allow themselves weakening of the intended learning activity by some different activities which are not directly connected with it. So the learning becomes absolutely ineffective if the interferences are not suppressed. Even if, for the first sight, it seems that the tested person might learn the best in the environment which he/she knows well and complies with. It is also necessary to take into account learner's personality because also the personality might influence efficiency of the processed material. It deals with the concept of personalized learning approach in which the ICT influence is set the way it respected learner's individuality (Kostolányová, Šarmanová, Takács, 2011).

E.L.Thorndike

E.L.Thorndike was J.B. Watson's contemporary. Although, by his researches, he might have been classified among representatives of American behaviourism, he preferred the approach to psychology called connectionism. His experiments with cats became well-known as well as his method of learning by the trial and accidental success. It means that the situation of the stimulus and response is not set the same way as in the classical conditioning in which case a tested subject is rewarded per a concrete response. In this method experimental persons or animals solve the problems to know how to cope with them by means of the trial and error method. If a cat wants to get out from the cage which can be opened by pressing a small lever, then by repeating of the same situation, the activity changes from a random lever pressing to the activity which is completely goal directed. At the same time, the timing of responses shows rate of learning ability.

The timing during the experiment shortened from the original 150 seconds that elapsed during the first trial when a kitten opened the gate up to several seconds which elapsed after five up to ten trials (Crider & col., 1989, pg. 219, in Plháková, 2012, pg. 154).

We cannot find a similar dark side of Thorndike's experiments that we can see at physiologists or other psychologists. The only known dark side of behaviourism was inconvenience for Thorndike himself at the beginning of his first experiments with chickens. He made experiments in a maze which he built from old books. He researched chickens ability to find out the way out the maze. The result was that his landlady forbade him to do these experiments because the birds were very noisy. (Goodwin, 1999, pg. 207-212; Hunt, 2000, pg. 236-237, in Plháková, 2012, pg. 154).

Importance of Thorndike's researches reaches far away beyond the scope of his pioneering works with non-humane objects. Příhoda (1926, pg. 10-11, in Förster, 2005, pg. 109) says that E.L.Thorndike is „ the *father* of educational psychology".

J.B. Watson

J.B. Watson became famous by the experiment which went down in history of psychology as „Little Albert Experiment". Watson and his graduate Ms. Rayner utilised the fact that in hospital where they worked together there was a wet nurse employed who had nine months old baby. They started experiment on this baby and at the beginning they exposed him to white toys. Later on, whenever the baby was exposed to a white toy, they made a loud noise and little Albert started crying. The repeated noise while seeing the white toy was the cause that the baby gradually feared all similar white things. The result of the experiment was that after conditioning Albert feared the white colour. The wet nurse, Albert's mother took her baby home when the experiment finished and nobody was able to deprive the baby of feeling the fear. (Cumminsová, 1998, pg. 126 in Plháková, 2003, pg. 37). From present point of view this achievement seems to be absolutely unethical. If we evaluate it more strictly, it seems to be even child abuse. However, there are showings that Watson planned to unteach the baby this fear but his mother took the baby from hospital home earlier than he expected. However, Watson's son describes his attitude to his own children in the following way: "According to him, Watson never showed affection or feelings towards his own children. He never gave them a kiss or cradled them in his arms. He might have been deeply confident that showing any sweetness should have had harmful influence on them." (Schultz, Schultz, 1992, pg. 289-297, in Plháková, 2012, pg. 155).

Knowledge of the fact that it is possible to learn fear was applied on the useful opposites. Ms. Jones's experiment is an example. She used the therapy for a little boy who was three years old and had a natural phobia from white mice, rabbits and wool. During the therapy these stressful subjects were presented to him while he was doing something pleasant for example having food, playing with friends or similar. His fear of stressful subjects was gradually successfully eliminated (Jonesová, 1924, in Kratochvíl, 1998, pg. 61).

Watson also made experiments on rats with the aim to show which senses the rats really need for learning. He put rats in the maze in order that they looked for food. He divided groups of rats up in the following way: he surgically removed a different sense organ on the rats from each group. So eyesight, rhinaesthesia, inner ear, tactile hair, planta pedises became insensitive. From the experiment it became apparent that the most important signals for the rats learning the maze were kinaesthetic signals from muscles. That way series of associations between muscles movements and maze curves were reached. (Carr, Watson, 1908, in Goodwin, 1999, pg. 303-304, in Plháková, 2012, pg.155).

This piece of knowledge might have been a mainspring for creation of special equipment for sightless and deaf-blind people. It deals especially with a special display device called Brain Port which, by means of week electric impulses on tongue area, "displays" an approximate vision of the surrounding world (Layton, not dated).

H. Harlow

Harlow utilised rhesus monkeys for his experiments. He bred them in huge amount in his laboratories. He took freshly born infants from their mothers and brought them up on so called mothersubstitutes. They were made of mesh wire nets and some of them were upholstered by soft materials, the others were made of wires only and contained small hoses with milk. According to behaviorists' theory, the infants should have spent more time on the mother that rewards them by milk. The truth was quite otherwise. A simple formula on stimuli, enforcing and response was not functional because the infants went to feed themselves on the wired mother, i.e. rewarding one but they spent most time on the mother that was upholstered by soft material. To a great extent it means denial of simple S-R framework because there are other factors which cause that needs might be saturated by a different way than direct rewarding is. That is precisely by the fact that there is a tool for satisfying their needs only without enforcing them (Slater, 2008, pg. 146-148).

Consequences of early removal of little monkeys from their mothers lead to complete destruction of their social behaviour. So the little monkeys were not able to live together, they were not able to breed independently and if a female was inseminated artificially, she usually denied the first child what usually caused its death. Harlow kept improving his experiments and tried to utilise various unpleasant incentives (punishment). He modified the soft mother in order that it splashed icy water on the infants, it pricked them or similar. He looked for a stimulus that would be a boundery in order that the infants stopped preferring the mother which did not offer any visible reward. In spite of that the little monkeys preferred "soft" mother for all the time.

Already during Harlow's life he was accused from behaving cruelly to his experiments even in that time (we talk about 1960'). However, thanks to these experiments we might come to a conclusion what could happen to children if they were deprived socially and emotionally. Slater (2008, pg. 149) quotes: „Watson in his books on children education wrote the following famous sentences: Do not spoil them. Do not kiss them when they go to bed. Rather bend down to them and before you switch the light off, shake hands with them. On the contrary, Harlow understood that these opinions belong to a waste basket and he replaced them by true pieces of knowledge: Do not shake hands with your child; do not hesitate and cradle your child in your arms. The touch is vital, it does not spoil children but it gives them security; and a good message is that everybody may provide it."

F.B. Skinner

Skinner made a lot of experiments on animals but even on his own children. This was a cause that the most famous American psychologist of 20th century was criticized during his life per his experiments. Skinner's box became a famous concept (even if Skinner himself promoted a different name) for the equipment which isolates an experimental animal or person from the surroundings in order that the experimentalist could maximally monitor experimental conditions. Skinner also demonstrated that a reward is more important than punishment during learning. His daughter Julia within the interview with Slater (2003, pg. 34) says: „He did not believe in any way of punishment because he could directly monitor animals for which it does not work." Further, she says that her father achieved abatement of physical punishment in California State (at the very same place).

In spite of that some controversial emotions are connected with his name. Skinner succeeded not only in demonstration that programmed learning is effective what he published in today's already cultic book which was built as a self-instructional program called Behaviour Analysis (Holland, Skinner, 1968) and translated by Tollingerová. The learning may be disintegrated into a line of small steps through which a pupil elaborates gradually to more complicated tasks and he/she is not clogged by them. The learning software is programmed the way that the level intensity gradually rises. The consequence is that the learner is positively fortified in his activity (Nye, 2004, pg. 70). Skinner showed that conditioning is functional also in more complicated activities. He tried to enlarge his thoughts also on social world. He believed that if an association was created and lead by behavioral psychologists then the world would be peaceable thanks to Skiner's methods. There is a certain feedback on this Skinner's philosophicly-social activity also in books of fiction or film art. A typical work is Clockwork Orange written by A. Burgess in which a deliquent heroe is treated by aversion therapy (it means by means of conditioning by negative emotions) and he becomes completely non aggressive. In this novel there is a conflict being solved whether it is correct to transform people on the base of foreign vision. It might not happen by chance that the novel author Anthony Burgess started writing his "behavioristic challenge" while staying in Leningrad in 1961 (The International Anthony Burgess Foundation, not dated).

Of course, Skinner, together with his investigations in learning, brought also important modifications in psychotherapy in which the methods have been applied successfuly. If somebody suffers from a learnt phobia from a concrete thing, it is possible to unteach it by the same way. Skinner's procedures are utilisable the same way for psychotic patients, retarded persons and defficiencies in behaviour (Nye, 2004, pg. 59).

Cyberbehaviourism for 21st century

It is well-known nowadays that the primitive behaviourism was transformed in neobehaviourism which accepted also a social side of human behaviour. This advancement from 1920' to 1960' is the last important thought advancement of behavioristic sciences. Results of the century of researches are practically utilised in many branches without showing any additive developmental change in registration and utilization of this know-how in human behaviour in this thought current. In fact, this revolution is already running but outside philosophy, science or moral imperatives. In these days, comercial companies are its drafters. They sell results of registration of people behaviour with such high added value that they are worth buying. This is realised with help of up to date information and communication technologies.

Exploitation of information on human beings behaviour results in efforts to maximise profit and direct goals and to a great extent it is influenced by cheapness of the whole process which has been already automatized nowadays. In these days, we are able to register a huge amount of behaviours by means of computers or other ICT facilities that behaviourism founders did not fantasize about in their wildest dreams. Every connection to Internet is monitored, evaluated which activities are carried on by the user of the given IP address and what kinds of goods he is interested in. Consequently goal-directed advertisements are offered to him that are custom-made according to his area of interests. A topographic localisation of the user is no problem as well as there is no problem to collect and evaluate answers from questionnaires that the user takes part in and from them it is possible to deduce user's political orientation or his system of values. With increasing possibilities to save data, it is possible to save it for a long time and to evaluate efficiency of interventions as a feedback. With the help of datamining and with the knowledge of typical samples, with a certain rate of probability we might also generate information which is not detectable directly. If we monitor timing of responses i.e. triming of clicks by mouse, we may also judge psychomotor timing of the given person and by that also person's age and state of health. By registration of typically and individually set enlargement of site, we may judge the state of eyesight. It is also possible to register times when the user is active in the network and by that we can find out his/her day habits including purely individual setting of circadian rhythms.

And we do not have to think of classical computers only because nowadays current applications in smart phones enable personalized measurements: acceleration, shakes, GPS, heart-beat frequency measurement, measurement of physical activity – pacemaker. There are other upgrades which measure not only behaviour but even emotions. An example is a voice identification of emotions for needs of marketing agencies that work with clients on telephones. We may certainly find out more and more aplications that come more quickly than we are able to change basic hardware.

Evaluation whether running practices with the vision of other activities that might not be anticipated yet and which are amazing in their possibilities but also alarming in their consequencies will be on those who will evaluate them with a certain distance as we have been evaluating founders' activities these days.

Conclusion

Science on behaviour and learning called behaviourism went through a giant part of the journey when it got from laboratories in which animals were maltreated to practice where it was used and is used as means for the purposes in order that people learnt and were treated more efficiently, lead more purposefully or also were cultivated. As the consequence, the present age and future might become either amazing dream on unbelieveble ICT possibilities or nightmare of an individual and society. However, in any case it depends just on us whether we want to be a readable and digitally evaluable personality who is hidden and isolated according to Skinner box even if it is now a small multimedial box (e.g. in mobile telephone) which will send information on how often we meet another multimedial box and when and where it happens. There is a question whether this perfectness of behaviour registration is not even more embarrassing for us who are people than for rats running through a maze that's just it that we can become aware of gravity of the whole situation.

These are means that might be misapplied but on the contrary they might be utilised for individual's well-being. We should consider attempt to give new life to behaviourism but in more cultivated form which would correspond to 21st century. Even if it is obvious that B.F. Skinner's vision of a perfect world which is controlled by clever behaviorists recedes with giant strides thanks to human being's explotation.

We have already learnt how behaviourism past looked like. It had both bright and dark sides. However, what we do not know yet, it is behaviourism future.

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THE POTENTIAL OF MULTIMEDIA PRESENTATIONS AS THE EDUCATIONAL TOOLS - POLISH EXAMPLES IN HIGHER EDUCATION

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Abstract

The article is a reflection on the use of multimedia presentations in higher education. The authors analyze selected methods of use such tools by students of pedagogy at the University of Silesia in Poland. They show the context of creation and use of slideshows during ICT classes, educational lessons and art workshops of shadow theater performances. The role of multimedia in teaching is considerable as it offers various information presentation formats simultaneously. The combination of text, audio, images, animation, video as well as hyperlinks has an advantage of using both of the two main channels – visual and verbal – for presentation in an efficient way. Features of effective presentation and examples of computer programs which may be used for this purpose have also been shown. Authors discuss linear and non-linear presentations. These days, there are many different tools available to create and present a slideshow, but we would like to focus on the two most popular – PowerPoint and Prezi.

Keywords

Multimedia presentation, software, education, ICT classes

Introduction

In the dynamically changing socio-economic conditions in Poland, the system of teacher education should be adapted to the ongoing political transformations and the accompanying profound economic makeover. On the one hand, these changes relate to the educational content, to the acquired competences, skills and attitudes. However, on the other hand, these objectives are impossible to achieve if not accompanied by changes in the methodology of teaching, as well as in the technology of teacher training procedures. The concept of multimedia education, postulated by many educators, has therefore become one of leading paradigms of modern education embedded in a knowledge society (Strykowski 2003:116). In terms of formal education, this implies a need to provide teachers with appropriate competences, among which media and ICT competences play a significant role. This area of competence does not merely manifest itself in the ability of functional and comprehensive application of available ICT teaching aids, but also in the ability to construct own unique teaching materials, among which multimedia presentations play an important role.

The bourgeoning technological development, dissemination of electronic equipment, and the dominance of pictorial culture are just some of the phenomena which may successfully expound the popularity of multimedia presentations in widely understood educational realms. The development of technology should be reflected in the didactic/educational and therapeutic process (Baron-Polańczyk, 2011:15). Slides combining text, images and sound have become a popular component accompanying presentations, lectures or school lessons. If we accept that verbal expression can be successfully enhanced by visual stimuli, this text constitutes a reflection on the possibility of using presentations in the process of teacher training at the level of higher education. The authors analyse examples of the use of presentations among a group of Polish students, as well as present examples of software that may be used for the purpose, at the same time indicating at some features of effective communication.

When analysing presentations in terms of their role in enriching the process of communication, they are often referred to as multimedia. According to Marcovitz, the concept has been present in the dictionaries on the subject for a long time. Initially, before the era of computers, it referred to, e.g. slide shows with accompanying audiotapes. However, contemporarily it is the use a variety of information channels simultaneously impacting multiple senses that has become a determinant of the notion: multimedia. Such multiple impact causes an increase in attention, concentration, motivation and enhances the effectiveness of the learning process (Marcovitz, 2012:2). This is due to the fact that each person receives stimuli in a comprehensive, multi-channelled manner, hence, a message that simultaneously activates several senses is favourable, as it provides a better understanding and more effective remembering of the forwarded information. Research shows that acoustic transmission allows the recipient to accept only 20% of information, visual transmission 30%, while a compilation of visual and aural stimuli augments the percentage to 40% (1994:51, Steinbrink; Łasiński, 1998:84). This criterion certainly corresponds to a multimedia presentation.

The purpose and the circumstances in which a presentation is embedded determine its form and appearance. The same tool will be used differently during a lecture designed to convey some knowledge to students, and in a completely different manner when showing slides to family members. The option of effortless modification of the content and form, multipathing and individualisation are all treated as an educational asset. These features make it possible to customise presentations to the needs and preferences of people with different cognitive capabilities (Huk, 2011:97).

Presentation software - selected aspects

A multimedia presentation may be regarded as a complex medium which may serve as an aid in the development of both knowledge and skills, as well as competencies in students of pedagogy. The results of some previous research clearly show a trend for the use of computer presentations in classes: 33 % of teachers surveyed used a computer model once a term, and 40% - every month. Only 10 % of teachers do not use computer presentations (Dimitrova, et al. 2013:80).

A typical presentation is compiled of text, images, graphics, animation, audio and video components. A combination of consecutive slides represents a traditional method of presenting content, i.e. a linear type, read from the beginning until the end, typical of the early period in the marriage of presentation techniques and education. Then arrived a non-linear presentation mode, which made it possible to organise content by topics or deepen the presented messages through hypertext references. The use of hypertext technology makes it possible to individualise and differentiate the multimedia communication. At the same time, it creates a type of narrative form with the characteristic feature of interactivity, thus allowing to simulate personal experiences, which greatly affects the processes of remembering and learning.

Microsoft PowerPoint is the type of popular software that makes it possible to create the first type of presentation. It is part of Microsoft Office (office.microsoft.com) and is based on the creation of slides displayed in sequence. The program gives the user the chance to combine text, graphics, sound and video. It is possible to create templates and print slides in it. Thanks to hyperlinks, it is also possible to obtain the effect of nonlinearity. Software developers of Prezi (prezi.com) resigned from the idea of a sequence of consecutive slides. It is a tool that allows users to view the presentation elements by zooming in and move along different axes in space. PowToon (www.powtoon.com) is yet another alternative approach which can help in the teaching process. Thanks to a special application, the educational content turns into a funny story. Presentations are created here as dynamic animations.

The offer of software for creating multimedia presentations is broad, but those preparing for the teaching profession are rarely familiar with niche programs1. It is an alarming consistency in the context of the need to find ways of effective presentation, i.e. such that will attract attention, motivate to learn and constitute a source of information. The following features of effective presentations are contemporarily emphasised:

- multiplicity of media - presentation should contain at least one static element, i.e. text, photos, graphics, and at least one dynamic component, such as video, audio or animation;
- nonlinearity - the user is able to "jump" from one item to another without losing the sense of the presentation;
- interactivity - which is based on the recipients' decision of what and how they want to see or read, and this is related to the requirement of content and form management;
- coherence - all elements of the presentation should form a coherent whole without the possibility of exerting separate control on its different parts;
- digital mode of inputting and outputting content (Parekh, 2006:2-5).

Examples of the use of multimedia presentations in the process of education

The effectiveness of pedagogical interactions is greatly influenced by functional preparation of future teachers, who when becoming coordinators of teaching/learning processes have the mission to pass on content, to stimulate cognitive development and to shape anticipated attitudes in a clear and understandable way as fully and efficiently as it is possible. For this reason, every contemporary teacher should have the ability to use computer hardware and, above all, to prepare a multimedia presentation together with its comprehensive array of components. It is therefore crucial that in the course of teacher training, students become acquainted with the methods of design, implementation and use of multimedia communication.

Multimedia presentations, both linear and non-linear, are present in various areas of higher education. For demonstrative/illustrative reasons, they are used both in lectures and during classes. However in the next section, examples of activities were shown in which these tools are used directly by learners.

- Presentation during ICT classes

Deepening the ability to create multimedia presentations constitutes one of the objectives of the ICT course run at the beginning of teacher training at the University of Silesia. Students are trained extensively with the aim of expansion of their ICT competence in order to make use of it at further stages of their university course and later as future teachers. This complies

[1] In the analysed group of students of pedagogy who participated in the survey at the beginning of the first semester of their studies, none of the respondents (N=48) was able to name more than one program for creating multimedia presentations. In responses only Microsoft PowerPoint was present.

with the assumption that every teacher, and more broadly: educator, should be prepared to use various ICT tools in their own individual work and when teaching, which entails the use of ICT terminology, software, hardware and methods (Baron-Polańczyk, 2011:77). The participants are meant to master the skill of creating academic presentations (by appropriately manipulating its text and graphics, colours, dynamics and animation) both in terms of content, technical aspect, as well as hobby-oriented presentations based on photographs and videos. Microsoft PowerPoint is primarily used. At the beginning of the cycle, students participate in an initial survey, by means of which they assess their ICT skills and knowledge. When asked for an opinion on their level of expertise in the use of MS PowerPoint, they mostly acknowledge that their competence in this area is average (66.67%). Only a small percentage of respondents rate their level highly (8.33%). Survey findings related to this aspect are presented in Table 1 by means of comparison between several programs.

Level of expertise in a given program	**Selected computer programs or groups of programs**							
	MS Word		MS Excel		MS PowerPoint		Graphic programs (not in the MS Office package)	
	No.	%	No.	%	No.	%	No.	%
Good	41	85.42	10	20.83	4	8.33	1	2.08
Average	6	12.50	12	25.00	32	66.67	15	31.25
Weak	1	2.08	26	54.17	12	25.00	32	66.67

Tab. 1: Self-assessment of the level of expertise and the ability to use computer programs selected among first year students (N=48)

Interestingly, when students wrote about their expectations towards the course and about the possibilities of the use of ICT in their future teaching work, they often pointed to the creation of multimedia presentations as an important task. Computer classes are designed to prepare them for this purpose by practicing the use of the majority of functions available in MS PowerPoint and by pointing to alternative presentation software.

- WebQuest using a multimedia presentation

Future pedagogues test educational use of presentations by performing educational projects on other objects by means of the WebQuest method. Slideshow is in this case only part of a broader activity in which students acquire knowledge of how by means of a presentation to create a framework for a comprehensive, even several-months-long project that may be used in the classroom. Project Method, focused on the exploration of the participating entities, usually makes use of a computer and the Internet and bases on pre-designed websites. A properly constructed presentation, which will point to the six stages of the traditional WebQuest by means of hyperlinks, may constitute an effective alternative. Presentations prepared in MS PowerPoint can also be used in educational quizzes, which are already in use in the education of children, i.e. in evaluation, systematisation and/or checking knowledge.

- Slides used during Shadow Theatre Art classes

Workshops on creativity and artistic expression, based on the use of shadow theatre, constitute a less obvious example of the use of multimedia presentations. In the academic year 2013/2014, a group of over fifty students of pedagogy, divided into eight teams for a period of one semester, created a show in which they made use of light, shadow, some props and their own bodies to tell a story. In this type of activities, multimedia presentation may be a tool assisting at the creation of stage sets. A slide displayed by means of a projector is a perfect backdrop for individual shots and scene sequences. Without being a carrier of information, presentation may in this case fulfil a completely different role.

Evaluation of classes using multimedia presentations

Within ICT course, students training to become teachers become familiar with presentation applications, appreciate their educational value and enjoy the opportunity to use them in practice by creating a presentation and making a practical use of it in front of their classmates. This allows students not only to master the necessary tools to prepare the presentation, but they also learn how to deliver a successful presentation.

Evaluation of a presentation constitutes an important component in the process of knowledge acquisition, because it provides feedback on how to behave, on what is attractive and what is not, as well as on the contents, effectiveness of interaction and quality of the prepared materials. After the presentation, students fill in evaluation sheets, in which they provide answers to the following questions:

- was the objective of the presentation achieved and to what extent?
- which part of the presentation fared particularly well and why?
- what needs improving?
- what content is missing?

Assessment conducted in this manner makes it possible to determine strengths and weaknesses of the presentation, so that suitable adjustments can be subsequently introduced, as only a properly prepared presentation, not only in terms of content, but also visually, may secure proper educational functions.

As demonstrated by the findings presented in Table 1, only 8.33 % of respondents rated their skills in the use of presentation applications highly. This means that over 90 % of students lack the necessary expertise. Numerous errors made by students who are less experienced in the area provide excellent exemplification of this status quo. Typically, they tend to overload their presentation with text or animation effects.

Type of error	Display	Effect
Excessive effects	Too frequent use of various sound and visual effects	It is not information that is communicated to its recipients
Incorrect choice of font	Use of fonts without Polish letters Use of multiple font styles within a single presentation	Presentation loses its clarity
Excessive text	The text voiced by the presenter is the same as the text on the display	The presentation is inflexible and boring, recipients lose interest.
Multiplication of the same effects	Use of ready slide templates	No originality, the presentation is not attractive for the recipient
Excessive array of colours	A single slide has more than 3 colours	Reception of information is made more difficult than it is necessary, visual perception is overloaded

Tab. 2: Errors made by students during the design of a multimedia presentation

Each multimedia presentation, in order to convey the intended effect, must be used in a manner consistent with the principles of teaching. A principle of teaching is such a standard of teaching conduct whose observance allows the lecturer/teacher/presenter to effectively acquaint the recipients with the prepared content (Kupisiewicz 1988:112).

The scope and methods of implementation of teaching principles both for designing and using multimedia presentations depend on recipients' readiness to assimilate the content and on angle at the specifics of the content are presented. Multimedia messages, when affecting the recipient with a variety of stimuli, must implement the principle of clarity, as well as the principle of affordability, also known as gradation of difficulty, which in presentations is effected by appropriate steps on the part of the person in charge of the presentation, who introduces the audience into the essence of the subject matter. The interactive nature of multimedia presentations is a typical example of comprehensive implementation of the principles of conscious and active participation in the teaching/learning process, together with the principles of regularity and combination of theory and practice.

Conclusions

A multimedia presentation that combines the advantages of a number of media which constitute its components, is a teaching tool characterised by a wide range of interactions. It is therefore important to equip students with the ability to create individual media and the skill of their rational integration.

Running courses assisted by multimedia presentations is becoming increasingly popular because of the ease in the preparation of teaching materials, simplicity in maintenance and availability of the necessary equipment. It should be emphasised that attention to the content of the presentation rather than focus on its visual aspect is of utmost importance. A multimedia presentation is a valuable teaching aid, provided that it is well designed, executed and implemented according to applicable methodology.

The use of the most modern audio-visual technology guarantees active participation of all parties actively involved in the process, as well as easy access to relevant information in many forms and at any time.

Thus in such a practical area as the use of ICT in teaching, solving problems rather than just performing typical tasks should be encouraged. If students adopt creative and active attitudes, master the right tools and methods, discover and develop skills in the process of their education, they will be able to solve real problems in the future, even in situations where it is necessary to acquire and filter information, identify and address the missing links, as well as retrieve what is relevant and reject what is not.

The purpose of the activities in question is to familiarise students with the basics of modern information technologies, with areas and impacts of their applications, with rules for their creation and application in teaching, as well as with the skill of shaping a coherent image of media perceived as a source of information.

A multimedia communication is a multifaceted creation comprising different components. The selection and use of the necessary means of media requires certain competencies that prospective teachers may acquire during the course of ICT. We have to remember that information and knowledge society requires computer and information literate citizens (Rosman, 2013:253).

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INFORMATICS AT THE CZECH PUBLIC UNIVERSITIES FOR BACHELOR STUDENTS IN THE BUSINESS PROGRAMS

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Abstract

The article, written in a form of a case study, deals with teaching informatics in bachelor study programmes of faculties of economics of Czech public universities. Its main target is to map teaching of informatics, to analyse and compare it. Teaching informatics has been dealt with by the authors for a long time in articles, the impetus for writing this article being the reviewers´ comments to their previous articles. The introductory part of the article specifies teaching informatics as an important prerequisite of students´ competitiveness in the sphere of commerce, in state and local administration. The next part analyses bachelor teaching programmes and study courses of faculties of economics and the contents of their informatics courses. A rough analysis shows the faculties´ interest in teaching informatics; the detailed analysis provides typical areas in teaching informatics. The final part proposes some improvements. The findings serve as a basis for further improvement in informatics teaching at the Faculty of Management and Economics, Tomas Bata University in Zlín.

Keywords

Informatics, Faculty of Economics, Computer Science, Education, ICT, Research, Teaching

Introduction

The significance of education in acquiring, processing and effective use of information is increasing proportionally with the increasing volume of information that (not only) the companies have to confront. The present is characterised by a continuous and fast development of information and communication technologies (ICTs). These changes are connected with a bigger effort to introduce new technologies and advanced procedures, which enables increasing the competitiveness.

Examples could be ICT services, cloud repositories or cloud applications, etc. Other trends include big data, the Internet of things, large multimedia screens, sensor networks, semantic web and desktop, enterprise social networking, augmented reality, cloud services or artificial intelligence. Launching ICTs in a company and their effective application provide a competitive advantage practically in all branches of economy.

This article aims to find out how students of the business programs are prepared in ICT. After the introduction, describes the research methodology are clarifying the requirements for the preparation of people in the information society. The main content of the article is an analysis of teaching at selected Czech universities, then discussion, and conclusion. The following research directions should solve education on the private schools in teaching bachelors and then teaching at the master's level.

Working Methodology

In a form of a case study the article aims to clarify the ways of providing support to information and computer literacy of the economists – in this case the graduates from faculties of economics and gives an insight into the current approach of these faculties to this area of education. The reason for choosing the topic was the authors´ effort to update the contents of the course Computer Science which is presented in the article (Buřita, 2010). The impulse also was the plenary discussion to new trends in education held at the Information and Communication Technology in Education conference (Buřita, 2012) and (Rosman, 2013).

The study aimed to ascertain the current situation regarding the study of informatics at faculties of economics of Czech universities. The main task was to map the situation on a sample of faculties of economics of public universities, including the Faculty of Management and Economics (FaME) of Tomas Bata University (TBU) in Zlín.

The case study is based on the analysis of bachelor study programmes of the faculties which provide study courses on economics and enterprise and also include the education in informatics. We were interested in how the so called "business students" are supported with this kind of education. The Introduction highlights the importance and need to integrate informatics in educating professionals capable of coping with increased demands and requirements of organisations and enterprises. The second part analyses the approach of individual Czech universities to informatics and to computer education. The follow-up part then compares the detected results with needs of the current society, namely with the present-day requirements, as in the course of time the forms and contents of this education have undergone a certain development. This part also mentions some trends in informatics, and finally also approaches of individual faculties to these problems are provided. The outputs will serve as a basis for informatics courses syllabi innovation at FaME.

Human Resources in Information Society

Modern ICTs are rightfully considered the key factor of the economic and social development. Relevant, timely and good quality information is essential for enterprises´ competitiveness on the market. However, gaining such information calls for systematic work, certain knowledge, skills, methodological approaches and technologies. The introduction mentions the increased demand for ICT services, significance of a relationship between e-business and ICTs, including knowledge essential for providing ICT services. Also human factor is a part of a successful ICTs development, their launch and utilization. However, to exploit its potential fully and effectively, certain knowledge together with availability of qualified experts who will use it effectively, are essential.

Qualified human resources play a key role in the process of knowledge creation and transfer, which is one of the basic prerequisites of a long-term economic and technological development. Universality and flexibility of graduates from the faculties of economics predestines them practically for any business, in any corporate environment. Information society is undergoing a wide range of changes – from social and cultural to economic and psychological ones. Consistent, systematic but also reasonable use of modern ICTs is one of the basic prerequisites for improving the quality of all forms of education.

Teaching informatics at faculties of economics aims at educating required amounts of professionals equipped with necessary economic education, with the purpose of satisfying the employers´ demand for such professionals – both in quantity and qualification. Thus quality of teaching informatics influences the human factor inside the information society considerably, i.e. the stock of professionals in the area of ICTs. Buřita (2012, 23) claims that a university should be a place developing informatics education, developing information society but also a promoter of new technologies. The article will attempt to map them and show them within this context.

Informatics at Faculties of Economics

While the previous chapter dealt with human resources, influences and impacts of informatics and ICTs upon economy and society, this part is going to deal with informatics as a course taught at universities. The chapter aims to compare 14 faculties of economics on the basis of specific topics and on the basis of comparable topics taught in informatics. According to the Ministry of Education, Youth and Sports (http://www.msmt.cz) there are 26 public and 44 private universities in the CR (data as of 30 April 2014).

Criteria and Defining the Sample, List of Faculties

For the purposes of this analysis we concentrated on faculties of economics of public Czech universities whose study plans in bachelor study programmes offer courses of economics and enterprise (the same also appearing in the name of the faculty). The list of the faculties chosen for the analysis is provided in Table 1.

The analysis compares bachelor study programmes of a selected sample of faculties. The faculties of economics were compared in the following categories: faculty of economics (YES/NO), study programmes in the area of economics and business (YES/NO), courses on informatics (YES/NO), focus of informatics courses (basic/extended).

	University	Faculty	WWW page
1	Czech University of Life Sciences Prague	Faculty of Economics and Management	http://www.pef.czu.cz/cs
2	Masaryk University in Brno	Faculty of Economics and Administration	http://www.muni.cz/econ
3	Mendel University in Brno	Faculty of Business and Economics	http://pef.mendelu.cz/cz
4	University of South Bohemia in České Budějovice	Faculty of Economics	http://www.ef.jcu.cz/
5	Silesian University in Opava	School of Business Administration in Karvina	http://www.slu.cz/opf/cz
6	Technical University of Liberec	Faculty of Economics	http://www.ef.tul.cz/
7	J. E. Purkyně University in Ústi nad Labem	Faculty of Social and Economic Studies	http://www.fse1.ujep.cz
8	University of Defence	Faculty of Economics and Management	http://www.unob.cz/fem
9	Tomas Bata University in Zlín	Faculty of Management and Economics	http://www.fame.utb.cz
10	University of Pardubice	Faculty of Economics and Administration	http://www.upce.cz/fes
11	Technical University of Ostrava	Faculty of Economics	http://www.ekf.vsb.cz
12	University of Economics, Prague	The Faculty of Economics	[http://nf.vse.cz]
13	Brno University of Technology	Faculty of Business and Management	http://www.fbm.vutbr.cz
14	University of West Bohemia	Faculty of Economics	http://www.fek.zcu.cz

Tab. 1: List of the Faculties Analysed [own source]

Ad 1) Faculty of Economics and Management, Czech University of Life Sciences Prague [*http://www.pef.czu.cz/cs*]

Czech University of Life Sciences Prague offers university education at five faculties, the Faculty of Economics and Management being the largest one. The faculty provides a wide range of education possibilities covering the whole area of management, economics and communication technologies. The study programme B6202 *Economic Policy and Administration* offers a wide range of courses on informatics. For the list of the courses see (Czech University of Life Sciences Prague, 2014).

Ad 2) Faculty of Economics and Administration, Masaryk University in Brno [*http://www.muni.cz/econ*]

The Faculty of Economics and Administration provides education in a wide range of disciplines. The study programme *Economics and Management*, study course Business Management does not mention any discipline on informatics. For the list of the courses see (Masaryk University in Brno, 2014).

Ad 3) Faculty of Business and Economics, Mendel University in Brno [*www.pef.mendelu.cz/cz*]

The faculty offers economic and informatics education both in the Czech and English languages. As a part of the bachelor programme, students can attend the study course *Economic Informatics* or a study course aimed solely at informatics. The study programmes *System Engineering* and *Informatics and Engineering Informatics* offer a wide range of courses in basic and also extended informatics. The graduates will acquire knowledge, skills and competences which will enable them to work in companies creating, buying and selling IS/ICTs and competences for effective management of companies, shops and services in the tertiary sphere of the national economy. The faculty offers a wide range of courses on informatics. See webpage (Mendel University in Brno, 2014).

Ad 4) Faculty of Economics, University of South Bohemia in České Budějovice [*http://www.ef.jcu.cz*]

The bachelor study programme N6209 *System Engineering and Informatics* offers six study courses. The study course Economic Informatics offers a range of courses covering nearly the whole area of informatics. The study course Management and Economy of an Industrial Enterprise offers courses Managerial Informatics 1,2. The study course Structural Policy of the EU for Public Administration provides the course Geographic Information Systems. See webpage (University of South Bohemia in České Budějovice, 2014).

Ad 5) Silesian University in Opava, School of Business Administration in Karvina [*www.slu.cz/opf/cz*]

The faculty provides education in economic, financial, social and administrative study courses and in informatics and economy. The study programme B 6208 *Economics and Management* offers economic education in the courses Informatics for Economists, Enterprise Information System and E-Commerce and E-business on the Internet. (Silesian University in Opava, 2014)

Ad 6) Faculty of Economics, Technical University of Liberec [*http://www.ef.tul.cz*]

The faculty offers the economic study programme B6208 *Economics and Management*. The study courses Enterprise Economy, Economics and Management of International Trade, Economics and Service Management comprise the courses Informatics I, II. For the list of the courses see (Technical University of Liberec, 2014).

Ad 7) Faculty of Social and Economic Studies, J. E. Purkyne University in Usti nad Labem [*http://fse1.ujep.cz*]

The faculty focuses on economic and social studies. The economic study programmes focus on enterprise economics and management, financial management and regional development. As a part of the bachelor study, the study programmes B 6208 *Economics and Management,* next *Economic Policy and Administration* and *Social Policy and Social Work* are realized. The study programme Economics and Management of the faculty offers the course Informatics; the study programme Social Policy and Social Work the courses Applied Informatics and Web and Databases. See webpage (J. E. Purkyně University in Ústi nad Labem, 2014).

Ad 8) Faculty of Economics and Management, University of Defence in Brno [*http://www.unob.cz/fem*]

The faculty educates professionals for managerial and economic positions in the Army´s organizational structures. The study programme of the faculty offers standard education in the area, fully comparable with education provided at civil universities, only extended by a special military-professional preparation, in accordance with the needs of the Army of the Czech Republic. The faculty guarantees a widely-oriented bachelor study programme B 6208 *Economics and Management*. The core informatics education inside this study programme is realised in the courses Informatics, Application Software, Work with Computer, Applied Informatics, followed by the courses Information Resources Management, Communication Technology, Information Resources and their Safety (University of Defence, 2014).

Ad 9) Faculty of Management and Economics, Tomas Bata University in Zlín [*http://fame.utb.cz*]

Recently the faculty has made a lot of changes in teaching informatics in the Bachelor´s degree, referring to the structure, extent and contents of the courses. The Bachelor´s degree offers three study programmes. The programme B6208 *Economics and Management* with the study courses Management and Economics of Enterprises, with a possibility to specialise in e-business, and Management and Economics in Public Administration and Regional Development. The faculty also offers study programmes B 6202 *Economic Policy and Administration* and B 6209 *System Engineering and Informatics*. The basics of informatics are taught in the courses Informatics for Economists, Computer Processing of Data and Applied Informatics, and in compulsory-optional courses Basics of Enterprise Management and E-commerce. For the list of the courses see (Tomas Bata University in Zlín, 2014).

Ad 10) Faculty of Economics and Administration, University of Pardubice

The Faculty of Economics and Administration offers three bachelor study programmes. The study programme B 6208 *Economics and Management* with the study course Enterprise Management aims at four main areas: economics and applied economic disciplines for enterprises, management and specific managerial activities, information technologies including mathematical and statistical disciplines. The faculty provides courses Computer Processing of Data, Fundamentals of Algorithmisation and Introduction to Information Systems. For the list of the courses see (University of Pardubice, 2014)

Ad 11) Faculty of Economics – Technical University of Ostrava

The university (Technical University of Ostrava, 2014) educates students in a wide range of disciplines. The study programme *Economics and Management*, study courses Enterprise Economics and Economics and Law in Entrepreneurship comprise courses Informatic A and Informatics B in wide range of interests.

Ad 12) Faculty of Economics, University of Economics, Prague

The Faculty of Economics enables education in a wide range of economic, legal as well as social scientific disciplines. The courses on informatics are guaranteed by the Faculty of Informatics and Statistics (University of Economics, Prague, 2014)

Ad 13) Faculty of Business and Management, University of Technology in Brno

The faculty offers a bachelor study programme B6208 *Economics and Management* with study courses Enterprise Economics and Economics and Process Management, with Informatics for Economists, Database Systems, Business Information Systems and optional courses Information Systems in Public Administration and IS/IT Security. The study course Accounting and Taxes comprises the courses Informatics I, II and Information and Data. For the list of the courses see (University of Technology in Brno, 2014).

Ad 14) Faculty of Economics, University of West Bohemia in Pilsen
[http://www.fek.zcu.cz]

Full-time studies the faculty offers the study programme B6208 *Economics and Management* with study courses Business Activities Management and Business Economics and Management, and the study programme System Engineering and Informatics, study courses Systems of Project Management (study specialisation Business and Management and Information Management) and the study course Economic and Regional Geography. The study courses comprise blocks of courses on economy, informatics, statistics, enterprise economics, marketing, business and services. (University of West Bohemia in Pilsen, 2014)

Results

The topics related to teaching informatics in study programmes of the selected faculties have been divided into two groups. Each study programme includes something specific, however their contents overlap to a certain extent (they have common features). The fundamental topics from the area of informatics which create the contents of informatics at individual faculties of economics are provided in Table 2.

	Topics	1	3	4	5	6	7	8	9	10	11	13	14	Sum
1	Algorithmisation	☑	☑	☑						☑	☑		☑	6
2	Data and Functions Analysis	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑		10
3	Security and Data Protection		☑	☑	☑	☑		☑	☑	☑		☑	☑	9
4	Database Systems and Tools	☑	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑	11
5	Ergonomics of Computer Use								☑					1
6	Hardware	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑	☑	11
7	IT Safety			☑		☑		☑	☑	☑	☑	☑	☑	8
8	IT Systems	☑	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑	11
9	Internet Applications, Services	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	12
10	Multimedia			☑				☑						2
11	Office-text editor	☑	☑	☑	☑	☑	☑	☑	☑		☑	☑	☑	11
12	Office-spreadsheet	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	12
13	Office-presentation	☑	☑	☑	☑	☑	☑		☑		☑	☑	☑	10
14	Operation Systems	☑	☑	☑	☑						☑	☑		6
15	Computer Graphics		☑	☑										2
16	Computer Networks, Services	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	12
17	Programming	☑		☑						☑			☑	4
18	Software	☑	☑	☑				☑	☑		☑		☑	7
19	Theory of Informatics		☑	☑	☑	☑			☑	☑		☑	☑	8
20	Web design	☑	☑	☑			☑							4
21	Data& Information Processing	☑	☑	☑	☑	☑		☑	☑	☑	☑	☑	☑	11
	Topics in Total	15	17	20	13	12	10	13	15	12	12	14	15	

Tab. 2: Fundamental Topics on Informatics Source: [own]

The extended topics on informatics courses are provided in Table 3. The tables 2 and 3 show not only detailed focus of informatics topics at individual faculties but also compare them among each other. The results can be divided into three groups:

a) Faculties without teaching of informatics.

b) Teaching basic informatics topics which develop students´ computer and information literacy for the needs of further education and further practice (see Table 2).

c) Extended teaching of informatics which guarantees specific students´ expertise, in compliance with the corresponding study course (see Table 3).

Ad a) Informatics is not guaranteed directly by the faculties of economics No. 2, 12 (Table 1); thus these faculties do not appear in the tables 2 and 3 of comparison.

Ad b) The analysis has shown that bachelor study programmes of the faculties of economics offer the following topics the most frequently:

- Database Systems and Tools
- Hardware
- IT Safety
- IT Systems
- Internet, www Services, Applications
- Office-text editor
- Office-spreadsheet
- Computer Networks and Their Services
- Data and Information Processing

The above topics can be considered as cross-sectional for the development of computer and information literacy, and they are a part of a majority of the analysed study courses. This means that development of informatics at "business students" is practically comparable. It is also evident that informatics has been taught in the same way for a long time and new trends in ICTs have not been reflected in it so far. It would be highly necessary to move from teaching ICT components (see the list of topics in Table 2) to teaching ICT services.

	Topic	1	3	4	5	6	7	8	9	10	11	13	14	Sum
1	IS Architecture, Design	☑		☑	☑					☑		☑		5
2	Process Automation							☑				☑		2
3	IS Security		☑	☑				☑		☑			☑	5
4	Business Intelligence				☑			☑	☑				☑	4
5	e-Business	☑			☑				☑	☑				4
6	e-Government		☑		☑		☑		☑	☑	☑	☑		7
7	Economic Informatics		☑	☑			☑				☑			4
8	Company e-Services			☑	☑			☑	☑					4
9	Information Management				☑			☑	☑	☑	☑	☑	☑	7
10	IS in State Administration			☑	☑				☑	☑	☑	☑		6
11	Business Process Modelling				☑			☑	☑	☑		☑	☑	6
12	Object-Programming	☑		☑						☑				3
13	e-Commerce			☑	☑			☑	☑					4
14	Enterprise IS	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	12
15	Project Management			☑				☑	☑	☑			☑	5
16	Artificial Intelligence			☑						☑				2
17	IS Life Cycle									☑		☑	☑	3
	Total Number of Topics	4	4	10	10	1	3	9	10	12	5	8	7	

Tab. 3: Extended Topics on Informatics Source: [own]

The combination of high demands upon informatics courses and a wide scope of study of the courses from the area of economy and theory of the enterprise are, in our opinion, a characteristic feature of many faculties of economics. The core of informatics curricula is based on the cognition that both the teaching process and the practical application of acquired knowledge have to make use of a wide range possibilities offered by the ICT applications, not only as passive ICTs users. The task of a teacher is to find a balance in methods and procedures so that each student has the opportunity to develop. The most important task will be to create a learning environment that will promote learning. As educators we feel the need to express a view on teaching informatics in the university education.

Discussion

Authors of the paper have been in charge of the computer science courses at the FaME for many years. The analysis of student´s learning styles is included in the articles at the ICTE Conferences (Buřita, 2012), (Kričfaluši, 2009) or (Rosman, 2013) or in articles (Eger, 2010) or (Doucek et al., 2013). The analysis of teachers´ learning styles will be another keystone of defining links between teaching activities and student´s learning styles.

Based on summary of the results above, some future trends have been identified. Another crucial technology which influences the whole branch of ICTs considerably is Cloud computing, primarily in combination with mobile services. The issues of the Cloud appear only scarcely in teaching and may be a part of informatics on the Master´s level. Other trends include shared document creation and shared contents creation. Also work with Google Tools enables to make use of the free Google Web and Google Documents tools as a support for teaching. Worth mentioning is also the creation of tests in Google Forms of Google Documents. The advantages of this environment include easy access and administration, sharing possibility and zero cost of acquiring. According (Černý, 2013) other trends may include big data, Internet of things, sensor networks, semantic web, cloud services or artificial intelligence.

Individual topics on informatics provide students with knowledge of enterprise IS architecture, some study courses touch informatics law and ethics, computer networks (including their design and security) and theory and practice of information management etc. This results in *informatics-oriented courses* integration in economic studies. This trend complies with the need to switch over from teaching ICT components (see the list of topics in Table 2) to teaching ICT services. Gradual *integration* of advanced areas of information literacy in study programmes is typical for a lot of faculties. Many faculties of economics aim at topics *concentration*, others *integrate* the problems lectured on in the follow-up courses. This results in changes of the *teaching contents* of the follow-up courses (Informatics II, Applied Informatics, Managerial Informatics) of the study programme Economics and Management, which include some elements of the course *Economic Informatics*.

The key to the improvement of teaching is to explore people’s learning styles (Eger, 2010) and (Buřita, 2012). Because our goal has been the analysis of bachelor study programmes of the faculties which provide study courses on economics and enterprise, we were interested in how the so called “business students” are supported with this kind of education. In opinion a model study plan (Doucek et al., 2013) of the courses supporting informatics education of economists can be divided into several levels (ACM, 2011). The first level, “Computer literacy“, aims is to make students familiar with the basics of informatics and ICT technologies. The second level, “Specialisation in ICTs”, should clarify the principles of informatics and basic user´s competences in ICTs application. This level is considered as the last compulsory one to reach the required knowledge and abilities. The third level can concentrate on a detailed study of a specific area of informatics. ACM (2011) is planning another, fourth level called “Modelling, Analysis and Design in Informatics”.

This decade is going to experience even more dramatic changes in the sphere of IS/ICT than there were in the last decade of the 20th century. Reich (2002) mentions three brand new groups of professions inevitable in the information society, namely *analysts of routine services and analysts of personal services*. Universities, which play an extremely important role in the sphere of information education, should be able to identify these technological trends properly and to include them in their study programmes.

Conclusion

Information society brings about a wide range of changes reflecting in all areas of human activities – from technologies, through society to economic consequences. Informatics and disciplines related to it play a very important role nowadays. Its impact upon human society is not negligible and its use is constantly increasing, together with the increasing rate of inter-human communication. The above mentioned trends influence the system of research, cultural and social institutions significantly and in particular educational institutions as such and call for new requirements upon professionals in informatics. By involving these problems in teaching, universities comply with the current requirements and trends in this area. This article can also be used as a basis for a more complex and wider comparison, which could not be done because of increased time demand.

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SUPPORTING LEARNING ACTIVITIES WITH LMS WEBWORK

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Abstract

The article deals with the use of online Learning Management System WeBWorK. The J. Selye University is a registered user of this open-source web-based software as the only institution in Slovakia and Central Europe, so the main goal of the authors is to introduce its use in the process of university education. WeBWorK supports learning activities, encourages self-activity of students. It is primarily used for homeworks and creating tests in mathematics and computation-near courses. It has many advantages (but also disadvantages) compared with paper-based and other LMS based forms of homeworks and tests. In WeBWorK is possible to make personalized problems with random parameters. WeBWorK uses different graphics options which increase the visualization of problems. In our paper the students' performance in relation to WeBWorK are examined. Results of a survey focused on homework solutions and students' opinions are also presented.

Keywords

LMS, WeBWorK, web-based practice, homework.

Introduction

At universities students accomplish their study in lectures and seminars. With the frontal method of teaching is often related the low activity and motivation of students, which is also typical in mathematics courses. What are the methods, possible ways that could increase the active approach and the motivation of students? The application of homework assignments may support continuous activity of students. The use of homework gives the opportunity to practice, it motivates students to work self-sufficiently, for gifted students demanding tasks give the opportunity to expand their knowledge.

There are many different Learning Management Systems (LMS) in use today in higher education. The number of universities integrated LMS including web-based practice or homework is increasing. Many institutions have relied on the use of technology to remediate students' lack of mathematics preparation (Tolley at al. 2012). Many of them are using commercial products, other institutions have developed their own web-based LMS. Kostolányiová and Takács (2013) described a simulation of an adaptive LMS that adjusts to the student's characteristics. These systems need to meet the specified requirements and expectations of web-based systems in the teaching and learning process as described for example by Mavrikis and Maciocia (2003). According to Thelwall (2000) the randomly generated open access tests attempt to provide an inexhaustible supply of formative assessment where the random element is able to provide one of the basic components of education: motivation.

This article aims to demonstrate the use of web-based Learning Management System to support teaching and learning. We mainly discuss the online homework system WeBWorK and its use in mathematics courses, but we also mention the adaptation in teaching Computer Science as well. Web-based practice or homework with WeBWorK offer such possibilities that have many advantages compared to traditional paper-based and other LMS based forms of practice and contribute to increasing the effectiveness of teaching.

Introducing WeBWorK, a web-based Learning Management System

WeBWorK is a free open-source web-based assessment system developed at the University of Rochester to generate, deliver, and automatically grade homework problems and distribute their solutions. WeBWorK is promoted by the Mathematical Association of America (WeBWorK 2014).

WeBWorK was originally developed to teach mathematics and is recommended to use with higher-level mathematics classes at universities. It is used by over 700 institutions worldwide among them J. Selye University as the only registered institution in Slovakia and Central Europe. WeBWorK was implemented into mathematics courses at our Department of Mathematics and Informatics in the school year 2008/09. As part of the learning process WeBWorK has been applied in assessment of Mathematics, Management and Applied Informatics students. In the school year 2013/14 our students have already had the opportunity to web-based practice and homework in seven different undergraduate mathematics courses. In this system approximately 300 users works regularly.

Online learning management systems commonly support option for storing educational material, tools for creating tests, evaluation, feedback and overall management of the educational process. From such a system the following types of implemented test-questions can be expected: true/false, multiple-choice answer, assignment, numerical answer and also an algebraic expression. WeBWorK meets these expectations, but it serves only to practice the subject matter in form of homework, study material is not part of it. Although it was not designed as an e-learning portal, it has the potential of integration with other LMS environments e.g. Moodle (Roth at al. 2008)

As confirmed in many publications (Mavrikis and Maciocia 2003; Roth at al. 2008; Sanchis 2001) immediate feedback is the most important issue in web-based practice. The immediate feedback about correctness of students' answers is one of the most important features of WeBWorK. Another advantage offered by WeBWorK over existing systems is the feature of individualized and parameterized assignments. Taking into account the general methodological aspects, we have also showed the advantages and disadvantages of WeBWorK based on our own experiences (Fehér 2013).

WeBWorK draws from a large library arranged by topics of problems. The database is constantly expanding, at the same time contains more than 25,000 problems. We are also constantly expanding our database of tasks in our own courses. Instructors can select and edit problems from a problem library or write their own customized WeBWorK problem sets in the Problem Generating (PG) macro language that mixes Perl, LaTeX, HTML and text (Gage at al., 2002). WeBWorK uses different graphics options which increase the visualization of problems. PG permits the drawing of graphs and functions in GIF, PNG, EPS formats or animated GIF, and it can be extended to use JavaScript and interface with Java Applets.

Supporting programming fundamentals with WeBWorK

As we have mentioned above WeBWorK was initially developed at Rochester University to support mathematics education. Being open-source, therefore customizable with randomization capabilities WeBWorK was found to be useful in the field of Computer Science too. In 2005 collaborators at Pace University and Cornell College began to adapt and extend

WeBWorK for use in the core courses of the Computer Science curriculum (Gotel and Scharff 2007). A new environment linked with WeBWorK was developed, it offers the possibility to check the correctness of program fragments. WeBWorK with the Java Auto Grader extension supports the teaching and assessment of programming fundamentals taught in Java and other programming languages (Gotel at al. 2007). Gotel at al. (2008) described an innovative approach in the undergraduate Computer Science curriculum and reported that students using WeBWorK for programming not only improved their problem formulation and testing skills, but they also improved their coding.

Does the use of web-based practice improve mathematics performance?

Various studies investigated the impact of web-based practice on students' performance and its influence to the effectiveness of teaching. The researches does not show definite results: while in some cases between two groups tested with paper-based and web-based practice there was a significant difference, another results gave no significant difference.

A study conducted by Tolley at al. (2012) at a sample (n = 346) of college students, found that the continued use of WeBWorK throughout the semester did not significantly improve the mathematics performance of students in the treatment group. They also noted that „WeBWorK is a valuable tool for refreshing basic mathematics skills and enhancing mathematics self-confidence", because it helped first-year students to eliminate the gap in incoming academic preparation.

On the other hand Nguyen and Kulm (2005) based on an exploratory study found that the mathematics achievement of middle-school students (n = 95) who had participated in the web-based approach was significantly higher than that of their classmates in the control-group who received the same assignments using paper-based practice. In this research the web-based system was used to in-class practice of mathematical assignments led by the teacher. The conclusions highlight that the better results are primarily due to feedback function of the used web-based LMS system. According to another study (Toth, 2013) WeBWorK had a significantly positive effect on the mathematical performance of university students, measured by final grades. In this study data were collected altogether from more than 3000 students, approximately 78% of them used WeBWorK for homework.

Very detailed, comprehensive research was made from one of the developers of WeBWorK. In a 3 year study 2387 students' engagement with the system in mathematics courses were investigated. Roth at al. (2008) found that the introduction of new features to the WeBWorK interface reduced the overall number of submitted errors by half. This is corresponding with the statement of Mavrikis and Maciocia (2003) that the design of computer software is one of the most influential factors for both encouraging use and in the effectiveness of the product.

We also carried out many analyses regarding the use of WeBWorK with similar results to other researches: the analyses did not show in all cases a measurable, significant improvement on students' performance (Fehér 2011). Generally there is no or weak connection between the use of WeBWorK and the exam results. It is known that students' mathematics performance depends on many factors, in general mainly depends on the existing skills acquired at secondary school. It is difficult to demonstrate that one factor alone such as an application of a new technology can improve the performance.

Results & Findings

The issue of mathematics preparation at universities can be especially important for engineering, technological, economics majors. Mathematics can be an area of weakness in their studies causing repetitions, or it may even cause the withdraw from the university. By analyzing data collected from the University's Academic Information System (AIS) from the school year 2004/05 to 2013/14 we determined the ratio of economics students having dropped first-year mathematics courses (Fig. 1). Based on the data an average of 19.8% of freshmen did not fulfill the MAT1 course and an average of 11.8% dropped the MAT2 course. The average of all subjects (8 first-year mandatory courses) is 16.73%.

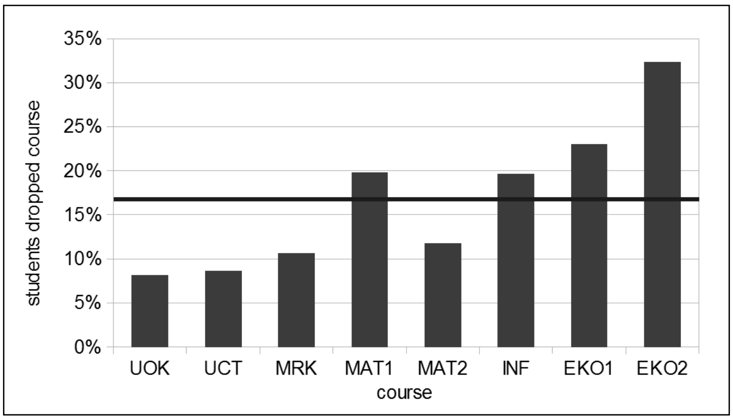

Fig. 1: Percentage of students who dropped course

Results of the ANOVA revealed significant difference in average values (F = 12.10, df = 76, $p < 0.01$) with an effect size $\eta^2 = 0.55$. Results of the t-test revealed MAT2 mean is significantly lower than MAT1 mean (t = 2.37, $p < 0.05$). This may be due to withdrawal some of the students during the first semester, while others may have improved their skills using web-based remediation. The lower performing students mostly have their secondary school mathematics results weaker, so the use of web-based practice can be helpful in remediation especially for them.

Research indicates that the transfer to university level mathematics can be eased by the use of computer based strategies and „students could benefit from mathematics remediation using computer based practice with an online system" (Tolley at al. 2012). We agree that the use of technologies may lessen students' anxiety and enhance confidence in their mathematics skills. For this purpose our first semester WeBWorK homework course also includes secondary school mathematics tasks.

Analyses of students' performance

The Mathematics 3 (MAT3) course's curriculum covers probability theory. As a lecturer of this course we have been continually collecting data from students' performance on tests, final exams and homework. We have been recording students' final exam scores since 2008, and homework-score since 2010, when WeBWorK was used at first time in MAT3 course.

	2010	2011	2012	2013
Students enrolled	151	173	139	116
Students finished	80,8%	92,5%	92,1%	82,8%
WeBWorK users	65,6%	86,1%	77,0%	82,8%
WeBWorK score	34,1%	41,5%	39,0%	76,6%
Exam score	52,4%	63,6%	54,2%	43,9%

Tab. 1: Average values of data on students' performance

In Tab. 1 we summarized data which we used to further analysis. The official data on students' grade are from AIS (2005-13). The time-series data (Fig. 2) show independence between the time-variable and exam average grade of MAT3 course. No significant improvement in average grade has been done after adapting WeBWorK, the homework has no or little effect on grades (ANOVA: $F = 3.31$, $p = 0.11$).

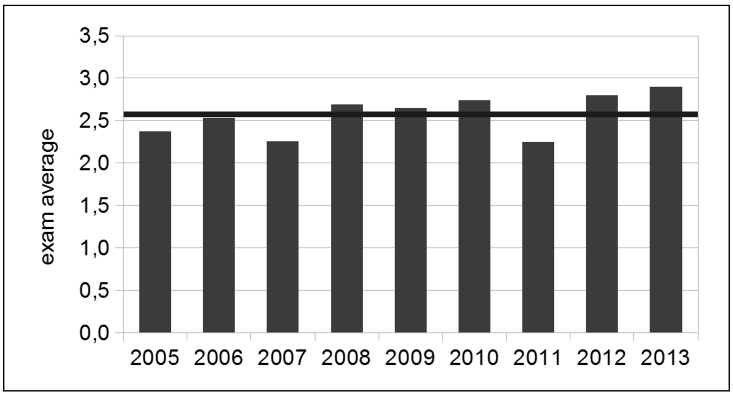

Fig. 2: Average values of overall grading in MAT3 course

Comparing final exam MAT3 score with homework score, the two variables show significant ($p < 0.01$) but weak correlation in years 2010, 2011 and 2012 ($r = 0.45$, 0.33 and 0.28 respectively). In 2013 there is no significant relationship ($r = 0.09$, $p = 0.17$). Although we have received positive correlation coefficients between the two variables, we can not interpret it as a causal connection between them. It is not evident, that higher homework score causes better exam results. As shown on Fig. 3 the data points are scattered.

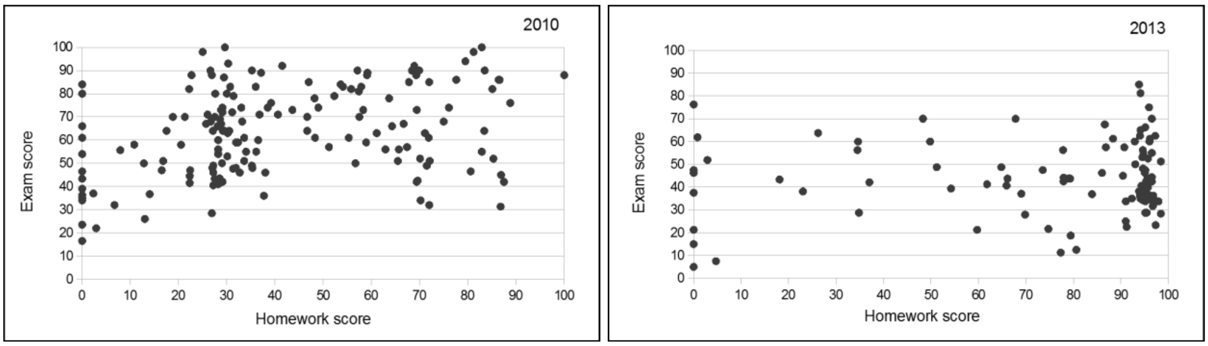

Fig. 3: Different patterns of homework-score and exam-score correlation in MAT3 course

Results of the survey on students' perceptions

At the application of web-based systems into education we should take into account its beneficial factors for students. It is important that the students accept its use and consider it useful for their study. This was the main goal of the survey. It contained questions about the student's opinion about WeBWorK and questions on time spent at online practice. A total of 185 economics students answered, of which 182 were WeBWorK users.

Q1: regularity of homework practice – 39% of the students indicated that they practiced usually once per week, in total 70% of the students worked 1-2 times per month or per week.

Q2: time spent per practice session – Almost half of the students (47.3%) spent at least one hour of practice per session. Almost quarter of the students practiced less then 30 min. and also 30-60 min. (24.7% and 24.2%, respectively) per online session.

Q3: How much did the practice help? – More than half (52%) of the student's thought that online practice mostly helped them understand the curriculum and in exam preparation. Aggregate 22.5% indicated that the homeworks did not or only slightly helped them in their study.

Q4: Reasons of practice – At the reasons of practice 36.7% marked the „*helped in my study*" option, but the majority of students (58.9%) considered the points possible to gain, as the most important motivation.

Q5: We consider it important that by the homework solution students work together and help each other. Almost half (48.4%) of the WeBWorK users worked always or mostly in groups. The others are practiced always or mostly alone.

Discussion

A student's achievement on web-based practice mostly shows his diligence and his motivation level. A less talented but diligent student can reach high homework score (up to 100%), but this may not be reflected in his/her exam-test. Other students who do not solve homework assignments (because they do not need it) in spite of this their exam-results may be better.

WeBWorK works online, multiple answers are allowed until the student succeeds on an assignment. At the final exam there is no such possibility. The mistakes committed at exam test can no longer be corrected, so it can degrade the result of the student. It seems that homework solution gives not enough experience to tackle the exam with fewer errors. Possible reason is that students know only the correctness of their answer and have no information on the solution. Other effect on performance would give a web-based in-class practice controlled and led by a teacher, where one can explain and correct the mistakes. Our students practiced voluntarily, but the assignments were possible to be consulted with the lecturer.

The homework practice with WeBWorK in university education is not efficient enough to support learning so that substantial improvements can be achieved. It has another benefit for the students: the use of such technologies may improve their self-reliance, enhance their self-confidence in their mathematics skills and can help in remediation especially in first-year study. Above examining scores, exam grades, and student opinions, a detailed analysis of students' entry errors (recorded by the system) occurs to be more useful for understanding both learning strategies and any possible obstacles introduced by the system as described by Roth at al. (2008).

Conclusion

The implementation of WeBWorK in mathematics courses has met our expectations. WeBWorK supports learning activities and encourages self-activity of students. It can be successfully used to support and control the continuous preparation of students. Positive achievement is that each year most of the students are involved in web-based practice, as this form of homework is convenient for them and properly motivating. Experiences show considerable differences among students' improvements in their mathematical performance and it is not in obvious causality with their homework achievement. Finally we emphasize that successful implementation of information technology in education always depends on the given conditions and many factors of the educational process.

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EXECUTIVE FUNCTIONS IN COMPREHENDING THE CONTENT OF VISUAL AND TEXTUAL INFORMATION

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Abstract

Executive functions include a set of higher order mental processes which are necessary for the concentration and focused attention on activities for which instinct or intuition are not sufficiently reliable. Executive functions participate in many cognitive tasks. Including e.g. focus, working memory and motor planning. The notable part for the aim of this paper, however, is the direct link between executive functions and eye movement, i.e. on the basis of eye tracking it is possible to make direct, unaltered conclusions on executive functions (Sereno, Babin, Hood, & Jeter, 2009). This is especially convenient when one of the aims of our study is to verify the methods of information retrieval for problem comprehension and solving. From this point of view, the dissertation thesis of Jansiewicz (2008) is of interest; its main goal is to show the relation between executive functions, close reading and use of metacognitive strategies. Jansiewicz combines psychometric methods with experimental methods, specifically with eye tracking. According to current researches, individual differences in eye movement patterns may be related to different ways of text processing, to comprehension difficulties, etc.

Keywords

Executive functions, cognitive functions, eye tracking, text comprehension

Introduction

Executive functions are a difficult to define, but important construct, which generally applies to psychic processes connected with conscious thought and behavior control (Kerr, Zelazo, 2004). Executive functions are described as cognitive functions conditioning the processes of deliberate andgoal-corrected behavior (Emick, Welsh, 2005). Koukolík (2002, 2003) describes the term executive functions in more detail. He states that executive functions include such abilities as creating and executing plans, creating analogies, problem solving, ability to adapt to new unexpected changes in circumstances, multi-tasking and arranging individual events in time and space. Moreover these functions enable us to store, process and retrieve information from our working memory and also to respect rules of social behavior. Karnath and Sturm (in Hartje, Poeck, 2002) understand the term executive functions as cognitive processes that enable people to solve problems, plan and also initiate and finish a specific activity. Furthermore, these functions are responsible for purposeful, goal-oriented activities and include the highest level of human function such as intellect, social interactions and self-restraint.

One of the basic human mental activities is comprehension, which represents grasping the meaning of specific information. Text comprehension is understood as interpretation; explication of the text to oneself (Gavora, 2008). In the area of reading skills it is the understanding of read or written text, including understanding of images or other visual elements. While working with text, different goals may be pursued (Koršňáková, Heldová et al., 2006), which differ in their cognitive demands. The primary level may include simple information retrieval. Higher cognitive goals are based on active work with the retrieved information. The reader not only finds and reads it, but further modifies it. The respondent must put the pieces of information needed for comprehension in relation, compare and combine them. The most demanding goal of working with text is its critical analysis and assessment. The reader employs deeper learning strategies.

Both theory and practice show that teaching pupils is not only using work with text, but is directly based on work with textual teaching materials. Results of researches state that textbooks are regularly used by 72 % of teachers (Lashbrook in Johnsen, 1993). The most used teaching aid in school work is the basic textbook. It is used extensively; its share in teaching (based on the subject) is almost one third of the total time (Červenková, 2010). Traditional textbook has a fixed structure. It comprises several components (verbal and visual). In this regard, Czech researches are mostly based on Průcha's textbook concept. Průcha (2002) discerns three textbook parts: curriculum presentation apparatus, learning management apparatus and orientation apparatus. Each apparatus is then comprised of many specific elements, which are represented by verbal and visual components. In our research, we simulated activities of respondents mostly connected with the curriculum presentation apparatus.

Material and Methods

Methodology Characterization

Text Participants' eye movements were recorded on a Tobii TX 300 Eye Tracker, and the data was collected and analyzed using Tobii Studio software. The Tobii 300 tracks eye movements at a resolution of 1920x1080 pixels at a controller refresh rate of 300 Hz. The Tobii 300 Eye Tracker allows 15 degrees of head movement 60 cm far from the screen and tracks corneal movements to identify gaze focus, fixation and saccade at 3 milliseconds.

The texts are taken from the textbook Dějiny 20. století [History of 20th Century] (Mandelová, Kunstová, Pařízková, Dialog, 2005) intended for primary schools and lower level of 8-year grammar schools. From the content point of view we chose a chapter from fine arts (the topic "Art on a Journey to Surrealism and Abstraction"), which deals with new art movements of the 1920s. As verbal components are concerned, the textbook favors explanatory verbal text, a glossary; the visual part is mainly comprised of artistic illustrations.

The choice and wording of the questions was chosen with the participants' current knowledge and age in mind. The tasks were selected as to ideally not predetermine the preference of textual or visual elements. Therefore the respondents were allowed to locate the relevant information in both (verbal and visual) parts.

Research Sample

For the initial phase of our research we chose pupils from the first and second grades (three boys and two girls aged between 11 and 12) of four different 8-year grammar schools. Ema, Zuzana and Viktor are excellent pupils with the average grade below 1.5; Ondra and Vojta are average pupils with The average grade below 2.5. The respondents work individually under the supervision of the experimenter. The test subject always had the text and questions at their disposal so that we were able to monitor where in the text they search for information and validate possible answers to the questions The novelty principle is observed as the pupils have not come across this curriculum before. Chosen strategies are signified by eye movement trajectories.

Procedure

The study was conducted in Ostrava between April and July 2014 at the University of Ostrava, Pedagogical faculty. Each participant was tested individually. The sequence of the test was:

a) Introduction to the nature of the test;

b) Calibration of the Tobii 300 to the participant's gaze (no participants wore glasses);

c) Testing, which included demographic data questions built into the gaze test using Tobii Studio software;

d) Participants viewing their own gaze plots captured by the Tobii 300 Studio software and hardware.

Data Analysis

The analysis proceeded in the following way:

Step 1 Gaze plot exploration. A range of gaze plots from each participant (pupil) were examined to ascertain the sequence of gaze plots and the areas of highest frequency and visual attention. *Step 2 Area of interest analysis was undertaken.* For each question, an area of interest (AOI) was selected which contained the critical information for correct answer. Relevant information areas were discerned by their visual or textual form. *Step 3 Area of interest data was generated*. AOI data was generated to compare the five pupils in relation to the: time to first fixation on the AOI, fixation count, visit duration. *Step 4. Heat map analysis of AOI.* A heat map analysis was undertaken to compare the five pupils in terms of the fixation count and frequency of visit to the critical area AOI within relevant information. The following analyses of the data and the findings reflect the steps identified above. Obtained data will be analyzed and discussed in the next section.

Results and Discussion

Tasks

During the testing, respondents were given four tasks in total, which represented different cognitive levels of work. This part covers empiric processing of the first two. Varying cognitive difficulty of the tasks was created intentionally. The first question asked mapped the basic orientation in the text and was oriented towards the central topic of the exposed page. Respondents were able to retrieve the correct information from both the verbal and the visual field. The second task posed a complex mental operation. Based on clues in verbal or visual fields, pupils needed to deduce additional information. By having to complete, compare and combine facts, respondents were forced to use demanding logical mental operations.

- Which new art movements were created in the 1920s?

(surrealism and abstract art): correct solution requires simple mental operation – to reproduce the text or captions of the images;

- Where did René Magritte and Josef Šíma draw their inspiration?

(being surrealists, from dreams, imagination, chance): correct solution requires complex mental operations – especially deduction.

Task Solution Evaluation

Tab. 1 contains the time it took each pupil to solve the first two analyzed tasks. The solution times differ greatly. The more difficult task does not always require more time for solving.

	Task 1	Task 2	Total
Ondra	288	191	479
Vojta	68	224	272
Zuzka	41	215	256
Ema	139	76	215
Viktor	75	69	144

Tab. 1: Time in seconds required for pupils to solve the task

When solving the first task, pupils split into two strategically different groups. We call them:

1. *Readers*, who read the text in much detail and for a long time before answering the question. These pupils had difficulties coping with the uncertainty which was caused by the relatively difficult task (by the high structure). These pupils wanted to be sure about their answers and repeatedly checked the text to verify their correctness.

2. *Scanners*, who scanned through visuals, captions and the text with the same amount of focus to each part. They chose the text's semantic core (vital information), which they were able to compare, extend and validate using the images and their captions.

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Fig. 1 and 2 show how the text was processed by the pupils from the first and second group, respectively.

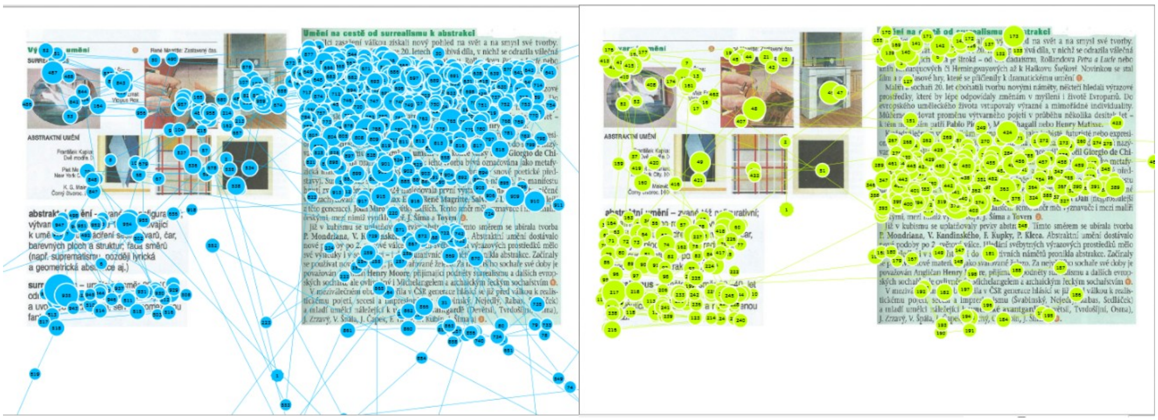

Fig. 1: Pupils who read the text in detail and for a long time (Ondra and Ema).

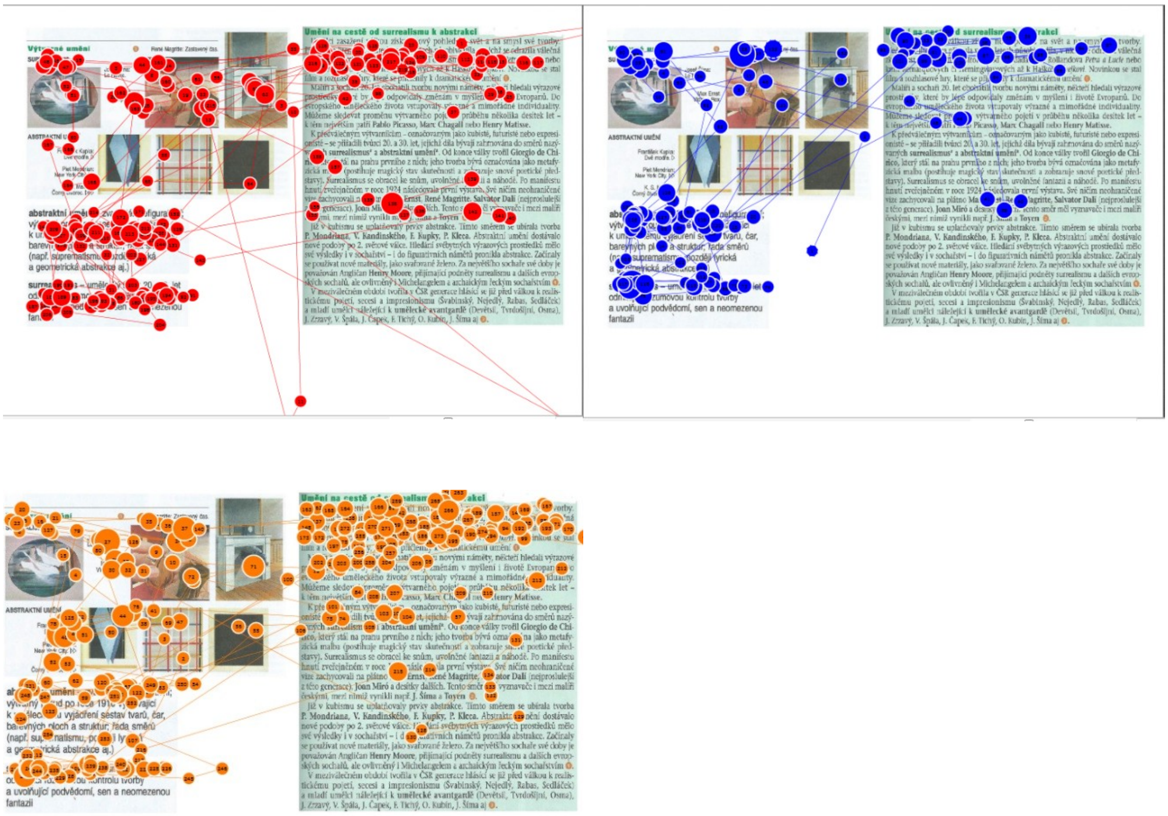

Fig. 2: Pupils who retrieved only the core information and constantly compared it with the content of the images and their captions (Zuzka, Vojta and Viktor).

The second task, more demanding on mental operations, again divided pupils into two groups:

1. *Effective scanners*, who only processed the part of the text which contained the necessary information to correctly answer the question (see Fig. 3). These pupils were also significantly faster in finding the correct answer (see Tab. 1).

2. *Readers*, who processed a significantly larger part of the text to correctly answer the question (see Fig. 4).

Pupils who were able to obtain necessary information from the verbal field spent little time in the visual part of the material. As it turns out they no longer returned to the visual components to verify their understanding. It is worth noting especially because if they used visual components before to solve the previous task, they checked the long text along with them as well, comparing and validating their answers.

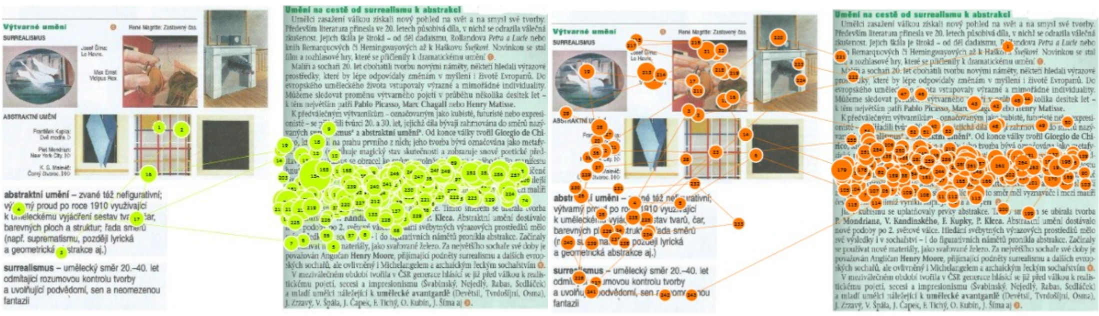

Fig. 3: Pupils who selected only the necessary information in a highly effective manner (Ema and Viktor).

Fig. 4 shows that some pupils spent a long time looking for the answer. These pupils have also devoted a lot of their attention to the visual part of the material. Eye movement trajectories and the number of saccades confirm that pupils read the continuous text and did not truly understand its content; therefore trying to find support in the visual parts. They were comparing the information, but kept going back to the text as the relevant authority.

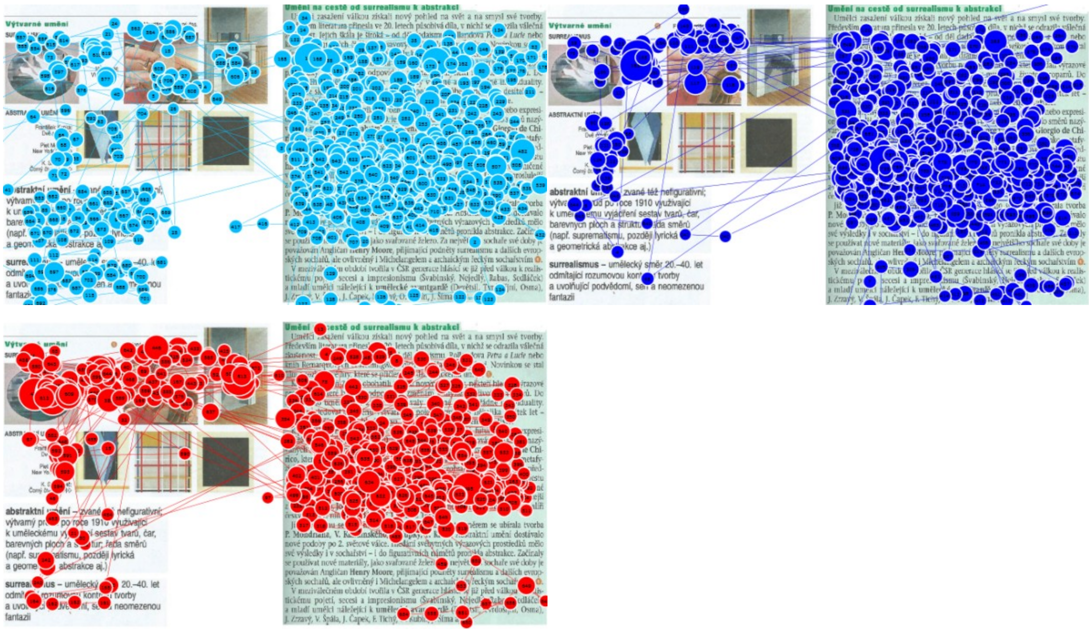

Fig. 4: Pupils who studied the text for a long time and in great detail (Ondra, Vojta and Zuzka)

Text material was divided into individual Areas of Interest (AOI) based on the location of the information relevant for solving the tasks. Pupils spent 65 – 89 % of the total time looking at areas without relevant information by the task 1. All pupils spent a relatively long time watching relevant visual information. Pupils – readers spent significant time on relevant verbal information. On the other hand pupils spent 56 – 74 % of the total time looking at areas without relevant information by the task 2. All pupils (Zuzka being the only exception) nearly ignored the relevant visual information. Pupils – readers spent significant time on relevant verbal information.

Conclusion

Qualitatively oriented research gave us extensively detailed information on how respondents worked with the verbal and visual fields, how they overviewed the material, to what extent they rested on individual structural elements, which components they utilized, for how long and how often. Using the chosen technology, we were able to exactly record the eye movement trajectories, number of saccades and the interest focuses of pupils. At the same time we evaluated the correctness of answers. We discovered two basic approaches of pupils when working with text, which we named detailed reading and effective scanning. Although we cannot yet conclude the relation between the used approach of pupils to search for and their ability to focus on relevant information in the sense of reading attention due to the small number of respondents, the research brought up interesting insights, which will be the focus of a follow-up research.

The results serve as the basis for the following discussion. With detailed reading, some pupils rested primarily on verbal fields of the text, even though the part's content did not match the given question. Certain perfunctoriness of work with the text shows lack of comprehension and probably stems from acquired reading stereotypes. Worth noting is the fact that detailed reading was the preferred style even for questions with lower cognitive level requirements, e.g. simple information retrieval or its reproduction.

The table with time spent on solving individual tasks shows that almost all pupils surprisingly spent the shortest time looking for the answer for the cognitively more demanding question. This shows that the important moment during reading is the primary orientation within the text.

Pupils worked effectively if they "scanned" the text while searching for information. Mechanical reading through the text without an effort to learn to navigate it resulted in longer work times. Effective scanners were able to find the required information faster. Interestingly, these pupils worked primarily with verbal text field, not with images.

Insights produced by this research will be further examined. We expect to design the next research in such fashion as to find specific relations between executive functions (especially attention, in the sense of focusing on relevant context). For this purpose we will be employing a complementary psychodiagnostic test. The research will be further extended by semi-structured interviews with respondents that will uncover further connections concerning text comprehension, work with text material and preferences of components that facilitate pupils' learning. Additionally, thematically different material may be introduced and work strategies of pupils on different content may be compared.

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EVALUATION OF PEER-REVIEW QUALITY IN COMPARISON TO TEACHERS' GRADING

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Abstract

Peer-reviews were found as useful to engage students with the outputs produced by their classmates, stimulate feedback, exchange of opinions, and thus social learning. It is however often the case that teachers as well are providing their evaluation to all items that are subject to peer-review. The question whether the "doubled" teacher's evaluation is necessary, and if it can be partly or entirely replaced by the peer-reviews is therefore relevant. We investigated the relevance of peer-review outputs in our course. We showed that these outputs are not significantly affected by friendly relationships in the cohort, however, the overall reliability was not very high when compared with teachers' evaluation. We also showed that the results can be improved by selecting a subgroup of more reliable students (in our case, students with previous experience with the course topics), and also possibly by adjusting the format of the peer-reviews to be more in line with teachers' evaluation criteria.

Keywords

Peer-review, assessment, education, blogging

Introduction

The peer-review technique has been used to enhance the learning methods for a number of years. According to several studies [11, 9, 17, 15, 13] the mutual reviewing of the colleagues' work helps the students to develop the critical and analytical thinking, communication skills, constructive criticism, etc. It can also stimulate the students' interest in course subject, foster students' engagement with the output of the others (e.g., essays, blog articles, wiki pages, but also software and other products) and stimulate feedback, exchange of ideas and opinions. Peer reviewing was successfully employed not only in writing courses but also in engineering, computer science, microeconomics, etc. Here it has the same benefits for the students, giving them experience in communicating with the kinds of audiences they will need to write for on the job after graduation [3, 7]. Such an approach is highly in line with constructivist learning theories, especially with social learning [16, 14].

Contrary to the undoubted contribution to the quality of the learning process, the peer-review activities militate against the teacher since she is often overwhelmed by providing feedback, correcting and marking of both – assignments and peer-reviews. The idea of using students' feedback from the peer-reviews in evaluation and reducing teacher's workload this way was previously explored [7, 2, 4, 5, 12, 15].

The basic problem of such an approach is the question whether the students are able to adequately judge the quality of their peers' contributions and what criteria they should follow. Aiming to solve this problem, we conducted a research in one of our courses where blogging assignment with peer-reviews was employed. In this assignment, teachers' evaluation of students' articles and reviews is binary (approved/rejected), but there are also evaluation points assigned to the students after achieving a stated number of approved articles.

As we found out that basic approaches, such as taking the average students' rating of each article are unlikely to be successful, we concentrated on the questions, if and how it is possible to identify at least certain group of reliable students, whose peer-reviews can be used to distinguish between the accepted and the rejected articles. Initially, we focused on revealing the friendly relationships among students and consecutively we studied whether these relationships influenced the reviews between friends.

Afterwards we tried to identify the group of reliable students in two ways. Firstly, based on the students' performance in the very beginning of the assignment we selected a group of students whose reviews were well-aligned with the teachers' assessment and studied the rightness of their peer reviews in the remaining parts of the assignment.

Then, we identified a group of students (called experts) with previous experience with the topic of the course (according to the judgement of their classmates) and studied if their peer-reviews were more reliable than the others.

During our research, we also concentrated on identifying the right criteria which could be followed by reliable students to produce the peer-reviews better corresponding to the teachers' assessment.

Our results were not completely positive, and given the initial character of this study we did not expect that (e.g., the peer-reviews were not anyhow calibrated w.r.t. goals of this study, they were conducted as usual in the last years). We found out, to our surprise, that at least in our data the friendly relationships in the cohort did not bias the rating in a statistically significant way. We also found out, that the experts group was much more reliable in their ratings and we were able to tell apart the accepted and the rejected articles with the success rate of 75.6%. Finally, when we only considered the rejection w.r.t. topicality, the expert group achieved the success rate of 94.5%.

Blogging with peer-review

Two years ago we started to employ peer-reviews in our web design course. The course is part of the Master curriculum of Applied Informatics, but also number of Bachelor students enrolls every year. In the current year 72 students enrolled altogether. Among the goals of course is to practise web publishing, professional writing, working with sources, copyright issues, etc. This is done using a blogging assignment, structured in two-week rounds: the first week dedicated to article publishing; second week to peer-reviews: students are randomly assigned three articles of their colleagues and are asked to review them. Only those who submitted an article are allowed to review in the same round. All these activities are optional but students can earn quite large amount of evaluation points for them (about 17.5% of all points possibly gained in the course). Hence the blogging and peer-reviewing contribute to the grading in a non trivial way.

The peer-reviews are structured into five questions concerning following aspects: usefulness, interestingness, comprehensibility, topicality[2], and overall impression. Students rate each aspect on the scale 1–5 (from weak to excellent) together with verbal justification.

Writing and reviewing were continuously evaluated by the teachers, and either accepted or rejected (together with verbal feedback from the teacher). The main reasons why articles were rejected were:

[2] The topicality aspect reflects whether the article corresponds to course topics

- article too short (less than 300 words),
- topic not related to the course,
- improper or unsuitable HTML formatting,
- copyright violation, missing or incorrectly used sources.

Reviews were especially rejected if they were inappropriate by large, or if the rating and justification were inconsistent.

The evaluation points for activities were assigned to the student as soon as certain number of her articles/reviews was approved: 3 articles/10 reviews to get one half of the points; 5 articles/13 reviews to get the whole amount. The reviews from other students had no influence on teacher's evaluation.

There were five ordinary blogging cycles during the course run and two extra cycles for those that forgot to submit in time. The students submitted 299 articles (240 accepted, 59 rejected) and 878 reviews (805 accepted, 73 rejected).

Students reliability

By friendship

Since the aim of peer-review outputs was using it in student's evaluation we were first interested in finding out if the reviews are influenced by friendship between the reviewer and the author. We will call reviews where this relationship exists *friendly* and the other case, when we know of no positive relation between the reviewer and the author, we call *non-friendly*.

To find out positive relationships between students we subjected them to a sociometric questionnaire. We used deception to improve accuracy of the survey: questionnaire objectives were explained to students as finding out collegiality, responsibility, and overall attitude towards studying in their cohort. They were asked to select from a given list of all enrolled students those colleagues they considered to be responsible, communicative, experts in the course subject, and they had a good relationship with. We were interested in the last question only, and the first three were filler questions. However, we subsequently made use of the third question as well.

To compare friendly and non-friendly reviews we selected only the articles which had at least one friendly and at least one non-friendly review. There were 58 such articles with 172 reviews in total, out of which 62 were friendly and 110 non-friendly.

We first computed the average review ratings for each of the five reviewed aspects, separately for friendly and non-friendly reviews. These did not differ very much. The smallest difference between the average values was 0.03 points in comprehensibility aspect and the biggest was 0.40 points in usefulness aspect.

To show this also statistically, we were interested in testing the obvious hypothesis H: *There is a dependence between the way how a student rates the interestingness (usefulness, ...) of her colleague's article and their friendship, respectively non-friendship.*

In the χ^2 significance test [6], we verified H as alternative hypothesis to the null-hypothesis H_0*: There is not a dependence between the way how a student rates the interestingness (usefulness, ...) of her colleague's article and their friendship, respectively non-friendship.*

For the articles rated by one friendly and two non-friendly reviewers we calculated the deviation between friendly and non-friendly reviews as a difference between the value given by the friendly reviewer and the average of the other two (for each of the five apects). For the articles with two friendly and one non-friendly reviews we calculated the difference between the values of friendly and non-friendly review in both cases. Then we used the same method for finding deviations in an opposite way – between non-friendly and friendly reviews.

This way we obtained positive deviations (when the review rating was higher than the value it was compared with) and negative deviations (in the other case). Given the review ratings ranging between 1 and 5, we placed the significance threshold to x = 1.5 and created the contingency table (Table 1). For each of the five reviewed aspects the "friend"' row in the table contains the numbers of negatively deviating (lower than -1.5), non-deviating (between -1.5 and 1.5), and positively deviating (higher than 1.5) friendly ratings. Analogously, for "non-friend" rows.

	rating type	**negative deviation**	**no deviation**	**positive deviation**
interestingness	friend	2	51	9
	non-friend	21	80	8
usefulness	friend	3	51	8
	non-friend	24	81	4
comprehensibility	friend	6	49	7
	non-friend	16	78	15
topic relevance	friend	2	55	5
	non-friend	12	91	6
overall impression	friend	2	52	8
	non-friend	21	80	8

Tab. 1: Contingency table of friendly and non-friendly ratings

On the data from the Table 1 we run the χ^2 test of independence [6], and then the polarity test [10], both separately for each aspect. Degrees of freedom were set to 2 and confidence coefficient was set to 0.05. The χ^2 test proved significant dependence between the friendly and the non-friendly reviews (i.e., it rejected H_0) in three aspects: interestingness, usefulness and overall impression. After polarity test we obtained the result which showed only that *students did not tend to give lower ratings to their friends* in these three aspects.

By the initial performance

From the previous section it is obvious that even if we rule out the friendly reviews from the evaluation, it would not help us. However, we simply analyzed that we cannot use all reviews in the evaluation: if we split all submitted articles into those accepted (240 articles) and those rejected (59 articles) by teachers, the mean average review rating for the former group is 3.8, whereas for the latter group it is 3.5. This difference is indeed very minute.

In our effort to take advantage of peer-reviews in articles evaluation, we tried to find "reliable students". Our first approach was based on the students performance in two initial blogging rounds. At first we defined three categories of main articles deficiencies tracked by teacher: formatting problems, copyright problems and problems with topic. For each feedback the teacher gave to an article and for each deficiency category we marked the deficiency level from *0* to *3 (0 – no problem, 3 – the reason why the article was rejected)*. Since approved articles had different levels of quality we needed to find out if students are able to reveal excellent, good, weak (but still approved) and unsatisfactory (rejected) articles. Therefore we compared their articles ratings in all five aspects with teachers' evaluation mentioned above:

- *excellent articles*: teacher evaluated at most one category by 1, other categories are assigned the 0 level; student's ratings should be at least 4 in all aspects

- *good articles*: sum of teacher's evaluations in all three categories falls in interval (1;3> (however, there is no 3 in any category); student's rating should be 3 or 4 in all aspects
- *weak articles*: sum of the teacher's evaluation in all three categories falls in interval (3;6> (however, there is no 3 in any category); student's rating should be 2 or 3 in all aspects
- *unsatisfactory articles*: teacher's evaluation is equal to 3 at least in one category; student's rating should be 1 or 2 in all aspects

According to these criteria we identified students able to reveal articles with different quality (group of reliable students) but also students who evaluated unsatisfactory articles as excellent, weak articles as good, etc. (group of unreliable students). Then we subtracted the number of times a student appeared in latter group from the number of times she appeared in former group. If the result was greater than 3, we marked the student as reliable.

We selected seven students from our cohort this way. However, we needed to find out whether their reliability is constantly on the same level or it varies during semester. These students reviewed 53 articles in total, 5 of them were rejected and 48 were approved by teacher. 14 out of 15 reviews assigned to those rejected articles were written by these seven students. However, unsatisfactory articles were not revealed by them. We also investigated if they were critical especially in evaluation of one particular aspect (interestingness, ...) but even this approach was not successful.

Therefore we concluded that it is not possible to identify a group of students after two rounds which can be automatically seen as reliable in next rounds. This finding can be related to the fact that two very first rounds served specially for training in blogging and teacher's evaluation was perhaps not so strict as in later rounds.

By the expertise

This is where our sociometric study comes into play again. In the questionnaire we also asked students to identify those of their classmates whom they considered to be already experts in the course topics. Thus we identified a group of students marked down as experts by at least five of their colleagues. This group (further called *experts*) consisted of 8 students.

To verify the actual expertise of the students in the experts group as well as the appropriateness of the selection, we examined their performance in the blogging and other course assignments.

Investigating the blog articles we found out, that the average number of articles posted by experts almost did not differ from the average number of articles posted by the others (4.9 compared to 4.8), but the quality of these two groups of articles was different (see Table 2). Whereas 92.3% of experts' articles were approved by teachers, in the case of other students it was only 76.7%. Since the score acquired for blog articles was not directly proportional to the number of approved articles, we evaluated this indicator as well. The average article score of experts was 6.1 and it was 4.3 for the other students. This means that the experts gained 87.5% and the other students 61.4% of maximum score in average.

	articles submitted	articles accepted	articles score	reviews submitted	reviews accepted	reviews score	midterm score	project score
experts	4.9	92.3%	87.5%	13.1	98.1%	81.3%	68.8%	77.0%
others	4.8	76.7%	61.4%	13.6	90.8%	51.8%	51.7%	69.0%

Tab. 2: Average results of experts compared to the other students

The evaluation of the experts group by way of average values of selected indicators showed that this group performs better in average than the other students. Moreover, the article success rate (the ratio of approved articles to submitted articles) of 6 out of 8 experts was 100%. In the case of reviews the 100% success rate was achieved by 7 out of 8 experts.

Criteria for article rejection by peers

We then turned towards the question, if the reviews written by students in the expert group can be used in evaluation. As we learned before, in the evaluation we only needed to decide which articles should be approved and which should be rejected. Hence we looked to those articles which were reviewed by at least one of the experts (90 articles, 12 rejected, 78 accepted), and compared their reviews with the teacher's decision.

As the students did not directly approve or reject articles, as the teachers did, we also needed to find the best criterion, based on which the students' ratings would be processed in order to approve or reject the articles.

We examined several criteria (peer-rejection criteria) including the average rating of the article, the rating of specific aspect of the article, the lower rating of two or three aspects, etc. [1]. For each criterion the most proper threshold constant was chosen, so that best results were achieved. The constant selection was either carried out experimentally or based on our experience and/or published studies [7].

All the peer-rejection criteria were evaluated as follows: For all articles reviewed by experts and rejected by teacher we compared the number of the articles rejected also according to the given criterion with the number of articles not rejected according to this criterion (i.e., false positives). The articles reviewed by experts and approved by teacher were treated the same way – we compared the number of these articles approved also according to the particular criterion with the number of articles rejected according to the same criterion (i.e., false negatives). We next calculated the overall success rates of the evaluation according to every particular peer-rejection criteria.

The results showed the overall success rate varying between 67.8% and 75.6%. More details about particular criteria can be found in our recent study [1].

While the peer-review questions were not completely synchronized with the teacher's evaluation (due to other pedagogical goals [8]), the reasons for low rating of the colleague's article were ordinarily different to the teacher's reasons for article rejection. However one aspect, topicality, was common for both, the students' peer-reviews and teacher's rejection criteria (see Section Blogging with peer-review). We were therefore interested, if the students were able to detect at least articles rejected because they were off topic. So the next considered *criterion T* for article rejection was: *Topicality is rated lower or equal to 3*.

articles reviewed by the experts		criterion T			
		rejected	approved	success rate	overall success rate
rejected by the teacher according to the criterion T	3	3	0	100.0 %	94.4 %
approved by the teacher or rejected according to other criterion than T	87	5	82	94.3 %	

Tab. 3: Articles evaluated according to the topicality criterion.

For the comparison, we tested this criterion also in the group of all students. The success rates were 72.7% for rejection and 60.4% for approval, which gave the 60.9% overall success rate. Then we tested this criterion just for the experts group. Here the resulting numbers were especially encouraging, yielding the overall success rate of 94.4% (100% for rejection, 94.3% for approval). However, it must be noted that the data corpus was rather small, there were 87 accepted but only 3 rejected articles (see Table 3).

Altogether we find the results very useful. While we were not able to find any criterion that would exactly sort out 100% of the accepted and rejected articles alike to the teachers' decisions, however we have showed that the expert students group can be identified based on a simple sociometric survey, and that the groups' judgement is very close to the teachers' decision. In addition we learned, that by selecting more suitable peer-review questions we can possibly improve the results in future experiments.

Conclusion

In this paper we dealt with the problem of finding a group of students whose peer-reviews could be used in assessment of other students work. Firstly we focused on the question whether the friendly relationships influenced the peer-review ratings and whether there is a necessity to exclude reviews produced by friends. We have showed that the positive relationship did not influence peer-reviewing in an inappropriate way.

Then we concentrated on identifying a group of reliable students whose peer-review ratings were well-aligned with teachers' evaluation.

The first tested methodology based on the students performance in initial phases of the assignment did not lead to identifying of students whose peer-reviews met the teachers' criteria also in next phases.

Another methodology – to find reliable reviewers among the students already knowledgeable in the course subject – worked for our purposes. Since the students' peer-review questions were not totally in line with the teachers' evaluation criteria, we had to find a way how to compare each other. After doing this, the peer-ratings of selected expert-students showed rather strong correlation with the teachers' decision, up to 75.6%.

We further analyzed the case of articles that were evaluated by the teachers as insufficient due to not being in line with the course topics. The expert students rating of this aspect corresponded to teachers' decision with 94.4% success.

Based on the results described above we conclude that expert-students could be helpful in the assignments of this kind since provided with well-chosen criteria they act as fair-minded and reliable reviewers. They might reduce the teacher's workload by detecting the articles of bad quality according to certain criteria. As our experiment showed, selection of experts in accordance with the opinion of their colleagues is quite a good starting point when creating such a group. Also the criteria we came to in our research showed good results in searching for students' reviews consistent with teachers' evaluation.

In the future we plan to investigate other possible ways to find reliable students. Another issue to be addressed is better synchronization of the aspects rated by students in their peer-reviews and the teachers' evaluation criteria. We believe that this way the results could be further improved.

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EXPERIENCE OF USING MOODLE E-LEARNING ENVIRONMENT AT THE FACULTY OF EDUCATION

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Abstract

High quality education is a source of long-term prosperity of each country and a personal development. At present, of the rapid development of information technology it is important to monitor new trends and seek their application in the teaching process and in spite of outdated concept of education, shortages and low level of technical support in teaching. We briefly describe the procedure and the benefits of using e-learning in the classroom in order to clarify the main trends on the issues emerging in the professional and scientific literature.

In the second part we process information dealing with the use of e-learning in the teaching of computer science and mathematics. Teaching students with enriched multimedia presentations, animations, simulations, images, videos and pictures give better abilities to learn the knowledge, because complex effects on their senses

We evaluate the use of e-learning environment Moodle at the Pedagogical Faculty KU in Ružomberok. E-learning has been a part of classical teaching on the faculty for 6 years. We sum our views on the benefits and also the drawbacks for its use. We analyze used and unused capabilities of e-learning in teaching computer science and mathematics in the light of knowledge and experience. We will also mention our experience with Geogebra software in creating e-learning content.

One of the major tasks now is to prepare future teachers for active and creative use of ICT in lessons. The aim of the paper is to highlight the need to integrate ICT into the educational process and to prepare college students for therir future teaching profession.

Keywords

GeoGebra, Moodle, e-learning platforms, teaching materials

Theoretical Background

According Caglar (2012) the new media oriented technology usage in education converts an information sharing classroom to a global information sharing classroom. Today, adoption of technology-oriented method has become a necessity rather than a need. New media is a communication tool, and communication with new media is one of the concepts that put forward the information society. New media includes websites, multimedia applications, such as interactive broad casting content with a large number of documents, images, audio, video, text, applets and text converted into digital data that can be accessed at any time and be transmitted from point to point over the network on the basis of the principles of modularity and variability. One of the main characteristic of the new media oriented education is bringing together the use of digital tools when compared to traditional education system, students, teachers and parents to increase interaction among them.

E-learning as a component of flexible learning describes a wide set of applications and processes which use any available new media in education. It includes computer – based learning, web-based learning, virtual classrooms, virtual excursions and digital collaboration. E-learning improves course content dissemination, classroom recording, field recording, study support, file storage and transfer (Belanger, 2005)

The concept of e-learning has been defined in many different ways by many researchers. It can simply be described as a learning process occurring in web-based environment, connected to the internet. Learners can access learning resources online, interact and communicate with their instructors and peers through online tools (Oaklay, 2000).

Universities need to make sure that their students acquire the necessary skills for themselves and their future users. Universities should also develop their own pedagogies and learning designs based on technology and social media according local needs.

According to Wang (2007), the main advantage of e-learning is that it overcomes the limits of time and space and provides learners opportunities to perform self-directed learning. However, it also lacks the teacher supervision of traditional teaching and makes learners feel isolated and disconnected. Thus, learners in e-learning environment must by highly self-regulated and independent, otherwise their e-learning effectiveness may be low (Kaufmann, 2004)

According to Kopka (1997) many educators say that some of the main goals of teaching mathematics and informatics are:

- the development of logical thinking
- the development of creative thinking
- the development of an autonomous person
- the development of the ability to solve problems.

One of the methods, which systematically create sets of internally connected problems, is method of generating problems (see Wittman (2001)). The activities of students and instruction have to be regarded as complementary factors in the learning process. Both the factors are necessary and must be systematically related to one another so that optimal progress may occur. The aim of our method is to create areas in which the students may, using the result of guided teaching, move as independently as possible and in which he/she may develop their own initiatives. The student in this method is presented with a problem and assisted in solving this problem as far as necessary. In this way he is given a basis for further work. After a problem has been completely solved and clarified the teacher together with students ask further questions and generate problems which relate to the problem just solved. Thus the original problem acts as a generating problem; we will call it generator problem (GP). Related problems are obtained by analogy, variation, generalization, specialization etc. The group of all new problems together with their GP will be called the set of generated problems of the GP or the problem domain of GP. This method is possible to demonstrate in using open source software GeoGebra by solving problems in mathematics education.

E-learning at Catholic University in Ružomberok

At the Catholic University e-learning was introduced in 2008. Since then serves as supplementary training to classical education. Learning can no longer be only a relationship of teacher and student to gain some quantity and quality of knowledge, but the whole process of knowledge transfer must be optimized in terms of time, economic costs and also in terms of the content itself .

Since there are many LMS platforms through which it is possible to apply e -learning in the educational process, the school has sought to find the optimal path and therefore it uses available resources such as Moodle.

The definition of Moodle Portal can be found home page. "Moodle is an Open Source Course Management System, also known as a learning management system." It is a free web application that teachers can use to create effective websites for learning (Dougiamas, 2003). Moodle provides easy access for teachers and students, the benefits of versatile application. There is registered more than 80,000 installations of the software worldwide. It is easy to operate and upgrade, full localization in over 40 languages.

Teachers use publishing options, but also feedback by collecting papers and by testing. E-learning portal http://moodle.pf.ku.sk is accessible on the Internet, users are students and teachers of the university. Cooperation with teaching system administrator enables rapid adaptation rate requirements of their creators and users. The reports of the course as well as its graphic content and editing is in charge of the course creator.

Moodle was introduced to all Faculty departments, its use in some departments is almost negligible. There are several reasons for that.

Teachers are afraid of modern technologies, they rather devote to their good practice, and lectures. It is also time-consuming to prepare good quality interactive resources for each module, which requires advanced credible sources, improvement due to the needs and requirements of a particular subject. Some teachers, however, do not realize that innovation of materials and improvement of interactive communication is consequently much less time consuming than preparing new forms and means of classical education. Finally, in terms of long-term effectiveness there are big savings in time and material costs for teaching. Unfortunately there is still certain distrust of e-learning resources. Some think that the student will try to somehow hack the system and affect the test results, evaluation, etc.

In the Department of Informatics the system applied to 100 per-cent of the subjects. For some serves only as a supplement to conventional teaching and includes supporting literature identification sheet and the requirement for passing the subject, etc. In other subjects, it's part of the whole teaching support. Contains all lectures enriched with interactive content, exercises and tasks. Students can not only communicate with the teacher through lecture but at any time using chat or forum. Lecturer verifies the individual facts through various activities such as polls. Also benefiting from the test during the semester where they can check the level of knowledge of their students.

Currently we experiment also with video lectures, serving for part-time students as well as students with disabilities who are unable to attend the physical lectures. For this purpose the, department prepared its own streaming server. Departments of Informatics and Mathematics for several years involve their students in the development of courses in different software environments. Students transform written notes into electronic courses, create animations, videos, and also test environments. Their activities are evaluated as thesis at the subject but the better quality ones as well as bachelor or master's thesis. On the Department of Mathematics they work with GeoGebra software for several years in e-learning.

Department of Informatics uses a number of open and commercial software for creating e-learning content e.g. Adobe products (Dreamweaver, Authorvare), Corel Draw, 3DStudio Max, etc.

In running the portal it is important to continuously update the system and data content. Each of the active users in this process has an irreplaceable position. Teachers with the rights of course maker take care not only of active use of their training courses in the teaching process, but must also actively collect information from students or teachers without these rights. Separate course called The Fundamentals of electronic education is dedicated to the Moodle system. Since faculty educates future teachers consider it necessary to acquaint students with e-learning technology from the point of view of teachers. Among other things, students throughout the semester become familiar with the installation, configuration and management of the Moodle system. Practice in secondary and primary schools suggests that the teacher of Informatics is almost always administrator of the information system, the creator and administrator of the website and also administrator of e-learning. Education. Therefore Department placed this subject among its elective courses and enjoy the great attendance by students.

GeoGebra on-line materials

According Hohenwarter M. et all (2014) GeoGebra is dynamic mathematics software for schools that joins geometry, algebra and calculus. On the one hand, GeoGebra is an interactive geometry system. You can do constructions with points, vectors, segments, lines, polygons and conic sections as well as functions while changing them dynamically afterwards. On the other hand, equations and coordinates can be entered directly. Thus, GeoGebra has the ability to deal with variables for numbers, vectors and points. It finds derivatives and integrals of functions and offers commands like Root or Vertex.

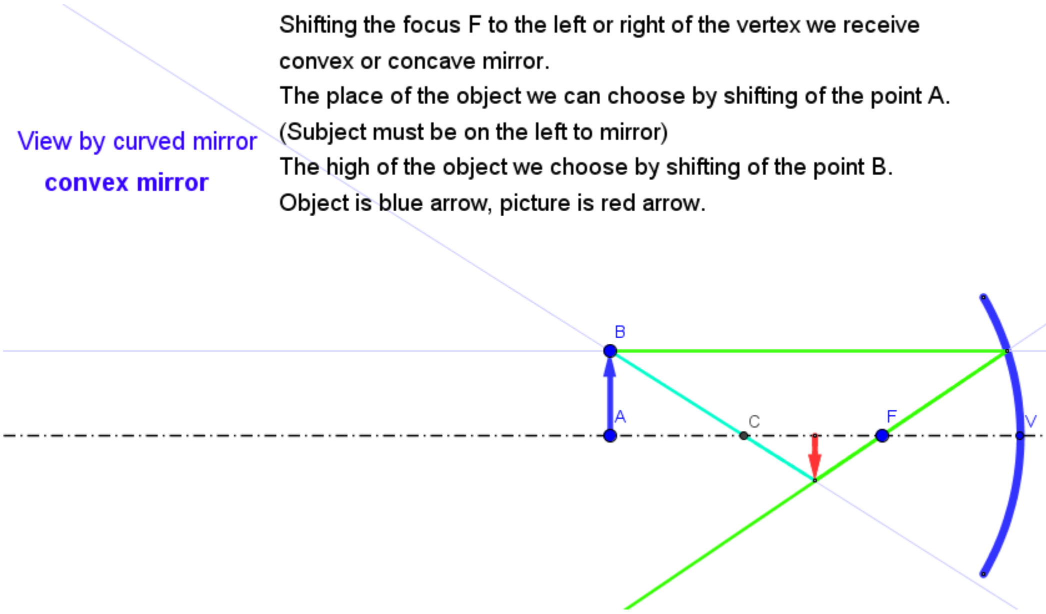

Fig. 1: Material from the Slovak – GeoGebra Wiki (physics education)

Some students and teachers work in open source software GeoGebra in Slovakia are presented on the website http://www.geogebra.org/en/wiki/index.php/Slovak. The website contains materials in mathematics and physics education prepared by teachers and teacher training students.

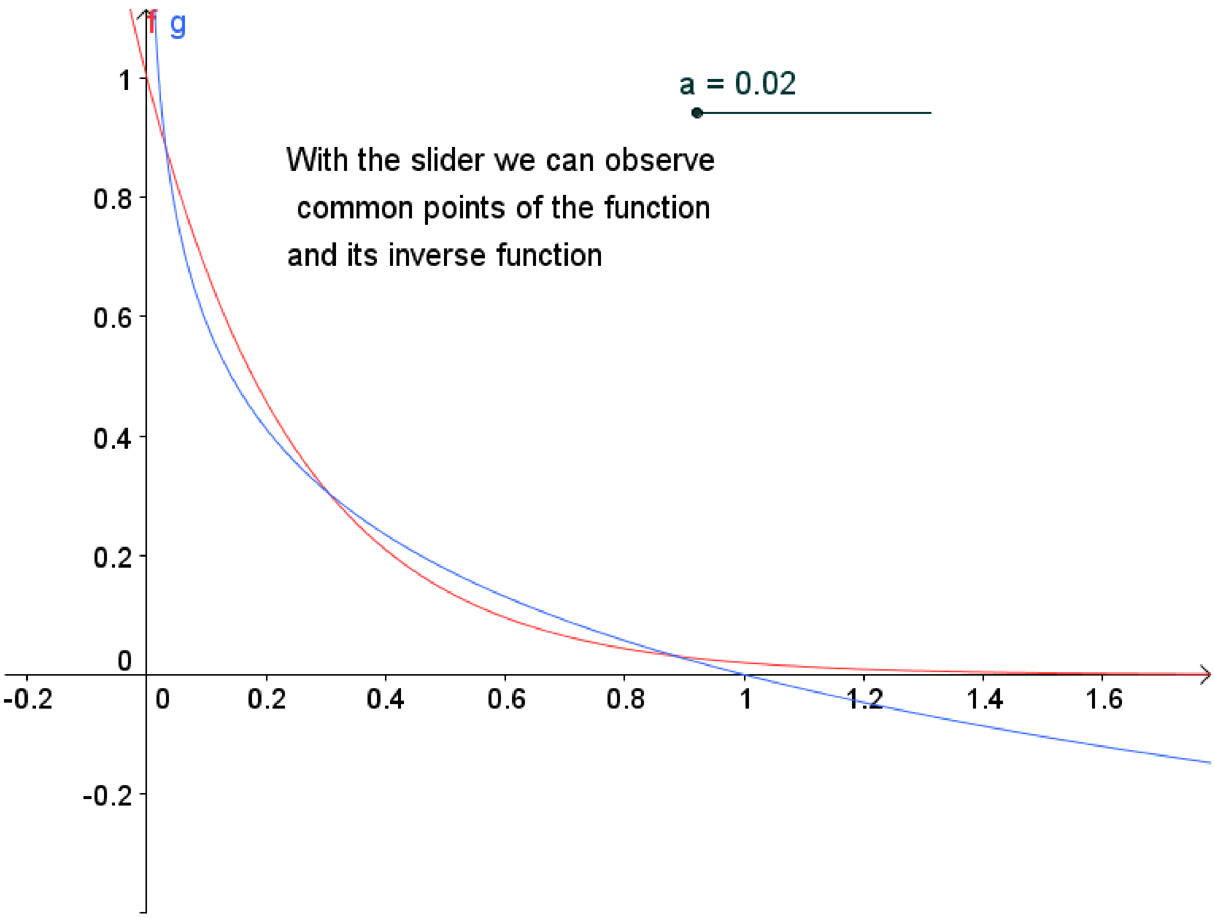

Fig. 2: Material from the Slovak – GeoGebra Wiki (mathematics education)

GeoGebra allow export of dynamic worksheet to a webpage, which is very useful in creating course in Moodle. Some experiences of using of this type of material has also *North American GeoGebra Journal* (see http://www.ggbmidwest.com/ojs-2.3.4/index.php/ggbj) and also Dynamical GeoGebra Journal (see http://www.uni-miskolc.hu/~matsefi/GGJ/).

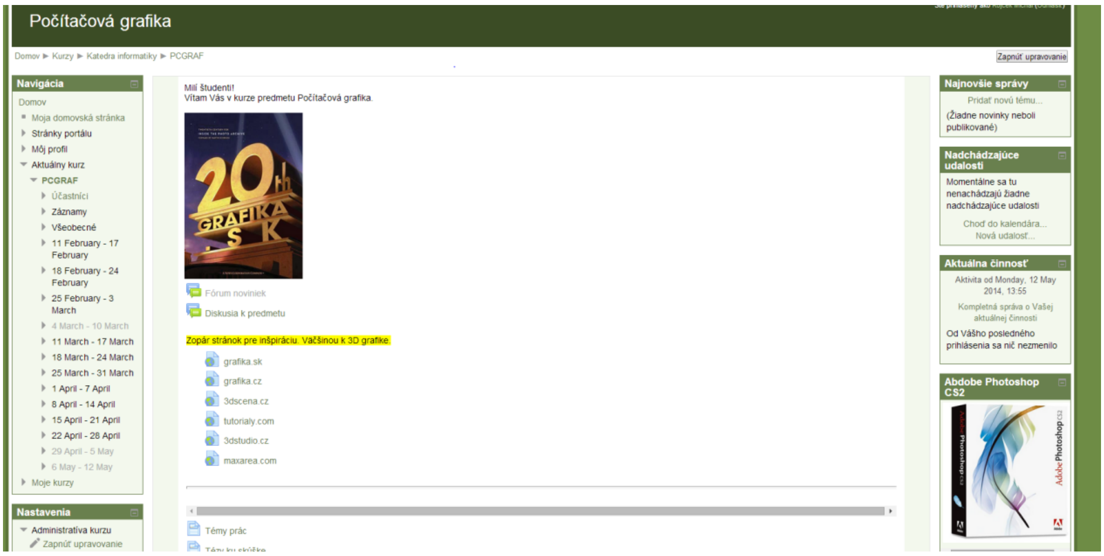

Fig. 3: Moodle course of the Computer Graphics – view of teachers

Example from Informatics Education

Future informatics teachers have course of Computer Graphics (see Figure 3). In the frame of the course students develop materials in Blender. Students learn basic knowledge about 3D modelling in open source software as well as in commercial software 3D Studio Max. The course contains also animations screen shots, videos and plenty of support materials for students. At the end of the course there is a test from practical and theoretical part. Theoretical part is devoted to graphics theory from mathematical point of view and in practical part students must show their abilities in modelling in different software environment. One of the student tasks is shown on Figure 4.

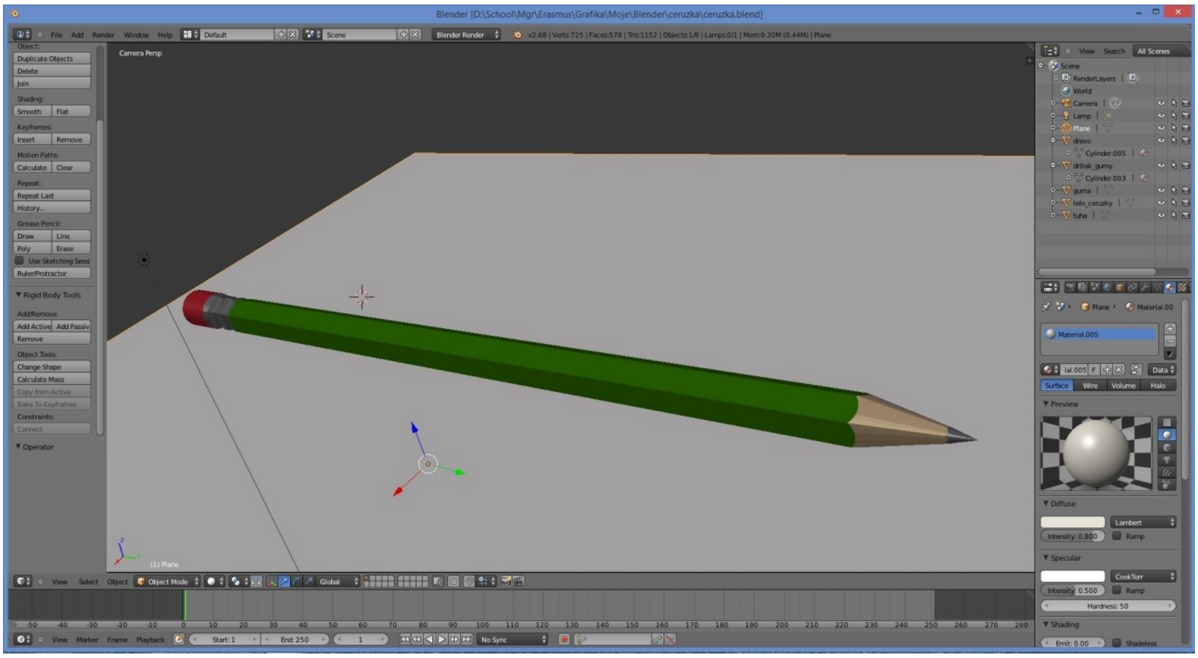

Fig. 4: Example of the Moodle course – Computer Graphics

Conclusion

In order to facilitate the continued and effective integration of e-learning and increasing the quality of e-learning processes universities should explore and observe potential ways to promote and encourage innovation in on-line learning, assessment support and feedback mechanism from teachers and students. There is possible to use interdisciplinary approach because online courses are used by different teachers in different study programs. We recommend use by the work of students the method of the cooperative learning (see Jablonský (2006)).

E-learning courses need to be designed in the way to handle different students and teachers expectations. Keeping in mind these facts, students should be provided with more rich applications and teachers should devote more time to evaluate learning outcomes, as well as student achievement. Students can prepare creative and interesting material for courses as learning outcomes, which can use teacher for innovating and updating of the course. Possible research in this field can observe effectiveness of different e-learning platforms.

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SYSTEM FOR INDIVIDUAL LEARNING OF MATHEMATICS

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Abstract

The paper deals with a theoretical concept, implementation and some practical results of the evaluation of a system for individual learning of mathematics. It explores the possibilities of improving the education process with the help of programmed learning. After analyzing the results of examinations and mathematics tests we can say that students have insufficient mathematical competences. Information and communication technologies (ICT) can help to solve the problem and are used in the process of mathematics teaching. The first part of the paper presents the theoretical background of the subject matter, inter alia: the description of mathematical competences and their identification at post-secondary school in Poland, Niemierko's taxonomy, the programmed learning theory and the structure of the system of education/learning in the eLearning environment. It expresses the preconditions, expected results, concepts, objectives, hypotheses and research methods. The practical part describes the structure of the system for individual learning *Mathematics with Moodle* based on the original author *MatLearn* module and its graphic representation. A didactic tool was proposed – an eLearning course preparing students for the school-leaving exam in mathematics and improving students' mathematical competences. Its aim is to increase the level of competences, especially those which have not been mastered yet. In order to construct study activities in the course, the programmed learning principles and Niemierko's taxonomy were used. The other part of the paper describes the main experiment and its most important results and conclusions.

Keywords

Information and communication technologies (ICT), key competences, mathematical competences, eLearning, Niemierko's taxonomy, programmed learning, *MatLearn* module, *Mathematics with Moodle*

Introduction

The findings of an analysis of the Program for International Student Assessment (PISA), which has been carried out since 2003, shows results in mathematics in Poland – the highest number of students is at the average level. It can also be noticed that the abovementioned results remain at the same level for a long time and the level of students' mathematical competences has not increased. As for the Polish school-leaving exams in mathematics, which are obligatory, a visible decrease of certain mathematical competences was noticed. In order to solve this problem and increase the level of certain skills and knowledge, in particular those least mastered by students, we try to improve the process of mathematics teaching by developing an ICT-supported course for individual learning of mathematics.

Mathematical competences at Polish secondary schools

Mathematical competences and basic competences in science and technology are ranked third in the list of "Eight key competences for lifelong learning" (Key competences, 2007).

Key competences were defined, developed and accepted in the document "Recommendation of Council and Parliament of European Union 18th December 2006 – key competences issues in the process of long life learning". The document says that "Competences are defined as a mixture of knowledge, skills and attitudes appropriate to the situation. Key competences are those, which people need for personal development, social integration, activity and employment" (Recommendation, 2006).

Mathematical competences can be found in the current mathematics core curriculum, which is in accordance with the Regulation of the Minister for National Education (in 2012) on the core curriculum for pre-school child development and general education in specific types of schools (Journal of Laws 2012, item 977, p. 245).

After graduating from the primary school a student continues general education at the third and fourth stages of education. The third stage of education in Poland is executed in junior high schools, whereas the fourth stage of education is executed in secondary schools. Although they are executed in two different types of schools, the third and fourth stages of general education form a coherent whole and constitute a basis of education, which enables students to gain varied professional qualifications and improve or modify them at a later stage, opening the process of lifetime education.

In accordance with the Regulation, an important aim of the school at the third and fourth stages of education is to prepare students for living in the information society. Teachers should create favorable conditions so that students could acquire skills in searching, ordering and using information from different sources with the application of ICT from different subjects.

The Regulation also contains teaching content, i.e. detailed requirements concerning mathematics at the fourth stage of education.

Research purpose

The main purpose of the research is to develop and assess the system for mathematics learning with the application of ICT, the element of which is a didactic tool – eLearning course which contains a teaching module developing mathematical competences of students. It is enriched with the elements of programmed learning and applies the principle based on the gradual increase of a difficulty level.

System for individual learning *Mathematics with Moodle*

The development of the author program *Mathematics with Moodle* is based on the ADDIE model, whose name is an acronym of English words: analysis, design, development, implementation and evaluation (Clark, 2002). The ADDIE model consists of the analysis phase, assumptions and conditions, course design, development of course component, implementation and evaluation. Developing a good e-course, which runs under the ADDIE model, is an ongoing process. The evaluation stage is followed by the analysis stage, which starts the next phase of working on the course and which is aimed at the creation of a bug free, efficient and user friendly product.

Analysis

The training goals and expected results of the proposed system were defined (Heba, 2013). Those were followed by surveys intended for 500 students and 500 teachers in secondary schools. The detailed results of the surveys are described in (Heba, 2009). Based on the results, the computer software was designed to support

- teaching of mathematics as well as technology connected with eLearning;
- extending knowledge and selected mathematics skills.

Subsequently, an analysis of mathematical competence of secondary school students in Poland was conducted. The results can be found in (Heba, 2013). Mathematics tasks for an eLearning course were organised according to Niemierko's taxonomy of educational goals: A, B, C and D (Niemierko, 1999).

Design

Following the examination requirement standards, the system contains the description of objectives and tasks for mastering of mathematical competences for upper-secondary schools. The schedule, organizational structure, duration and pace of the proposed learning system were outlined.

It included

- the scheduled extent of extra classes with the *Mathematics with Moodle* (max number of classes):
  - 64 classes (32 weeks x 2 classes) in school in a computer room or using tablets;
  - 128 classes (32 weeks x 4 classes) individually at home.

  total: 192 classes
- aims and objectives;
- educational and didactic goals;
- pedagogical goals;
- hardware and software requirements;
- ways of implementation;
- methods and forms of work;
- teaching aids;
- educational content;
- specific program for implementation in classes;
- students' competences required before the start of additional mathematics instruction;
- expected students' competences after the completion of the course;
- communication procedures;
- conditions of course completion;
- evaluation of the system *Mathematics with Moodle*.

The charts and diagrams representing the manner of training content were developed. In order to verify the hypothesis of the potential increase of mathematical competences for a particular topic, a prototype class in the eLearning course with the application of the *MatLearn* module was created and tested in an experimental group. The methods and conditions for assessing were specified. System evaluation and data collecting methods for analyzing and reporting were established.

An analysis of objectives, scope of teaching, activities of a teacher in the course is followed by the formation of the educational content in the eLearning environment. It is assumed that the program corresponds to mathematics in terms of subject matter and is constructed according to the following rules:

The eLearning course should have a module structure and should consist of several standard blocks (Smyrnova-Trybulska, 2009):

- introduction: educational objectives, abstract, contents, references, definition of terms, forum, registration questionnaire;
- thematic modules: pretest (diagnostic test), study materials, block of tasks, verification of information, creative tasks, interactive communication – teacher with students and among students;
- summary: exam test, final questionnaire.

The system *Mathematics with Moodle* contains:

- documents: new mathematics core curriculum, Polish educational program *Matematyka z plusem*, Central Examining Board's Guide for school-leaving examination;
- eLearning course preparing students for the school-leaving exam in mathematics with the author *MatLearn* module available at www.matlearn.pl (Fig. 1);
- user manual for students.

Fig. 1: Homepage of the portal *Mathematics with Moodle*

Following the evaluation of the system, necessary adjustments were conducted, which resulted in the creation of a methodological guide for teachers. It includes numerous scenarios of mathematics classes with the use of the eLearning course *Mathematics with Moodle*.

A course preparing students for the school-leaving exam contains the following parts (Fig. 2):

- introduction to the course;
- eight eLearning units, each of which will contain a maximum of five classes;
- sets of tasks for the previous years' versions of the school-leaving exam;
- end of the course.

The eLearning course contains a module that forms mathematical competences. The module is controlled by the *if–then–else* condition. It verifies whether the condition placed after *if* is fulfilled. If it is, the block of instructions following *then* is realized. If this condition is not fulfilled, the block of instructions following *else* is realized.

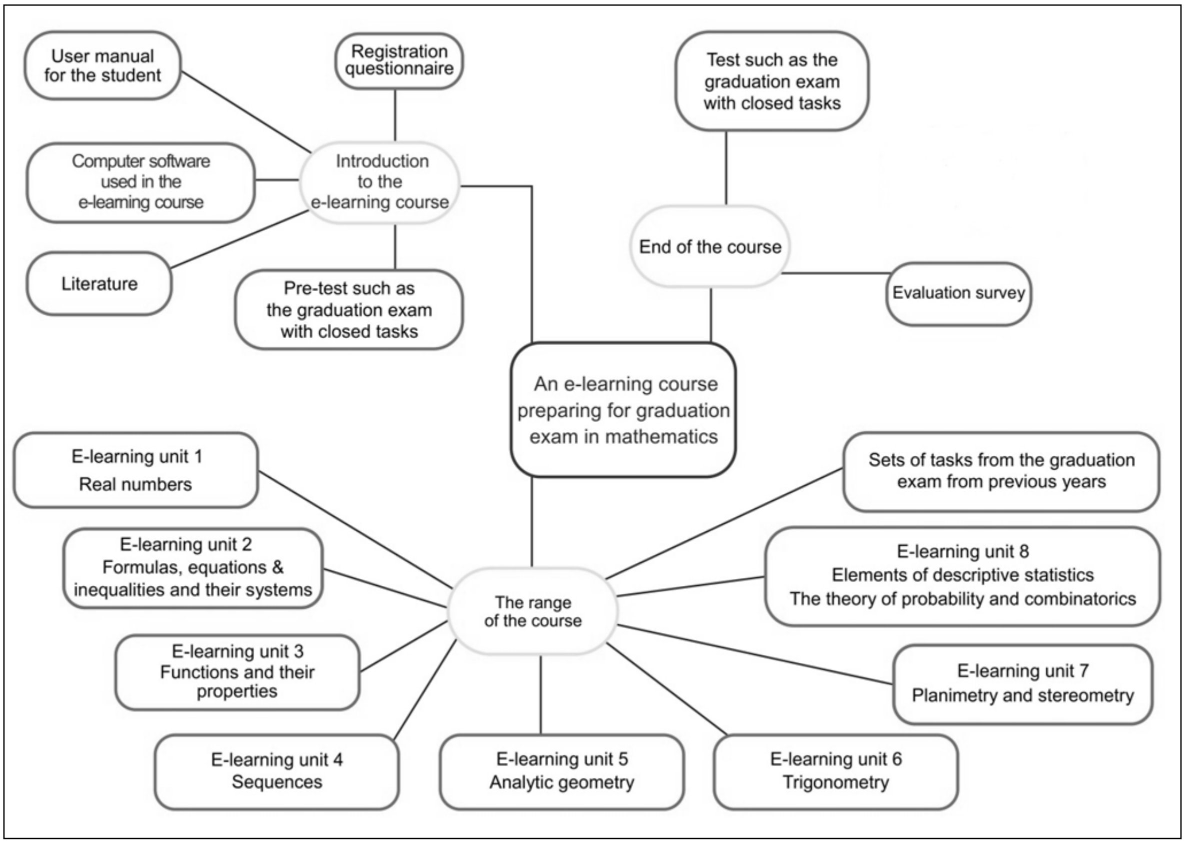

Fig. 2: Structure of the eLearning course

Development

The final product – the eLearning course is developed. Study materials, tasks, *GeoGebra* applets and tests are prepared. The *MatLearn* module is based on a number of theoretical resources (Bertrand, 1998): behaviorism (Skinner, 1977), constructivism (Weicker, 2004) as well as Niemierko's taxonomy of educational objectives (Hudecová, 2003 and Niemierko, 1999) and Skinner's programmed learning elements as described in (Kapounová and Pavlíček, 2003):

- principle of small steps;
- principle of active response;
- principle of immediate confirmation;
- principle of self-pacing;
- principle of self-evaluation.

Nowadays, computers at schools may be used as teaching machines for the realization of programmed learning in combination with hypertext and multimedia being used in eLearning courses.

Implementation

Study materials are stored in the Moodle platform and information on how to operate the course is given to students and teachers in the form of specific training sessions. An administrator helps with technical problems and teachers help students with their mathematics problems. The training/experiment is managed according to a schedule planned in the design stage. During the pilot stage the functionality of the *MatLearn* module was tested and the contents of Niemierko's categories, mathematics tasks, timing of tests, and students' understanding of tasks were verified.

Evaluation

At the final stage the operation, form and content of the course were evaluated. The formal evaluation of the eLearning course follows mainly Kirkpatrick's model of the effectiveness of training (Kirkpatrick, 2009).

MatLearn module structure

Each level of the *MatLearn* module contains the following (Heba, 2013):

- *Test I* – contains tasks from a particular level of educational aims. The results of the test tell a student whether they need to become acquainted with other parts of this level, or if they can continue at a higher level.
- *e-tasks 1* (a maximum of 5 tasks) – contain the solved tasks; among others the tasks solved with the help of the *GeoGebra* program.
- *Test II* – a summary of the most important parts of a class. It contains tasks for independent solution (a maximum of 5 closed tasks).
  The module contains feedback – evaluating to what extent the aim of a particular class was met; information about incorrectly solved tasks (which of the tasks were solved incorrectly).
- *e-tasks 2* (5 tasks) – support the development of students' mathematical competences. They consist of an additional set of the *e-tasks 1* type (5 sample tasks) and also use the *GeoGebra* program.
- *Test III* – a student has to solve the test if they did not pass the *Test II*; and when they become acquainted with particular parts of the *e-tasks 2* (5 tasks).
- *help-teacher* – consists of solving the *Test I*, *Test II*, *Test III* tasks, the results are analyzed either individually or with a teacher (through a chat or a forum, or through tutoring at school).

The test results are saved automatically. Three Moodle platform databases cooperate with the module:

e) student database with the results of pretest, posttest, retest, and solved school-leaving exam tasks;

f) student database with the results of pretest, final test, and retest;

g) database of a student's activities, in which information is stored:
   in which way a student used individual parts of an eLearning unit;
   what their study path was like within the scope of the *MatLearn* module.

Progression of a student passing the *MatLearn* module:

h) fills out the registration form;
i) goes through the Moodle platform instruction manual and is redirected to study sources;
j) solves the pretest and acquires information about which mathematical competences they handle the worst at the beginning of their preparation for the school-leaving exam;
k) continues by reading the theoretical part;
l) solves the *Test I* (*Tests II* and *III* respectively) on the A level; according to the results, they proceed to the B level, or intensify the subject matter on the A level.
m) if they remain on the A level, they proceed to the *Test II* (*Test III* respectively) through the *e-tasks 1* (*e-tasks 2* respectively);
n) if a student remains on the A level even after the completion of the *Test III*, they use the *help-teacher* part where they can find the solutions to the *Tests I-III*, which they then analyze by themselves or with a teacher;
Note: if a student needs to use the help-teacher to proceed to the next level, they are awarded a "failed" grade, which influences the overall grade for the course;
o) realizes the higher B level (C and D respectively) in a similar manner as they realized the A level;
p) at the end of a study unit a student solves a task – a set of open tasks evaluated by a teacher, who then sends the results to a student (via Moodle);
q) continues on the A level in the following classes (new topic);
r) at the end (after completing all the eLearning units), a student solves 5 sets of school-leaving exam mathematics tests compiled by the Central Examining Board; the correctness of the solved tasks can be verified in the *help-teacher* section;
s) after completing the course, a student solves the same test as when entering the course and compares whether they have improved the competencies that were problematic at the beginning.

Evaluation

t) a student evaluating the eLearning course (evaluation questionnaire);
u) a teacher analyzing a student's work, which results in a grade which has an impact on the final grade for mathematics;
v) all the information about a student's passing the course is stored in the database of their activities.

Pedagogical experiment and results

The research sample comprised 58 students and was divided into two groups with the same number of students. The experiment took place within the mathematics tutoring sessions. In the eLearning course, the experimental group (EG) had 4 classes a week at home and 2 classes a week at school. The control group (CG) had two classes taught at school (with the use of ICT, including the GeoGebra program) and 4 classes of independent work at home without the access to the eLearning course. The tutoring in both groups followed the same pattern. Students' taking part in the experiment was voluntary. Test data and results for each work stage were stored in a database and then processed in MS Excel.

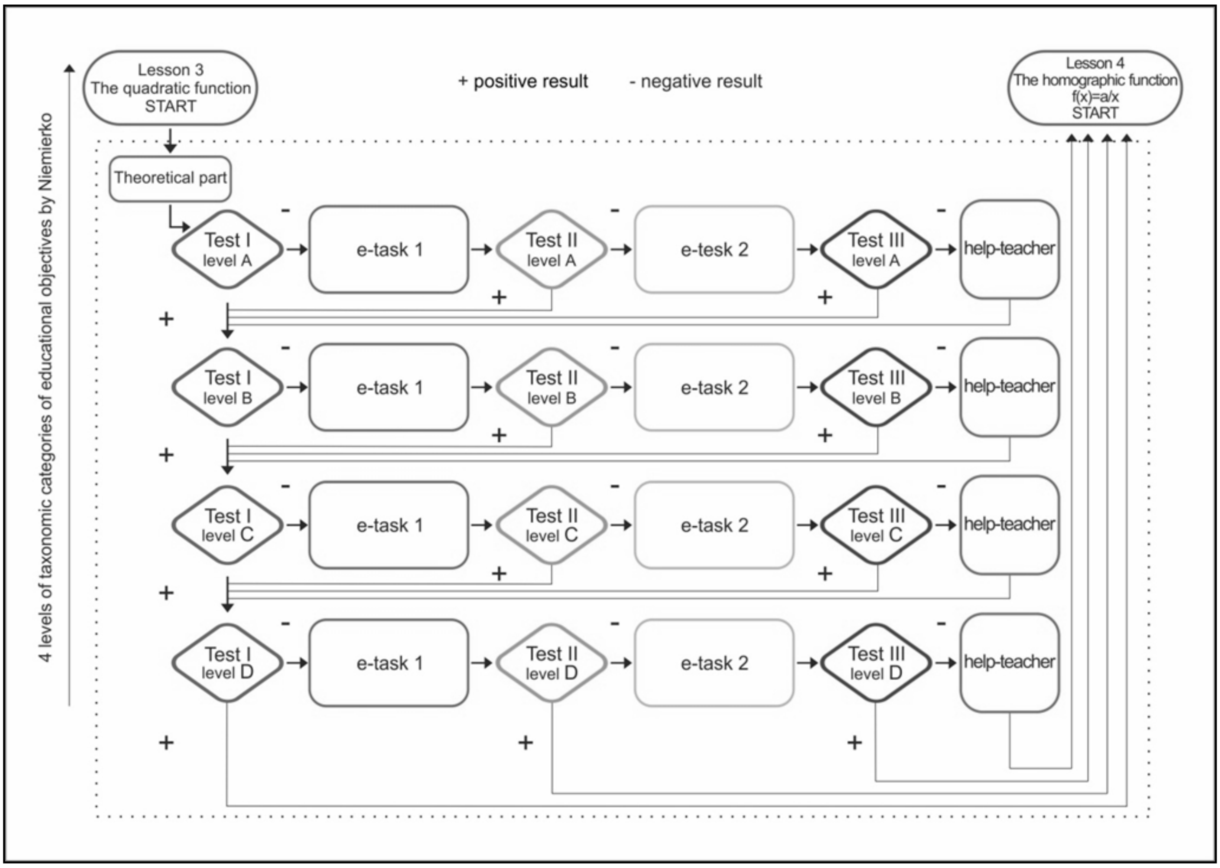

Fig. 3: Structure of the *MatLearn* module

Tested hypotheses

H1 – When using the proposed eLearning mathematics course, the mathematical competences of students improve (compared to the students working by conventional methods).

H2 – The development of mathematical competences with the help of the eLearning mathematics course influences the posttest results in particular areas of mathematics:

Functions and their qualities
Analytic geometry
Planimetry and stereometry

H3 – There is a relation between the posttest results and students' motivation

H4 – There is a relation between the posttest results and the average evaluation at the end of the second year.

H5 – Teaching by the proposed eLearning mathematics course influences students' acquiring more permanent mathematical competences.

For H1 – H5 zero and alternative hypotheses were established.

Experiment results

The results of pretest, posttest and retest were used to find out whether the learning results of EG and CG are different and whether the EG students studying by the proposed eLearning course improved their results. The analysis of the results proved that:

- The EG students achieved a higher level of mathematical competences than the CG students (both overall and in individual tested areas of mathematics) (*Functions and their qualities, Analytic geometry, Planimetry and stereometry*).

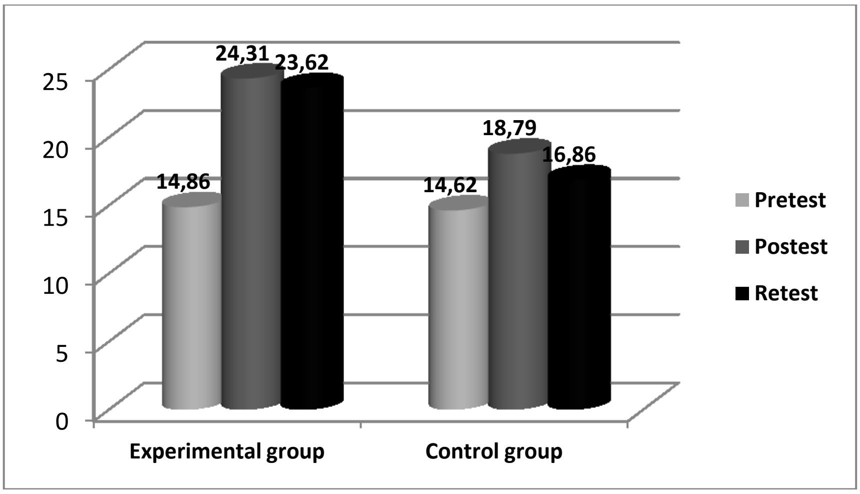

Fig. 4: Arithmetic mean of the pretest, posttest a retest results

- As far as the relative effect (Juszczyk, 2001) of learning is concerned, it can be said there is a relation:
  - Between the posttest results and students' motivation; correlation is significant.

  If a student is motivated by the school-leaving exam in mathematics, their posttest results are better.
  - Between the posttest results and the average evaluation at the end of the second year; correlation is significant.

  If a student's average evaluation at the end of the second year is higher, their posttest results are better.

Note: relative effect of learning in percentage $E = \sum_{i=1}^{N}(\frac{V_{post}-V_{pre}}{V_{max}-V_{pre}} \cdot 100)$

V_{max} – highest possible result of learning; V_{pre} – achieved result according to the pretest;

V_{post} – achieved result according to the posttest.

At the end of the experiment, the EG students and high school mathematics teachers from Katowice evaluated the eLearning course that prepares students for the school-leaving exam in mathematics.

Students evaluated working with the course study materials, which mathematical topic they liked the best, which of the course components they liked and why. The majority of students (25 out of 29) answered that the course motivated them to extend their knowledge of mathematics. All the EG students are convinced that the information and skills that they acquired in the course will be useful for the successful completion of the school-leaving exam.

Teachers (30 respondents) filled a questionnaire, which was compiled according to the criteria for the creation of a good online course (Smyrnova-Trybulská, 2012). The results can be found in Fig. 5.

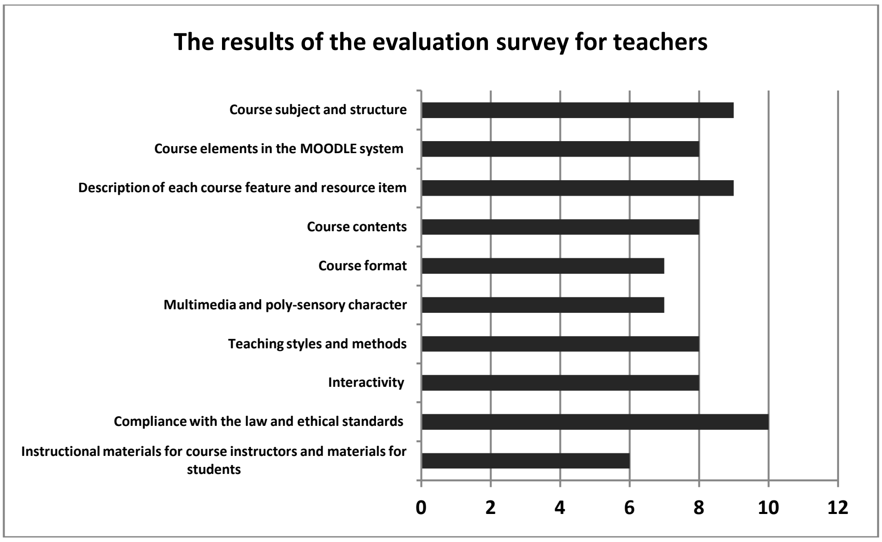

Fig. 5: Results of questionnaire for teachers

Conclusion

The mathematics author course, which contains elements of programmed learning, was proposed and tested. It is based on Niemierko's taxonomy of educational aims and works on the principle, which is based on the gradual increasing of the difficulty level of the solved tasks. The proposed system is realized as a Moodle platform eLearning course. It was tested for three areas of mathematics: *Functions and their qualities, Analytic geometry, Planimetry and stereometry*.

The mathematical experiment, which took place in the experimental and control groups, proved that students, who used the *Mathematics with Moodle* system for their preparation for the school-leaving exam, improved their competences in the taught areas of mathematics.

Observations and findings acquired during the pedagogical experiment brought ideas for further development and practical improvement of the course such as:

- Designing a system for the individual teaching of mathematics *Mathematics with Moodle* for the entire cycle, which would be designed for elementary and advanced levels of high school;
- Comparing the results of the school-leaving exam in mathematics of the group, which took the mathematics eLearning course, with the results of the school-leaving exam in mathematics in the region/Poland;
- Monitoring a student's teaching trajectory on a Moodle platform;
- Adapting the proposed system of learning to other subjects/contents in Polish high schools

and many others.

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APPLICATION OF ICT IN TEACHING PHYSICS FRICTION

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Abstract

The Physics of friction is an important topic in the teaching of physics at schools of all types and also of our everyday interest. Students, however, are often unable to imagine the applicability of what they learn to real-life situations; therefore, experiments should be an integral part of the teaching and learning of physics. The main objective of this experiment is to demonstrate static and dynamic friction on inclined plane with commonly used surfaces. Experiment have been designed as such that he is not difficult for students and teachers and, at the same time, he use the basic concepts of friction to measure the coefficient of static and dynamic friction.

The article presents a newly constructed school tribometer, which is accessorized with Vernier sensors in the physics classroom to demonstrate problems in the mechanics curriculum for middle schools, high schools and universities. The method of finding the static and dynamic friction coefficient described in the text is: Determination the coefficient of sliding friction through with the aid of changing the inclination of the tribometer.

Keywords

Friction, Coefficient of dynamic friction, Tribometer, ICT, Education

Introduction

Tribology is the science and engineering of interacting surfaces in relative motion. It includes the study and application of the principles of friction, lubrication and wear. Modern tribology began some 500 years ago, when Leonardo da Vinci deduced the laws governing the motion of a rectangular block sliding over a planar surface. Hundreds of years later, in 1699, the French physicist Guillaume Amontons published the first formal account of the classical, macroscopic friction laws. He found that the frictional force that resists the sliding motion between two interfaces is directly proportional to the perpendicular force that squeezes the surfaces together. In addition, the frictional force is independent of the apparent area of contact. Charles Augustin de Coulomb later proposed a third law of macroscopic friction, which states that at ordinary sliding speeds the frictional force is independent of velocity.

Since the 1990s, new areas of tribology have emerged, including the nanotribology. These interdisciplinary areas study the friction, wear and lubrication at the nanoscale, for example: materials in biomedical applications. Many industrial processes require a detailed understanding of tribology at the nanometer scale. The development of lubricants in the automobile industry depends on the adhesion of nanometer layers (mono layers) to a material surface. Assembly of components can depend critically on the adhesion of materials at the nanometer length scale.

Practical exercises in physics friction focus on improving the quality of results with the use of ICT. The opportunities include using data-loggers and a PC in order to process data and control variables as well as understanding the principles, their scope and limitation and modelling the processes, (including information from the Internet).

Materials and methods

New constructed school inclining tribometer

The new declinable tribometer was used to determine the coefficient of dynamic friction for common materials such as spruce wood, perspex, sand paper P180). This method was carried out with Vernier data-loggers, which made lessons more effective and improve the quality and accuracy of data collection and data analysis when connected to a PC.

The new tribometer may be used in secondary school or college Physics to demonstrate problems in mechanics enables taking measurements for the following type of problems:

- Finding the coefficient of static and dynamic friction for motion on flat or inclined plane
- Finding the coefficient of rolling friction
- Measuring kinematic quantities of a body moving on a horizontal and inclined plane
- Construction of a tribometer may also be used to demonstrate a fibre friction

Another significant advantage of this inclinable tribometer is its angle, which lies in the range between – 90° and 90°. This enables measurements of surfaces with very high dynamic friction coefficients.

These methods enable students to verify the following claims through experiments:

- The direction of the frictional force is always opposite to velocity and acts at the point of contact between the moving body and the surface.
- Friction is directly proportional to the component of weight normal to the surface.
- The coefficient of dynamic friction depends on the material of the moving body and the properties of acting surfaces (how rough they are).
- The coefficient of static friction is greater than the coefficient of dynamic friction
- There is a relationship between the coefficient of dynamic friction and the angle of the inclined plane.
- Friction can be useful or nuisance and the frictional force can be altered.

Fig. 1: Newly designed school inclining tribometer

Fig. 2: Universal protractor attached to the inclining tribometer

Material of the removable tribometer test pad: Spruce wood, shaped by grinding
Materials friction body: Perspex, Sand paper P180

Determination of the coefficient of friction through finding the friction angle with the school tribometer (Vernier system)

The method is based upon moving a test body along the inclined plane of the tribometer, which allows altering the angle of inclination. The test body starts to move at the point when the angle of inclination is being increased. The angle at which this happens is called the friction angle and it allows us to determine the coefficient of friction.

Vernier sensors used:

- Sensor LabQuest mini
  LabQuest is a standalone and computer interface for Vernier sensors.

- Position and motion detector Vernier
  The motion detector uses ultrasound to measure the position ball, people, etc. Attaches easily to the Vernier dynamic system. Sensitivity switch reduced noise and produces higher quality data for studying dynamic carts on tracks.

- 3D gravitational acceleration sensor Vernier
  The 3-Axis Accelerometer consists of three (–5 to +5 *g*) accelerometers mounted in one small block. Using the appropriate data collection hardware and software, you can graph any of these components, or calculate the magnitude of the net acceleration. The 3-Axis Accelerometer can be used for a wide variety of experiments and demonstrations, both inside the lab and outside.

The testing surface of the tribometer was set in a horizontal position, using a spirit level and universal workshop protractor, and a 3-D sensor for acceleration due to gravity was attached. The 3-D sensor measures the *x, y* and *z* components of acceleration due to gravity and it was used to measure the angle of the tribometer testing plane. The sensor was attached to the pivoted joint of the inclining tribometer. The *x* axis was chosen to be along the testing plane of the tribometer, *y* axis was perpendicular to it (vertical). The 3-D acceleration sensor was connected to CH 1 of the LabQuest, which was connected to a PC. The settings on the Logger Lite programme were as follows: Duration of sample 10 s, sampling frequency: 50 /s.

The sliding test body was placed on the tribometer testing plane. The angle of inclination was increased until the body began to move. Vernier data-loggers enabled us to find the *x,y* components of the acceleration and the friction angle was found as $\tan\alpha_0 = \frac{a_y}{a_x}$

At the moment when the test body begins to move:

$$\vec{F}_p = \vec{F}_t$$

$$mg\,sin\,\alpha_0 = f_0 mg\,cos\,\alpha_0$$

And therefore the coefficient of static friction is: $f_0 = \tan\alpha_0$
Coefficient of dynamic friction is : $f = \tan\alpha$

F_p- movement force, F_t - frictional force , g - acceleration of gravity
When the coefficient of dynamic friction was measured, the test body was moving at a constant speed down the plane, which was monitored by the Vernier position and motion sensor. Two bodies of different masses were used to find the coefficient of dynamic friction for each pair of surfaces. Each measurement was repeated 10 times and the average value was calculated.

Results

	m [g]	Friction angle α_0 [°]	Friction angle α [°]	f_0 [1]	f [1]
Average value	$m_1 = 138{,}507$	17,244	16,826	0,310	0,302
Average value	$m_2 = 256{,}800$	17,140	16,921	0,308	0,304

Tab. 1: Values of coefficient of static and dynamic friction obtained (spruce wood and perspex) Vernie

	m [g]	Friction angle α_0 [°]	Friction angle α [°]	f_0 [1]	f [1]
Average value	$m_2 = 102{,}014$	33,472	32,758	0,661	0,643
Average value	$m_4 = 216{,}040$	33,269	32,296	0,656	0,632

Tab. 2: Values of coefficient of static and dynamic friction obtained (spruce wood and–sand paper P180) Vernier

The measurement results correspond to the theoretical dependencies. The measurements were validated by the relationship between the coefficient of friction, frictional force and normal force. It was confirmed by the dependence of the coefficient of friction on the angle of the inclined plane. The work verified the claim that the static coefficient of friction is greater than the dynamic coefficient of friction.

Conclusion

Friction is a force that resists motion and lessens energy. It acts parallel to objects that are in contact with each other. Friction can be either helpful or harmful. Friction is helpful when you want to slow or stop a bicycle, but it is harmful when it causes wear on the parts of a machine. Sliding friction depends on the nature of materials in contact. Some surfaces are rough. Other surfaces are smooth, causing them to slide easily. Engineers are concerned with friction when designing machines, fasteners, and lubricants. In this activity was studied the effects of surface smoothness and material properties on sliding friction.

Contribution of this work is the validation of the current knowledge concerning the measurement of the coefficient of friction by using the Vernier measurement system. Vernier data-loggers enable us to measure several quantities simultaneously and display the relationship between them. Data can be transferred to other programs and can be saved for later data analysis. Using Vernier data-loggers also helps students be more competent in the use of ICT.

ICT makes an integral part of Physics lessons since it enhances understanding of practical findings. The computer serves as an output unit, which monitors and visualizes the results of the measurement. Teaching Physics through data-logging belongs to cognitive technologies, during which the teacher uses special programmes for the course. This implementation allows students to gain knowledge and skills in numerous ICT areas, that are inevitable for modern people.

Acknowledgements

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ROBOTIC SYSTEMS IN TECHNICAL EDUCATION

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Abstract

We can call the current situation concerning technology and crafts, without exaggeration, the "dark age technology." Masters that are able to pass their knowledge and skills on their apprentices are disappearing and crafts lost the social prestige. Knowledge can be preserved in books, electronic media, animations and movies, but experience and skills can be passed only if masters and their apprentices work together. We can't wait for changes in legislation and social perspective on this issue. For several years, we are trying to find ways to bring the young generation back to technology. We are trying to rise interested in technology, we are trying to change attitudes and learn patience, diligence, consistency and precision. Our more than five-year work starts bearing fruit. This paper aims to briefly show some results of our research and suggest ways how to stop the current trend, or even reverse it.

Keywords

Technical education, technical subjects, robotics, robotic systems, voluntary courses, motivation

Introduction

We can call the current situation concerning technology and crafts, without exaggeration, the "dark age technology." Masters that are able to pass their knowledge and skills on their apprentices are disappearing and crafts lost the social prestige. Knowledge can be preserved in books, electronic media, animations and movies, but experience and skills can be passed only if masters and apprentices work together. We can't wait for changes in legislation and social perspective on this issue. For several years, we are trying to find ways to bring the young generation back to technology. We are trying to rise interested in technology, we are trying to change attitudes and learn patience, diligence, consistency and precision. Unfortunately, the situation in our educational system has a negative impact. The poor interpretation of the Charter of Fundamental Rights of the Child has led to anarchy not only at schools. Discipline has subordinated to a child and his education is regarded as suppression of his development and individuality. The basic principles of education are forgotten and it needs to be reminded that education must first act upon external authority that will teach all children the basic rules and habits, and only then it is possible for the child to follow the principles of internal authority (Vališová, 1990). Children should be thus able to sufficiently and individually develop and in doing so, to honour and respect the basic social rules, laws and principles, and not to run away from problems. They should be able to confront problems and deal with them, appreciate honesty, be consistent, careful and patient. Technical subjects and disciplines naturally develop these qualities and skills. In addition, they create natural environment for natural mutual authority between a teacher and a pupil and among pupils themselves. Without the cooperation, teamwork, the basis of successful work in most fields, is not possible.

We are not able to improve the above situation just by a few simple changes in the current way of teaching. It requires a comprehensive approach – we have to start by addressing the younger generation and their parents. Also increasing the prestige of crafts will allow systematic changes that will result in an overall improvement in this situation. It is not easy, but it is very important. Let's look at a few fundamental areas where changes must take place.

Teaching method

As already mentioned, the first most important task was to find a way to educate children in classes so they would learn everything important. Since our school system was considered the best in the world in the eighties, which was confirmed by Professor Millo Shott, the co-founder of the Open University, at the week of distance education in České Budějovice in the spring of 1995, it was decided that pupils will follow authority and discipline and be educated in this way. However, the school nowadays is completely different. Therefore, a research was carried out in the form of the after school activities and the parents had to confirm that they agree with the teaching method.

Fig. 1: Work in courses "Electronics via play" and "Build a Robot"

It started with courses called "Build a Robot", "Electronics via play" and one year later "Building and programming robots." After six months, we met with parents and pupils and asked using directed interviews how they perceive the method of teaching mentioned above.

Parents and children praised this method of teaching. We teachers appreciated the work in the courses, the behaviour of pupils and their approach to work. It turned out that this is a good way to follow and we should prepare a methodology of work for such courses.

Even a few hours of teaching have significantly improved the atmosphere in the class, the kids enjoyed the work, and they soon began to collaborate spontaneously.

We also have to focus on important qualities not only of future engineers – patience, diligence and consistency, which is another important task. Technical education and training in technical subjects allows us to actively develop these qualities, and therefore the courses were carefully prepared with regard to them.

It took a little longer than the pupils started appreciating their work. At first, they didn’t like when they had to remake their products, before they have learned to work the best they could according to their capabilities. This situation lasted for three months. After that, they were able to produce their first really good and nice product. Very strong motivation for them was the reaction of parents and friends, when they brought the finished product home or to school. As early as the second product, they started to notice inaccuracies and imperfections and tried to repair or remake the product until it was good. They, of course, found some imperfections in the end, but it is natural.

They also learned to take care of used tools to maintain order at work, and not to give up when they encountered a problem. They learned not run from away from the problem, but to deal with it and overcome it.

Course type selection

Even if we had some ideas about what might entertain the children and how to motivate them for systematic education in technological areas, it was necessary to start to systematically pursue this issue. We have started to prepare and realize robotic days and workshops for elementary school pupils where they themselves could build simple electronic circuits, program and control robots, etc. Our experience with the scientific days significantly helped us with the content as well as addressing children. It turned out that electronics, automation and robotics sounds mysterious and interesting for children and has a broad technical scope from the perspective of technology. These areas extend from engineering, through technical design, electronics, microprocessor technology, communication systems, IT technology to artificial intelligence.

Fig. 2: Robotic days at elementary school

Thanks to the robots, the pupils can learn to develop, design and program systems working in real time and write drivers for computer components. Also, they learn philosophy of diagnostics, analysis, management, algorithm development and behaviour of systems around us. This training can and must focus on different application domains according to pupils' interests and needs of the labour market.

Teaching robotics systems should be focused in two directions. The first direction is a systematic and targeted education of the target groups of children that will lead to a high level of knowledge, skills and habits and will direct and shape pupils professionally. For this purpose, there are training courses organized by "Technické kurzy s.r.o". These courses lead children from third grade school to university.

The second direction is focused mainly on teaching teachers who will use the robotic systems together with their pupils at school. These systems are suited to be used in many subjects from design and construction of various devices in technical subjects, to support and demonstration in science subjects such as Physics, Biology, Environmental education, Geography, etc. Children learn there through these systems about measurement and analysis and to explore the behaviour of systems around us with practical examples such as what happens if a way of the system control and its behaviour changes, when the system does not respond properly to changes, etc.

They also become familiar with the latest technologies, intuitively understand the differences between various solutions and get the idea of the technology in a broader sense. They also find out what is involved in various professions. All of this is preparing them for the choice of a future profession. Teachers can thus in a natural way find out childrens' talents. Children will learn about a variety of new, unseen professions. By cooperation between teachers and parents, children can not only choose right when deciding about the future study or craft, but it is also possible to prepare children systematically in training courses according to theirs interests.

When to start and what we need

We have started with robotic education in the seventh to ninth grade using robotic systems "RoboRobo". These systems fulfilled most of the requirements with respect to the price and options. After six months of teaching, I was asked by Mgr. Dana Tunkrová whether it would be possible to begin teaching children in the third grade of primary school and thanks to her great help it was possible to realize it. Before we started working with these third graders, we felt a bit sceptical but it was very quickly replaced with joy and enthusiasm. It turned out and confirmed many times that we have found the best age for teaching. This however required adapting teaching methods. Again, a great deal of the work was done by Mgr. Tunkrová who is not unfortunately among us anymore. Nevertheless, the way she showed us was confirmed to be the best.

Fig. 3: Course "Design and robot programming" in the third grade led by Mgr. Tunkrová

Gradually, we have begun to create teaching methodology. We were bringing robotic systems to classes, but it turned out that this was not the ideal way. Children could play with robots, learn, train and work independently only in the course and not at home individually.

However, problems with robotic kits such as unstable structure, large power engine usage or unreliable programming environment also appeared.

Doc. Hrbáček thus started the development of his own kit. Based on previous experiences and needs for creation of high quality courses and for the possibility of realization of whole systems, the kit was not created as a toy for children, but rather as an open modular system using standard electronic an processor modules widely used in electrical engineering, automation and robotics. This gives the possibility to create not only widely modifiable kit, but also a system allowing creation of real systems or prototypes of professional systems and devices. Sýkora company then began the kit production.

In relation to the broad needs of the kit, the development and production shifted from "kit as a toy for the children" to "kit as a real system". The kit was called H&S electronic system. This kit was supplemented with a universal multipurpose robotic undercarriage and can be combined with MERKUR kit. The basic kit can be easily and dynamically extended with many other components such as wireless Bluetooth communication module, data bridges, IR sensors and remote controls of standard SONY 12 bit, a very fast bus bar, SPI, USART with baud rate of 2400 Bd/115200 Bd, gyroscopes, processor modules for the use of a large number of different types of processors from different manufacturers, etc. If there is any component destruction on the modules, it is very easy and cheap to fix it or any part of the kit can be sold separately.

Basic kit uses a PICAXE processors and graphical development environment from the same company, which is suitable for teaching in courses of robotics since the third grade. If we replace the basic processor for another processors with costs tens to hundreds of crowns, we can gradually switch to programming in Assembler language, C, etc. Then we are able to manage and implement even the most demanding professional systems.

Thanks to the low cost of the kits, it was possible for all the pupils to have their own kit in the courses. They learn to fix it by themselves and in the fifth grade they individually mount PCB and they can even work with SMD components. Therefore, if something happens with the kit, they are able to repair it by themselves.

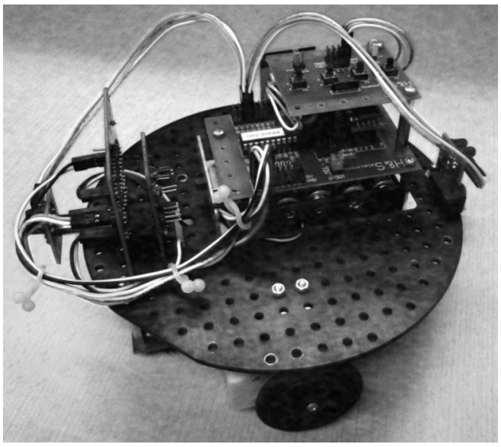

Fig. 4: On the left the basic H&S robot composition, on the right the pupils from third to ninth grade on a national competition "Design and robot programming for elementary school pupils" in June 2013

The robotic kit can be used in various practical applications. For example, it is currently being used as a measuring system that measures the temperature in a bee hive and weights the bee hive in the arboretum. The measured data are passed to the website of the arboretum, where can also be seen the honey harvest and life in the hive thanks to the installed camera.

A student Jíři Jursa is currently working within his bachelor thesis on a design and prototype of a small greenhouse suitable for schools and households. The robotic kit is used for realization of automatic electronic control of the greenhouse (ventilation, shading and watering).

In order to popularize and raise motivation of children, a second year of national competition "Design and robot programming for elementary school pupils" took place, which was supported by the Regional Chamber of Commerce South Moravia, and the Department of Technical Education and Information Science, The Faculty of Education, Brno. The competition took place at the elementary school in Židlochovice. The categories in the competition were 3rd – 4th grade, 5th – 7th grade and 8th – 9th grade of elementary schools. There was also a category for pupils of optional robotic courses, where there were the same categories as in the case of elementary schools. There was also a category for the lectors of robotic courses. Within the competition, the robotic day also took place where the competitors became teachers and taught their parents and others to program robots.

The competition was attended by thirty pupils from two elementary schools in Brno and from primary schools in Židlochovice and Svitavy.

Conclusion

In the school year 2013/2014 we have been training courses at four elementary schools in and around Brno. Robotic kits have been used by two vocational schools (Svitavy, Sokolnice), three universities (Masaryk University in Brno, Constantine the Philosopher University in Nitra and University of Patras) and six elementary schools. There have been five trainings for elementary school teachers. It turned out that the methodology of training courses can be applied even in its basic form and teaching has been running as expected.

Concerning the elementary school pupils, the perfect age to start working in courses is from third to fourth grade. Contrary to previous assumptions, the fifth and the sixth grade are already on the edge. It is beyond the scope of this contribution to describe in detail how we have come to the above findings, because it would be worth publishing in the form of a scientific monograph.

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USE OF GOOGLE TOOLS IN SCHOOL. LIMITATIONS AND OPPORTUNITIES

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Abstract
New media are increasingly used in education at the primary school level fulfilling the assumptions of cognitivist theories. Progress in this area would not be possible without the offer of many free tools developed by large Internet companies, which are addressed directly to schools. Among them there are Google tools that enable the teacher to implement the educational process. E-mail, virtual disk, calendar, image gallery, maps, translator, scientific literature search engine or combinations of these in the context of working in the cloud, if properly used, can increase the level of education. Educational work with multimedia tools has many advantages, yet involves some limitations and difficulties which are defined as part of the research.

Keywords

School, Internet, Google Tools, E-mail, media education, learning principles

Introduction

The result of the development of new information-communication technologies is a change of the method of functioning of the human being in the society based on digital information. We perceive the changes also at schools, which have the concept of teaching using the new media. Therefore, among the educational goals, there must also be those which refer to media education, which were defined by B. Simieniecki as: -selective selection of information; -dealing with a phenomenon of total takeover of our time by the media; -critical an active reception of messages; -understanding information generated by the media; -assessing from where the message flows, who is the sender and what are the goals; -differentiation Basic theories of the media impact and understanding the context of the message; -analysing, assessing, valuation of media communication; -creating media messages; -assessing new social interactions created under the influence of cyber space; -understanding mechanisms of creating information, presenting it and receiving it; -awareness of threats from the media and prevention therefrom (B. Siemienicki, 2008, p. 17).

As far as the above skills are concerned, we state that the texts of the general education an texts of media education indicate a direction of operation of the school based on new media. In order to realize the concept, it must rely on the tools of information-communication technology, which will be coherently creating a logical entirety. An interesting example of such a system is Google Apps for the schools, being the subject of the considerations. The proposal of Google is worth noticing, first of all, due to access of educational offices free of charge, to offered services. A basic condition to use Google Apps is data communication infrastructure. Thus, the school should have an access to Internet and is to allow for all students and teachers to connect with the Net in any place in the building.

Benefits

Google Apps for Schools and Universities contains many functions and security devices prepared especially in order to assure data security and control over them. Basic tools of Google Apps are based on functions of the computer programmes included in the most popular office packages. The benefits of using the tools of Google Apps include:

- their usage is free and compatible with different computer systems;
- all activities, e.g. creating the presentations, are automatically recorded in a safe cloud;
- resources such as: e-mail, documents, calendar an www websites may be edited from almost any telephone or tablet where the access to Internet is;
- cooperation of students and teachers on-line, due to a possibility to create and edit websites and documents in real time by different persons being the members of the group;
- constant access to free software and servers reduces costs of the school.

Google Apps consists of a few basic tools such as: electronic mail, calendar, virtual disc, documents (spreadsheets, presentations, websites) forms, discussion groups (M. Springer, 2013).

Gmail – electronic mail, which is a necessary element for Google Apps to function. A reception box allows not only to send and collect messages but also text chats, sound and video ones. It means that students and teachers may see who is online and connect immediately. The creation of the a mail account by a teacher for each student of the mail account in the school domain allows to manage the mail accounts effectively. The teacher being the administrator grants permits to students to use the chats, send messages or generate new password in the situation when a student forgets necessary data.

Calendar – allows to plan classes, meetings or exercises of teams of students or teachers. The administrator of the calendar may create access levels to the data located there. Programming the calendar allows to send invitations to the meetings to the selected students or teachers.

Disc – a tool to store data and electronic mail. On the virtual disc, teachers and students may record photo, video materials, create text documents, spreadsheets, presentations, drawings and surveys, which in operation are similar to popular office programmes. The document created on the Google disc may contain graphics and freely formed text. To such documents one may put the graphics coming directly from internet resources. In similar way, as in case of the text-image documents the presentation documents may be enriched with film materials from such services as YouTube. All documents may be directly translated by Google Translator. Another unique option is a possibility to create interactive surveys containing open questions, closed, one- or multiple choice, assessment by the scale. Storing documents in Cloud allows to avoid recording data on the local disc of the computer. Therefore, from any place the teacher and student have the possibility to read and modify the documents.

Creator of websites – allows for the students and the teacher to create their own Internet website. This tool may be used to describe an education project of the students or be used to create internet website of the school or class.

Discussion group – allow to conduct discussion on selected topic. The discussion may be moderated by the teacher, who has a possibility to create defined groups.

Restrictions

Google Apps, however, is not a perfect system, therefore except for many advantages, it has certain limitations:

- tools to create text documents, presentations, spreadsheets have fewer functions in comparison with commonly used commercial programmes. Thus, using at school only tools of Google Apps may be the reason for the students to possess a lower level of skills in the area of using popular office package, namely MS Office.
- implementing Google Apps in education requires to possess large experience in using the system. Thus, if school does not have a person with proper competences, it is necessary to order such a service and this is connected with incurring costs.
- many additional tools which improve the functioning of the Google Apps at school, should be bought. Thus, one should assume that the operation of the Google company tends to introduce more and more number of tools for which one should pay.
- velocity of the operation of online tools not always allows to use them fluently.
- entrusting the files generated by the student and teachers to Google servers makes the work of the company dependent.

Google Apps in connectivist theory

Usage of connectivist theory in the description of the autonomic learning is based on many classic aspects of behaviorist, constructivist and cognitive theories. Conectivism became already a recognized description of the learning environment of informal usage of resources and services of the dynamically developing global network and the social media developing therein (S. Juszczyk, 2012a, p. 12). Contemporary, many fee internet computer system, including Google Apps, allow for implementing the assumptions of the connectivism also in the area of the formal education.

Connectivism similarly as constructivism is based on adopting and transforming a certain definition functioning in another area. This is also the name of model of artificial intelligence, in accordance with which learning involves strengthening certain connections in the brain through using them. In the philosophy of education, connectivism is a concept in accordance with which learning involves combining certain facts or sources and shaping skills of their searching in Internet (G. Siemens, 2004).

In accordance with connectivism, learning is process of creating connections between different junctions and developing the network. Enthusiasts of the theory put a larger emphasis on a skill to search for information than on possessing it. Although in the context of using Internet, the concept seems to be new, from the point of view of the pedagogics, the idea is not inventive. The necessity to break with didactic materialism, called encyclopedism, was declared by fans of fundamentalism (turn of $18^{th}/19^{th}$ c.), and didactic utilitarism (turn of $19^{th}/20^{th}$ c.). The common feature of modern, mature concept of the selection theory of text of education is to overcome unilateral attitude in the selection. Mindless adoption of the conectivism assumptions will result in harmful limitation of priorities in education through identification of the knowledge with the resource of information (M. Słomczyński, D. Sidor, 2012). Therefore, it is significant to find “a golden measure” in realization of the education process, which will be realized in accordance with the concept discussed.

Why is connectivism a popular concept in education? The answer to the question will be found in words of S. Juszczyk (2012b, p. 242) who thinks that „to a larger extent than the present electronic classic media, and including mass media, social media fulfill cognition-education, emotional-motivation functions as well as activity-interaction ones are realized more effectively. They develop better perception, intellectual and execution processes of the learners. They activise them inspire to start social interactions, supplement the limits of our senses, static texts may be changed into dynamic and image, which increased effectiveness of perception and dynamises development of higher level thinking and imagination of the learners". Thus connectivism, which is based on operation of multimedia and social services of global network is an attractive media for a child and an adult. The theory may be therefore successfully used in learning process.

J. Berbaum from the University in Grenoble developed a complex Aid Programme in Developing Learning Skills (M. Ledzińska, E. Czerniawska, 2011, p. 174). The assumptions of the programme correlated with the assumptions of connectivism may be concluded in the following statements:

- a human being uses Internet and mobile devices such as smart phone, tablet, or laptop learns always and everywhere,
- a human being is a subject of his own actions, and therefore an ability to know more than you know is more important than what is known,
- learning with the use of new media is effective, as for the learner the media are attractive,
- ability to learn can be developed by the access to Internet, in which the learner creates new connections of the present and new knowledge.

Using the theory of connectivism and Google Apps in realization of the learning process may be followed also on the example of the following learning principles of R. H. Davis L. T. Alexander and S. L. Yelon (1983, p. 277-286):

Importance principle. As for the modern student, Internet is of large importance, one should expect that he will have a motivation to learn what is presented in attractive manner in the Net.

The principle of necessary initial conditions. It is most likely that the student will learn something new by means of Google Apps tools if he has competences in the scope of using the information technology.

Principle of pattern. It is more likely that the student will acquire new behavior if the patterns in the Internet are presented, which could be observed by him in any place.

Principle of availability. One should expect that the student will command new knowledge easier if he has free access to all messages transferred by the teacher placed on the website, such as Google Apps, for example.

Principle of novelty. It is more likely that the student will learn, if his attention is attracted to the new material, based on Internet services.

Principle of activity connecting the theory with practice. It is more likely that the student will reach education goals, if he participates actively in practical classes. These classes may be performed within the frames of computer simulation.

Principle of dividing exercises in time. Learning will be more effective, if practical classes are divided into short period allocated in time. Logical division of exercises in time and re minding about performing the exercise will allow to use the calendar which is the tool of Google Apps.

Pinciple of extinguishing. It is more likely that the student learns if proper facilitations are gradually withdrawn. Which means that the student will use independently Internet to perceive the connections between the areas, ideas and concepts.

Principle of pleasure. It is more likely that the student will continue the education if the education process is in nice atmosphere. Therefore, strengthening and maintaining connections between gaining knowledge and using the Internet is necessary to faciliate the constant learning.

Both in connectivism and during using Google Apps communication between the student and a teacher is important. E. Lubina indicates that in the education environment the education roles of sender and recipient should be dynamic. The communication should take place bilaterally, based on the fact that flow of messages goes often from student and opposite. The practice shows that despite larger knowledge on Internet from the student, he rarely uses this medium to balance the bi-direction communication. Traditional communication, located in relations between the teacher and the student characteristic for the school and direct contact – has usually unilateral nature, reflecting the structure of dependence on the teacher (E. Lubina, 2012, p. 151). Therefore, one should create communication competences, which will facilitate the learning process and will increase its quality. This in turn, it is possible, inter alia, due to using the Google tools and implementing the Aid Programme in Developing Skills in Learning. The programme assumes the following method of learning:

- never learn alone – others are always necessary in learning, a positive attitude is important towards others. For this purpose use the social portal, electronic mail, forum and communicators in Internet by means of which one may ask questions to teachers and mates on the interesting topics for you;
- learning allows to cross next stages – using social portals will make you aware that the knowledge increases autonomy of the person giving at the same time to them larger possibilities of development;
- I am interested in what I am learning – interest is a condition of effective learning and one may raise different interests. Internet is a place for developing interests. Using social portals an possibility to create own blogs, own Internet sites strengthen connections between the students with similar interests.
- my surrounding teaches me many things – learning is not a limitation to certain situations, but it takes place in different circumstances, also those taking place in Internet.
- I take my own learning in my own hands – a person may learn only then when he adopts an active attitude towards learning. The activity will be realized due to using Google Apps, which offers the services which support your activity.
- what I learned is really necessary for me – finally the learning can be stated that a human being is not able to use what he learnt. What you know and what you can may be conveyed to others using available forms of communication in Google Apps.
- what I learn depends on what I know – effectiveness of learning depends on earlier knowledge and showing possibility to activise the earlier knowledge. Therefore, create in Internet active knowledge junctions which will prove your level of competence.

- my physical condition, my psychical condition – show to others what you can do to be in good shape (M. Ledzińska, E. Czerniawska, 2011, p. 176), create Internet communities, the goal of which being mutual help and support.

Conclusions

A theory of connectivism as a concept of learning was only a certain inspiration so far, presently, however, due to Google Apps, inter alia, more and more often, it has its reflection in education practice. Many new internet systems, allowing to work in the cloud indicates new trends in education which for many teachers are revolutionary. More and more often it is observed that children, the youth and adults read books, which by means of mobile devices have new electronic form. An Italian philosopher Umberto Eco thinks that „different forms of books did not change their function, nor basic component functions for ages" (J. P. De Tonnac, 2010, p. 14), to calm down those who identify the appearance of new technologies with degradation of the education process. Teachers however are seriously afraid that a philosophy of education of a human being, in accordance with the theory of connectivism assuming that the knowledge of a human being may reside in non-human devices, e.g. internet clouds or memory carriers will result in situation where a human being could not function in the society without a proper device which will allow a readout of information to him.

However we should we bear in mind that the technological development results from the nature of a human being and available solutions allow to exit the standard methods used in e-classes (I. Bednarczyk, B. Michałowicz, L. Rudak, D. Sidor, 2012, p. 109). Therefore, practical activity of student should raised, which is based on the knowledge, also from the internet servers.

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PRESENTATION OF THE RELATION BETWEEN MATHEMATICS AND PHYSICS BY THE DYNAMIC MODELING

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Abstract

Today the modern technologies are integrated into the most fields of the education. The ICT provides new opportunities for educators and students to increase the efficiency of teaching.

This paper deals with possibility of using software GeoGebra dynamic mathematics in education. The software has widespread use not only in mathematics but also in solving and modeling several problems from physics. The article presents, by means of some simple application examples, how to use the GeoGebra software for dynamic modeling, as an application of mathematics utilized in the praxis.

The simulated examples using GeoGebra software for dynamic modeling of phenomena from nature allow students to better visualization of problems, to understand basic and advanced science concepts, and thus an easier mastery of the subject mater.

Keywords

GeoGebra, modeling, practical tasks, mathematics, physics

Introduction

During the education teachers and students from time to time can meet practical tasks, problems from real life. Solving these tasks need mathematical and physical knowledge. By means of practical problems we present relations between mathematics and physics. Solving practical problems proves for students that the mathematical knowledge is applicable and useful in practice. On the other hand, in physics teaching and learning, the students make sure of the necessity of mathematical apparatus.

Possibilities of using GeoGebra

Solution of these tasks and problems confirms for students the efficiency and generality mathematical knowledge in practice. Conversely, in physics, by solving the problems and practical tasks the students can satisfy oneself about the necessity of mathematical apparatus. Presenting and modeling natural phenomena and solving practical tasks supports the strengthening of relations between the mathematics and physics. As confirmed in many publications (Kllogjeri, 2010, Rodriguez, 2013, Kozielska 2009) that by applying a computer simulation and an actual experience at the same time, students may improve their analytical and creative thinking skills, as well as they can make better use of information technology. Furthermore, there is a higher level of understanding the physical phenomena by students in this way of teaching, than in teaching by using only actual experiences.

The ICT provides new opportunities for educators and students to increase the efficiency of teaching.

According to Martinez at al. (2008) use of simulations helps to deepen and broaden understanding of physical phenomena and concepts; prepared simulations may be very useful to help the less gifted students to better understand problems. Simulation software allows the professor to make his/her own didactic design, including not only the qualitative observation of the phenomena but also the solving of quantitative problems.

For support and development the cross-curricular relations can help GeoGebra (Gunčaga and Majherová, 2012, Abdul-sahib, 2010), as assistance in imagine the meaning of curriculum, the tasks with its application and practical use in practical life. During problem solution with physical subject, the good graphic presentation facilitates for students the way towards understanding and extension their mathematical imagination.

Solving the above mentioned tasks can indicate a problem that for the solution we need knowledge from physics. These tasks are from various fields of physics and present the interaction between mathematics, physics and reality.

The main objectives of modeling and solving practical problems are:

developing the logical, algorithmic and critical thinking of students,

the ability to read connected text comprehension contain numbers, dependencies and relationships and incoherent texts contain tables, graphs and diagrams,

the use of different representations of mathematical content (text, tables, charts, diagrams),

- teaching students to express mathematically the problems observed or deliberately demonstrated in real situations (symbolism and visualization)
- motivating students to mastering the mathematical apparatus that will prove its necessity and usefulness in practice,
- showing the applicability of transferred mathematical curriculum,
- teaching students how to find and identify data necessary for solving the problem,
- teaching students to search and follow the simple functional relationships and quantitative connection in their own environment

GeoGebra offers the possibility of graphic solutions (Bukor at al., 2012) of some tasks or graphic representation of the course of events, dependencies variables and supports the introduction of a specific situations and problems. The simplest examples and tasks are related to motion (rectilinear uniform motion - Graphic solve systems of two linear equations with two unknowns, or uniformly accelerated motion, free fall - a quadratic equation, function).

During the solving of problems with physical theme GeoGebra supports the understanding of certain physical phenomena using virtual experiments (free fall, horizontal and inclined discharge, movement, pendulum, ...). GeoGebra makes it easier to learn the physical laws (law of conservation of energy, Ohm's law). The dynamic modeling supports the better introduction of the relationship between the physical variables and the observation and understanding of certain physical quantities depending on the time (speed, velocity). In terms of cross-curricular activities it allows to use functions and equations. Supports learning of the concepts from different areas of physics, such as movements, energy, friction, vibrations, waves, optics, electricity, heat. GeoGebra can be used for revelatory teaching, since it supports experiments and mathematical discoveries.

Example 1 – Motion of two cars
From the city started two cars at once. One car carries an uniform linear motion with constant velocity 25 m/s. Second car performs uniformly accelerated rectilinear motion, with initial

velocity of 0 m/s and acceleration of 1 m/s². When and how far from the starting point will the two cars meet?

GeoGebra offers us a graphical problem solving, which displays the graphs (s, t) of functions (Fig. 1). In the case of the uniform linear motion it is a linear function and in the case of the accelerated motion it is a quadratic function.

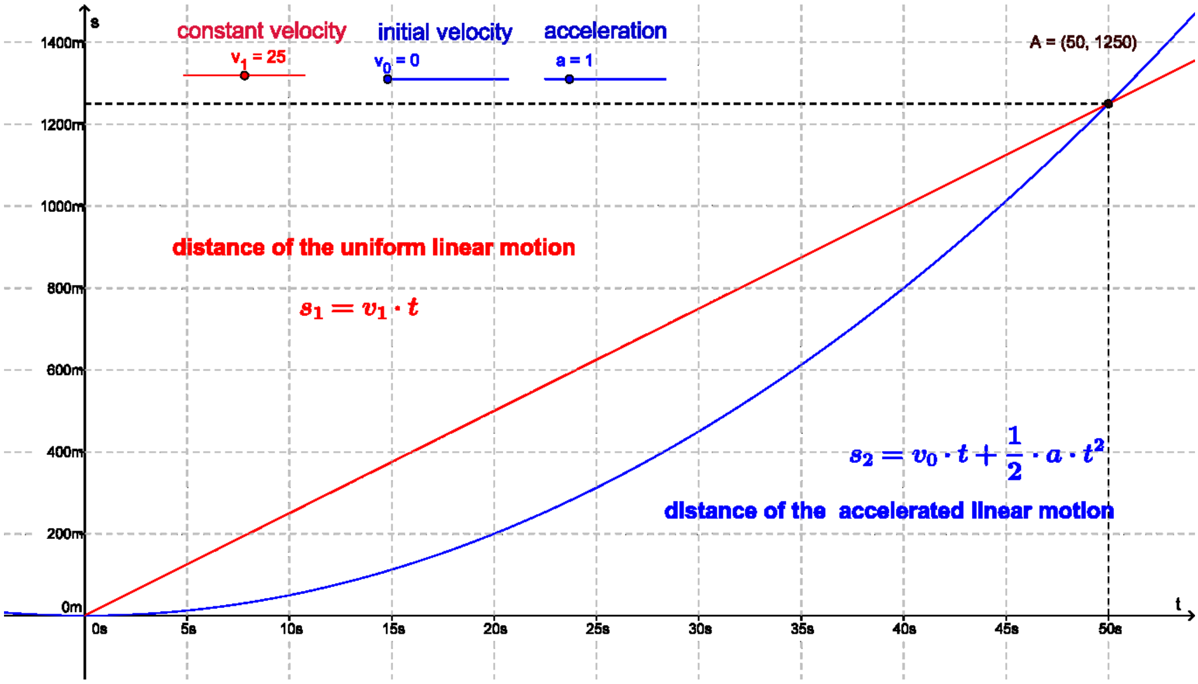

Fig. 1: Solution of the example1

$\boldsymbol{v_1} = 25\ m/s$ – speed of the uniform linear motion

$s_1 = v_1 \cdot t$ – distance of the uniform linear motion

$s_2 = v_0 \cdot t + \frac{1}{2} a \cdot t^2$ – distance of the accelerated linear motion

$\boldsymbol{v_0} = 0\ m/s$ – initial speed of the accelerated motion, therefore $v_0 \cdot t = 0$

For the distances:

During the $s_1 = s_2$ Graphical solution the uniform rectilinear motion will be described by linear equation, which is understood and presented as a linear function. The accelerated motion will be described by a quadratic equation, which is understood as a quadratic function.

As we look at the graph above, we see that the two lines are intersecting. The intersection of the two graphs is a single point and actually it is the solution of the problem. The coordinates of that point *(x, y)* satisfies both equations. The *x*-coordinate represents the time elapsed from the start to the meeting point, and the *y*-coordinate represents distance between initial and meeting points, i.e. A = (50,1250).

During the solution by using sliders we can change values in the task, which are the speeds v_1, v_0 and the acceleration *a*.

Example 2 - Oblique throw from the height h

It is known that if we throw stones with same initial velocity, but at different elevation angles, that the stone thrown at elevation angle $\alpha = 45$ ° will have the farthest distance of the impact. Projectile motion is a form of motion in which an object or particle (stone) is thrown near the earth's surface. Of course, in this case the stone is considered as point mass, which moves along a curved path under the action of gravity only - approximately along parabolic trajectory. The only force of significance that acts on the object is gravity, which acts downward to cause a downward acceleration. There are no horizontal forces needed to maintain the horizontal motion – consistent with the concept of inertia.

In the horizontal direction the object's (stone's) motion is not affected by the resistance of the environment, or other force, therefore it maintains the appropriate velocity component $v_x = v_{x0}$, with which was thrown. Therefore, the motion in the *x*-direction is a motion with unchanging velocity – uniform motion.

In the vertical direction the stone falls due to gravity, so in the *y*-direction is the motion with acceleration, i.e. an uniformly accelerated motion. In this case the motion along a parabolic trajectory will be described by means of two rectilinear motions, which are perpendicular to one else.

The initial velocity $\vec{v_0}$ vector of the thrown object can be broken into two mutually perpendicular vectors $\vec{v_x}$ and $\vec{v_y}$ which are parallel to the axes of the Cartesian system, in which we draw the throw. For the size of these vectors, we can write:

$$v_x = v_0 \cos\alpha$$

$$v_y = v_0 \sin\alpha - gt$$

The horizontal component of the object's velocity remains unchanged throughout the motion. The vertical component of the velocity increases linearly, because the acceleration due to gravity is constant.

At any time *t*, the stone's horizontal and vertical displacement is:

$$x = v_0 t \cos\alpha \qquad y = h + v_0 t \sin\alpha - \frac{1}{2} g t^2$$

Time of flight ia:

$$t_d = \frac{v_0 \sin\alpha + \sqrt{v_0^2 \sin^2\alpha + 2gh}}{g}$$

The maximum distance is:

$$d = v_0 \cos\alpha \frac{v_0 \sin\alpha + \sqrt{v_0^2 \sin^2\alpha + 2gh}}{g}$$

The maximum height is:

$$h_m = h + \frac{{v_0}^2 \sin^2\alpha}{2g}$$

In this way we obtain the dependence of both *x* and *y* coordinates on the time. To visualize the motion of the stone in GeoGebra we need to combine the two equations above. (Fig. 2) During the modeling of the stone's motion GeoGebra offers us the ability to change parameters by sliders, which affect the motion of the point A.

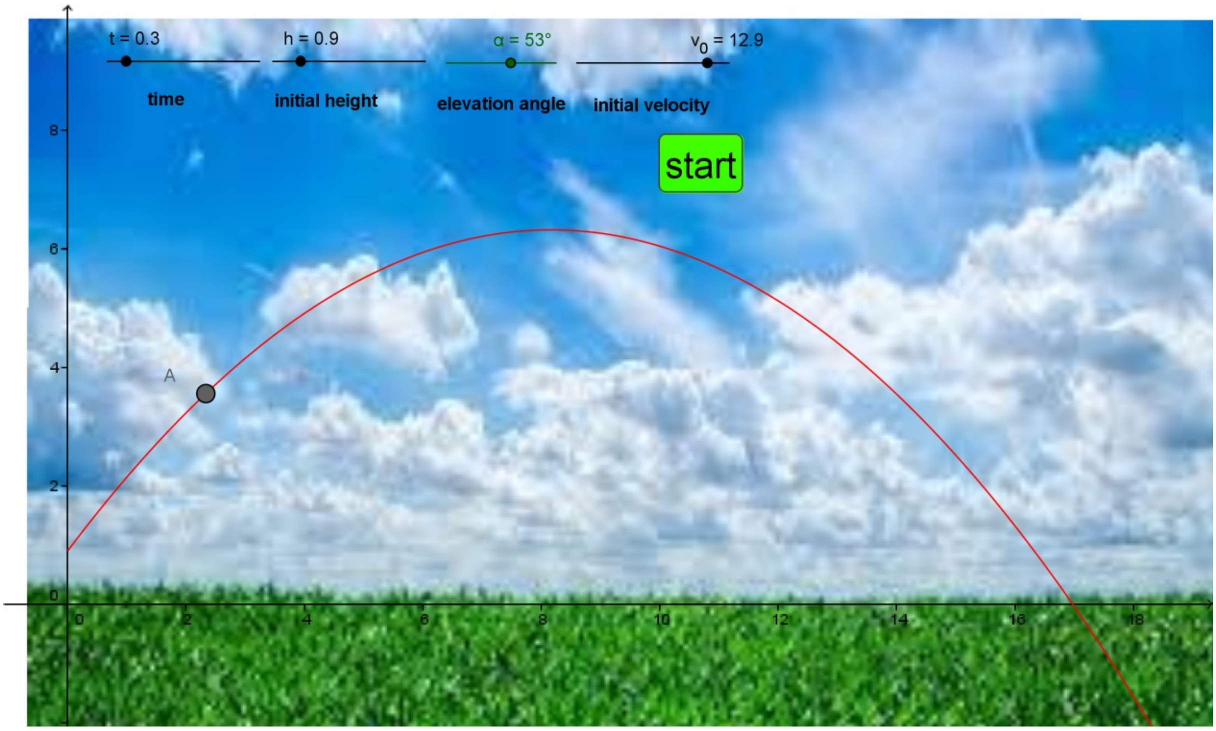

Fig. 2: Modeling the oblique throw in the GeoGebra

We assigned the following parameters to the sliders: initial height of point *A*, elevation angle *a*, the initial velocity v_0.

This example is more difficult because modeling needs combine two changing variables, i.e. *x* and *y* coordinates, in one equation.

Conclusion

Using the visualization and modeling in the education supports the students' motivation and imagination and increase the effectiveness of teaching methods. Creation of dynamic virtual models by using GeoGebra brings new possibilities in the exploring mathematical relations-contexts. Appropriate visualization promotes the understanding of the context and it is helpful in assessing the properties of concepts and relationships between quantities.

In the article we would have liked to point out the possibilities of visualization and modeling of mathematical knowledge in teaching physics and hence the importance of cross-curricular activities. Applets can contribute to a better understanding of the general relations and also help in solving problems.

Acknowledgements

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USAGE OF DATA FROM CATALOGUES OF ASTRONOMICAL OBJECTS IN ICT

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Abstract

This contribution contains attractive examples that use catalogs of astronomical objects available at Astronomia web pages (astronomia.zcu.cz). Hertzsprung-Russell diagram will be created online from stars catalogue HIPPARCOS or SIMBAD. It is possible to change the star distance used for diagram creation. List of numbered minor planets is used to demonstrate the current position of objects in the Solar system, to construct a Kirkwood gap graph or to interactively verify Kepler's laws. On Night sky application should be demonstrated progress chart of Sun below horizon during the night. It can be used to explain twilight, sunrise and sunset. For a particular moment there can be found a list of brightest stars, constellations visible above the horizon or Messier or NGC object visibility. All these features are available as online applications on web pages and it can be used during ICT lessons.

Keywords

Catalogues, HR diagram, Kepler's law, minor planets, stars, Kirkwood gap, interactive, application, multimedia, education

Introduction

Project Astronomia is a multimedia textbook established in 2000 available online at web address astronomia.zcu.cz. It contains sorted information about planets of solar system, deep-sky objects, stars and other objects in the Universe. These pages are collected from many relevant sources, usually translated from English ones. Currently there is no plan to create an English version of these pages. On the other hand, one unique part is prepared also in English mutation. It is focused on catalogues of astronomical objects; it is integral part of Astronomia web pages. There are more than six hundred thousand objects in total volume of about 180 MB of data. Catalogues should be in general divided into three categories. Firstly as deep-sky objects (nebulae, stars clusters and galaxies) are located in three of them – NGC, Messier and IC catalogues. The second area are stars, there is a list of constellations (88 items), Gliese catalogue (contains 3 803 nearby stars), Hipparcos catalogue (118 218 stars) and a part of astronomical database SIMBAD (118 171 stars with HIP equivalent). The third area is a list of minor planets; currently (in May 2014) we know more than 393 thousand numbered minor planets. A very important issue is to update values in catalogues from credible sources with the permission of their authors, e.g. SIMBAD database directly updated from French source and minor planets from American Minor Planet Center.

These data should be used effectively in education process, especially during ICT as interesting exercises on computer. In this contribution I am going to introduce several astronomical examples based on catalogues of astronomical objects.

Online applications using data from catalogues

I have prepared several online interactive applications, available from Astronomia web pages, which are using data from catalogues of astronomical objects. These applications can be used for demonstration of following issues (in the brackets is name of used catalogue):

- Analysis of Minor planets parameters (minor planets)
- Kirkwood gaps (minor planets)
- Historical development of Minor planets (minor planets)
- Current location of Minor planets in the Solar system (minor planets)
- Kepler's laws demonstration (minor planets)
- Apparent magnitude of Minor planet calculation (minor planets)
- Surface temperature of Minor planet estimation (minor planets)
- Online HR diagram construction (stars)
- Sun below horizon, Sunset and sunrise, Twilights (stars)
- (Circumpolar) constellations (stars)
- Length of (astronomical) night (equinox, solstice) (stars)
- Sidereal and solar time (stars)
- Nebulae, star clusters and galaxies on the sky (deep-sky)

It is not possible to describe all possible options and features of these applications in this contribution. Use it as an overview to be able to decide which application you use for education at your classroom. And not only at school; some of the applications can be used before visiting observatory or observing the sky at night. For more detailed description visit Astronomia web pages on English guidepost that is available at link: astronomia.zcu.cz/katalogy/education/.

Minor planets

There are several interesting examples of using catalog of numbered minor planet. For a first one we should consider the following question: "*The minor planet (15925) Rokycany is in opposition. Is it visible by telescope located on Rokycany Observatory?*" Anyone can choose any minor planet for this task. To solve this task we have to find date where the considered minor planet is in opposition. We can found the date of this event on the web page astronomia.zcu.cz/katalogy/minorplanet-15925 by changing of the day, the month and the year (see fig. 1). Then we can calculate (by simple formula or it is written on the image with location of minor planet in solar system) apparent magnitude of minor planet and compare it with limiting magnitude of telescope.

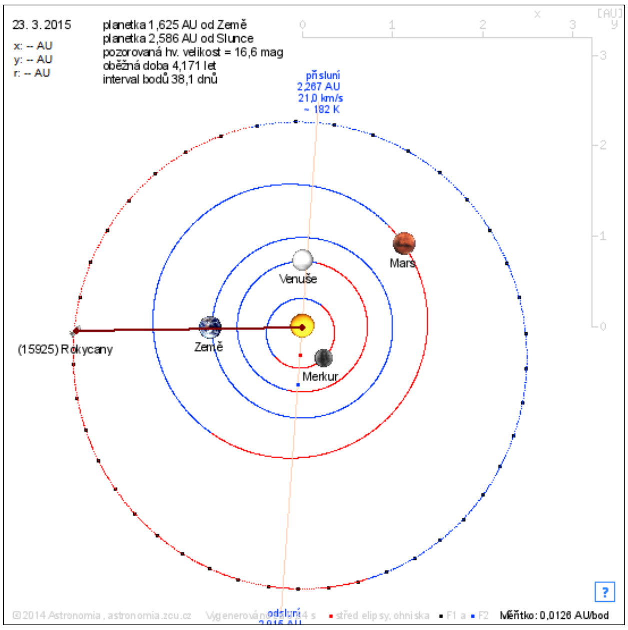

Fig. 1: Minor planet (15925) Rokycany in opposition during year 2015

On Fig. 2 it is possible to demonstrate all Kepler's laws, including the location of focuses and the center of the ellipse, perihelion, aphelion, mainly the law of equal areas (using the interactive behaviour with area calculation – see Fig. 2), and more. There is also calculated apparent magnitude for given Earth, Sun and minor planet configuration. This value should be also calculated from knowledge of the absolute magnitude of minor planet and its distance from the Earth and the Sun.

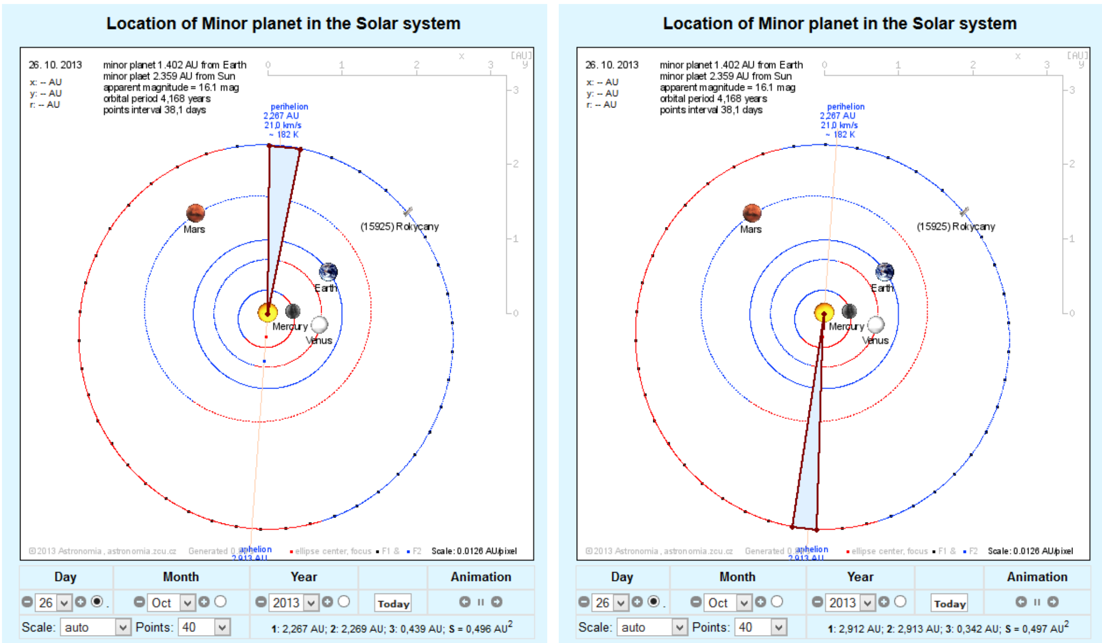

Fig. 2: Comparison of area in perihelion (left) and aphelion (right). The area is almost same = 0,496-0,497 au^2.

Part of Analysis of Minor planets parameters is a special Data Export. It shows graph of semimajor axes on quantity of minor planets. There can be found several gaps (e.g. at 2.5 au or 2.83 au), see Fig. 3. They correspond to the location of orbital resonances with planet Jupiter.

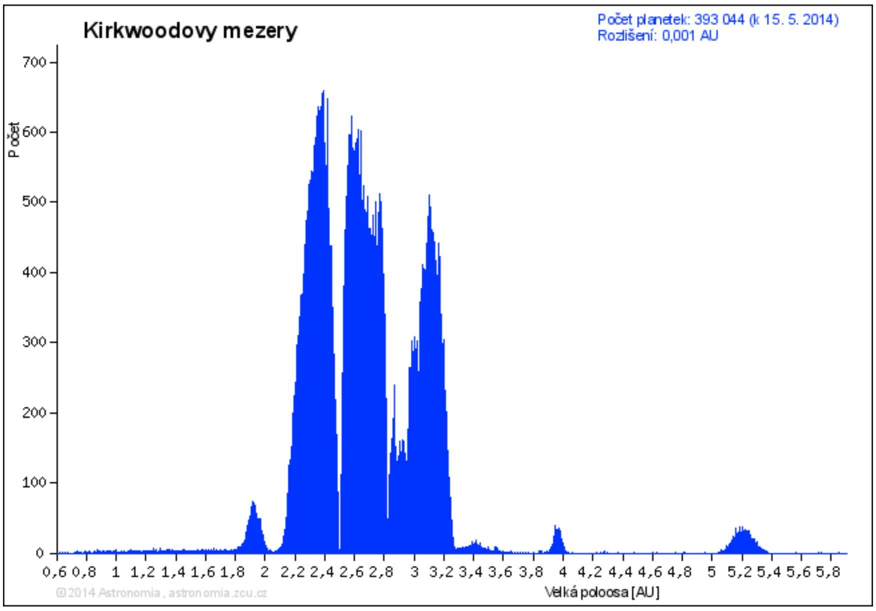

Fig. 3: Kirkwood gaps

There are two areas on fig. 3 where orbital resonance with Jupiter create stable group of minor planets. They are located around 4 au (2:3, Hilda family) and around 5.2 au (1:1, Trojan group). Long-term distribution of Hilda family in the solar system produces approximate shape of an equilateral triangle (see Fig. 4 right image). Trojan minor planets orbit around one of the two Lagrangian points of stability (see Fig. 4 left image).

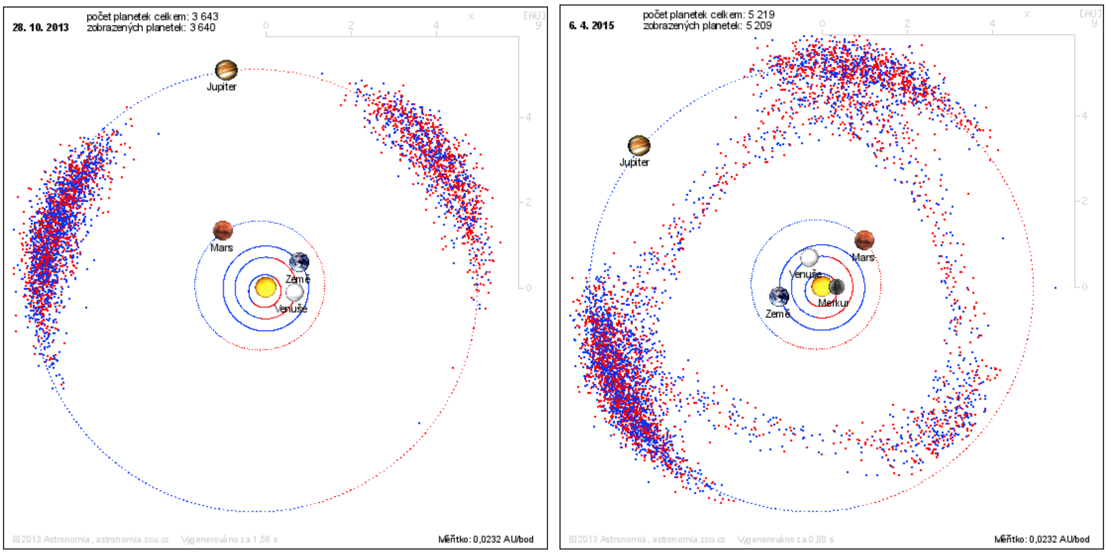

Fig. 4: Trojan group (left image) and Hilda family with Trojan group (right image)

Stars

Hertzsprung-Russell diagram (HRD) is online generated directly from the Hipparcos star catalogue (this one is not updated, it contains original data published on 1997) or the SIMBAD astronomical database (regularly updated on week bases). This application allows viewing of HRD for stars in selected distances (nearby – see Fig. 5 left side and far – see Fig. 5 right side) and it displays the location of the selected stars in the diagram.

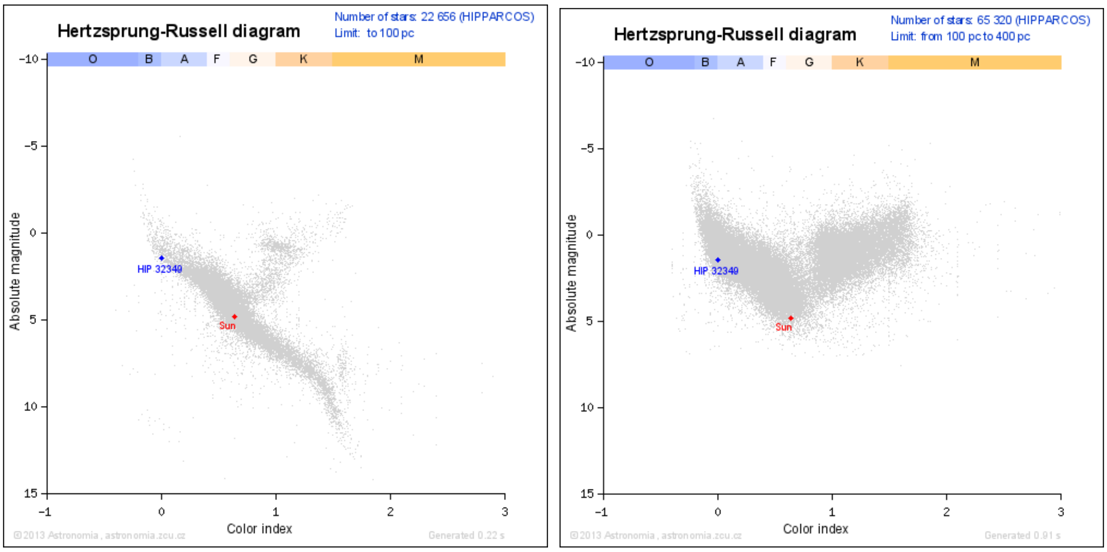

Fig. 5: HR diagram for nearby stars (left, up to 100 pc) and far stars (right, from 100 pc to 400 pc)

Another application shows (see Fig. 6) graphical representation of the sun below the horizon to the chosen location (currently restricted to selected towns in the Czech and the Slovak republic) for a selected time. It begins before sunset and ends after sunrise next day. There are highlighted all twilights. For selected day it is calculated length of night (from sunset to sunrise) and length of astronomical night (interval, when the sun is more than 18° below the horizon). It is possible to demonstrate the situation for equinox whether night and day is really equal; it means both have 12 hours, less or more?

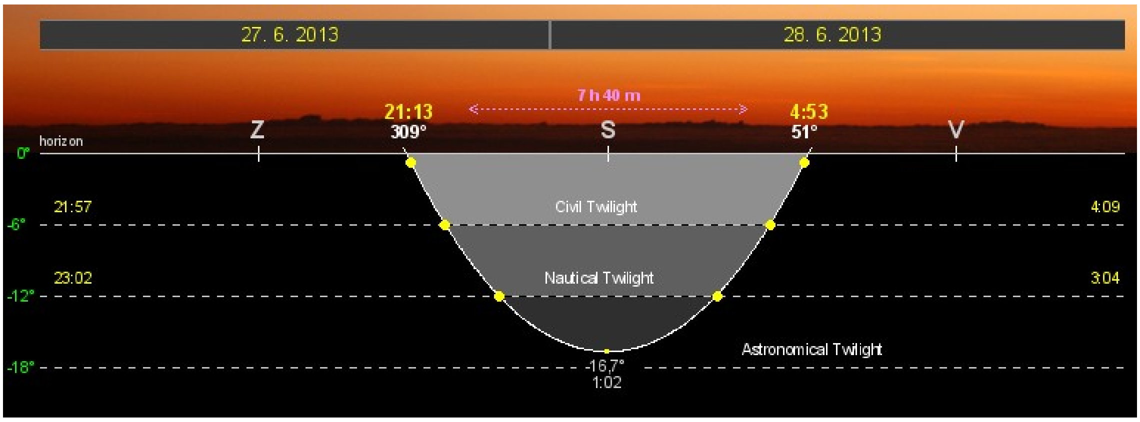

Fig. 6: Night sky available on astronomia.zcu.cz/katalogy/education/2410-night-sky

For each point on the line of sun; list of constellations visible at a given time and place on the sky including an indication of circumpolar constellations is calculated. There are only five constellations assigned as circumpolar for the Czech Republic, see fig. 7.

Fig. 7: List of visible constellations from Czech Republic

Conclusion

Any experiences with the above applications, comments, ideas or suggestions, please, let me know (kehar@kmt.zcu.cz). I will keep the applications updated and fully working as long as it will be possible. It means you can implement them in your education process. My near future plan is to extend Night Sky apps to world coordinates (currently they are limited to selected towns in the Czech and the Slovak republic), introduce new application (e.g. Daytime Sky) and prepare more Worksheets & Instructions mainly in English language.

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DIAGNOSTICS OF STUDENT´S CHARACTERISTICS AND STUDY MATERIALS STRUCTURE IN ADAPTIVE LANGUAGE LEARNING INSTRUCTION

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Abstract

The issue of personalized education is gradually shifting from the general area of solution to the specialized areas of solution, one of which is a foreign language instruction. This paper deals with the comparison of input diagnostics of a general subject student and a foreign language student. The second part of the paper introduces the teaching materials structure in adaptive language learning instruction.

Keywords

Language learning instruction, electronic learning instruction, personalized learning instruction, sensory modalities, student's static characteristics, student's dynamic characteristics, adaptive LMS, adaptive eLearning

Introduction

Our society is developing quickly. Requirement for the effective acquisition of a new knowledge goes hand in hand with society development. The whole society gains different kinds of knowledge. However, the requirements for educational results are mainly reflected in school environment and working process. From economic perspective of a country, educated students and gainfully employed people are essential part of economic prosperity.

To make the process of learning instruction more effective, a tool of electronic instruction can be used. A research carried out by Šimonová from the Department of Applied Linguistics in Hradec Králové proves that 80% of the approximate number of 100 respondents would prefer their university studies to be in the form of online education (Šimonová, 2013).

The tools of online instruction contain the possibility to adapt the educational process to students' individual needs. The tools of electronic instruction, such as eLearning or a computer instruction have been known for a long time. However these days (2013), the so called personalized instruction comes to the fore of the electronic instruction. Personalized instruction means taking self-paced instruction of a student into account including his study experience, characteristics and preferred learning style.

Being able to carry out personalized instruction approach, student´s characteristics that influence his learning style must be identified together with a suitable study material and educational environment. There is an overlap of information technology and pedagogy area in this issue.

Figure 1 below presents the designed model of adaptive instruction for general subject which is identical with model of adaptive instruction for a language learning.

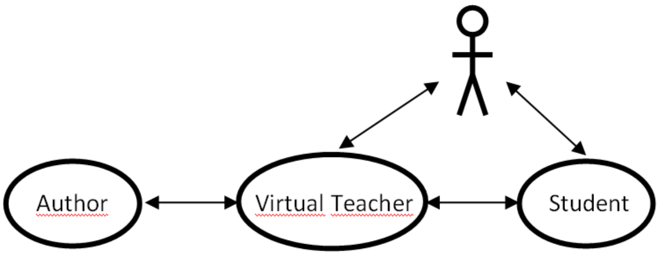


Fig. 1: Theoretical Model of Adaptive Instruction

The whole module has been divided into 3 parts (Kostolányová, 2013)

- Diagnostics of student's learning characteristics, continuous study instruction and testing (*Student Module*).
- Methodology and adaptive study material structure (*Author Module*).
- Adaptive algorithms design to make the optimized study environment and to record the process of study process (*Virtual Teacher Module*).

Being able to find out whether the theoretical model of adaptive instruction can be used in a foreign language instruction, some adjustments must have been done on the level of diagnostics of student´s characteristics as well as on the level of adaptive study material structure.

The Student Module in the original model of adaptive eLearning

Now we will focus on Student Module in adaptive eLearning where I introduce basic principles of student´s characteristics detection in a general subject instruction. Further I present basic principles of student´ s characteristics detection in a language learning instruction.

The authors of the original model in adaptive eLearning have designed three levels of student´s characteristics detection. These are *static*, *dynamic* and *continuous monitoring* of study activities.

Static characteristics of a student are meant to be sensory preferences, social aspects of study, motivation to study, the way of processing information of each student and a student´s self-regulation. To detect all these static characteristics of a student, a tailor made questionnaire has been created by a psychologist from Ostrava University (Kostolányová, Šarmanová, Takács, 2010). There are 31 questions with the answer key. The questionnaire is a tool to detect static characteristics of a student in the original model of adaptive eLearning.

Dynamic characteristics have been defined as a current knowledge of a student in a given subject. The knowledge of a student will be detected with the help of a pretest before the study process itself. The pretest is aimed to consist of questions corresponding with the curriculum of a given subject.

Continuous monitoring of student´s activities can serve not only for present curriculum but also for adjustment of initial student´s dynamic characteristics

Acquired data from a questionnaire and from a knowledge pretest about a student would be compared with so called "virtual student" which is a prototype of a student where similar students´characteristics and their learning strategies are summarized. Each student would be matched (after initial testing) with the "virtual student" of the most similar characteristics. The learning instruction would be then controlled according to these detected characteristics.

If later, from a continuous monitoring, will be detected that the student had been categorized incorrectly and he is not in a correct "virtual student" group, he can be then transferred to a different virtual group (Kostolányová, Šarmanová and Takács, 2010)

The Student Module adjustment in a language learning instruction

The student´s characteristics diagnostics in a language learning instruction is similar to the original approach. Again, static and dynamic characteristics of a student are detected.

The static characteristics are called sensory modalities according to Fleming, Barbe (Swassing Barbe, Swassing) and Dunn R.and K. Dunn (Dunn, 1997),

]. Sensory modalities has been chosen from a range of learning styles categories for the reason to match language competences of a student which is an ability to read, listen, write and speak in a foreign language. For "reading" and "writing" language competences a category of "Read/Write" student defined by Fleming (2001-2014) has been chosen. For "listening" and "speaking" competences "Aural/Audial" student defined by Fleming (Fleming, 2010-2014) has been chosen.

"Read/Write" category is a subcategory of a visual student. Fleming divides a visual student category in "visual - spatial" and "visual-linguistic" category. The "visual – linguistic" category is a synonym for the "Read/Write" category where students like to acquire information via text and they like to learn and practice via writing. Fleming emphasizes that this category doesn´t include pictures, photos, videos and Power point presentations. However, in a language learning instruction discussed together with a sensory modalities these elements appear very often as Lojová and Vlčková describe a "visual type" of a student as someone who likes to get information from text as well as he likes pictures, mental maps videos and subtitles. Basically all elements stimulating visual imagination of a student.

Their supposition has also been supported by the research from the field of cognitive styles where two groups of students (visual and verbal) have undergone magnetic resonance experiment. The results have shown that brain of visual students transforms the words read by students into visual images in their mind. On the contrary, verbal students, when they have been exposed to some pictures, the brain part responsible for sound form of a language has been activated (*Visual Learners Convert Words To Pictures In The Brain And Vice Versa., on-line)*

"Visual" and "verbal" students are two categories in the field of cognitive styles. "Verbal" student, in sensory modalities, would be "aural" student as he likes to learn by words listened and spoken. The difference between learning modalities (from this group sensory modalities are deduced) and cognitive styles are: learning modalities are more connected with memory and perception and cognitive styles are understood as a subcategory of learning styles. Riding and Sadler (1997) doing research in cognitive styles field define cognitive style as individual, unchangeable approach on how to percept and categorize information through learning process. Cognitive styles are more based on neurobiological basis. There are many kinds of categories defined within cognitive styles field of study but only two categories seems to be the most significant and accepted by experts. These categories are visual-verbal student, global – analytical student (Riding, Sadler, 1996).

On the contrary, "Aural/Auditory" students are defined by Fleming (Fleming, 2010-2014) as those who like to learn from spoken words in a form of audio recordings or lectures. They like to learn by discussing new information or reading information out loud or for themselves. Lojová and Vlčková (2011) claim that "Aural/Auditory" students remember the information best when connected with sounds.

The dynamic characteristics in a language instruction are: student's previous knowledge from the field of grammar, reading, listening, writing, and speaking.

As far as general subjects instruction, the authors suggest the static characteristics to be acquired from the psychological questionnaire, and the dynamic characteristics from the knowledge pretest.

But, as for a language learning instruction, the static characteristics are suggested to be acquired by the knowledge pretest – the so called "language placement test". The placement test should also acquire dynamic characteristics.

We have decided to acquire both static and dynamic characteristics in a language learning by one testing tool which is considered to return more relevant data about a student. We assume that psychological questionnaire doesn´t return such a relevant information about a student as testing tool returning objective data based on measurable results.

Research results

We assume that the knowledge tests offer accurate and measurable values on the contrary to the psychological questionnaires. For this reason, the knowledge tests results were subjected to the comparative research. Both the psychological questionnaire and the knowledge test has used. The psychological questionnaire tested student's sensory characteristics (Read/Write and Audial characteristics). At the same time, these characteristics were being determined by the language placement tests corresponding with student's language competencies (reading, listening and writing). The speaking competence hasn´t been tested. To test 130 students individually appeared to be difficult to organize as the tested students were from three different schools. However, audial competencies of students have been tested in the form of a listening test. Student´s visual characteristics (reading and writing skills) have been determined by reading and writing test.

After accepting the results acquired from the psychological questionnaire it was necessary to set the minimal bound of agreement between the psychological questionnaire results (students' subjective opinion of themselves on the basis of psychological questions) and the language test results (verifying students´ answers from the psychological questionnaire). The bound of agreement between the results from the psychological questionnaire and the language test was set to 90% and higher. Also, the tolerance between a questionnaire and test results was set to maximum of 20%.

The respondents were students aged 15-18 from language-oriented grammar schools and one secondary school of Art. The questions in the psychological questionnaire were compiled by a psychologist while the tasks in the placement test were taken out of a testing CD for teachers, which is a part of the NEW ENGLISH FILE textbooks published by the Oxford University Press.

Out of the overall number of 130 relevantly filled psychological questionnaire and a language test the following results arose:

Personality Type / Language Areas	Results Agreement/ Questionnaire vs. Language Test	Overall Number of Students	Result Agreement in %
Audial type/ Listening	47	130	36
Visual type/ Reading	20	130	15
Visual type/ Writing	20	130	15

Tab. 1 – Presentation of the research data

The research confirmed the fact: psychological questionnaires are not a suitable tool for determining students' sensory characteristics (the minimal 90% agreement hasn´t been reached). Also, the research showed the identical results in the visual type (reading/writing) groups. But these results have been detected from the overall number of students. The identical results within one student (the same reading and writing results have appeared only with 25% of the students). In other words, the correlation between reading and writing skills appeared only with 25% of the students.

"Didactic Placement Test" description within the adjusted Student Module

As it has been said before, in a Student Module, the static characteristics (sensory modalities) as well as dynamic characteristics (initial language knowledge) of a student will be determined by a placement test called "Didactic Placement Test". First the students undergo the grammar placement test and on the base of their initial grammar knowledge they will be tested on initial knowledge in other language areas together with their sensory preferences.

The output of the "Didactic Placement Test" will be the % result of knowledge for language competencies as within the scope of one language knowledge level. Determining students' sensory modalities will be a "side-product". The test will include language levels A2, B1, B2 according to CEFR (Common European Framework of Reference for Languages) standard.

It is a recognizable fact the field of pedagogical-psychological didactics that the quality of the results acquired depends on the content validity and on the reliability coefficient of the tests used. The following results were acquired from the research (June 2012) that was intended to determine content validity and reliability coefficient of the grammar placement test:

Amount of content validity: 47%

In words: Medium amount of content validity

Reliability coefficient: 0.88

In words: the test is suitable as one of the bases for evaluation

The reliability coefficient is determined by the method of splitting the test.

The Author Module in the original model of adaptive eLearning

Unfortunately there is not only difference in Student Module of adaptive eLearning when used for a language learning instruction. Some adjustments must have been done in Author Module as well.

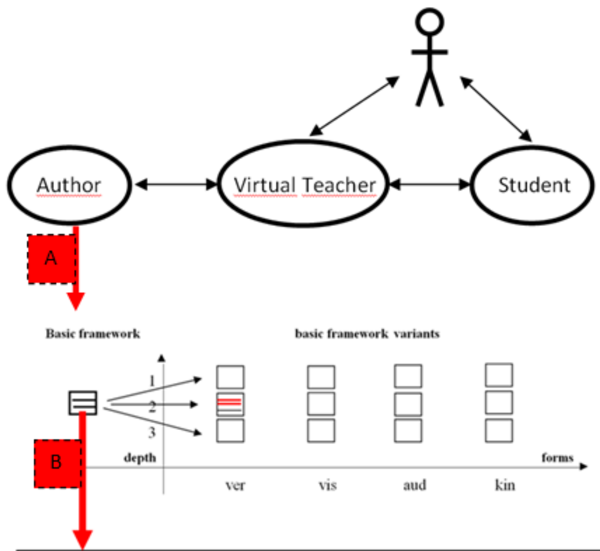
In Fig. 2 (see A) four framework variants and layers of explanation in a basic framework are presented. The basic framework is meant to be a unit existing in four framework variants.

Framework variants are different ways of presenting the same curriculum.

There are four sensory perception forms in original Adaptive eLearning for general subjects as:

- Verbal – variant contains mostly text,
- Visual – variant contains a number of images, graphs, animations, etc.
- Auditive – variant contains a large amount of spoken word, sounds, etc.
- Kinaesthetic – variant contains a number of interactive learning objects, etc.

A variant of a strictly one form is very rare. Usually it is a combination of forms about a percentage ratio of which it is decided by the author parts (Kostolányová, 2012)].



Types of layers (in a basic framework for general subjects)	
Expositional layers	(Theoretical, Semantic, Fixational, Solved exercises, Practical)
Testing layers	(Questions, Exercise, Practical tasks)
Other	(Objectives, Motivational, Navigational, Literature)

Fig. 2 – Author Module in Adaptive eLearning for general subjects

There are also three levels of explanation in a basic framework as presented in Figure 2 (see B). These levels of explanation are aimed to adapt the presented curriculum to student´s comprehension speed. Last there are layers of a basic framework presented in Figure 2 (see B). The layers of a framework are meant to be particular phases of a teaching process (expositional layers, testing layers and other layers) (Kostolányová, Šarmanová, Takács. 2012).

There is also one important fact that needs to be mention about a basic framework. Each basic framework (a unit) is a part of one teaching subject (geography, mathematics, biology, etc.). We can see its role in Figure 3.

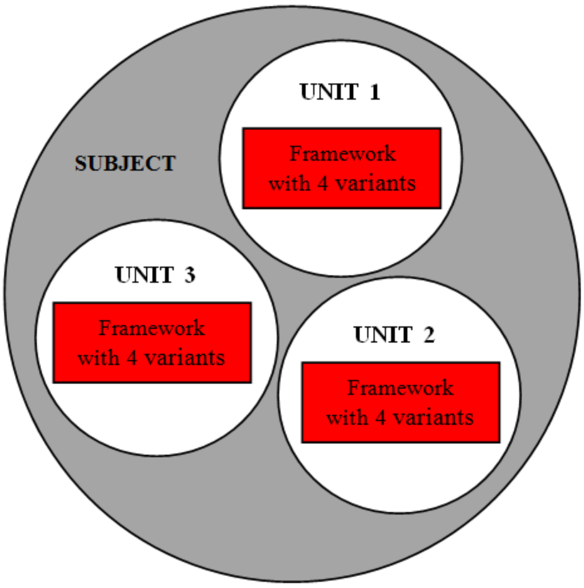
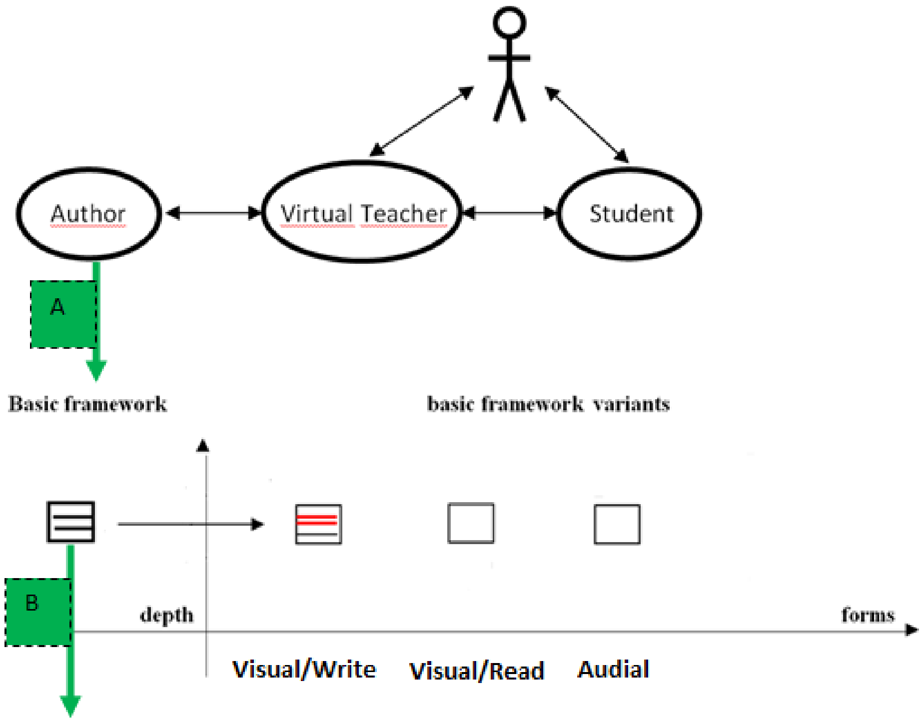


Fig. 3 – Author Module in Adaptive eLearning for general subjects

Subject is a top unit of a study support. Then there is an instructional unit (a basic framework) corresponding to one instruction lesson. A unit is further divided into frameworks and the frameworks into 4 variants following sensory characteristics of a student (Kostolányová, Nedbalová, 2014).

The Author Module adjustment in a language learning instruction

However, for a language learning instruction the original Author Module must have been adjusted to correspond with specific attributes of a language learning. The adjustments have been done in a structure of a basic framework as you can see in Figure 4.



ESA model = SLA model	Types of layers (in a basic framework for a language learning)
Engage (Motivational)	Other (Motivational)
Study (Present, Practice)	Expositional layers (Theoretical)
Activate (Produce)	Expositional layers (Fixational)
Language knowledge test	Testing layers (Questions, Exercise, Practical tasks)

Fig. 4 – Author Module in Adaptive eLearning ina language learning instruction

Concerning of a basic framework structure in a language learning in Figure 4 (see A) there is only one level of explanation in each variant as the main help for a student is seen to be adaptive study support chosen on the base of his dominant sensory modality. Also, the framework variants has been adjusted to "Visual/Write", "Visual/Read" and "Audial" forms.
Also, there are layers of a basic framework in a language learning presented in Figure 4 (see B) showing the basic framework structure which is in other words the structure of a lesson. These layers has been designed taking international standards for a lesson language structure into account. Saying in more details, the SLA model (Second language acquisition) together with ESA model (Engage – Study – Activate) was found to choose particular layers from the original model for general subjects. As you can see in Figure 4 (see B) the original layers must have been reordered. These layers are: other (motivational), expositional layer (theoretical), expositional layer (fixational) and a testing layer (questions, exercise, practical tasks) (Kostolányová, 2012)..

Results on adaptive study support design in a language learning instruction

To test the functionality of adaptive study supports in a language learning two following steps must be done. The testing material detecting sensory modalities and initial language level of a student must be downloaded in adaptive LMS. Further, adaptive study support respecting designed study structure must also be downloaded in adaptive LMS.

To exclude the unwanted complexity of the whole testing, one language level has been chosen. On this language level 24 sheets of adaptive study support have been made. The sheets are part of 1 unit: Shopping. Within this unit the sheets are divided into 3 types of basic frameworks (listening, reading and writing) at intermediate language level (B1 level according to CEFR).

One important fact that should not be left out is that the designed adaptive study support follows the idea of dominant sensory modality of a student. After all testing materials will be downloaded in adaptive LMS system, the technical functionality and the testing materials for a language learning will be tested. After the functionality testing, the target group of students will be exposed to the testing materials based on their dominant sensory modality.

The students being part of an experimental group will also be a part of the control group where the foreign language is taught by the traditional way, in the classroom. However, the students in both groups will be exposed to the same unit topic (Shopping) but to the different content of grammar structures and vocabularies. As a final point of the research there will be a knowledge testing in both groups and then the results comparison of both groups (experimental vs. control group)

Summary on both LMS model comparison

When comparing Student Modules of both LMS systems, there is a different approach on what kind of information to acquire about a student and a way of getting this information.
In addition, there is also other difference in the Author Modules. In a language learning instruction there is a different basic framework structure ("kinesthetic" variant is omitted and the verbal variant is changed to the "Visual/Write" variant). Levels of explanation (there is only one depth) and the structure of layers in a basic framework are also different in a language learning. The layers in a basic framework must have been reordered in comparison to the original study materials structure.

Conclusion

As a subject of our research effort is to contribute to student´s learning process in a language learning in a way of detecting dominant sensory modality and an initial receptive and productive language skills before the study itself. The whole approach will be then tested in adaptive LMS in order to make student´s study effort more effective. More effective in this context means to be able to put the most of his gained knowledge into practice.

Acknowledgment

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INQUIRY-BASED LEARNING IN PHOTOMETRY

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Abstract

In the Czech Republic, the pupils are not interested in science today. Undoubtedly important part of today's modern education is information and communication technology. The research said that pupils want to use ICT in learning and also want to do experiment it yourself (KEKULE, 2008). The aim of this paper is to suggest a set of inquiry-based learning experiments using ICT. Worksheets are designed for high school pupils (from 15 to 18 years-old) in optics (Ličmanová, 2012). In particular, pupils should be able to work with a data logging system and then to process and evaluate the measured data using some program such as Excel. Then pupils have to create a protocol.

Pupils will work in groups. Qualitative research will be done on how pupils work together in groups and what ideas they have for solutions in the following academic year 2014/2015. The research question asks whether pupils' hypothesis depend on their mark of physics.

These suggested experiments should development creativity, increase the level of knowledge and skills and teach pupils to work with ICT at the high school. And these experiments teach pupils work in groups, to present the results of their work and explain the problem and solutions to each other.

Keywords

Inquiry-based learning, illuminance, spectrum, work in group

Introduction

Because general educational program for high school does not contain photometry, a few interesting and problematic tasks was selected. Everybody encounters with the concepts of light, illuminance, luminous intensity and luminous flux in our everyday life. Everybody of us is currently trying to conserve energy. Therefore, everybody should know these terms. And we should be able to choose the appropriate source of light to our homes. The tasks of photometry for pupils' measurement are inspired by everyday life and using of modern sensors. Pupils do an experiment, they will be measured with the spectrometer SpectroVis Plus, Light Sensor and Motion Detector by Vernier (Vernier, 2014) and then evaluate the measured data using some program such as Excel and create a protocol. The Light Sensor approximates the human eye in spectral response. This can be used for inverse square law experiments or for studying polarizers, reflectivity, or solar energy. Motion detectors measure distance ultrasonically to the closest object and create real-time motion graphs of position, velocity, and acceleration (Vernier, 2014). Also pupils measure light sources, e.g. classic bulb, energy saving lamp (Compact Fluorescent Lamp), LED bulb (Light Emitting Diode) (SEVEn, 2010).

Methods

Pupils use worksheets including inquiry-based teaching during measurements (Mechlová, a další, 2012). Inquiry-based teaching is called as methods of scientific knowledge (Louck-Horsley, 2003; Mintzes, Wanedersee, & Novak, 1998; Redish, 2003). Pupils are involved in their learning, formulate questions, investigate widely and then build own new understandings, meanings and knowledge. That new knowledge is new to the pupils and may be used to answer a question, to develop a solution or to support a position or point of view (Alberta, 2004).

Pupils will work in groups. How many members does a group have? According to Erika Mechlová the optimal size of a group in high school is 4-5 members (Mechlová, 1984).

Inquiry-based learning experiments

Task: The 1st problem

Teacher explains to pupils the necessary concepts before measuring (light, illuminance, etc.).

> *In everyday life we encounter the concept of lighting. We hear from parents and teachers that it is important to read and work with adequate lighting. What is the dependence of illuminance on the distance from the light source (use classic bulb, e.g. 12 W, 40 W, 60 W)? Suggest an experiment to verify yours hypotheses.*

Pupils create a hypothesis about dependence of illuminance on the distance from the light source. Hypothesis are verified by pupils' experiments, see Fig. 1.

Results:

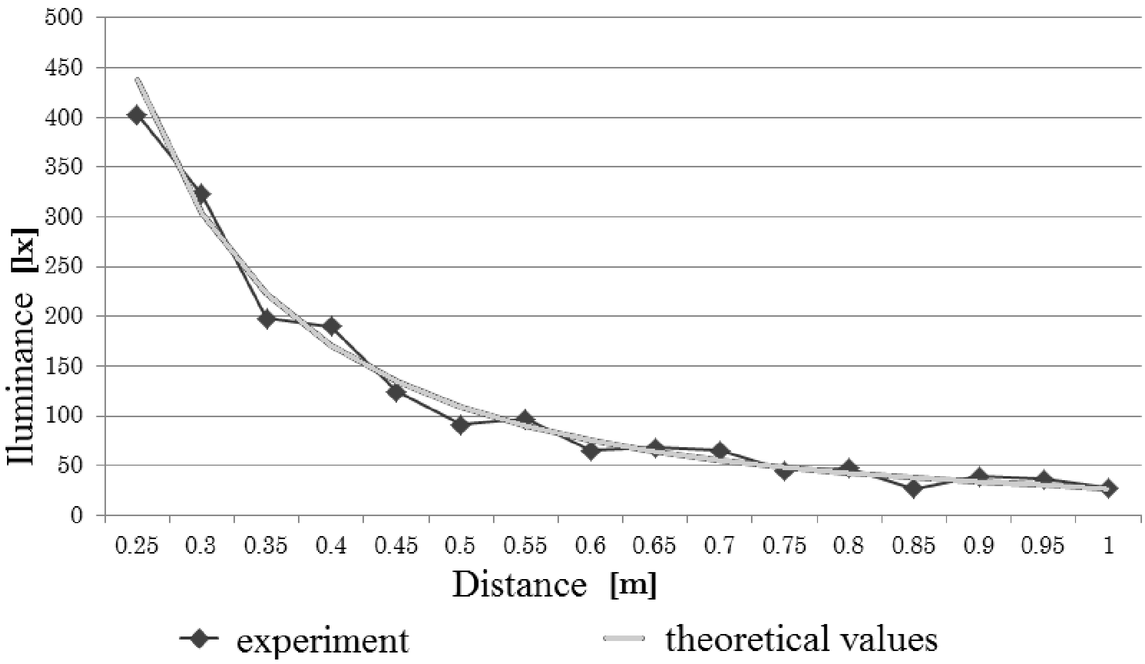

Fig. 1: Dependence of illuminance on the distance from the light source (pupil used small classic bulb 12 W, graph was created by pupils 17 years old)

Pupils find that illuminance decreases with the square of the distance from the light source. Pupils can compare the measured values to the norm of illuminance. Pupil's assumption of dependence illuminance on the distance from the light source you can see on the Fig. 2. About 70 % of pupils think that the dependence is linear.

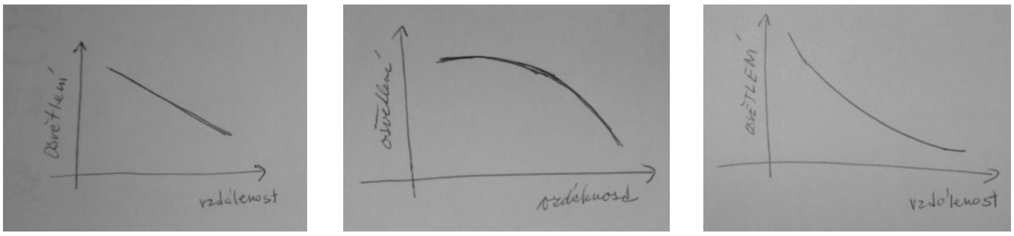

Fig. 2: Pupils' hypotheses of dependence illuminance on the distance from the light source (16 years old)

Task: The 2^{nd} problem

Teacher explains to pupils the necessary concepts before measuring (light, illuminance, input power, etc.).

> *Nowadays everyone is trying to take care of their health and also save energy. We know the bulb for 135 years also we know CFL – Compact Fluorescent Lamp for some time. New light source LED – Light Emitting Diode comes to the fore in the last few years. Which light source is better? Which light source is suitable for table lamps and chandeliers that? Which light source is most efficient?*

Pupils create hypotheses about comparison illuminance of various light sources in space. They verify hypotheses by measuring.

Results:

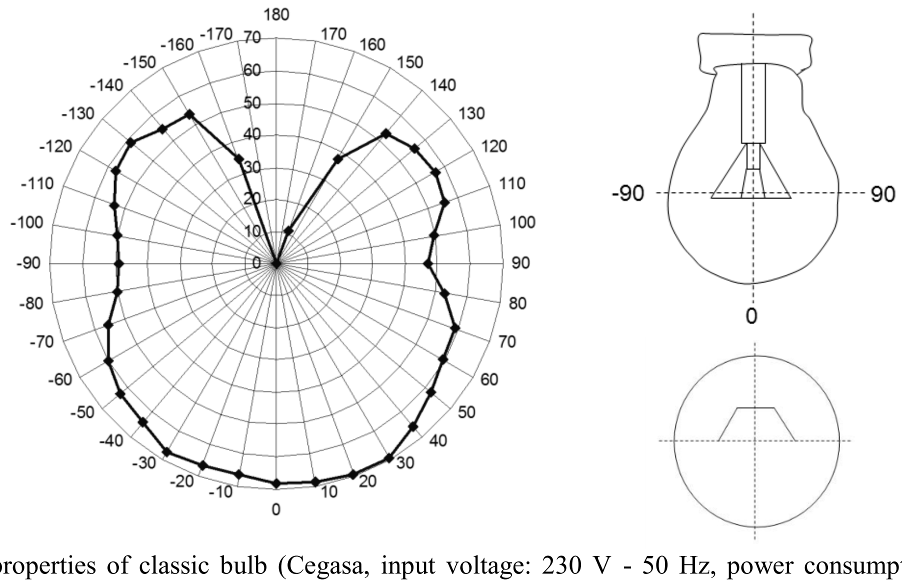

Fig. 3: Spatial properties of classic bulb (Cegasa, input voltage: 230 V - 50 Hz, power consumption: 60 W, luminous flux: 710 lm, energy class: E, lifetime: 1000 h, diameter: 60 mm, height: 75 mm, graph was created by author)

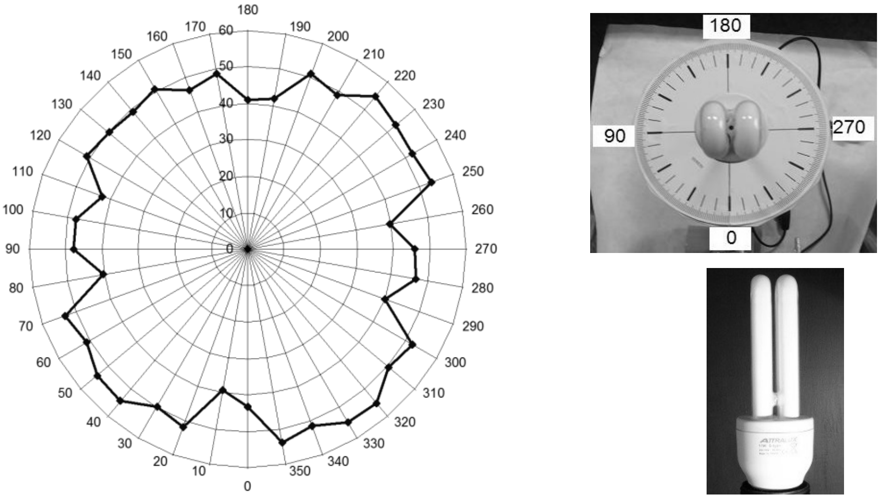

Fig. 4: Spatial properties of Compact Fluorescent Lamp (Atralux, input voltage: 230 V - 50 Hz, power consumption: 11 W, luminous flux: 600 lm, energy class: A Life: 6000 h, dimensions: 27 x 27 mm, height: 85 mm), graph was created by author

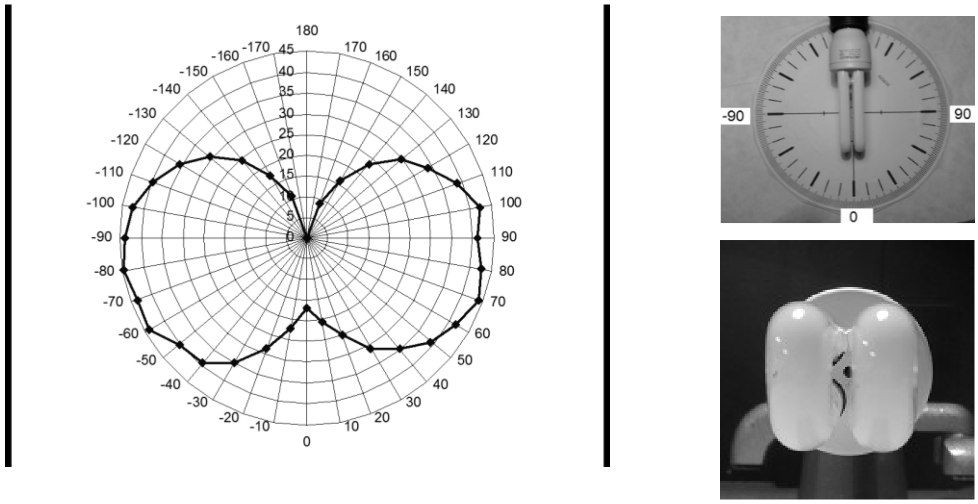

Fig. 5: Spatial properties of Compact Fluorescent Lamp 2 (Atralux, input voltage: 230 V - 50 Hz, power consumption: 11 W, luminous flux: 600 lm, energy class: A Life: 6000 h, dimensions: 27 x 27 mm, height: 85 mm), graph was created by author

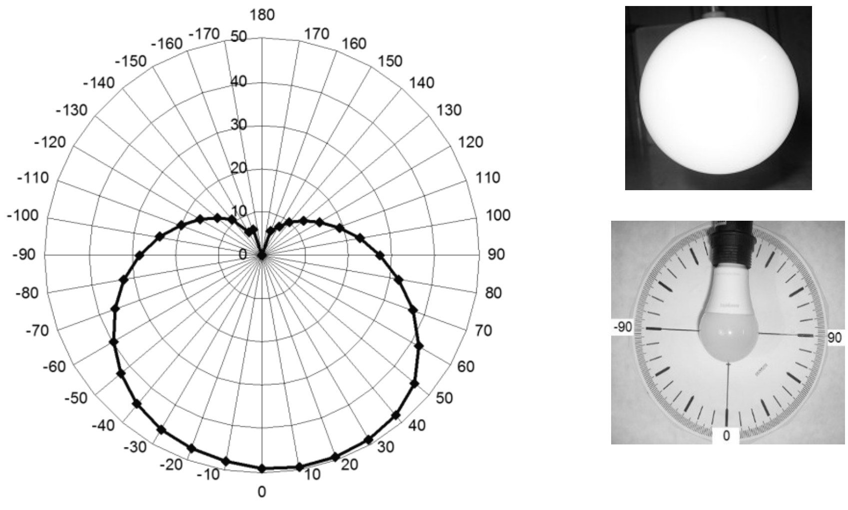

Fig. 5: Spatial properties of Light Emitting Diode (Energetic, input voltage: 230 V - 50 Hz, Power consumption: 6.5 W, luminous flux: 470 lm, diameter: 60 mm, height: 45 mm), graph was created by author

Spatial properties of light different source depend on the shape of the source and its construction. Pupils get a foretaste of light sources properties and they suggest which one is suitable for table lamps and chandeliers.

Pupils process all measured data in Excel. They create a graph, calculate values and find dependency.

Task: 3rd problem

Teacher explains to pupils the necessary concepts before measuring (light, spectrum**,** etc.).

What is light? How do we gain white light? Why do you see color?

The pilot study found that pupils often have a misconception about what happens when light passes through a colored foil. Pupils think that white light passed through a red foil will be higher the intensity in the red part of the spectrum.

Fig. 6: mixing of colors

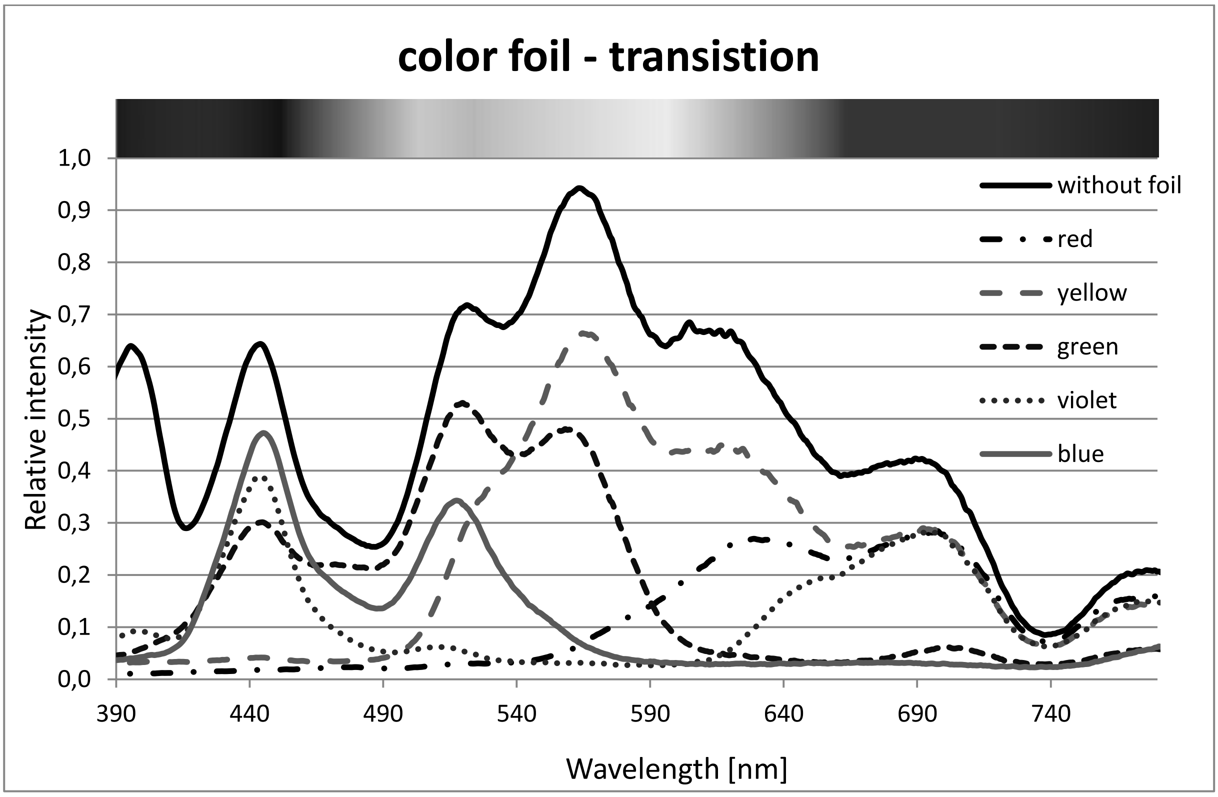

Fig. 6: Light passes through a color foil

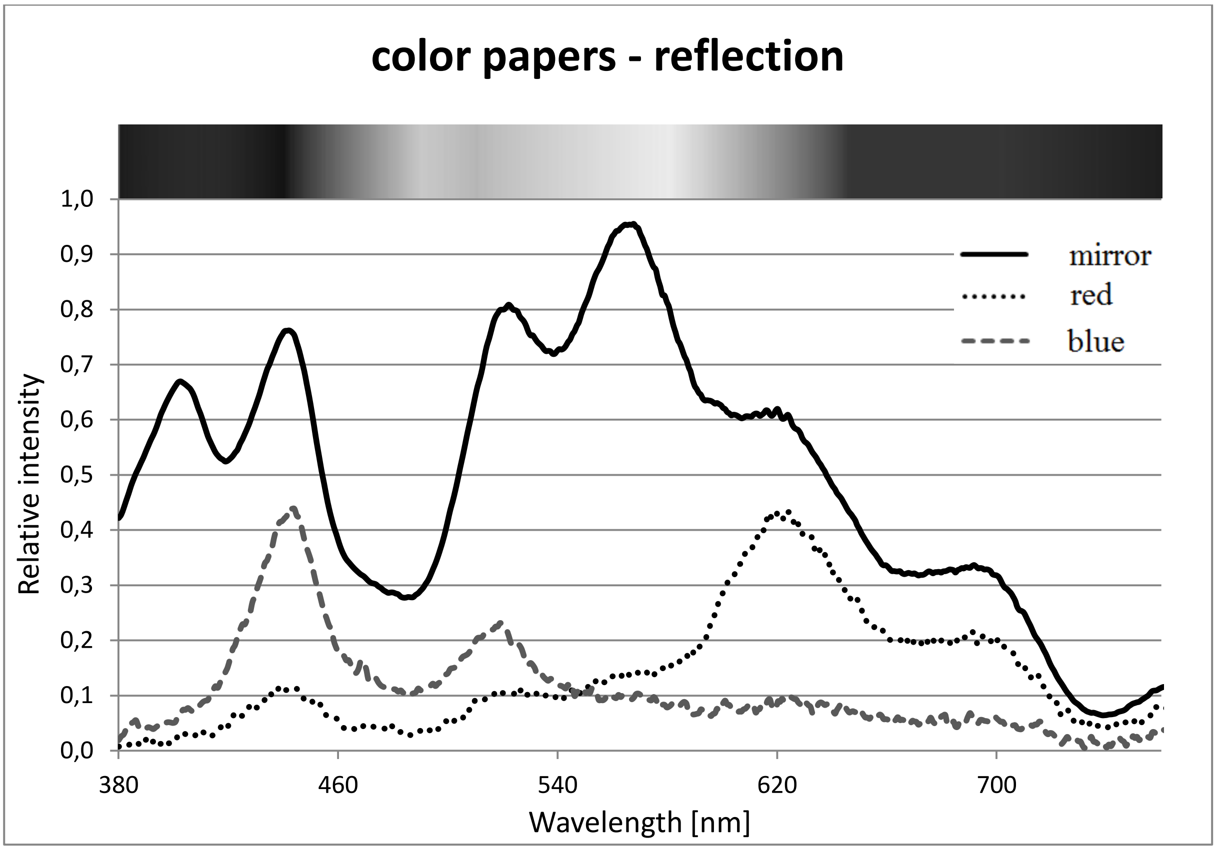

Fig. 6: Light reflected from surfaces of different colors

Pupils get a foretaste of color mixing; they learn about with the two models: RGB and CMY.

Pupils learn that human sees in color because of each subject reflected the light to the eye. A color can be seen on dependence how the light is reflected from an object.

Discussion and Conclusion

Pupils get a foretaste of light sources properties and they suggest which one is suitable for table lamps and chandeliers. Pupils get a foretaste of color mixing and of reflection. Pupils said that experiments were interesting. Pupils appreciate the modern equipment during measurement and appreciate that the tasks relate to their everyday life. Currently, the pre-research was carried out on about 30 pupils (15-19 years old).

Many misconceptions will be discovered by this research. We will obtain feedback from answered questions. The feedback will be base to create a part of photometry in the textbook of optics. Photometry is interesting part of physics as follows from these researches of pupils.

The research will be done on a larger sample of pupils in the autumn of 2014. These experiments should develop creativity, increase the level of knowledge, and develop natural-science skills with the aid of information technologies of pupils at the secondary school (Mechlova, etc. 2012).

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Reflection of Programmed Learning in Pedagogical Literature and Professional Community

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Abstract

The paper presents a quantitative and qualitative analysis of the content of selected textbooks in terms of how they present and assess programmed learning as a specific educational concept. Moreover, it also lists the results of a survey performed among experts in relation to their views on both the past and the present status of programmed learning as well as its future potential.

Keywords

programmed learning, programmed instruction, textbooks

1 Introduction

Programmed learning has undoubtedly left and is still leaving a significant footprint in the development of pedagogical or didactic thinking and educational practice. This paper presents an analysis of selected, primarily Czech pedagogical works in terms of their description or assessment of programmed learning. At the same time, it provides the results of the survey performed among experts in the field of information and communication technologies focused on their views on selected passages of professional literature related to programmed learning and its potential to affect key areas of educational theory and practice. The empirical findings can serve the objectification of the assessment of this psychodidactic concept's importance for current theory and practice as well as for possible corrections of incomplete or incorrect interpretations of programmed learning.

2 Description and Assessment of Programmed Learning in Pedagogical Literature

Chosen for the analysis were selected publications, as representative as possible, by Czech and Slovak authors of several university textbooks related to pedagogy, didactics and educational psychology.

In the repeatedly published textbook **Obecná didaktika** (General Didactics) by Jarmila Skalková one of the sub-chapters has been devoted to programmed learning and its technical devices (251-253). This part describes the history of its origin starting from Skinner's speech in Pittsburgh in 1954. It also captures the following development from Skinner's linear program, through Crowder's branching program to adaptively controlled learning invented by the English scholar G. Pask and recalls the enrichment of the knowledge acquisition process using algorithmic models by L.N. Landa. The indicated connection with cybernetics, personality development (required by N.F. Talyzinová) and Bloom's theory of learning objectives has been developed in our country by D. Tollingerová. After the evaluation of this development, she reaches the following conclusion:

> The initial enthusiasm stemming from the possibilities of programmed learning has faded away and the original ideas about creation of programmed textbooks have become rather history, similarly to the scientifically unjustified and unfounded expectations that learning machines would replace teachers. However, the essential elements of this issue remain alive in the new conditions and new concepts. They represent a certain stage of the journey to computers and their function in the instruction process. (251–252).[3]

In the text of her earlier book **Od teorie k praxi vyučování** (Instruction: From Theory to Practice) J. Skalková stresses that programmed instruction brings

> demanding requirements on an accurate clarification of the objectives of teaching as well as on the analysis of curriculum or related activities of students. It is based on the idea of control when it comes to leading the learning pupil from the initial state of ignorance to the target state of knowledge. The target category is of paramount importance not only for the determination of the sequence of operations but also for the ongoing management of the learning process. The structure of learning in programmed learning assumes, as shown by Talyzinová, a) earmarking of the basic information unit (i.e. the basic elements of the curriculum), which constitute all sub-phenomena in the area of knowledge, b) determination of the basic method of a student's work with these elements as well as the system of activities which are adequate to the specifics of the subject being learnt (32).

In the same publication J. Skalková specifically states that “programmed instruction represents a new approach to teaching, instigated by looking at teaching as a regulatory process with feedback and new requirements for the management of pupils’ learning process... as well as the efforts to measure the results of teaching more accurately” and she adds that “it brings also a new approach to the analysis of the objectives of teaching.” (24-25)

J. Skalková further states that it is reflected mainly “in the efforts to analytically express in detail the content of the curriculum as well as the processes associated with its mastery” and points to the taxonomy of teaching objectives of American scholars B.S. Bloom and D.R. Krathwohl in the cognitive and affective area (1956, 1965), “which were established on the basis of a long-term research focused on programmed instruction.” This quote is given explicitly because some authors citing Bloom do not mention the connection between his scientific work and the development of programmed learning.

Moreover, J. Skalková agrees with N. F. Talyzinová's critical views of the state of setting learning objectives at that time and adds: “But Talyzinová in connection with the development of programmed learning rightly draws attention to aspects that are of general importance to the management of the teaching process and the work of teachers even if programmed instruction is not used.” This demonstrates the positive impact of programmed learning/teaching on the development of didactics.

An objective approach to programmed learning is taken by the authoring team called **Školní didaktika** (School didactics) led by Z. Kalhous and O. Obst (24-26). The textbook explains the development of educational ideas in connection with the socio-economic and technological development. The authors of this publication associate Thorndike’s behaviourism describing the relationship between the stimulus and the response to a reward or punishment with scientific management and effective production control, which was in our country represented by Baťa. They appreciate the fact that behaviourists “provided the theoretical basis for today's dominant approach to teaching: the curriculum is systematically

[3] All translations are the author’s except where otherwise noted.

broken down into small units, which shall be forwarded to the student; their memorization is fixed by revision in practice and testing." A great practical importance is also attributed to the development of techniques for setting learning goals. B.F. Skinner perfected the use of positive and negative reinforcement. In the subsequent neobehaviorism, he described this theory of learning as programmed learning "based on clearly defined tasks expressed by the target pupil's behaviour, segmentation of the curriculum taught at a rate determined by the pupils themselves, and immediate feedback."

E. Vyskočilová and D. Dvořák (17-62) observe that in the 1960s educational programs, their branching and adaptation to individual pupils underwent a lot of experimentation (N.A. Crowder, G. Pask). They note that in addition to the reception of foreign models, also original works in the field of programmed learning are produced thanks to V. Kulič, D. Tollingerová (taxonomy of learning tasks) and others. At the end of the chapter on neobehaviorism and programmed learning, they soberly express that

> programmed learning has not fulfilled the hopes invested in it, but it has taught teachers to pay more attention to pupil's learning process and less to what the teacher does, which led to the effort to produce the most accurate possible formulation of learning objectives; stressed the importance of individualized learning pace and others. Later, with the emergence of new, more powerful technical resources for the implementation of learning programs (computers, multimedia), there was something to build on.

K. Janiš assesses the theory of programmed learning from the current point of view. In his **Obecná didaktika** (General Didactics), Janiš deals with the concept of education and types of instruction. The main attention is paid to programmed learning – both to its history and basic concepts and to its principles of management, creation of programs, advantages and criticized aspects. The basic tenet is as follows: "With sufficient lapse of time, during which there was a fundamental critique of the key principles, followed by extension and subsequently extinction of interest in programmed learning, there remained numerous inspiring ideas on the management of the learning process." (ibid, 24–31, 46). According to Janiš, "programmed learning is currently applied to the concept of the integrated didactic system." This categorization is explored by various teachers in different contexts (ibid, 27).

In his book **Kompendium pedagogiky** (Compendium of Pedagogy), J. Dvořáček deals with programmed learning in relation to seven presented teaching concepts. He claims that programmed learning and teaching is derived from behaviourist learning principles of conditionings. The author presents the basic idea of programmed learning and briefly recalls the development of programs from linear to adaptive. Furthermore, he notes that

> programmed instruction was criticized for the fragmentation of the curriculum into short steps, for the missing holistic view of the subject's content, alienation and excessive individualization of learning process devoid of social ties and direct personal influence of teachers, limitations of pupils' verbal expression, etc. Despite these objections, programmed instruction and learning is a real asset, it activates pupils, and the individual pace is particularly effective in various forms of self-study.

The characteristic of programmed learning and instruction as described by J. Dvořáček is entirely apposite.

In his publication ***Prameny výchovy IV. 20. století*** (*Sources of Education IV. 20th century*) (1995, 172-485), M. Cipro pays attention to B. F. Skinner. He relates the excitable objectivity of Americans to his theory of behaviourism. In his analysis, he sees not only the mistakes in his positivist approach, but he also lists his benefits, his inspirational stimulus and practical use:

> The fact is that the idea of programmed learning, whose main protagonist was B. F. Skinner, brought some practical results and, in his time, strongly influenced pedagogical thinking. It literally picked up around the world and was one of… the most popular pedagogical concepts, promising an epochal revolution in the methods of education. And it did not remain only an idea, indeed. Programmed learning began to penetrate into educational practice as well.
>
> Furthermore, Cipro mentions why programmed learning gradually began to subside, although it was enriched with other improving elements by other Americans Crowder and Stolurow, Englishman Pask, Germans Frank and Kelbert, Russian Landa and others. "Certain intelligence, time, financial and material costs for the application of programmed learning showed that the path without international coordination is hardly feasible." With hindsight, Cipro comes with a new thought and says:
>
> The movement entered a new, more sober and long-term stage of its development, in which it should be rather important how to enrich the existing traditional and modern teaching methods and resources with the ideas and practices of programmed learning. A new impulse was brought by microprocessors which can be seen as a promise of programmed learning renaissance.

An example of partial application of the ideas of programmed learning is epitomized by the current publication **Didaktika pro vysokoškolské učitele** (Didactics for University Teachers) by L. Podlahová et al. In Chapter 1.4 on important figures in the history of didactics, V. Kulič and D. Tollingerová are named in connection with Bloom's taxonomy of objectives. In Chapter 3.3 with title Učební úlohy ve výúce (Learning tasks in teaching), she verbally and graphically illustrates the taxonomy of learning tasks and introduces motivational verbs for the formulation of learning objectives and learning tasks (135-136). However, in the examples given on pages 99-102, Podlahová presents only tasks that require formulation of answers, contain different selective answers or are based on matching of the correct answer, making the note on the development of thinking rather a proclamation.

J. Horák quotes in his minor work **Obecná pedagogika** (General Pedagogy) Bertrand's table of seven educational theories, where B. F. Skinner is included among the leaders of technological theory.

In the chapter Programované vyučování (Programmed instruction) in the **Pedagogika pro učitele** (Pedagogy for teachers) textbook, A. Vališová sets with a deep knowledge programmed learning into the development of didactic thinking:

> The gradual uncovering of the learning process patterns (primarily with the support of behavioural psychology), together with the effort to apply basic cyber practices in pedagogy and psychology, gave rise to the theory of programmed learning. Programmed learning means **enrichment of individualized didactic models** in the idea of **management of pupils' learning activities**. Programming as a process determining the optimal workflow, operations, tasks and order of task solving in a specific process (production, teaching, etc.) is used in the current school practice even more often. (165 et seq.)

A. Vališová also comes with realistic and thoughtful suggestions for a solution:

> At present time, as the citizen initiative is no longer sufficient, **it will be necessary to elaborate a systematic and meaningful project that would sum up everything we know about programming in our country and in the world** (from both theory and practice, mainly a project that would determine the direction of research and implementation in the future. Programmed instruction should today have a firm place of an approach to alternative education and training as a didactic submodel with its

> theoretical basis and specific practical application. Pedagogical practice requires not only well-written programs for the curriculum content, but also social training programs, programs for the training of teachers' decision-making skills and so on.

A. Vališová advocates learning from past experiences and suggests its further direction:

> In the 1960s, programmed instruction was rather promoted alongside other methods and organizational forms. Today, it is necessary to consider **the introduction of programmed instruction within all forms and methods of teaching**. This requires high-quality programs for paired teaching, microteaching, cooperative and competitive programs, as well as programs for teaching in groups. At this time, it is necessary to focus particularly on programs for personal computers and video programs, to build material and didactic technique as a part of the teaching environment. Programmed learning now draws not only from empiricism, but uses also scientific theories.

In several points, A. Vališová summarizes the positive benefits of programmed learning as well as its problems and shortcomings, and concludes that

> programmed learning provided valuable suggestions for teaching practice. At present time, it is also being considered in which subjects and sub-topics it is appropriate, proportionate and fair to use programmed learning. It is also necessary to consider **the optimal combination of programmed learning with other forms of teaching**, as well as **new inspirations representing a certain stage of the journey to computers**, their function and use in teaching (170).

A Czechoslovak publication with the bilingual title **Předškolní a primární pedagogika. Předškolská a elementárna pedagogika** (Preschool and Primary Pedagogy) (Kolláriková, Pupala, ed., 2010) pays attention to passwords of programmed learning and behaviourism in the chapter called **Teórie učenia a ich odraz v poňatí vyučovania** (Theory of learning and its reflection in teachings concepts). Pupala's view of behaviourism, which is explained on the basis of creation of patterns formed by the outside environment, is insightful and quite objective. He further deduces:

> Pedagogical approach oriented in the behaviouristic direction thus counts with a well-planned educational process. If man can be controlled (shaped) by external stimuli, it is possible to program and precisely define, in advance, the final product of the educational process. This will take the form of the expected type of behaviour (e.g. well-learned answers to a question) as the so-called output from the educational process. If this output is achievable by external organization of these stimuli, then it is possible to define not only the output, but also the so-called inputs, which are stimuli triggering the appropriate change in behaviour. The pedagogical version of the behaviourist psychological S-R scheme formulates the so-called inputs and outputs of the pedagogical act. While the input is the stimulus (e.g. a dose of the curriculum), the output is defined as the so-called educational goal (expected and observable change in behaviour, for example a demonstration of the newly acquired knowledge), which should be achieved by means of the corresponding input.

B. Pupala further recalls that "the path between the input and output may not be immediate or straight". By this, he probably means the linear, alternative, branching or adaptive program. With the ability to determine categories of inputs and outputs, B. Pupala highlights another important factor related to the taxonomy of objectives initialized by B. S. Bloom, which is currently applied in programmed learning:

> In this context, it is understandable why certain direction of pedagogical thinking seeks for precisely formulated goals of instruction ... It is about the expression of assumption

> that teaching can be well organized, if we know ahead which new type of observable behaviour (a certain performance) we want to bring children to.

He continues with a note about '**the movement for teaching objectives**', which came with very detailed technological recommendations of how to formulate individual educational acts in terms of the ahead scheduled output (the so-called specified objective) that we expect from children. The author also highlighted another aspect of the pedagogical process associated with the application of programmed learning:

> The exact definition of these outputs should allow effective control of individual pedagogical acts. In other words, a good definition of outputs enables the measurement of the quality of outputs. It also includes the trust to testing (related particularly to didactic tests) as a tool for measuring the effectiveness of the teaching process. (184–185)

In **Základy didaktiky** (Basics of Didactics), J. Malach briefly outlines the historical roots, principles of programmed learning, types of programming and computer functions at different stages of education. Very inspirational is the assignment for students who are asked to mark in a table with nineteen items those educational functions which make use of computers and to state how often they use them. Among the weaknesses of the programmed learning application, he lists "the absence of sufficient amounts of ICT (information and communication technology) at schools, the demanding character of the creation of high-quality educational programs, restriction of personal contact with the teacher and other pupils." On the other hand, J. Malach sees the strengths in "increasing the effectiveness at all stages of the educational process: learning, implementation of individualized learning, and strengthening and enriching the so-called computer literacy". (ibid, 114-117) Methods of programmed learning, e-learning and simulator training are described by J. Malach in separate chapters of his publication Efektivní metody vzdělávání dospělých (Effective Methods of Adult Education) (2003b, 46–50).

References to programmed learning are present also in the relatively new publication **Pedagogika** (Pedagogy) by D. Čábalová. However, the evaluation of theoretical and application psychological background is done only on the basis of the initial behavioural concept of Skinner, Pressey and Crowder, which may lead to a certain reduction in its theoretical roots and application experience. This may deprive the programmed learning image of the benefits of Pask's adaptive programs, Landa's contribution in the form of algorithms, its link to cybernetics, teaching machines and computers, or of its connection to Bloom's taxonomy of learning objectives, which emerged in a direct relation to the research and implementation of programmed learning.

A successful contribution to the quality improvement of higher education is the study Strategie výuky ve vysokoškolském vzdělávání (Strategies of Instruction in University Education) by J. Vašutová. She states that

> university is the place where individualized instruction is most often happening in two different concepts, namely as a) self-directed study supporting student's independence which is based on psychological principles of management, programming and programmed learning and b) group instruction supporting collaboration, in whose theoretical background social interactions and dynamics of small groups plays a vital role.

And she continues even further by claiming: "Programmed learning, which is sometimes called programmed instruction for convenience, is one of the most modern concepts of university education based on independence and directed learning. The Renaissance of its principles relates to the development of concepts of computer-aided teaching." In her observation, J. Vašutová included two essential propositions: the first is that she sees the Renaissance of programmed learning principles in the developing computer instruction, and the second indicates the further development of programmed learning, which did not stagnate at Skinner's linear program. J. Vašutová also highlights the role D. Tollingerová played in the creation of learning tasks taxonomy, without indicating her association with programmed learning, for which the taxonomy was actually created.

A separate chapter is devoted to programmed instruction also in the latest edition of **Obecná didaktika** (General Didactics) by the Slovak author E. Petlák. He generally captured the positive and negative aspects of programmed learning. Concretely, the author defines the positive aspects of programmed learning as follows:

- The processing of the program pays attention to key issues of the curriculum.
- The curriculum is divided into steps which ensure its mastery.
- The program maintains the attention of pupils.
- The program respects the principle of proportionality.
- Programmed instruction supports pupils' confidence.
- The program provides accurate information.
- Thanks to its processing, the program supports the strengthening and permanence of knowledge.
- The program consistently informs the pupils about their performance.

On the other hand, he mentions the following negative aspects:

- The division of the curriculum into steps ensures its adoption, but there is a risk that the student will not fully understand it and will not be able to use it in practice, in the new changing conditions.
- The processing of the curriculum into a program reduces pupils' mental operations; they work only with words listed in the program, which does not contribute to the development of their vocabulary and expressive skills.
- Programmed instruction impoverishes the teacher – pupil interaction (when working with programs, the teacher communicates with pupils very little, or does not communicate at all).

Attention should be also paid to constructive suggestions of J. Maňák stated in his book **Nárys didaktiky** (Outline of Didactics). He earmarks four so-called types of teaching; namely informative, heuristic, productive and regulatory teaching. The regulatory type of teaching builds on the automatic regulation and management of pupils' learning activities through programs, algorithms, and computers. He can see its advantages in: "a) the growth, speed of acquiring and persistence of the adopted knowledge, b) individualization and c) differentiation of pupils according to the speed, strategy and number of pupil's activities."

In his book **Psychologie výchovy a vyučování** (Psychology of Education and Instruction), J. Čáp devotes to programmed learning a special chapter. His presentation is based on the criticism of the then traditional school with an atmosphere of fear, limited control over pupils' results, overloading teachers with monotonous work when checking written assignments, insufficient consideration of individual differences among students. On the other hand, he appreciates the breakdown of the curriculum into individual steps and their arrangement after a thorough analysis and verification. He also correctly explains the meaning, ways and possibilities of control information including the choice of programmed textbooks or teaching machines. He further explains that:

> This arrangement allows a successful procedure, motivates pupils and extends their independent activities. Programmed learning facilitates the extensive, tedious work of

teachers, stereotyped activities spent on testing and correction of written assignments and saves time for more important pedagogical actions as well as for the individual work.

Furthermore, J. Čáp explains the preparation of different types of training programs and as for the branching programmes. He also appreciates the error analysis. He recalls that programmed learning followed after a series of progressive psychological and pedagogical principles and identifies its strengths. Among the main problems he mentions the saturation from small steps, the loss of novelty of the work on teaching machines, the loss of independence to external control, etc. He adds that

> critical comments were related mainly to the early forms of programmed learning, when the teaching machines were imperfect and programs pursued mainly elemental targets or did not adequately take into account newer concepts of the psychology of learning, problem solving, or intellectual operations.

Referring to Kulič (1966) and Landa (1973), J. Čáp comes to the following assessment:

> Programmed learning provided valuable suggestions for teaching practice, but it is not the only and universal form. It is necessary to carefully consider, in which subjects and topics is the use of programmed learning appropriate and how to combine it with other forms of teaching. (255–256).

Rank	Author	Title	Pages about PL	Total no of pages
1.	CIPRO, M.	Galerie světových pedagogů, 2002	5	633
2.	ČÁBALOVÁ, D.	Pedagogika, 2011	3	272
3.	ČÁP, J.	Psychologie výchovy a vyučování,2011	10	415
4.	ĎURIČ, L.	Pedagogická psychológia, 1988	6	333
5.	DVOŘÁČEK, J.	Kompendium pedagogiky, 2009	4	176
6.	HORÁK, J.	Obecná pedagogika, 2004	1	81
7.	JANIŠ, K.	Obecná didaktika, 2007	12	109
8.	JURDIN, R. in Kol.	Pedagogika II., 1993	7	288
9.	KALHOUS, Z., OBST O. et al.	Školní didaktika, 2009	10	247
10.	KOLLÁRIKOVÁ, Z., PUPALA, B. ed.	Předškolní a primární pedagogika. Predškolská a elementárna pedagogika, 2010	9	455
11.	MALACH, J.	Základy didaktiky, 2003	4	181
12.	MAŇÁK, J.	Nárys didaktiky, 2001	5	104
13.	MUŽÍK, J.	Andragogická didaktika. Řízení vzdělávacího procesu, 2010[4]	15	323
14.	PETLÁK, E.	Všeobecná didaktika, 2004	12	312
15.	PODLAHOVÁ, L. et al.	Didaktika pro vysokoškolské učitele	2	160
16.	SKALKOVÁ, J.	Obecná didaktika, 2007	4	292
17.	VALIŠOVÁ, A., KASÍKOVÁ, H. et al.	Pedagogika pro učitele, 2011	6	456
18.	VAŠUTOVÁ, J.	Strategie výuky ve vysokoškolském vzdělávání, 2002	6	282
19.	ZLÁMAL, J.	Didaktika profesního vzdělávání klasifikace metod výuky, 2009	2	208
20.	ZOUNEK, J. ŠEĎOVÁ, K.	Učitelé a technologie mezi tradičním a moderním pojetím, 2009	4	172

Tab. 1: Quantitative comparison of textbooks in relation to programmed learning (source: own analysis)

[4] The chapter is called *Didaktická relevance E-learningu* (Didactic relevance of e-learning) and the author states that “e-learning is a didactic method, which is an implementation of programmed instruction and learning...” (196)

After the partial analyses of the publications specializing in pedagogy, it is possible to perform a quantitative and qualitative assessment in relation to the examined programmed learning. Included in the survey were only those publications which contained at least some information on programmed learning. However, this does not mean that all recently edited publications have been taken into account.

The quantitative assessment of the extent of information concerning programmed learning shows that in the twenty analysed works the range of text devoted to this issue moves between 1 and 15 pages. The majority of works (i.e. 11) devoted to programmed learning the space of 4 to 9 pages, four publications presented this topic on 1 to 3 pages, while 10 or more pages were found only in five sources.

Rank	Author	Title	Incomplete or inaccurate presentation	Appreciates the contribution	Sees good prospect
1.	CIPRO, M.	Galerie světových pedagogů, 2002			x
2.	ČÁBALOVÁ, D.	Pedagogika, 2011	x		
3.	ČÁP, J.	Psychologie výchovy a vyučování, 1993			x
4.	ĎURIČ, L.	Pedagogická psychológia,1988		x	
5.	DVOŘÁČEK, J.	Kompendium pedagogiky, 2009			x
6.	HORÁK, J.	Obecná pedagogika, 2004		x	
7.	JANIŠ, K.	Obecná didaktika, 2007			x
8.	JURDIN, R. in Kolektiv autorů	Pedagogika II.,1993			x
9.	KALHOUS,Z., OBST, O. et al.	Školní didaktika, 2009			x
10.	KOLLÁRIKOVÁ Z, PUPALA, B. ed.	Předškolní a primární pedagogika, 2010		x	
11.	MALACH, J.	Základy didaktiky, 2003			x
12.	MAŇÁK, J.	Nárys didaktiky, 2001		x	
13.	MUŽÍK, J.	Andragogická didaktika. Řízení vzdělávacího procesu, 2010			x
14.	PETLÁK, E.	Všeobecná didaktika, 2004			x
15.	PODLAHOVÁ, L. et al.	Didaktika pro vysokoškolské učitele, 2012	x		
16.	SKALKOVÁ, J.	Obecná didaktika, 2007			x
17.	VALIŠOVÁ, A., KASÍKOVÁ H. et al.	Pedagogika pro učitele, 2011			x
18.	VAŠUTOVÁ, J.	Strategie výuky ve vysokoškolském vzdělávání, 2002			x
19.	ZLÁMAL, J.	Didaktika profesního vzdělávání, 2009		x	
20.	ZOUNEK, J., ŠEĎOVÁ, K	Učitelé a technologie mezi tradičním a moderním pojetím, 2009			x
			2	5	13

Tab. 2: Qualitative assessment of textbooks and other educational resources in terms of presentation of the programmed learning concept (source: own analysis)

Qualitative assessment of sources in terms of content presentation of programmed learning issues, or in terms of its future development, is not easy and may be subjectively coloured, which, however, should not significantly affect the categorization of sub-articles, chapters or segments of text devoted to programmed learning according to these criteria:

- According to the completeness or accuracy of the presentation of the programmed learning concept.
- According to the degree of recognition of the contribution of programmed learning to the development of (current) didactics.
- According to the degree which the authors attribute to its future prospect.

Statement expressed by the author	Incomplete or inaccurate presentation	Appreciates the contribution	Sees good prospect
Number	2	5	13
Percentage	10	25	65

Tab. 3: The attitude of pedagogy textbook authors towards programmed learning (source: own analysis)

The analysis of publications containing information about programmed learning shows that one-fifth of the authors appreciate the contribution of programmed learning to the development of didactics as well as to the improvement of teaching and learning process. More than half of the authors (65%) expects its further development and sees the prospect of its application, often in the context of the widely understood eLearning. Only in two sources, the presentation of programmed learning was found incomplete or inaccurate.

3 Views of Professional Community on Programmed Learning and its Prospects

In order to increase the objectivity in relation to the perception of the importance of the use of programmed learning and its other perspectives, a supplementary survey was performed in September 2013 on a randomly chosen moderately large sample of experts who accepted participation in the conference aimed at the usage of ICT in education. This representative sample included teachers of various school levels, workers in the IT field, researchers, school managers and postgraduate students. The respondents were requested to fill in a paper and pencil questionnaire consisting of two parts. While in the first part they were asked to express their opinion about a few quotations from textbook authors related to programmed learning, the second part was focused on the assessment of the potential of programmed learning in selected components of the educational process. Of the 67 respondents who were approached, 32 submitted the questionnaire, which accounts for quite a high return rate of 47.8%.

From the set of expressions used by authors of pedagogically oriented works relating to programmed learning, the following ten characteristic quotes were selected:

1. Programmed learning has taught teachers to pay more attention to pupil's learning process and less to what the teacher does, to individualized learning pace and, last but not least, to coping with learning.
2. Programmed learning has enriched the individualized didactic models by introducing the idea of pupils´ learning activity management. Programming, as a process determining an optimal workflow, operations, actions and sequence of tasks solved within a particular process (manufacturing, instruction, etc.), is being used in the current school practice more and more often.
3. The Renaissance of the programmed learning principles is closely related to the development of computer-assisted instruction concepts.
4. …has brought valuable suggestions for the teaching practice.

5. Its rational elements constitute a valuable contribution to the great historical synthesis that is permanently under reconstruction.
6. The main reasons for the small extension into practice were the high economic costs and the unpreparedness of a sufficient number of high-quality educational software developers.
7. In addition to other types of teaching, regulatory training (which according to the author includes also programmed learning) has also its own irreplaceable role in the complex integrated system of education.
8. Programmed instruction and learning are an indisputable benefit–they activate pupils.
9. Many of the programmed learning principles have gradually become generally applicable and accepted didactic principles (e.g. the principle of feedback).
10. Certain principles of programmed learning and teaching machines have not lost its usefulness.

The quotes were presented without the authors' names, so that they could not influence the opinions of the respondents, who rated their level of agreement with the statements of individual authors using a five-point scale from 1 (Strongly Disagree) to 5 (Strongly Agree).

The obtained results are summarized in the following chart:

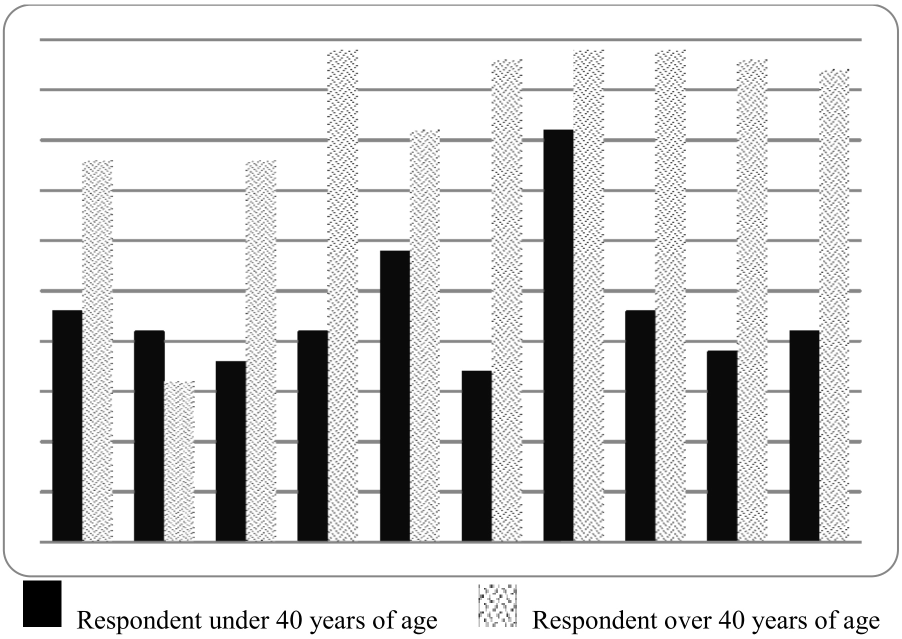
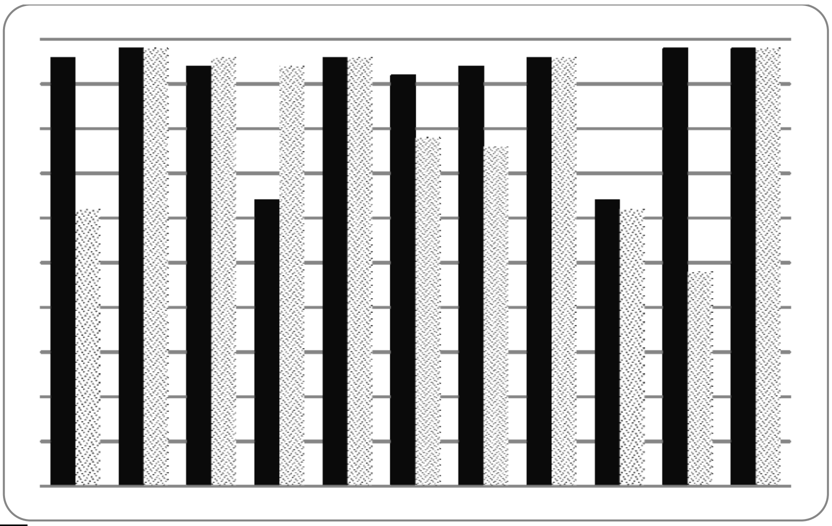


Fig. 1: The level of agreement with statements related to programmed learning (own research)

The result of the survey showed a significant difference in generational understanding of the concept of programmed learning. Respondents younger than 40 (left columns) were largely sceptical to the authors' favourable statements. A certain consensus in favourable assessment appeared in both age groups in item no. 7, which contained the statement by J. Maňák concerning the place of programmed learning in the regulatory type of training in the integrated system of education (26). Respondents over 40 years of age can imagine the possibility of wider application of the principles of programmed learning. The most widely accepted idea was the one expressed by the author in item no. 4, which appreciated the contribution of programmed learning to practice. Also the statement by J. Čáp related to the causes of programmed learning downturn (255-256), indicated in item no. 6, was greatly accepted. As the diagram shows, positively received were also the thought of J. Dvořáček (item no. 8) about the pupils being activated by programmed learning (5) and broader expression of the usefulness of programmed learning by J. Zounek and K. Šeďová (item no. 10) (30-31). A smaller degree of agreement was obtained by A. Vališová's idea stated in item no. 2 (165 an).

In the second part of the questionnaire, the respondents again expressed with the help of a five-point scale their opinion about the potential of programmed learning to influence the following 11 specified areas, where 1 meant "Zero potential" and 5 "High potential":

1. Formulation of educational goals and learning outcomes.
2. Formation of learning tasks with varying degrees of intensity of required mental operations.
3. Selection of key elements for the curriculum (core curriculum).
4. Acquisition of psychomotor skills.
5. Ensuring perfect mastery of the curriculum by revision with immediate feedback.
6. Usage in the creation of computer tutorials.
7. Ensuring individual independent learning.
8. Creation of didactic tests with a rich set of test item types.
9. Creation of equal opportunities and conditions for learning.
10. Implementation of screening (in the form of the "state" part of the maturita exam or tests for pupils in 5th and 9th grades).
11. Formation of diligence, accuracy and consistency at pupils.



Respondent under 40 years of age Respondent over 40 years of age

Fig. 2: Respondents' views on the potential of programmed learning (own research)

More specific proposals for the realization of programmed learning potential were met with a greater favour in both age groups. A higher level of compliance was recorded especially in the creation of learning tasks with varying degrees of difficulty in thinking operations (item no. 2), in the selection of the core curriculum (item no. 3), in ensuring perfect mastery of the curriculum by revision with immediate feedback (item 5), in the creation of didactic tests with a rich set of test item types (item no. 8) and, last but not least, in the formation of diligence, accuracy and consistency at pupils (item no. 11). While the lowest rating was recorded in item no. 9 relating to the creation of equal conditions for learning, the biggest difference by age group was reflected in item no. 10 stating the potential benefits of programmed learning for the implementation of screening in the form of "state graduation" and in testing pupils in the fifth and ninth grades.

The questionnaire also contained empty space which the respondents could use for free expression. As an example of their opinions, the following statement can be chosen: “Today's teachers do not know the true principles of programmed learning. It is necessary to start all over again.”

4 Conclusion

The analysis of university textbooks, particularly in the fields of pedagogy and didactics, showed that the majority of authors appreciate the contribution of programmed learning to the development of didactic knowledge as well as to the improvement of educational practice, and that they consider its main ideas to be applicable to both a theoretical and practical purpose. According to the experts, it is still prospective to use the concept of programmed learning and its individual components especially in the areas of learning tasks creation, selection of the core curriculum, acquisition of psychomotor skills, perfect mastery of the curriculum, and testing of students.

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THE PROGRAMMING ENVIRONMENT FOR THE LEGO WEDO ROBOTIC CONSTRUCTION SET

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Abstract

In this article, we discuss the properties and control methods of the LEGO WeDo robotic construction set with its integrated programming environment for children. We describe the characteristics of the software environment with categories: general vs. specialised, programming style, the level of object orientation, code representation, programming constructs, project construction, preventing (syntax) errors, saving and exporting and localisation. These categories are covered by the publication from Gujberová and Tomcsányi. According to these categories, we describe the control methods of the software, the range of its possibilities, and also its advantages and disadvantages. We use pictures to demonstrate code samples for a better understanding of the code structure described in the text.

In our conclusion, we propose to create two new categories due to precise classification of educational software LEGO WeDo. Preliminary results of research indicate intuitive work with various commands, thus fostering the development of skills and the knowledge of creating programming constructs.

Keywords

Classification, Educational software, LEGO WeDo, primary school pupils

Introduction

In recent years, the interest in the use of robotics in the education process has significantly increased. All around the world, there are attempts of its use in kindergartens, as well as in university courses, where it is used mainly in science- and technically-focused subjects (Alimisis 2009). The authors (Mubin et al. 2013) believe that robots are not only modern cutting-edge technologies, but that they also represent a tangible result of the learning process of the students. Such approach really supports the idea of implementing robotics into the teaching process. However, such implementation is not an easy process and does not only include the choice of a good and proper robotic construction set for the given age category, but also the selection of a proper programming environment for this set. Of course, there are also some introductory activities related to robotics, which do not require using a computer. Micheli (2008), for example, suggested such activities designed for age group of 5 to 8-year-olds. However, for a group at the age of 9 or 10, the authors recommend using adjusted iconographic language NXT-G (visually adjusted motive on the command icons), which is to be used together with a very popular construction set LEGO Mindstorms NXT. The authors (Hirst et al. 2003) have drawn up a brief analysis of available programming environments for the robotic construction set LEGO Mindstorms RCX for a wide range of age groups (from primary school pupils, to university students and life-long learning adults, to teachers). Criteria created by these authors are primarily meant for a pre-entry level university course, but the authors are planning to use them to support students in competitions such as RoboFesta and RoboCup. The authors (Gujberová and Tomcsányi 2013) focus on specifying adequate selection criteria (yet in terms of programming, not from the didactic aspect) of the programming environment for pupils of primary school. The authors, in their article, chose for their research several well-known programming environments for children (Scratch, Imagine Logo, Baltie, Kodu, etc.), which they analysed on the basis of the established criteria. When setting up the criteria, they were inspired by (Kelleher and Pausch 2005).

In our article, we intend to analyse the software for robotic kit LEGO WeDo on the basis of criteria from article (Gujberová and Tomcsányi 2013) and also suggest a number of improvements of these criteria for a more precise software classification.

Research methodology

In our dissertation research (Mayerová and Veselovská 2012; Veselovská and Mayerová 2013), we focus on the creation and verification of activities for students and methodological materials for teachers. These activities are destined for Informatics lessons using the LEGO WeDo construction set for 8 to 12-year-old pupils. We tested these activities in more than 60 lessons therefore we have sufficient experience of using this software by pupils.

However, our theoretical research we have established based on the results of Gujberová and Tomcsányi (2013), who developed an overview and an analysis of programming languages for children. We reckon that the software for the LEGO WeDo ranks also among them. In this article we analyse the software for LEGO WeDo according specified criteria by Gujberová and Tomcsányi (2013). We chose these criteria, because they meet our goals: they focus on programming environments for children and on various programming concepts. In this paper we describe in detail and explain which of these criteria meets our software and which not. Respectively, which possibilities our software provides for teaching programming in primary school.

Description of the software environment for LEGO WeDo

There is indeed a particularly vast selection of robotic construction sets offered on the market. We have given a fairly extensive overview of educational construction sets and a detailed description of their classification based on diverse criteria in (Mayerová 2013) and (Veselovská and Mayerová 2013). Relying on these criteria, we chose the LEGO WeDo construction set for the purposes of our research and original software to operate it.

In the following chapters we will use a structure where first will be list of categories and only after we explain the following categories into which falls WeDo software and why.

The focus of the program environment for children
At the very beginning of their article, the authors divide the programming environments using the following characteristics:

- Specialised focus
- Openness

This classification depends on whether the environment focuses on a specific concept (one kind of activity) or whether it is a general language allowing to create arbitrary concepts. If the environment allows to perform merely one type of activity (e.g. moving through a labyrinth), then authors consider the openness of such a software, that is whether individual tasks, or rather levels are determined beforehand, or whether the user can create his or her own activities in this environment.

With such a system, we are unable to precisely classify the WeDo software (hereinafter referred to as WDs). The WDs allows the users to create arbitrary concepts, but only as a way of operating a specific construction set, thus falling under both categories and making its classification unclear. (That is why we regard it as a very atypical programming language for children). So we would like to suggest adding another category, i.e. the *control software*. This category will contain programming environments that are used to exert control over construction sets and other devices.

Programming styles

- Procedural
- Event-based
- Object-oriented

From the programmer's viewpoint, WDs cannot be regarded as object-oriented. It does neither contain nor support any classes. Thus we can automatically rule out the group of criteria referring to the possibilities and levels of object-oriented languages.

In WDs, we even cannot create any procedures. Out of these three options, WDs therefore corresponds merely to the category of *event-based programming*.

We run the program by pressing a key, clicking on a button or sending a virtual message. With such a manner of operating, we can say that the environment is **event-based**.

Fig. 1: showing the simulation of the *play* procedure (on the right), when together with three repeated moves of the motor, there is a parallel sound.

Programming constructs

- For loop
- Repeat (in the sense of repeat)
- Conditional (loop with conditions)
- Casing command
- Procedures
- Variables
- Parameters in my procedures

Out of these programming constructs, only three are supported by WDs. The repetition of some commands is approached differently than in the majority of general software environments for children. Mainly because it is a software intended for controlling the construction set, as some type of repeat occurs automatically. With one icon, it is possible to set the infinite rotation of the motor. The use of such an icon may not be entirely intuitive for children. When they want the motor to rotate longer, they put more of such icons one after another, which does not make sense, as one would suffice. The icon representing the loop (Fig. 1) can change its size depending on the length of the program we want to put into the icon. This is also of one the reasons why the children find the icon very intriguing. Explaining the instructions is easy and the use is intuitive and the pupils thus learn how to use a loop fairly early.

The classic *for loop*, which allows us to set the number of repeats und use this number in the loop, is not present here. However, there is the *repeat* (in the sense of repeat) in the way that the user is able to define the number of repetitions for the same set of commands, but they cannot use this number in the loop. The loop is thus present in the software in a very simple form. It is either infinite and cannot be followed by another icon, or it is finite and the number of repeats is determined by the parameter.

The presence of the *loop with conditions* can be confirmed for instance using the example in Fig. 2 (b – on the right). We run the program, which waits until it spots something and then plays a sound, i.e. until a certain event occurs. However, there is not a more complex *casing command*.

As outlined above, WDs does not support the construct of procedures, yet it allows a partial simulation of procedures with a virtual sending of messages. Such simulation is displayed in Fig. 1.

The *variables* are dealt with in a very untraditional manner. There is only one global variable in the entire software. Authors of the software have adapted the entering of input values to children's creativity. The classic attribution of a value to a variable is replaced by an extract of parameters (text, numbers, images) into the virtual display in the upper left corner of the screen, as shown in Fig. 2 (a-on the left).

Fig. 2: (a – on the left) A picture 1 and the text "abc" are shown on the virtual display. (**b – on the right)** The program is waiting until it sees something (wait until), then it emits a whistling sound twice (the for loop).

Unlike variables, *parameters* are used more often. As for their appearance, these cards are smaller than others. In command to attach them to the basic card, they must have a pocket or slot at their bottom edge, as for example puzzles have. Apart from the form, which is the same for all the parameters, the environment offers numeral and textual types of variables, then random and the loading of the input from the sensors and the virtual small screen. However, we are not able to use these parameters in our own procedures (as there are no procedures here). So WDs also does not support the construct *parameters in my procedures*.

During the activities we devised, the pupils were motivated to use, change and edit various types of parameters. The use and ways of editing of the parameters thus became trivial to them.

Code Representation

- Textual
- Iconic
- Card or Puzzle-like

For most adult programmers, it is intuitive to write instructions using texts. With children, it is different. Therefore, when (Gujberová and Tomcsányi 2013) analysing programming languages for children, the authors have proposed three categories.

One of the categories representing the program code is *textual representation*. This means that the program code can be edited only with text, i.e. letter by letter. The remaining two representations of the program code are similar, though there are some differences between them. They differ mainly in the fact that *icons* use for representation of the program code only the graphical representation of commands without using text. Conversely, *cards /textual parts puzzle-like pieces* use text for representing commands. These textual commands are usually written on regular rectangles in the form of cards or puzzles.

We categorised WDs as falling under the representation of program code with icons on the basis of software classification in (Gujberová and Tomcsányi 2013). According to the authors of the article, WDs can fall into this category in spite of the textual representation of variables and parameters.

Project Constructions

- Typing code
- Selecting pieces of code from menus
- Assembling code from rectangular cards
- Assembling from puzzle-like pieces
- Assembling from icons
- Direct manipulation for creating (visual) objects

When creating the program code in WDs we can choose only icons offered by the software. We predominantly use the project construction *selecting pieces of code from menus*. However, we use the *typing of code* to enter numbers and text. The range of icons is not as wide as we are used to from other programming languages for children, e. g. Scratch or Imagine Logo. The basic palette of icons consists of 15 icons. This set can be extended by other seven icons. However, these icons are more complex, less used and therefore they appear only after having been requested by the user.

As already indicated in the previous section, the software contains **several types of icons**. We will start with the description of the group of icons, which are always given **at the beginning** of "the command line" – before the group of commands. In programming environment of WDs, several different commands may occur and they can be executed in parallel or individually. We can activate group of commands by pressing a button on the screen, pressing a key on the keyboard or by receiving an expected group of characters in the form of a message (Fig. 1). All these icons are in yellow colour. Another group of icons serves the purpose of **controlling the motor**. These icons are in green colour. The red colour is reserved for icons with which we **display messages** or images on the small virtual screen in the upper left corner of the computer screen and it is also reserved for the **sound**. The **icon for loop** has a special shape. We can stretch this icon, so that it will contain all icons creating commands that are to be repeated. However, this icon cannot be used to create an inner loop. **Icons for parameters** have another untraditional shape. Parameters, which obtain information from sensors, are in orange colour. Other parameters are in green colour. The icons of parameters are approximately half the size of the other icons. At the top, they have a tab, with which can be "pinned" to selected icons designed for this purpose. These icons have a slot or a pocket at the bottom, where we can pin the parameters.

The construction of program does not proceed with *direct manipulation for creating (visual) objects*, because there are no visual objects on the computer screen. If we took into account the physical model as well, then construction of the program could proceed with direct manipulation for creating objects, but this is not the case.

Preventing (syntax) Errors

- Shape matching
- Selection from valid options
- Syntax-directed editing

The software for children contains various features that attempt to automatically correct the syntax errors in the creation of the code or prevent them from happening. It can helps children, not to be so disappointed. In this way, the children are not discouraged by such errors that make the program unable to run

WDs for example, contains round shapes that determine the beginning or end of the program. The commands, or rather dents at the bottom of icons indicate required parameters. Parameters and sensors have the same shape as they are used as inputs for some other commands. So there some *shape matching* in the WEDO software.

The *selection from valid options* is not needed because the commands can be either executed or not. The program created by the pupil does neither crash, nor does it enter an infinite loop. For instance, if a variable is assigned to an icon that requires a different input than the one which was given, the software adjusts this variable. Example: The rotation speed of the motor cannot have a textual parameter, but a numeric one. So the assigned textual parameter will be changed for a numeric parameter. Such automatic editing can be classified under *syntax-directed editing*, which is manifested differently only in an automatically extending loop.

Saving and Exporting

- Own format
- Result (jpg, mov, ...)
- Standalone project (exe)
- Save into Clouds
- Save for web (html, ...)
- Automatic saving

WDs as one of the few examples of software automatically storing all project data to a disk, in the folder where the software is installed. If we open a new file, or rather a new "sheet", previous work is *saved automatically*. This method of automatic saving has not been recorded by Gujberová and Tomcsányi in any other previously examined programming environment for children. Projects are stored in a *custom format* and WDs does not support any other form of saving and exporting. To some extent, this is not surprising, because the result in the form of an exe file cannot be shown without the LEGO WeDo construction set. If creators allowed it, they would partly go against themselves, for the sharing of such exe files might jeopardise the marketability of the original software.

Localisation

- By end-users
- Number of localisations

Some programming environments for children (mostly the ones available for free) allow users to change their localisation, i.e. the language version of the control software. The most of all localisations among programming languages for children are found in Scratch, which has been translated into 50 languages.

Such localisation is needed in cases where the software is controlled fully or at least partly by using text commands. Since WDs is icon-based, i.e. based on images, the sole text with which the user comes into contact is the description of icons. It appears when the mouse hovers over the icons at the bottom of the screen. So far we have not found any other localization of this software.

Discussion

Based also on our work history at schools, we can say that LEGO construction sets are a truly engaging teaching aid for pupils. In their passionate attempts to achieve the „desired" results, the pupils are often not aware of the fact that by defining the moves of the construction set they are actually **programming**. In using simple commands intuitively, they gain skills and initial knowledge in the field of creating basic programming constructs.

In spite of our initial intentions, we did not address the discovering of programming constructs by students in further detail owing to space limitations.

Conclusion

When using the software and also with regard to its possible integration in the classroom for primary school, it would be appropriate to examine the software from a programmer's perspective. We hope that this particular article will help teachers to decide whether to use the WeDo software or not.

In this article, we have described the properties of the software environment for children, see summary via mind map in the Fig. 3.

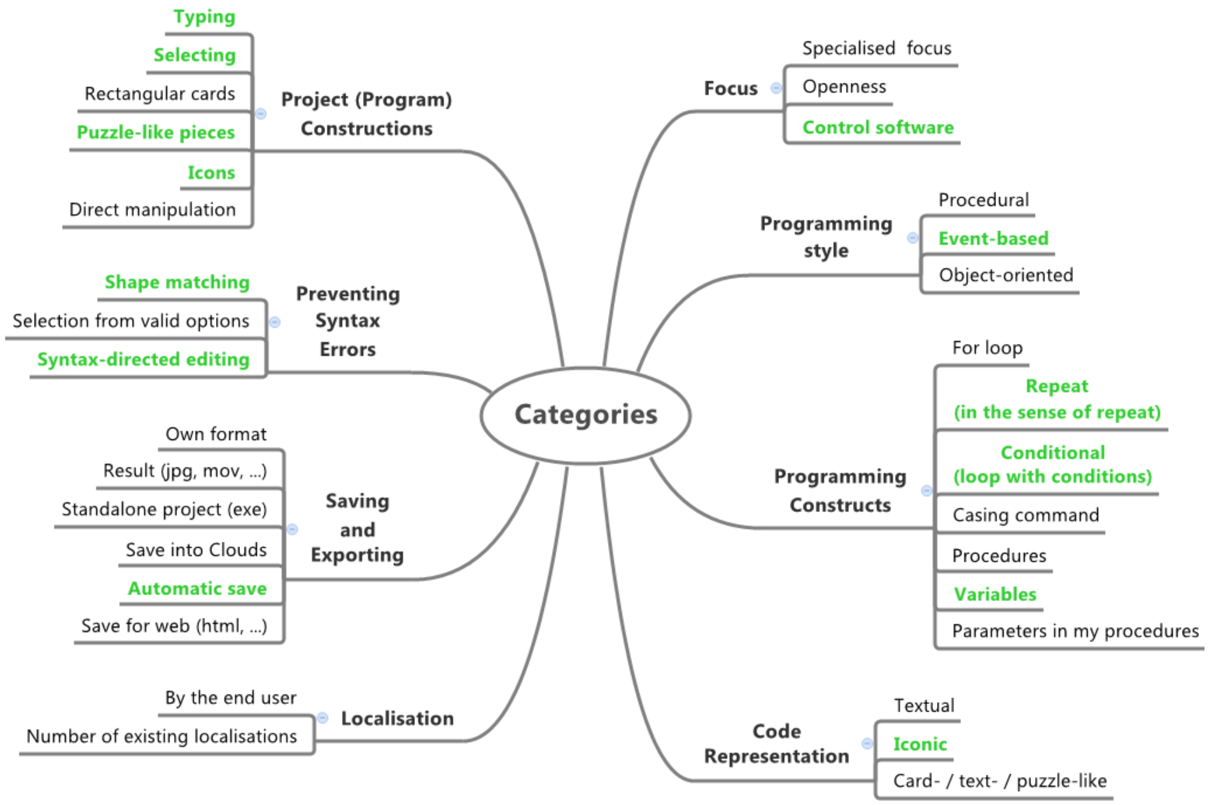

Fig. 3: The final mind map: Categories of properties for children environments. Properties, which fall into WDs, are labelled in green colour.

Most of the properties fit into the pre-defined categories. The only area this software does not fall into is object programming, because the whole programming is aimed at the control of one real object, and not of virtual classes. Therefore we did not mention it with respect to the origin category.

In determining the software focus, it was not possible to include WDs into any of the existing categories, therefore, to create a more precise classification, we suggested a third, new category: *control software.* Likewise, within the ways of saving, we proposed a new category *automatic project saving,* which the original authors have not mentioned in their work.

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PERSONALIZED EDUCATIONAL ENVIRONMENT - AS ONE OF THE TRENDS OF MODERN EDUCATION

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Abstract

To meet the needs of the modern information society one must constantly improve the education system. The effectiveness of teaching today's students fully depends on the implementation and use in the study of modern information and communication technologies, including network services that allow you to create an appropriate pedagogy and technology support base of modern information systems for educational purposes, and effectively organize the electronic learning university environment.

An analysis of e-learning environments of modern domestic and foreign universities demonstrates quite a high level of qualitative and quantitative indicators of the implementation of electronic resources for educational purposes. However, despite the relatively high level of organization and content of university portals, the creation and implementation of students‛ personalized e-learning environment, which in turn is based on personalization in a global network, student-centered learning, which acts as a basis for the formation of ICT and key competencies of modern student, is still an open issue. The self-spontaneous creation of personalized e-learning environment does not cover the training needs of students, but is only partially able to satisfy them, as knowledge students cannot improve the quality of both formal and informal learning.

This paper focuses on the study of students‛ ICT competencies and their ability to use information and communication technologies to carry out information activities in their professional field. The authors also discuss the results of studies on personalized and adaptive learning, based on consideration of learning styles. Based on a statistical analysis of the pedagogical experiments, some recommendations are suggested for technology training for teachers and students in order to to improve training efficiency.

Keywords

Personal oriented environment, Cloud Computing, e-environment of the university, some paradigm of contemporary education, Project IRNet, modern educational trends, learning styles, key competencies

Introduction

The XXIst century has been proclaimed as an era of the information society in which information and knowledge are produced in a single information space. Characteristic features of the information society include: increasing the role of information and knowledge in society; increase in the number of people employed in information technology, communications and production of information products and services; enhancing the role of information technology and information in social and economic relations; a global information space, providing an effective information interaction of people and their access to global information resources and meeting their needs for information products and services. Information and communication technologies are widely used by people in all spheres of their activities, including in education. Today, the use of current information and communication technologies through the introduction of cloud technologies along with LMS, CMS, Social media, Web 2.0, Web 3.0, Virtual classroom, YouTube, relates to promising innovative directions of information and network services communication technologies. These technologies with the priority of cloud technologies (Cloud Computing), which is one of the paradigms of modern information and communication technologies, provide distributed and remote processing and storage.

Information and communication technologies, including network services to create a proper pedagogy and technological basis of modern information systems support educational purposes, where a priority is to provide the basis of any educational process and effective organization of the learning environment of the educational institution.

Key Competencies of Modern Generation

The rapid development of information and communication technology is placing new demands on modern higher education. This has generated a **contradiction**: between the rapid development of ICT and the level of implementation of elements of open education and universities‘ unpreparedness for their effective use and integration of the learning process; between the need to provide free access to educational resources and the ability to use them off-campus, between the needs of students to use cloud oriented and other Internet services described above of personalized learning environment in the context of student-centered learning, which takes into account their characteristics as representatives of Y-generation, and the objectives of the competency approach and the lack of an appropriate set of software quality and electronic content.

One solution to these conflicts is to design and develop a modern educational cloud oriented university environment, which is integrated with other Internet services, global and corporate, that takes into account the needs and characteristics of ICT use all of the educational process of the University (on the one hand - students and on the other - teachers and leaders) who belong to different generations and have different needs and characteristics, different levels of ICT competence and different understanding and vision of educational policy. The task has become more pressing as e-learning courses and open MOOC courses become widespread, which serve as a catalyst for qualitative changes in the development of university education, because on the one hand support the natural competition of modern universities, teachers, learning systems and innovative pedagogical techniques, on the other hand - the spread of non-formal education, especially given the current trends.

These trends of the study "School's Over: Learning Spaces in Europe in 2020: An Imagining Exercise on the Future of Learning", conducted by the European Commission Joint Research Centre together with Institute for Prospective Technological Studies [1], are divided into several conventional levels - macro -, meso and micro. To macro-trends study factors authors include such factors as the emergence of new skills and competencies, demographic change and globalization. The meso-level trends that lead to the situation in Europe include: development of non-formal education, education reform, in particular through the introduction of distance learning technologies, and changes in corporate training based on the flow of formal training in an informal, the results of which involve receiving no formal outcomes - knowledge, skills and new competencies. The comparison of the formal, nonformal and informal education is described more detail in [2].

When generalized, these factors contribute to the situation where personal learning paths are very different for each person and constitute a personal learning environment. What contributes to the development and popularity of non-formal education is mainly innovation in various educational systems and social-psychological factors – human need to undertake joint activities, exchange of ideas and mutual learning. Learning acquires social nature as social networking and modern technology distance learning, based on the use of Web 2.0 and Web 3.0, provide opportunities to any person for self-study, including personal needs and range of interests.

The above translates into the following micro-level trends:

- informal education is becoming more widespread and the trend to provide different educational content of different generations and develop the competencies required by the modern labor market is increasing.
- Increase the number of representatives of Y-generation consisting of human resources requires consideration of their features in the design and selection of educational technology and educational virtual environments, and implementation of learner oriented education, which already goes beyond formal training and development must take into account personal learning environment of each learners, and attempts to take into account the peculiarities of the environment while creating relevant to educational institutions, including the University.
- Uneven use of technology in teaching of different generations.

Given such trends, one can formulate the hypothesis that the quality of a virtual learning environment of modern educational institution must be based on the learning needs of its students, content and technology that they use in creating and maintaining their own personal learning experience. Filling up the virtual learning environment, the quality of the content and effectiveness of its use by students in order to achieve the objectives of education and training of future competitive specialists for the modern labor market depends on the level of ICT competence of teachers and match the services that they use in the formation of their personal learning environment, with services used by students (Fig.1.)

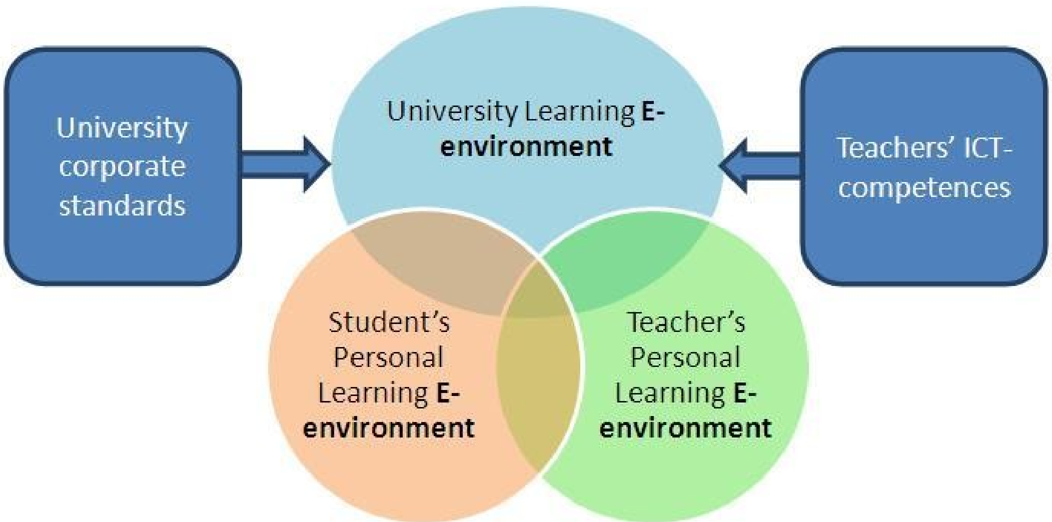

Fig. 1: A virtual learning environment of the modern student
Source: Own work, 2014

The main purpose of specialist training in the socio-economic conditions of the information society is not training specialists in selected highly specialized fields, but the acquisition and development of certain competencies that should provide them with the opportunity to adapt to the dynamic development of the modern world. We note that competence are considered as a set of interrelated personality traits (knowledge, skills, ways of life) for a certain range of objects and processes required for quality productive activities. Competence – holding by a person of such competence or a set of competences that includes the person's attitude and competence of the subject. Then, given the active use of ICT in all areas of human activity, particularly in education was necessary separation ICT competence in the total student-teacher professional profile and implementing competence-based approach, which focuses on educational outcomes, and the result is not a set of assimilated information, and the ability of people to act in a variety of problem situations.

In scientific discourse and content of ICT-competence is defined as Digital competence involves the confident and critical use of information society technology (IST) and thus basic skills in information and communication technology (ICT) [3] - one of the eight key competences for lifelong learning.

Analysis and synthesis of research results allows us to consider the concept of ICT competence as the ability to use information and communication technologies for the implementation of information activities (search, identification, organization, analysis, processing, creation and dissemination of information) in their professional field.

Research was conducted within the framework of the international IRNet project [4] as well as a PhD study one of the author. During our research study, the following methods, research techniques and tools have been used: quantitative methods (in particular, a diagnostic survey) as well qualitative methods (depth interview, qualitative analysis of the text (documents), observation, other). Among techniques of educational research, first of all, questionnaires were used. The main research tools are: an interview questionnaire, questionnaire, survey, observation tools, development of the subject dictionary, research trip and visiting a partner university, meeting, (video) conference, seminar, workshop, etc.

This paper describes only a part of the research conducted at the University of Silesia in Katowice and in Borys Grinchenko Kyiv University. More than 190 students from different faculties and specializations participated in this research. BGKU students from the Faculties of Information Technology took part in the survey; 104 students in total. The University of Silesia conducted the survey on the Faculty of Ethnology and Sciences of Education among students of the humanistic specialization: Integrated Primary Education and Kindergarten Education, Kindergarten Education with Child's Development Early Support, Social-Cultural Animation with Cultural tourism, Integrated Primary Education and Pedagogical Therapy; in total 105 students took part. Generally, within the IRNet Project, near 1000 students from partner universities [4] are scheduled to take part using LimeSurvey services as well as a Google Drive. The questionnaire covered several group of topics, concerning the aim of the research. The research instruments have been described in more detail in the authors' other publications [5, 6].

Below Tab.1 and Tab. 2 present a Percentage distribution of answers of students from US and BGKU in the group of questions reflecting students' educational strategies and Students' opinion about most effective ways of submitting their final work for checking to the instructor.

Question	US	BGKU
If you have access to the Internet, with what aim do you use it most frequently?		
To search for course materials, to advance your own knowledge	79,5%	87,2%
To participate in the e-learning course(s)	41,9%	27,4%
To contact friends (e-mail, social network, messenger)	72,4%	90,3%
For entertainment (on-line games, free surfing, watching movies)	45,7%	44,4%
For file sharing (P2P)	15,2%	42,1%
To develop your interests, hobbies	42,9%	72,2%
Looking for interesting materials on the Internet, you use most frequently:		
Search systems, for example, Google	84,8%	85,1%
Wikipedia	53,3%	81,5%
Electronic catalogues (bibliographical references and data bases)	21,9%	37,3%
References to other web sites, placed on the pages	27,6%	28,1%
Social networks	21,9%	31,3%
Reliable and well-tested portals	33,3%	37,2%
Blogs	6,8%	7,1%

Tab. 1: Percentage distribution of answers of students from US and BGKU in the group of questions reflecting students' educational strategies

Source: own research, 2014

After analyzing the results, we can conclude that the percentage distribution of responses of BGKU students, almost in respect of all the positions, though to a small extent, is higher than the distribution of answers students of US. Thus, items such search for learning materials, entertainment resources, using search engines, social networks, blogs, etc. differ by only small percentage ± 10%, serve to express the similarity and typicality of the psychological development of US and BGKU students.

However, the focus should be paid to the points where the gap between the percentages of students' responses is significant (20% - 30%). Thus, students of BGKU showed less tendency to use e-learning than students of US, suggesting the need for greater involvement of, or improvement of existing e-learning systems in the educational process. However, at the same time, students of BGKU show almost twice as much regularity using the services of file sharing and finding interesting and scientific materials in electronic catalogs and in the pages of the free encyclopedia Wikipedia. The biggest difference between the percentage of students' responses, almost 30%, demonstrating the issue of development interests and hobbies: for 72.2% students of BGKU to use the Internet is self-development, and thus it can be concluded that the share of informal learning increases significantly and cannot be taken into account in educational activities of the university.

Questions	US	BGKU
What methods of submitting final work for checking to the instructor do you consider the most effective?		
By email	71,4%	76%
By portable (external) means of information storage (for example a flash-memory stick)	23,8%	26%
By means of the distance learning platform, for example the Moodle system or similar ones (Forum, Tasks, etc.)	31,4%	18%
Cloud services	9,5%	6%
Social networks	83,8%	19%
Traditional paper forms (press, photo-copying)	27,6%	59%
Orally during the classes	5,7%	47%

Tab. 2: Students' opinion about most effective transferring the final works for checking to the instructor

Source: own research, 2014

Results of BGKU shows that students are less involved in e-learning and prefer the traditional debugging sessions with a "real" relationship, visual communication and the use of traditional paper checks remaining forms of knowledge, and believe that such training is most effective for them. This can be explained using non-system e-learning systems in various disciplines.

Students of BGKU are quite familiar with the platform Moodle. What was surprising was the fact that almost half of the students prefer the traditional system of learning in groups and only one third chose the distance form of classes. This is an important signal for the further improvement of the information environment.

Thus, we can conclude that the analysis of student's information behaviour in the university's virtual environment is an effective tool to verify the correctness of existing decisions and findings. These data are also important for further virtual environment development in accordance with the informational and communicational request of its main users - students. At the same time, these data help to understand how we can help students in correct applying and understanding of existing open recourses and learning opportunities.

CLARIFICATION OF MODEL OF PERSONAL LEARNING ENVIRONMENT UNDER THE INFLUENCE OF INDIVIDUAL FACTORS

In the pedagogical experiment BGKU students majoring in "Information" were asked to diagnose their own style or strategy learning by VARK [7] questionnaire methodology by using simple and understandable tools for helping people understand each other, students - effectively learn and teachers - more closely relate to the needs of today's youth, that use different learning strategies in presenting scientific material to bring to the learning and interest as many students as possible.

The authors also studied and analysed the results of research concerning a personalized and adaptive learning based on the account of learning styles, which were conducted by scientists of other countries [8-10].

The survey results allow diagnosing the learning style of each student who participated in the experiment [11]:

- visual V (visual) - people prefer to use in the learning process pictures, images, charts, color charts and links;
- aural A (aural) - people who emphasize the sense of hearing, use rhythm, music, listen to records, make up rhymes for better absorption of information;
- verbal R (read/write) - people who use verbal techniques in written and spoken language, for example, make notes or verbalize information aloud;
- kinesthetic K (kinesthetic) - people who study acting - draw diagrams, use surrounding objects or participate in role plays.

The survey results show that in all the vast number of courses, students use the auditory learning style, in second place - kinesthetic, but the verbal and visual style is used by a very small number of students.

After analyzing both styles, one can make some recommendations for technology training for teachers and for students to improve learning efficiency. The main task of the teacher in teaching the group is to compile a coherent logical sequence of auditory and practical aspects of learning, that is, the teacher is interested in theoretical material, and deepens students' knowledge using practical work, individual educational and research objectives, project method, etc ...

The best information is perceived when traits inherent in both styles are combined:

- visiting group sessions, discussion clubs and discuss scientific problems with other students, teachers with a harmonious presentation, demonstration rules (laws), the employment of the senses (visual, tactile, gustatory, auditory, sensory);
- explain new ideas to other people;
  presenting scientific material, using real-life examples, samples demonstrate research subjects, using trial and error;
- use approaches to assimilate knowledge in practice;
- learning to perform on-site classes, tours.

As a result of a number of interviews, questionnaires, surveys and statistical data processing our pedagogical experiment, we had the opportunity to make a content-based structural model of cloud educational environment for training of teachers of computer science, with the vision of the students of the fourth year of study (Fig.2.).

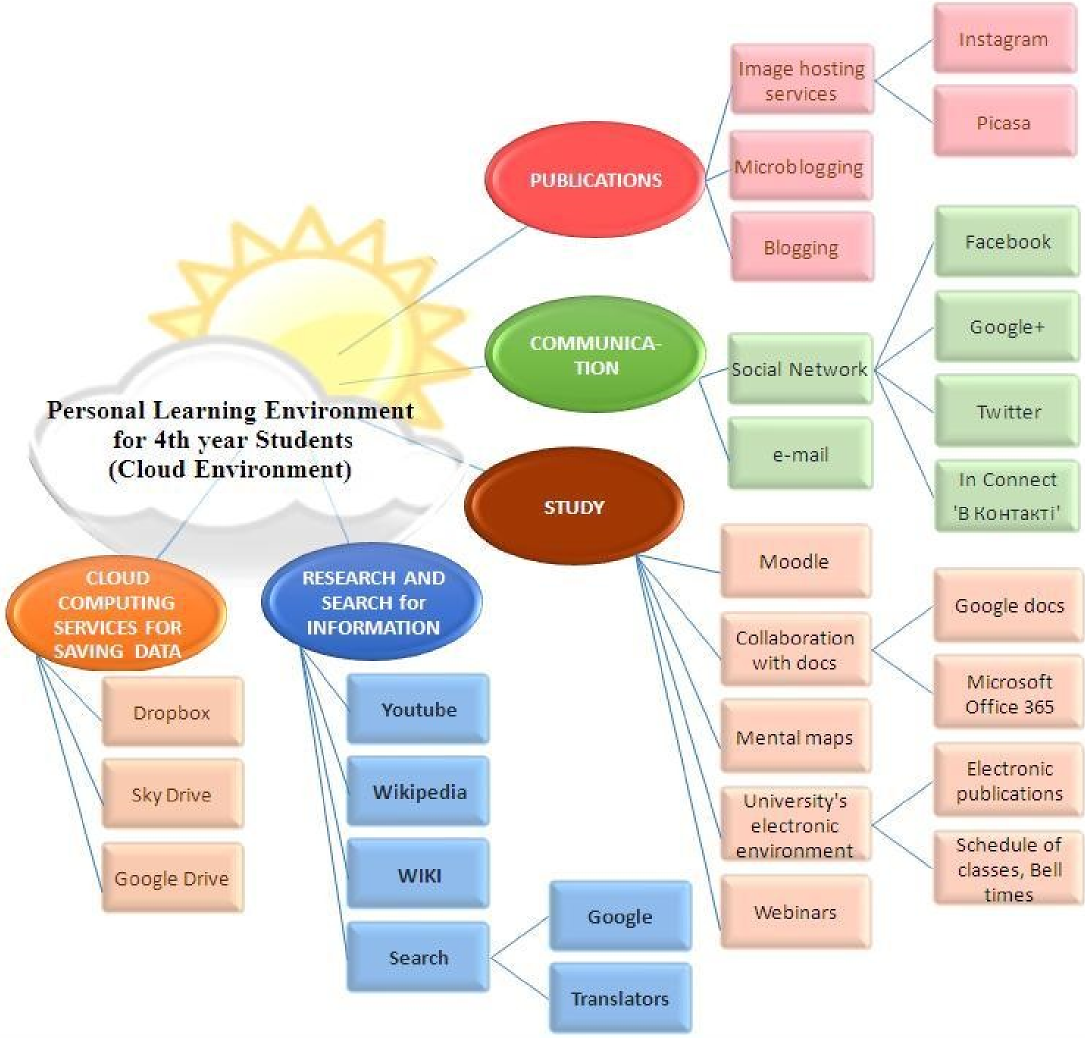

Fig. 2: Content-based structural model of cloud learning environment according to pedagogical research students of the fourth year of study *Source: Own work, 2014*

Conclusion

Research of studentss ICT competencies and their ability to use information and communication technologies to carry out information activities in their professional field has shown that the quality of a virtual learning environment of the modern educational institution must be based on the needs of students as well as the content and the technology they use. The ICT competency of the modern student plays a key role in shaping the electronic learning environment of educational institutions and cloud oriented personalized learning environment that allows students to set learning goals and manage their own process monitoring academic progress and, on the basis of its own electronic portfolio form educational space, create their own e-library, make and publish educational and scientific project activity and so on. In addition, based on a statistical analysis of the pedagogical experiments relating to personalized and adaptive learning, based on consideration of learning styles, a number of recommendations have been put forward for technology training for teachers and for students to improve learning efficiency.

An analysis of student information behaviour in the university's virtual environment is an effective tool for building and continuous refinement of the model of personal learning environments at universities in the context of student-centred learning and can produce valuable competitive professionals, and students who can acquire modern and up to date knowledge and constantly improve themselves.

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EDUCATIONAL TECHNOLOGIES IN THE PREPARATION OF FUTURE TEACHERS

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Abstract

Nowadays, school is automatically linked with modern technical equipment that supports the education process by making it more effective, current and also attractive. The education process cannot by influenced by the technologies alone. The changes can be initiated only by people, teachers, who use the technologies in the right way in their work.

The educational technologies courses intended for future teachers of the non-informatics study programs try to educate students mainly in the multimedia field. The Educational Technologies – Tools course is aimed at the bases of working with text, images, sound, animations, etc. When working with the technologies, students use their knowledge and skills for creating computer presentations or simple websites. The article introduces suggestions for education in these areas, analyses students' work and deals with the methods, forms, and problems of this education

Keywords

Educational technologies, information literacy, constructivism, e-learning

Theoretical Bases

The changes that are directly connected to the development of information and communication technologies (ICT) have been talked about in the education field for the past several years. The initial instructive approach – the principle of which was programmed education, settled and consistent curriculum and standards, factual knowledge gained mainly from training, testing and strict evaluation, and in which the teacher was the authority and the only source of information – is becoming the constructivist approach. The principle of the constructivist approach is ICT-supported projective education; task solving that leads to finding the connection, verbal evaluation, etc. The teacher status changes as he/she becomes the initiator of activities, students' helper and guide. Nowadays, even connectivism is being talked about. Connectivism stems from constructivism, but in addition assumes good orientation in the environment of social networks.

Trends in the development of educational theories and concepts suggest that education of the future will not do without information and communication technologies. While in the past the teacher could do only with knowledge of the subject and some pedagogical skills, the present time teacher must also have technological skills and knowledge, i.e. a certain degree of information literacy – see the Technological Pedagogical Content Knowledge model (TPCK) (Mishra et al., 2008).

There is a large number of definitions of information literacy. The most quoted definition is the one by the Association of College and Research Libraries (2000), which directly connects information literacy with educating and learning. *An information literate individual is able to determine the extent of information needed, to access the needed information effectively and* *efficiently, to evaluate information and its sources critically, and to incorporate selected information into one's knowledge base. Information literate individuals are prepared for lifelong learning as they are able to find information and use it effectively to accomplish a specific purpose.* Brief and concise definition of information literacy provides company CILIP: *Information literacy is knowing when and why you need information, where to find it, and how to evaluate, use and communicate it in an ethical manner.*

Becoming information literate is not a single-shot task. (Dostál, 2007) Information education, i.e. a process leading to information literacy, is a continuous process which is not bound to a particular level of education or a particular age group. Information education should be a lifelong process and every citizen should take part in it. Considering the suggested changes in the education field, the urge for teachers' preparation in this area is even more present.

In connection with information literacy we often come across the term computer literacy, which covers competencies aimed at operating and using of a computer (including its peripheries), and at the use of computer networks (particularly the Internet). The exact definition of the term computer literacy can be found in the structured syllabus of the ECDL (European Computer Driving License).

Computer literacy is a prerequisite for information literacy. The two terms, however, are not interchangeable. A computer literate individual does not have to be information literate as information literacy is a broader term.

Materials & Methods

One of the main priorities of the Pedagogical Faculty of the University of Ostrava is the preparation of future teachers for pre-primary and primary education. The concept of the development of students' information literacy has been in preparation for several years. The concept assumes that students acquired computer literacy during their previous high school studies.

There are e-learning-supported courses in the LMS Moodle environment prepared for the development of information literacy of students (future teachers) (Oujezdský et al., 2013). The main course is the one entitled Educational Technologies – Tools, which is compulsory for the majority of students. The course is followed by specialized, broadening courses that students attend according their specialty and interest.

Within the scope of the Educational Technologies – Tools course students become acquainted with different types of information – text, image, sound, animations, etc. and learn how to work with them. Through the use of ICT, students learn to process the information and further use it – publish, present, etc. according to the type of particular information:

- **Image information:**
  - Knowledge: orientation in different types and sizes of an image – photographs, animations, see-through background images, etc.;
  - Skills: processing and the use of image information – taking pictures, searching and editing of images, work in layers, the use of images in presentations and on websites;
- **Sound information** – Skills: sound recording, sound editing, the use of sound in presentations;
- **Animations** – Skills: searching of an animation, creation of a simple animation, setting the timing and effects, the use of animations in presentations and on websites.

Brdička argues (Brdička, 2012, p. 38) that educational activities can be divided into activities building knowledge – explanation of subject matter, reading, training, etc. – and activities expressing knowledge. Activities expressing knowledge can be further divided into convergent activities (test, examination, etc.) and divergent activities (all activities aimed at expression and creativity in all sorts of forms – written, visual, product-oriented, etc.). In this regard, activities in the course can be classified as divergent activities leading to the creation of a product – images, videos, presentations, etc.

Within the scope of the Educational Technologies – Tools course, the main form of education is students' individual work on assigned correspondence tasks. According to Lerner (loosely according to Vohradský et al.), the teaching method can be classified as heuristic, which means that the teacher designs the tasks in a way so they would be demanding for students and some phases of a problem would require individual solving. The tasks are chosen with regard to the skills that students are supposed to acquire in the course, e.g. working in layers, working with the timing and effects in presentations, etc. At the same time, the tasks are formulated generally so they help support and develop students' imaginativeness, creativity and imagination. For each task students must specify the topic they will work on. This means students are required to think up a suitable story, suitable educational situation, etc. and to have a clear idea of what the plot of the given story will look like, how a situation will develop, the continuity of individual scenes, the characters, animals, things, relations between them, etc. They are supposed to follow this conception and to solve the task using the chosen technologies and suitable software tools.

For instance, when creating a comics story, students start with the formulation of a humorous story they will later elaborate in the comics. They divide the story into eight parts (scenes) according to the requirements of the task. They prepare images for individual characters, animals, and things, and speech bubbles for direct speech of the characters. If the images are to be inserted into the comics, they need to have a see-through background. Students also prepare images of individual scenes. The work on the comics consists of making the eventual product out of the prepared parts. Students learn to work with images in layers, insert them into layers, edit their size, rotation, correct placement of an image in a layer and setting the correct sequence (overlapping) of layers.

There are five similar tasks in the course. The work process is similar. It begins with the preparation of materials needed (texts, images, sound files, etc.). These are then used for a creation of the eventual product.

As far as the organization is concerned, the education process takes place in computer classrooms where students have a chance to work on individual tasks under the supervision of their teachers. Participation in the attendance tutorials is optional, students can work at home. The time allocation of the course is as follows: one semester, 2 hours a week, i.e. 26 hours of full-time education. Usually, no more time is needed for working on the tasks.

The used evaluation methods correspond with the forms and methods of education. The tasks are evaluated continuously in individual solving phases, i.e. the preparation part in individual phases and the whole are evaluated separately. The work is evaluated by points and verbal commentary. The deciding point evaluation is only aimed at mastering and using of the required technologies. Aesthetic level of the eventual product, students' creativity and imaginativeness are reflected in verbal evaluation, which, however, does not influence student's overall result in the course.

The Educational Technologies – Tools course takes place regularly in the winter semester of a particular academic year. Nearly 400 students participate in the course every year. The majority of students are women – future kindergarten and primary school teachers.

Results

349 students (288 women, 61 men) took part in the Educational Technologies – Tools course in the winter semester of the 2013/14 academic year. Every year very little men take part in the course. In this particular academic year almost five times more women than men took part in the course.

The work of students in the course is diverse and stems from the methods and organizational forms of education. Students can be divided into several groups according to the working process they choose for particular tasks:

- They understand the work and can do it independently – they find suitable tools and use them according to their previous knowledge, they often work on the tasks outside of school;
- They master the work in the course with the help of study materials – following solving instructions, often work on the tasks outside of school, attend the attendance tutorials only when they have a problem;
- They are not able to work independently, they make use of the lector, who suggests to them the most suitable solving technique and supervises the mistakes which they are likely to make in the beginnings.

The teaching of the course took place in the LMS Moodle, which records students' activities in the course – displaying of study materials, submitting of homework, etc. These data help gather information about students' real work in the course. We will take a look at students' work in the Educational Technologies – Tools course.

177.255 students' activities were recorded in the Educational Technologies – Tools course during the winter semester of the 2013/14 academic year. Only 18% (32.112) of them were done in computer classrooms, the remaining activities were done outside of school. On the average, one student did 508 activities in the course.

Course activities can be divided according to which of them are offered to students – study materials, tasks, tests, etc. Activities aimed at correspondence tasks prevail – submitting of homework, evaluation check, etc. These activities make up 36% (64.670) of all course activities. The other 34% (59.651) are activities aimed at displaying of the main aspect of the course. These activities can demonstrate students' work in the course. However, because their character cannot be determined from the course, we will not be considering them anymore. The remaining activities are aimed at scanning of study materials, testing, communication in the course, etc.

	Overall	**Correspondence tasks**	**Study materials**
1. Introduction	5.525	4 (0%)	5.521 (100%)
2. Movement paths	13.535	7.276 (54%)	6.259 (46%)
3. Comics	23.172	15.378 (66%)	7.794 (34%)
4. Working with sound	15.989	9.453 (59%)	6.536 (41%)
5. Presentation	14.606	10.047 (69%)	4.559 (31%)
6. Websites	28.853	13.755 (48%)	15.098 (52%)
7. Conclusion	2.910	4 (0%)	2.906 (100%)
Overall	104.590	55.917 (53%)	48.673 (47%)

Tab. 1: Number of Course Activities in Individual Chapters

The number of course activities, which are directly related to the individual chapters (apart from displaying of the main aspect of the course, discussion forums, etc.), was 104.590. 53% of the activities were aimed at correspondence tasks, the remaining activities correspond to working with study materials. The division according to individual study chapters (including the portion of activities aimed at correspondence tasks and study materials, respectively) can be seen in the Tab. 1.

The Tab. 1 shows that the largest number of activities (28.853 – 28%) was done in the sixth chapter dedicated to websites, followed by the chapter dedicated to comics (22% of activities). As expected, the lowest number of activities was recorded in the first and last chapters, respectively. The remaining chapters covered 13-15% of students' activities (see the Overall column).

A comparison with correspondence tasks activities shows that students spend more time on tasks than study materials. The chapter aimed at the creation of presentations is the one where the least information is needed (only 31% of activities corresponding to working with study materials). This means that it is a revision chapter with the only new part being the topic and the use of a presentation and its sounding. The highest number of study-oriented activities was recorded in the Websites chapter, which can be considered as one of the most demanding chapters; and not only because it is aimed at the creation of websites, but also because it contains working on animations, caricatures, etc.

The Tab. 2 shows the numbers of students' activities when working on individual chapters of the course in computer classrooms. At the beginning, as much as 43% of the activities are done in computer classrooms. This number gradually decreases to approximately 10% at the end of the course.

	Overall	**In classrooms**
1. Introduction	5.525	2.363 (43%)
2. Movement paths	13.535	3.622 (27%)
3. Comics	23.172	4.508 (19%)
4. Working with sound	15.989	2.557 (16%)
5. Presentation	14.606	1.856 (13%)
6. Websites	28.853	4.320 (15%)
7. Conclusion	2.910	265 (9%)

Tab. 2: Number of Course Activities in Computer Classrooms

The real number of students, who regularly attend the classes, does not correspond to the activities recorded in the e-learning environment. Within the scope of full-time education, students often spend the time on solving of the tasks, not on studying. It is because they acquire the needed information from the teacher or from working with their classmates. The proof of this statement can be seen in the Tab. 3 – study materials are hardly used in the classrooms (only 16% of activities). Many redundant activities are not needed in the classrooms – the permanent need of task evaluation, grade evaluation, etc. Students in the classroom know right away if they did the task correctly and that they can correct possible mistakes in the next class. That is why the overall number of activities in computer classrooms is much lower (only 18% - see above).

290 students (83%) fulfilled the requirements of the course at the proper time and obtained the credits. Drawing on past experience, some students did not finish the course because of the interruption or termination of their studies. Some students (approximately 5-10%) will fulfill the requirements in the spring semester.

	Correspondence tasks	Study materials
In classrooms	11.768 (21%)	7.723 (16%)
Outside of classrooms	44.151 (79%)	40.948 (84%)

Tab. 3: Number of Activities in Computer Classrooms

Discussion

The Educational Technologies – Tools course has been taking place for many years. Since then, the course has gone through many changes, be it the list of used technologies and the structure of correspondence tasks, or the study support in the form of study materials. The course now contains not only text materials but also images, animations, sound samples, model solutions, etc. However, the experience from the evaluation of correspondence tasks points out mistakes and problems students continue to have. The most frequent problems are:

- See-through background of images;
- Image cropping;
- Image resolution;
- Working with images in layers;
- Sound recording;
- Working with sound;
- Transformation points dragging when morphing;
- Websites publishing.

The main problems are deduced from the analysis of students' activities recorded by the LMS Moodle e-learning environment. Students do not attend regular classes and thus lose the chance to work under the teacher's supervision. Working home requires more activity, more intense studying of study materials and it is more time-consuming.

Conclusion

The main goal of the Educational Technologies – Tools course is to contribute to the development of students' (future teachers') information literacy. Therefore, the course is aimed not only at the improvement of students' computer literacy, which they acquired during their high school studies. It is expected that within the scope of the course students will learn to work with all kinds of information and use it to create something new. Education in the course can be considered constructivist-oriented.

Years of experience prove that fulfilling these intentions and expectations is not easy. The constructivist-oriented education principle alone is very demanding for students. Having ideas and being creative is very difficult. However, changing the conception of education seems to be wrong.

A study support of the same name (Nagyová, 2013) has been created to make the work easier for students. In future, we intend to support the education process by using video tutorials and video work instructions, which could replace the teacher who is missing when working on tasks at home. These video instructions will be created with regard to the most frequent problems students encounter.

The Educational Technologies – Tools course is a suitable preparation for students – future teachers. Considering the requirements of society listed among others in the system of curricular documents (RVP), it would be appropriate if this course was not the only compulsory course from the field of information education. Students should learn to work with ICT with pupils. Moreover, in order for them to be able to use ICT effectively, they should master basic didactic techniques.

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Research-Oriented Teaching of Science and Technology Education in Primary Schools

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Abstract

Inquiry-based instruction of natural history and technical subjects is important for improving key competencies. These are not only learning and working competencies, but mainly problem-solving competencies. The most important for inquiry-based instruction of natural history and technical subjects is students' motivation. However, as a result of these subjects being very demanding, the issue of students' motivation tends to be problematic. Inquiry-based instruction with the use of information and communication technologies enables more illustrative access to natural history subjects. Thanks to the "Windows of Science Wide Open" project, elementary school students will have the opportunity to visit a special laboratory at the Pedagogical Faculty of the University of Ostrava. There they will deal with inquiry-based instruction of natural history and technical subjects. The instruction will use measuring systems connected to computers and programmable robotic systems. Using sensors, students will also measure many electrical and non-electrical quantities.

Keywords

Inquiry-based instruction, measuring system, robotic system, ICT

Introduction

In the majority of cases, elementary school students do not find instruction of natural history and technical subjects attractive (the subjects being mainly physics and chemistry, but also informatics – algorithm development and programming) (Nagyová, 2010). Apart from the fact that these subjects are very demanding, the lack of experiments and special tools that make instruction of these subjects attractive is another reason for their "unpopularity". However, students can be motivated by the more frequent use of information and communication technologies in these subjects. Generally, students tend to have a positive attitude to the use of ICT although they are familiar with another part of it (students usually use ICT in the form of communication, social networks, and game playing). ICT connected with natural history and technical subjects offers the possibility of inquiry-based instruction. The advantage of such instruction is the modern form of education which enables the incorporation of various teaching methods, the structure of which is not determined by either sequence or diversity. The teacher's activity is represented by the choice of topics, educational situations; and the student's activity is aimed at inquiry through which they become acquainted with the world around them (Dostál, 2013).

Within the course of instruction, many physics and chemistry experiments can be carried out with the use of a measuring system connected to a computer. Through the use of sensors connected to a measuring system, physics and chemistry quantities are displayed and evaluated in a computer. Robotic systems can be used in a similar manner (e.g. LEGO MINDSTORMS). The robot can be used not only for the measurement of the basic non-electrical quantities (temperature, lighting, distance, pressure, etc.) in physics experiments, but also for instruction of programming when the robot is programmed for tasks aimed at the use of all the available sensors and servomotors.

The “Windows of Science Wide Open” project is intended to introduce inquiry-based instruction of natural history and technical subjects to elementary school students. A specialized laboratory, which is aimed at measuring and robotic systems and how they can be operated through a computer, enables the interconnection of ICT with natural history and technical subjects.

“Windows of Science Wide Open” Project

The “Windows of Science Wide Open” project is financed from the “Education for Competitiveness” Operational Program. The University of Ostrava is both the applicant and the receiver of the project. The Faculty of Science and the Pedagogical Faculty participate in the project.

The project is aimed at the transmission of the findings from the area of science and research of natural history and technical subjects to elementary school and high school students. Part of the realization of the project is holding courses, lecture cycles, events, seminars, and field trips which should support science, research, and systematic work with students.

The goal of the project is to eliminate stereotypes and to innovate forms and methods of education in the context of constructivist approach to education – at the Pedagogical Faculty students will have the opportunity to improve their knowledge about working with new technologies and measuring and diagnostic devices.

Specialized Laboratory

Part of the project is the creation of two laboratories, one of which is aimed at inquiry-based instruction of natural history and technical subjects with focus on measuring and robotic workplace.

The basic equipment of the laboratory is:

- Mobile computing technology (laptops);
- ICT tools for computer-supported experiments (universal measuring, controlling and educating systems compatible with a large number of measuring probes, sensors and other accessories);
- Robotic systems for education and extracurricular activities;
- Student chemistry packages containing chemical glass and other laboratory tools;
- Chemicals and security tools for inquiry-based instruction;
- Microscopic preparations and sets for their preparation;
- Microscope for inquiry-based instruction with computer output;
- USB oscilloscope for computer;
- Electronic kits for the following topics: electricity, magnetism, electronics, solar panels, light and sound experiments.

Elementary school students will visit the laboratory where they encounter physics and chemistry experiments with the use of ICT and special tasks for programmable robotic systems.

Measuring Systems

Various manufacturers offer several kinds of measuring systems that are aimed at instruction of natural history and technical subjects at elementary schools. Every manufacturer has their own interface which enables the connection of different sensors. The interface is connected to a computer where the measured data are visualized, analyzed, and archived with the use of special software (Veřmiřovský, 2012).

The best-known manufacturers of measuring systems for education are Vernier, Pasco, or EdLab. Figure 1 shows the EdLab measuring interface which has 6 analog inputs and 2 digital inputs for various sensors.

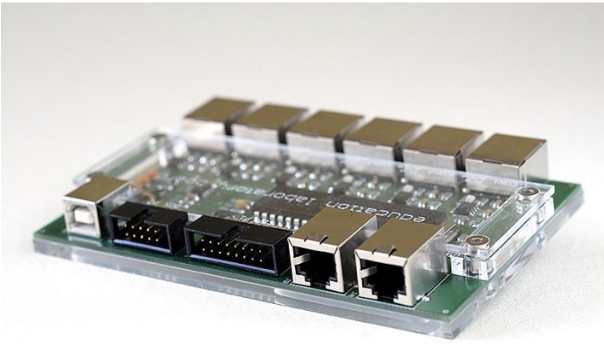

Fig. 1: EdLab Measuring Interface (source: www.edlab.cz)

There will be three measuring systems for the measurement of electrical and non-electrical quantities within the scope of the project. The created tasks will cover the following areas:

- Basic electrical quantities (tasks aimed at the measurement of voltage, current, and resistance);
- Electricity and magnetism (tasks aimed at electric motors);
- Electronic components (creation of electrical networks and their measurement);
- Chemical quantities (measurement of CO_2, O_2, pH);
- Physical quantities (measurement of place and movement, measurement of power);
- Measurement of non-electrical quantities (lighting, sound, UV light);
- Measurement of meteorological quantities (temperature, static pressure, relative humidity);
- Spectral analysis (visualization of radio and television broadcast frequencies, cellular phone networks).

When visiting the laboratory (action on behalf of "Measurement around Us") students will become acquainted with a measuring system, they will compile and try to solve several tasks (from different areas), on which they will then conduct practical measurement with the use of a computer.

Programmable Robotic Systems

Robotic systems in the form of kit have been used in education for several years (Kammer, 2011). The best-known robotic kits are LEGO MINDSTORMS. Recently, LEGO MINDSTORMS EV3 – the new generation of robots – has been introduced.

The programmable processor connected to a computer through USB or through wireless technologies (Wi-Fi, Bluetooth) is the heart of the robot. It is a cube-shaped encapsulated processor. Various sensors, which are part of the robot, can be connected to the "cube". The kit contains many constructional components, which can be used for the construction of robotic models. Figure 2 shows a model created from the LEGO MIDSTORMS EV3 kit.

Fig. 2: LEGO MINDSTORMS Robotic Kit Model (source: mindstorms.lego.com)

The kit further contains servomotors which enable the robot's movement. The robot has sensors which enable monitoring and researching of the outside world. Standard equipment of the robotic kit is as follows:

- Two large interactive servomotors with integrated rotational sensor;
- Medium interactive servomotor with integrated rotational sensor;
- Ultrasound sensor;
- Light and color sensor;
- Gyroscope;
- Two touch sensors;
- Rechargeable battery;
- Multidirectional wheel;
- Connecting wires with connectors.

The basic program equipment of the robotic kit contains an application which is intended for programming of the robots. Moreover, a special application can be bought which enables not only the creation of simple and transparent programs through a graphic tool, but also a software recording of data, i.e. the collection of data from sensors, their display, analysis, processing into interactive graphs, etc. This application is also more suitable for education.

When visiting the laboratory (action on behalf of "A Day with A Robot") students will become acquainted with a robotic kit, make their own robot and compile several tasks. In the tasks they will program the robot to cross the prepared obstacle course and use its sensors to identify the outside world.

Conclusion

Inquiry-based instruction is one of the new trends in the field of competency improvement in natural history and technical subjects. The "Windows of Science Wide Open" project, which is financed from the "Education for Competitiveness" Operational Program and the receiver of which is the University of Ostrava, will enable not only the purchase of new equipment for inquiry-based instruction, but also the support of elementary school students' interest in natural history and technical subjects. Elementary school students will also be given insight into the area of university science and research.

A new laboratory equipped with measuring systems connected to a computer and with many sensors for the measurement of electrical and non-electrical quantities from the areas of physics and chemistry will be created. Students will take part in a series of experiments, which they both compile and conduct the measurement. The laboratory will also be equipped with robotic programmable systems in the form of kit. When visiting the laboratory, students will create their own robot model, learn to program it to solve given tasks, and use its sensors when overcoming the obstacles.

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THE BENEFITS OF GEOSPATIAL CLOUD FOR EDUCATIONAL PROCESS

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Abstract

One of the significant ICT technological innovations is the cloud solution for thematic areas including geospatial information. Their development provides new possibilities and supports teaching/applications of geoinformatics on all levels and in all forms of education. The key feature presented by cloud orientation is the shift of the GIS role (already in progress) from the category of special software to indispensable omnipresent IT background – in the area of map material availability and basic spatial functions, for example the already functional Common GIS, ArcGIS Online, and others. The user does not seek, install and learn a new special tool but accesses a generally available tool through the internet and a common browser. It provides data resources (maps, satellite images, sensor information) which are integrated and continuously updated. User interface is simple and based on controls and conventions of a common browser with intuitive, user-friendly environment that can be immediately filled with data without the need to deal with technical aspects (coordinate system, data format) and is available any time and anywhere. It provides relevant tools facilitating simple processing of the data. The producers/providers have filtered away the information from the data resources which a common user does not require.

Keywords

Cloud, GIS, education, web services

Introduction

The rapid development of information and communication technologies (ICT) in recent decades has brought many new opportunities, methods and processing techniques, innovative solutions as well as ways of presentations and displays of results in many fields. The development of ICT enabled the rise of fields or sub-fields which focus primarily on applications of modern technologies in task-based solutions. One of the new fields is geoinformatics – a field which applies the modern computer technology to process spatial tasks in geography, cartography, geodetics, spatial planning and others (Machar, Pechanec, 2013).

Disciplines such as environmental education, landscape cultivation, forestry, geography, archaeology and many others make use of geographic (spatial) information through the geographic information systems (GIS). Students become acquainted with GIS products in varying extent during the course of their university study programme (Kimerling et al., 2009).

Teaching geoinformatics

Geoinformatics uses information technologies to solve geographic problems, it creates geographic information systems, it processes data acquired in remote sensing, it uses thematic and digital cartography, it models spatial phenomena in the landscape, etc.

When a new field, method or technology is introduced and extended to general awareness, it clashes with ignorance of both lay and professional public and a new process of teaching for various age groups is elaborated.

Geoinformatics is a relatively new application field ans as such it clashes with lower level of computer literacy, especially in middle- and higher-age groups of possible users. The truth is that middle- and lower-age groups including young pupils can usually use computers and accept novelties more readily. However, it is necessary to introduce the possibilities of the field to younger pupils, as was the case in the described programme.

Geoinformatics as a study field is quite specific and as such it is taught exclusively at universities. It is not taught at lower-level schools. The task is not easy for several reasons:

- University teachers deal with university students, i.e. the age range of 19 – 25
- they deal with students with basic computer and information literacy
- they apply relevant didactic methods and procedures in teaching
- they work with groups of students of adequate numbers
- the lessons are closely tied by computer laboratories with special hardware and software.

Every teacher strives to make his/her subject interesting for the pupil or the student, to stimulate their interest in the field and to pass his/her knowledge which the student/pupil will further develop. The methods and forms of teaching differ according to the age and number of pupils, their level of knowledge, demands of the fields, etc.

The creation of qualitatively new systems of alternative education in geoinformatics for two completely different age groups – younger pupils and the elderly – was built on these foundations. It follows from their current knowledge and skills, in which it continues and provides new knowledge and information.

The more entertaining "action" and multimedia form of transmission of knowledge will be more captivating in the curricular and extracurricular education. This principle has been prior in compiling the programmes of alternative forms of education. A didactic game is an important teaching method (Skalková, 2007).

Current use of geospatial tools in teaching

As for the current teaching of GIS within vocational study of geoinformatics and other above-mentioned disciplines in the Czech Republic, the most widely used product is ArcGIS for Desktop from Esri, now in version 10.x. The dominance of this product is due to a) its worldwide popularity and the corresponding extensive marketing, and b) the requirements of state administration and mainly the branches of nature conservation and land-use planning in the Czech Republic where this product prevails for historical reasons, whereof standards and country data sets have been created based on its technologies (Pechanec, 2006). De facto, all universities in the country having GIS in their curricula use ArcGIS in some way. ArcGIS is a powerful and an extensive environment, which is difficult to learn and master for students in short semestral courses (Pechanec, 2009).

Regarding other commercial products, education is carried out in the IDRISI system (current version Selva) from ClarkLabs (UP Olomouc, Mendel University in Brno, Czech Technical University in Prague) or, in an increasingly receding extent, in the Geomedia system from Intergraph (UP Olomouc, VSB-TU Ostrava). These products require the payment of license fees and, in some cases, there are constraints limiting the possibility of providing the programmes to students homes so that they can sufficiently acquire the learned procedures and eventually transfer the products (or requirements for their purchase as they can work with them) into their practice.

In addition to commercial products, also non-commercial products – freeware and open sources – are used in teaching GIS. Maintaining the history in such programmes is demanding because they can be installed at any time, used for educational purposes to demonstrate one task and then uninstalled. The widely used products primarily include GRASS / QGIS (e.g. Czech Technical University in Prague, VSB-TU Ostrava), Kristýna GIS (e.g. University of Ostrava, UP Olomouc), Janitor (e.g. UP Olomouc, Czech University of Agriculture Prague) and many other products such as uDig, gvSIG, MapWindow, GeoTools, PCRaster or the freely available data viewers of commercial products such as ArcExplorer, etc.

Web technologies, services and cloud

The trend in recent years is to transfer data, information and tools to the Internet (Morrison, 1994). In this area, there is a great and not yet completely used potential for new products that can be incorporated in teaching. It is, therefore, possible to use a solution that is free, operated in the Internet environment and needing just a web browser as the only necessarily installed software; this allows reducing the requirements for licenses, expands availability of the products to students in both numbers and time – tools / services are available 24 hours a day without the necessity of physical presence in a classroom with limited places (Vávra, Pechanec, 2013). Other benefits include a positive relationship of the students with the web services and the possibility of using the products on one-time basis (or for a certain period of time) in practice. It often concerns the adoption of working with data and information in the given environment and its involvement in routine activities in practice, not the need to use only one "web" application. As for web products, the main available tools are Google Maps /Google Earth (http://maps.google.com) from Google Inc., Mapy.cz (http://mapy.cz) or the dynamically evolving ArcGIS online (http://www.arcgis.com) from Esri. The use of all of these products is free; payment is required only for expanded functionality.

Web Services

The W3C defines web services as software systems that are able to provide means for interaction and communication of applications via a computer network. Web services represent an interface that enables diverse applications to communicate via HTTP, exchange XML messages in a unified format defined by the SOAP standard. The qualities of individual interfaces are defined by a machine-readable description in WSDL (Web Services Description Language). Metainformation about web services can be collected in registries and clients can search web services using the UDDI protocol. Web services can be used in many ways.

Cloud computing involves distributed computing over a network, where a program or application may run on many connected computers at the same time. It specifically refers to a computing hardware machine or group of computing hardware machines commonly referred as a server connected through a communication network such as the Internet, an intranet, a local area network (LAN) or wide area network (WAN). Any individual user who has permission to access the server can use the server's processing power to run an application, store data, or perform any other computing task. Therefore, instead of using a personal computer every-time to run the application, the individual can now run the application from anywhere in the world, as the server provides the processing power to the application and the server is also connected to a network via internet or other connection platforms to be accessed from anywhere (Regalado, 2011). All this has become possible due to increasing computer processing power available to humankind with decrease in cost as stated in Moore's law.

In common usage the term "the cloud" is essentially a metaphor for the Internet. Marketers have further popularized the phrase "in the cloud" to refer to software, platforms and infrastructure that are sold "as a service", i.e. remotely through the Internet (Rittinghouse, Ransome, 2010). Typically, the seller has actual energy-consuming servers which host products and services from a remote location, so end-users don't have to; they can simply log on to the network without installing anything. The major models of cloud computing service are known as software as a service, platform as a service, and infrastructure as a service. These cloud services may be offered in a public, private or hybrid network. Google, Amazon, IBM, Oracle Cloud, Rackspace, Salesforce, Zoho and Microsoft Azure are some well-known cloud vendors (Rittinghouse, Ransome, 2010).

	AWS	**Windows Azure Platform**	**OpenShift**	**App Engine**
Demo version	Yes	Yes	Yes	No
Student acount	Yes	Yes	No	Yes
Programming languages	JAVA, PHP, Python, Ruby, JavaScript	JAVA, Python, Node.js	JAVA, JAVAScript, Ruby, PHP, Python, Perl, Haskell	JAVA, Python, PHP, GO - experimentally
Operating systems	Windows, Linux	Windows, Linux	Linux	Windows, Linux
Platform	IaaS,PaaS, SaaS	PaaS, IaaS	PaaS	PaaS

Tab. 1: Basic cloud services (own source)

Network-based services, which appear to be provided by real server hardware and are in fact served up by virtual hardware simulated by software running on one or more real machines, are often called cloud computing. Such virtual servers do not physically exist and can therefore be moved around and scaled up or down on the fly without affecting the end user, somewhat like a cloud

Benefits of clouds

Cloud computing relies on sharing of resources to achieve coherence and economies of scale, similar to a utility (like the electricity grid) over a network (Reese, 2009). At the foundation of cloud computing is the broader concept of converged infrastructure and shared services.

The cloud also focuses on maximizing the effectiveness of the shared resources. Cloud resources are usually not only shared by multiple users but are also dynamically reallocated per demand. This can work for allocating resources to users. For example, a cloud computer facility that serves European users during European business hours with a specific application (e.g., email) may reallocate the same resources to serve North American users during North America's business hours with a different application (e.g., a web server). This approach should maximize the use of computing power thus reducing environmental damage as well since less power, air conditioning, rackspace, etc. are required for a variety of functions. With cloud computing, multiple users can access a single server to retrieve and update their data without purchasing licenses for different applications.

The term "moving to cloud" also refers to an organization moving away from a traditional CAPEX model (buy the dedicated hardware and depreciate it over a period of time) to the OPEX model (use a shared cloud infrastructure and pay as one uses it).

Proponents claim that cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of infrastructure. Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables IT to more rapidly adjust resources to meet fluctuating and unpredictable business demand (Reese, 2009) Cloud providers typically use a "pay as you go" model. This can lead to unexpectedly high charges if administrators do not adapt to the cloud pricing model.

The term "cloud computing" is mostly used to sell hosted services in the sense of application service provisioning that run client server software at a remote location. Such services are given popular acronyms like 'SaaS' (Software as a Service), 'PaaS' (Platform as a Service), 'IaaS' (Infrastructure as a Service), 'HaaS' (Hardware as a Service) and finally 'EaaS' (Everything as a Service). End users access cloud-based applications through a web browser, thin client or mobile app while the business software and user's data are stored on servers at a remote location. Examples include Amazon Web Services and Google App engine, which allocate space for a user to deploy and manage software "in the cloud".

Web services represent an interface that enables diverse applications to communicate via HTTP, exchange XML messages in a unified format defined by the SOAP or REST standard. The qualities of individual interfaces are defined by a machine-readable description in WSDL (Web Services Description Language). Metainformation about web services can be collected in registries and clients can search web services using the UDDI protocol or OGC-CAT standard (Pechanec, Vávra, 2013).

Benefits for Education

These technical aspects will always be important as the Internet will remain the leading connecting infrastructure allowing cloud, replication, and interoperable services, among others (Leipert, 2013).

The development itself is detected by the current transfer of the GIS role from the category of special software to the role of the necessary, omnipresent IT background, mainly in the area of map resources and basic spatial functions (spatial search, localization, navigation, zoom in/out, measurement, calculation of geometric properties, …). All this is achieved and further developed through the development of the geoweb (with emphasis on spatial relation on the web) (Vávra et al., 2010). Its foundation is cloud solutions, for example the already functioning e.g. ArcGIS Online, GIS cloud (see table 2).

	ArcGIS Online	GIS cloud	Geocommons	Mapmint	CartoDB	Crowd map
Demo version	Yes	Yes	Yes	No	No	Yes
Student acount	Yes	No	No	No	Yes	No
Support of web services (WMS, WFS WMTS)	Yes	Yes	Yes	Yes	Yes	Yes
Support of vector formats	SHP, KML, GPX, CSV, GeoRSS	SHP, KML, GPX, CSV, DXF	SHP, KML, CSV, GPX	SHP, KML	SHP, KML, CSV	KML, CSV
Changing of the symbology	Yes	Yes	Yes	Yes	Yes	Yes
Basemaps	Yes	Yes	Yes	Yes	Yes	Yes
Support for mobile phones	Yes	Yes	No	No	Yes	Yes
Technology	Flex, HTML5	HTML5	Flex	HTML5	HTML5	HTML5
Visualization and Analysis	Yes	Yes	Yes	Yes	Yes	Yes

Tab. 2: Comparison of the properties currently available geospatial cloud

The user does not seek, install and learn a new special tool but accesses a generally available tool through the internet and a common browser. It stores data resources in the same space (maps, satellite images, sensor information – traffic density, records collected from weather stations) which are integrated and continuously updated. User interface is simple and based on controls and conventions of a common browser with intuitive, user-friendly environment that can be immediately filled with data without the need to deal with technical aspects (coordinate system, data format) and is available any time and anywhere. It provides relevant tools facilitating simple processing of the data. The producers/providers have filtered away the information from the data resources which a common user does not require.

All this is related to another aspect of the development – sharing of spatial functions. Currently, several standards of publishing analytical spatial tools through the Internet exist. They are the OGC – WPS standard, its modification PyWPS or the corporate format of geoprocessing services by Esri. This aspect presents a possible effective division of labour. GIS specialists can write algorithms usable by others. Experts in decision-making processes can create and share a functional algorithm that others will incorporate in their work-flow. There is no need to duplicate the basic tool and to develop the one which already exists.

The third element of SDSS development is the construction and sharing of knowledge database. The knowledge once gained, which will be formally documented and shared throughout the community, is the key element. This step will present a shift from locally oriented knowledge databases to web-oriented distributed databases. The term "web-oriented" means that a database is placed in a server/cloud and is available from any location for inference mechanism via the internet. The present standard databases offer this feature (e.g. PostgreSQL, SQL server, Oracle...) although they do not have specific tools to record knowledge, such as NetWeaver or RuleWorks. The eXpertise2GO or CLIPS tools are examples of web orientation.

A distributed database then represents the following concept: a complete database consists of several separately existing databases, usually with the authors of the contents, and it uses replication tools to synchronise the united content. This provides the distribution of load to smaller units, a constant unity of all parts (in the whole community) and a better protection of copyright.

It is desirable from the perspective of the development of decision-making algorithms that the knowledge bases implement means of a formalised record of the decision-making process in the near future. It will clearly capture the decision-making process and the possibility of its repetition, but also with the possibility to capture the reality – the "easy" implementation of the fuzzy logic and soft-computing methods.

Conclusion

The development itself is detected by the current transfer of the GIS role from the category of special software to the role of the necessary, omnipresent IT background, mainly in the area of map resources and basic spatial functions. All this is achieved and further developed through the development of the geoweb. Its foundation is cloud solutions, for example the already functioning e.g. ArcGIS Online or Common GIS.

Benefits are in three aspects: a) The user does not seek, install and learn a new special tool but accesses a generally available tool through the internet and a common browser. It stores data resources in the same space which are integrated and continuously updated. User interface is simple and based on controls and conventions of a common browser with intuitive, user-friendly environment that can be immediately filled with data without the need to deal with technical aspects and is available any time and anywhere. b) Sharing of spatial functions. GIS specialists can write algorithms usable by others. Experts in decision-making processes can create and share a functional algorithm that others will incorporate in their work-flow and c) construction and sharing of knowledge database.

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M-LEARNING IN UNIVERSITY ENVIRONMENT

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Abstract

Substantial shifts have been detected in approaches how the information and communication technologies are used within the current period. While ten years ago the computer was the only digital device in the family or workplace, currently its role and services are taken over by other ones – smart TV, smartphones, tablets, e-readers etc. Currently M-learning, i.e. using mobile devices for educational purposes, is a new approach how to reach the same objectives as Comenius did - Schola ludus. From the FIM´s point of view M-learning is an approach which uses portable information and communication technologies within the process of instruction and students´ education. It does not matter what device is used - smartphone, notebook, netbook, tablet… Since 2001 the FIM has been using the online education solution based on LMS WebCT/Blackboard technology, and the ´Blackboard Mobile´ was selected for M-learning. There are two main approaches how M-learning can be used: (1) to apply the currently used learning contents and methods on mobile devices listed above – this approach can be only effective if we aim at supporting the face-to-face process of instruction; (2) to understand how new devices work, what they strengths and weaknesses are, and apply such new teaching/learning methods which are able to profit from them – this approach is positively preferred and represents the concept which the FIM is running.

Keywords

Edutainment, e-learning, gamification, M-learning, university education

Introduction

Substantial shifts have been detected in approaches how the information and communication technologies are used within the current period. While ten years ago the computer was the only digital device in the family or workplace, currently its role and services are taken over by other ones – smart TV, smartphones, tablets, e-readers etc. As mainly children and young people are interested in such devices, the phenomenon of gamification has appeared, which means games have been implemented in uncommon (mostly business) environments to promote selected products. In 2014 half of promotion campaigns were of gaming type (Černý, 2012). Despite successful these days, the idea is not new. Been called "schola ludus", it was applied 400 years ago by a Czech humanist, scientist and "teacher of nations" Jan Ámos Komenský (Johannes Amos Comenius). His education concept is still alive being based on principles of gaming, learners´ interest, entertainment and engagement without decreasing the quality of learning content and learners´ final knowledge.

Currently M-learning, i.e., using mobile devices for educational purposes, is an approach how to reach the same objectives as Comenius did, under some conditions – not as the only concept of teaching/learning, but in selected subjects, reflecting learners´ age and IT literacy etc. The aim of the paper is to present how this problem is solved at the Faculty of Informatics and management, University of Hradec Kralove (FIM UHK). First, Comenius´didactic principles are introduced and applied in the ICT-supported instruction in the form of e-learning and M-learning. Then, conditions and the process of using the ICT-supported teaching strategies are described on the example of online course Czech Language for Foreigners (Čeština pro cizince). Finally, M-learning and its implementation on the process of instruction are presented and discussed.

Didactic principles

For ages scientists have been running researches to define rules and make the education process effective. Comenius (1964) was the first one who formed basic principles which have been valid for centuries. Comenius was a great scholar, philosopher and educational reformer of the 17th century coming from Bohemia (nowadays the Czech Republic). His thoughts and works brought revolutionary changes into education, his principles or theorems even now sound modern and natural and form fundamentals of didactics, disregarding which philosophical paradigm is currently trendy (cognitive science, behaviorism, constructivism) (Comenius,1964).

The joint feature, which is reflected in each principle, is the "schola ludus" approach representing the *edutainment principle*, which is understood from several points of view as follows:

- any entertainment content designed to educate and entertain – as frequently mentioned, the entertainment includes games, films, shows, and last but not least, it works with latest ICT-supported devices as mobile phones, computer, tablets etc.,
- the content with a high degree of both educational and entertainment value,
- the content that is primarily educational but has incidental entertainment value,
- the content that is mostly entertaining but can be seen to have some educational value. (Edutainment, 1973)

The didactic principles influence one another, depend on each other, work together towards developing the final product – an educated person.

The most important principles defined by Comenius (1967) include

- *Purposefulness*. Teaching is a purposive activity which requires stating strategic and partial objectives, explaining them to students and thus motivating them to reach objectives defined at the beginning of the process.
- *Systematic approach.* Each education activity should be structured in a logical system leading to methodological, systematic way of learning. "Let everything what comes after be an objective, everything what comes before be means targeting to the objective", Comenius (1967) stated. This principle forms the basis of programmed instruction where all information to be learned is presented in the system of logical steps, including feedback, continuous checking and controlling.
- *Learner´s activity.* The principle comes from individual activity of a single student, arises from cognitive, emotional and volitional processes, stimulates interest and motivation, leads towards application of gained knowledge and to the use of creative approaches to all activities.
- *Clearness*. The principle requires activating as many senses as possible, which enables students to research the real life as indirect opinion, form ideas on their own experience as indirect opinion and thus continually and simultaneously develop the whole personality. The process of cognition begins with sensory perception and leads to general thinking and

verification of conclusions. In practice this principle is applied in visual aids, explanatory examples, motoric training, using symbols and schemas, watching films and last but not least in a clear way of teacher´s explanations. At present the ICT provide teachers with a wide range of technologies suitable for the purpose.

- *Awareness*. The principle demands full understanding of all intentional activities and steps which are made by the student during the educational process. The gained knowledge formulates clear terminology, views and judgments leading to mind operations (analysis, synthesis, induction, deduction), to the use of clearly defined terms and understanding why and how to use knowledge creatively in practice.
- *Retention*. The principle covers the field of knowledge, abilities and aptitudes. It is put into effect by practicing and training. There is no doubt that practicing not only strengthens the knowledge gained before but brings a new point of view. This rule both results from keeping the principles mentioned above and results in the following ones.
- *Adequacy*. The principle requires adequacy in setting the learning content according to the student´s age and level, and in pacing, i.e., studying at one´s own pace. Haste makes waste. This principle developed into following rules: when doing any explanations, start with a close topic and head towards a faraway one, start with a situation which the student is familiar with and head towards an unknown one, start with description of concrete things and head towards abstract terms, start with easy, simple examples and head towards difficult, complicated ones. The successiveness of performed steps is a must. To be really able to apply these principles into the education process it is necessary for every teacher to have information about age differences and individual differences of the students, consider their prerequisites, abilities, experience. To meet all the demands the teacher should be educated in diagnostics, be able to evaluate the situation and according to it to adapt the content, methods, forms of the educational process. The adequate level of demands results into individual approach to each student.
- *Emotionality*. Communicating warmth, teacher enthusiasm, awoken emotionality during the education process contributes to its climate. All factors participating in the education process are concerned: teacher, students, educational content, methods, forms, etc.
- *Unified approval* and the consensus of the family and educational institutions and other organizations dealing with individual upbringing and instruction is required in activities of all factors and phases of the process. This results in pluralistic view of the society and real life, humanism, democracy and tolerance. Setting rules and keeping them is necessary.

Using effective teaching strategies

If the process of didactic principles application is to be successful and effective, any educator should be (NRCCLREP, 2000):

- a mature personality,
- a psychologist,
- a teacher,
- a subject/field expert.

The order of the characteristics is obligatory but only a mature person is able to bear and accomplish demands required from teachers, a good psychologist is able to recognize weak and strong points of student´s personality, a good teacher is able to design, create and perform an effective education process, an expert knows the subject well.

The Faculty of Informatics and Management (FIM), University of Hradec Kralove (UHK) has been deeply involved in the field of ICT-supported education for more than two decades (being established in 1993). There is 16-year experience in e-learning at the faculty.

The online courses run in LMS Blackboard. In 2014 more than 220 e-subjects – e-learning courses were supporting the process of instruction in single subjects The LMS is designed as a virtual learning environment, which means it provides tools to accommodate all didactic requirements on designing and running online courses according to didactic principles. Teachers are motivated by various types of incentives to design their e-subjects reflecting the didactic principles – they are included in the system of criteria under which each e-subject is evaluated by faculty experts before being used by learners.

Presentation of the learning content reflects principles of adequacy, awareness and transfer of learning material into practice. In selected activities the principle of fun (game) is highly appreciated so as not to bore the learners by empty memorizing. Numerous games, films, video-recordings are available on the Internet to support this approach. Above all, the principle of humanism, where self-motivation, human potential and learner´s interest are main attributes, enables teachers and learners to create fruitful and supportive environment with self-activating learners, and thus accomplish learner´s affective and cognitive needs.

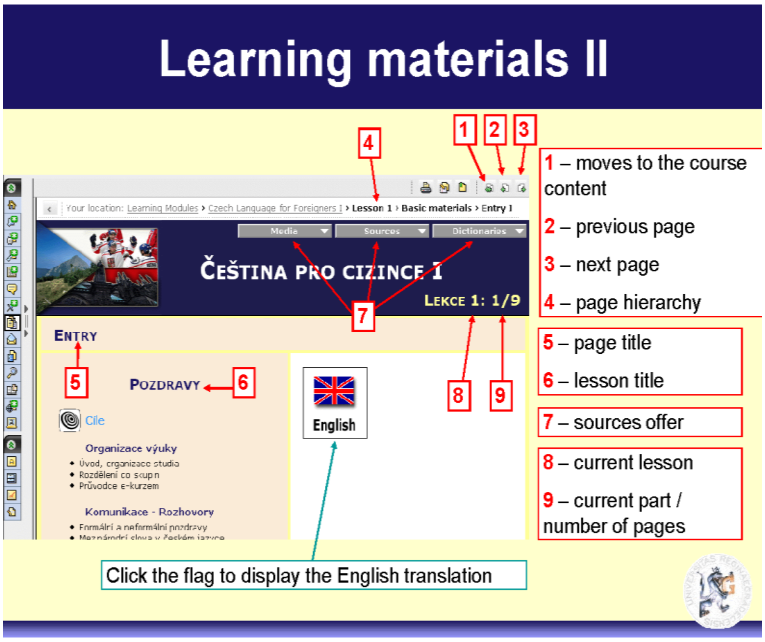

Fig. 1: Principle of clearness and systematic approach in e-subject Czech language for foreigners

A sample of the e-subject reflecting didactic principles in design and tutoring is Czech language for foreigners (see Fig.1). The scheme of each lesson follows the identical layout and pattern starting with objectives and tasks of each lesson on the entry page, key vocabulary being displayed at the beginning of the main part, followed by the blend of grammar and communication supported by practical activities in the form of quizzes and individual assignments for the next lesson. The text is complemented with graphic elements harmoniously corresponding to the content of the page. These graphic elements were designed not to disturb the user from the page content; they nearly blend with the background but are visible enough to help with navigation. The text is enriched with icons underlining important information or message; they always introduce the same topic, which makes the navigation user-friendly. Audio-recordings were added to the course to help students with pronunciation. They are digitally adapted so that all vowels and consonants can be clearly audible. And, extra exercises are designed for students who dare to catch main information from three authentic radio recordings. Oral communication runs in face-to-face lessons and a/synchronous tools are provided by Discussion, Chat or Skyping. Using the 'What's up?' tool learners present latest news from their country, world or the Czech Republic, in the written form first, followed by oral presentation and discussion in the face-to-face lessons. Assessments and Assignments tools are standard means facilitating student's feedback in the course. Another tool for revision and studying are 'Minutes from classes' which are regularly included into the discussion section providing absent students with basic information on latest lessons. Calendar, Syllabus and Announcements are used for both the navigation and planning learning activities. In Syllabus students find a brief content of each lesson and requirements for getting credits at the end of semester. Calendar permanently informs on the lesson that is being learned/taught and on scheduled events; Announcement tool is used to remind students of important events or deadlines.

The course is highly adaptive. Easy navigation system and clear transparent design make provided learning material easy to follow, thus reflecting the principle of clearness and adequacy:

- study material either vocabulary or grammar is in a systematic and repetitive way incorporated into dialogues, tests, assignments;
- pronunciation work is integrated but it is desirable to practice pronunciation especially during face-to-face classes;
- prompt feedback, challenging tasks, supplementary material for study enthusiasts are proven motivating aspects working on the principle of systematic approach and principle of having fun and gaming.

Teachers find positive the possibility to have their own separate on-line language section and add materials that suit their group either we have in mind the level of their students´ language abilities or students´ interests. This way they can enlarge the space and time which is normally limited by two hours weekly in the classroom, they are given chance to create their own ´micro-world´ and adapt it accordingly.

Foreign students appreciate another option to communicate with each other. In comparison to Czech students of English language, foreign students are more open to communication. Each lesson is unique, it captures students´ involvement and experience which are noted down into the word-document and then placed into the virtual space in the e-course. The students themselves participate in creation of their own study materials and consequently find it easier to learn and repeat the material they are familiar with, which applies the principle of student´s active approach.

Current ICT-supported trends in education

Institutional education is and will be the basis of the education process. But today´s social situation leads to developing new forms and methods which will enable gaining education during the whole life cycle. Comenius´ centuries-old principles provide us with still effective and respected rules helpful in today´s educational process (Trna, 2000). The aim of all forms of education is to prepare any individual to be competent to solving present and future problems. Even if we sometimes are not able to imagine the situations students should be prepared for, new curricula are to involve basic competences in science, computer and foreign languages. This may lead towards international as well as inter-subject collaboration.

The ICT-implementation in the process of instruction has become standard; online courses are currently being under the development towards MOOC (Massive Open Online Course). Above all, the latest technologies, which are of high interest of young people, can be (and still are) used in education – thus reaching objectives of edutainment. The Faculty of Informatics and Management has started the use of mobile device - smart phones and tablets for education purposes within the LMS Blackboard in 2013/14 in pilot courses. This process requires special didactic preparation and skills of both the teachers and learners, adequate to the situation years ago, when first online course were introduced. Reflecting this experience the process will be easier for designers, tutors and learners both in identifying with a new approach to running the process of instruction and developing new skills required for running the process.

The distance education, which was the start point for numerous e-subjects designed and used at FIM, runs on anywhere/anytime principle, i.e., it provides 365/24 access to education; this idea is now supported by another factor - not only personal computers are used for education purposes but all types of latest and frequently used devices are trendy and helpful. Learners´ interest in them is a strong motivator and their latest IT competences should be used towards making the process efficient.

The FIM UHK has been the leader in the process of ICT implementation in university education for more than two decades. Since 2012/13 academic year virtual desktops running on VMware tools are used to support the process of instruction in selected subjects. Currently all IT laboratories have the "twins" in virtual desktops, which enables students to have anywhere/anytime access through a specialized software.

The same approach is provided by M-learning tools/devices. Similarly to the e-learning implementation, various approaches and ways to using mobile devices for learning purposes are available. Quinn (2010) has given a definition of M-learning from a technical perspective stating M-learning is a digital learning method realized through Intelligent Apparatus equipment. These Intelligent Apparatus equipment include Palms, Windows CE equipment and digital cellular phone and so on. Chabra and Figueiredo (2013) have given a broader definition: “M-learning is to be able to use the task equipment to acquire knowledge at any time and any place”. In the general definition mobile learning is defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices" (Crompton, 2013). In other words, with the use of mobile devices, learners can learn anywhere and at any time. (Crescente & Lee, 2011)

From the FIM´s point of view M-learning is an approach which uses portable information and communication technologies (except the computer) within the process of instruction and students´ education. It does not matter what device is used - smartphone, notebook, netbook, tablet, PDA (Personal Digital Assistant), e-reader, mp3 player, game console etc. The mobile devices vary significantly in their abilities, sizes and prices. The common ability is their easy mobility/portability and wireless connections. The main types of mobile devices used in the education process are as follows:

- *Notebooks*. From one hand, they have such abilities as desktop personal computers; from the other hand, they are of small size and support wireless communication.
- *Netbooks*. They are of smaller size and weight than notebooks, focusing on mobility, low energy consumption, price, weight, Internet access (WWW, E-mail) and simple office works.
- *Tablets*. These are one of the newest mobile devices providing full range of services as personal computers. Some of them do not have keyboard but software to recognize a handwritten text.
- *Personal Digital Assistants (PDA).* They usually have a stylus to touch the screen. Originally they were designed to support time management, nowadays the can record and play video-recordings, run applications etc. Despite all services provided they are considered obsolete, being replaced by smartphones to a large extent.
- *Cellular phones*. These currently low class devices can be mainly used for voice communication and sending and receiving of text messages (SMS). Some of their disadvantages are low memory capacity and low data transfer rate. The cellular phones of higher level can be used to Internet access via WAP or GPRS technologies and sending/receiving multimedia messages (MMS).
- *Smartphones*. They are hybrid devices which combine abilities of cellular phones and PDAs, being of smaller sizes than PDA and larger than cellular phones. Typically they do not provide full-size keyboard but they are able to read a handwritten text, have Internet browsers and potential to be efficiently used in the mobile multimedia education.

Since 2001 the FIM has been using the online education solution based on LMS WebCT/Blackboard technology, and the ´Blackboard Mobile´ was selected for M-learning. There are two main approaches how M-learning can be used: (1) to apply the currently used learning contents and methods on any mobile devices listed above - this approach can be only effective if we aim at supporting the face-to-face process of instruction; (2) to understand how new devices work, what they strengths and weaknesses are, and apply such new teaching/learning methods which are able to profit from them – this approach is positively preferred and represents the concept which the FIM is running.

Conclusion

Mobile learning is concerned with a society on the move, particularly with the education of "… how the mobility of learners augmented by personal and public technology can contribute to the process of gaining new knowledge, skills and experience" (Sharples et al., 2012).

A growing understanding of the learning and instructional affordances of mobile technologies reflecting latest technological developments have enabled to design and investigate mobile learning experience. There is much appreciation of learning principles, such as contextual, situated, augmented and collaborative among others, particularly suited to M-learning. There is a large amount of studies reporting on how these principles can be effectively applied in the field. There are also new technologies continuously being implemented in the context of M-learning, while the area of M-learning evaluation has lagged behind.

As mentioned above, the mobile nature of mobile learners and the application of traditional strategies and tools have often limited the scope of investigation to what can be observed by researchers or devices. Thus, the question what happens while learners are on the move, is a topic of future research.

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EVALUATING STUDENT'S KNOWLEDGE THROUGH THE USE ADAPTIVE TESTING

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Abstract

Nowadays, an incorporation of information and communication technologies into the education process is not rare. The idea is on the rise that the sooner children become acquainted with these technologies and learn to work with them, the more successful they will be in their lives. Information and communication technologies can be used in different phases of the education process: from the presentation of the new subject matter and practicing the newly acquainted knowledge, to the verification and evaluation of student's knowledge. And it is the last two of the mentioned phases where electronic adaptive testing can be used.

When compared with the classic didactic test, which only gives us information about the total number of points and the number of correct and incorrect answers, adaptive testing – apart from similar information – also gives us information about how the tested student improved, in which areas he/she improved, in which areas, on the other hand, he/she did not live up to his/her potential, and what he/she has to do to achieve the best possible result. Moreover, as a part of knowledge revision, adaptive testing also offers a student additional information.

Keywords

Electronic adaptive testing, the Barborka LMS, revision mode, auto testing mode

Introduction

First mentions of adaptive testing appeared as early as at the beginning of the 20th century. It was in psychological research concerning mentally challenged children and their placing in special classes. The 1970s mark the beginnings of the use of computer in adaptive testing, which can be seen in the work of Weiss (1974). The following decade is characterized by further research and development of electronic adaptive testing – represented by scholars such as Lord, Lewis, and Sheenan.

The described algorithm of adaptive testing and its being connected with the Barborka LMS not only tests students' knowledge, but (through the use of study supports and HELPs) also offers a student the chance to find the correct answer (even if he/she may not always do so at a first try). The incorrect answer does not discourage the student, but encourages him/her to try to find the correct answer once again, which is what every teacher's intention should be.

The simplest definition of the term "to adapt" is the ability to conform. Kostolányová (2012) claims that being adaptive means "having dynamic quality, being able to change in time and space, and having the ability to perceive impulses from the outside world, store them and adapt one's behavior to them". This is the principle on which electronic adaptive testing works. The word "electronic" evokes the use of a suitable system that is able to realize adaptive testing. In this case the Barborka LMS will be used – the program is still being developed and enhanced by a team of programming engineers in conjunction with the pedagogues at the Department of Information and Communication Technologies of the Pedagogical Faculty of the University of Ostrava.

How does electronic adaptive testing work? A large set of tasks is stored in the adaptive system (in this case it is theoretical questions and application tasks for revising mathematics for 9th graders). These tasks have different levels of difficulty and on the basis of the particular level they are divided into individual categories. Every task has variants for both verbal and visual types of student. Students, who take part in adaptive testing, begin with the task of the so called intermediate difficulty. If the student answers correctly, the next task is selected from the more difficult category. If the student answers incorrectly, the next task is selected from the less difficult category.

Where can adaptive testing be used? When studying a new material the student is systematically going through particular phases – modes. The first phase means that the student sees the material for the first time, becomes acquainted with it, and focuses mainly on headlines and bolded passages. In the second phase the student is able to make notes, is able to answer subsidiary questions, and deal with the tasks resulting from the study material. The *revision* part follows. The student will test him/herself to find out whether his/her knowledge is sufficient and whether he/she is able to sufficiently understand the new study material. During the testing process, the student is being given not only feedback following the correctness or incorrectness of his/her answers to every single task, he/she also has a chance to consult the particular study material. Moreover, the student has the HELP at his disposal – solving process with the correct result. The last phase is the "real" *testing*. The testing is uninterrupted and the overall feedback is given to the student at the end. The first phase is realized by the student him/herself, by examining the new subject matter. The second phase is the teaching process, be it in the classic, or the e-learning form. It is the revision and real testing phases where electronic adaptive testing can be used.

What is the contribution of electronic adaptive testing? An incorporation of adaptive testing should positively affect student's mind during the revision and testing parts. Because the following task for every student is selected according to his/her previous answer, the fear of failure and the inability to solve any task should be eliminated. Adaptive testing adapts to the student even in the pace of the test solving. There are students whose decisions are spontaneous and who respect their initial ideas. On the other hand, there are also students who contemplate all the possibilities and try to find the optimal one. Student's progression in the test depends on the time spent on individual tasks. As a result, student's fear of not being able to finish the test in time or of being slower than other students is eliminated. Another factor supporting adaptive testing is motivation. Even a less successful student can have a good result. If the student knows, which areas (not entire chapters, but references to their particular parts, e.g. formulas, etc., or intended help) are problematic for him/her and what he/she needs to do to improve in them, nothing can prevent him/her, after revisiting the subject matter, from reaching a good result that can be compared with other students. Knowing that self-study and their own efforts will result in the improvement in solving examples that up until now were hard to solve can have the decisive impact on students. The revision mode can be perceived as a virtual consultation (without emotions, without student's fear of repeated failure) with increasing help.

Even teachers are exposed to consequences of adaptive testing. Besides the classic feedback (evaluation by points, ratio of correct and incorrect answers) the teacher will know which type of tasks was the most problematic for students, or how students dealt with tasks of different difficulty. As far as the less successful students are concerned, the teacher can notice progress in trying to solve even the more difficult examples. The teacher can also learn that in some cases he/she should probably change the way of interpretation of the problematic issue or that more time is needed for students to understand it (Prextová 2013).

Material and Methods

The adaptive testing experiment has two phases. In the **first phase** the questionnaire examination is carried out. The student, who takes part in adaptive testing, fills out a questionnaire consisting of three parts. The *Social Factors* part uncovers sex, age, and family situation. The *School Environment* part uncovers equipment in the mathematics class, interest in mathematics, taking part in mathematics activities in their free time, future direction of study. The *Learning Style* part uncovers student's preferred sensory learning style. Because the test tasks are now adapted only to visual and verbal types of students, the student is assigned one of these two types. The first phase in itself does not decide whether the second phase (electronic adaptive testing) will be realized or not. The questionnaire research was included in the experiment on the basis of a presumption that the student's answers and electronic adaptive testing result can bring interesting findings (how social environment and preferred learning style influence the student's overall results).

In the **second phase** electronic adaptive testing takes place. In order to realize it, we had to create a large set of tasks that would be suitable for electronic testing and for dividing the tasks into different categories according to their difficulty (to fulfill the adaptability requirement). On the basis of *formal classification* the tasks were divided to automatically inevaluable and automatically evaluable (the second group suits the purposes of our electronic testing). Drawing on Dana Tollinger's taxonomy of learning tasks (1970) and following a detailed analysis, a *content classification* was created that consists of five categories that represent five levels of difficulty (level 1 is for the most difficult group). There are several mathematical tasks in each category and every task has a determined type – verbal or visual.

The final set is made up of tasks fulfilling both classifications. The tasks are from mathematics for the 9th grade of elementary school and are thematically divided into six parts: *Number and variable, Expressions and equations, Data, charts, tables, functions, Planar geometry and Spatial geometry*. For each part there are 25 theoretical questions and practical tasks. Theoretical questions test definitions while practical questions have concrete solutions. The more tasks and questions, the better is the set. That is why for each task there are two other ones that are equivalent. They differ in formulation, numeric values, or in offered variants of answers (overall: 450 test tasks). As far as the individual testing tasks are concerned, the correct answer is when the student writes down all the possible correct answers (be it numeric values, or a letter representing the correct answer). If the student does not write down all the possible correct answers, his result is considered to be incorrect.

Each task has assigned to it a reference to a particular study material that is related to it and the HELP – a step by step solving process of the task with the correct result. When creating the tasks and the following assignment of a particular study material I drew on textbooks by Odvárko – Kadleček, who created an entire series of books covering the subject matter of 6th to 9th grades. Considering that in the 9th grade a revision of the subject matter of the previous grades takes place, the choice was inevitable.

Barborka LMS

Since electronic adaptive testing cannot function without a controlling programmed system, the aforementioned Barborka LMS will be used. Barborka is a web application-type programmed system, which is used for an adaptive control of individualized education and its administration. That is why the system can be classified as a LMS. Moreover, we can insert study materials into Barborka, realize testing, manage the control of subjects and tasks, file students and their activities, results, etc. (Drápela 2013). We gradually inserted into the system all the tasks, which were divided thematically and we specified whether it was a verbal or a visual task. The following figures demonstrate samples of the tasks in the system:

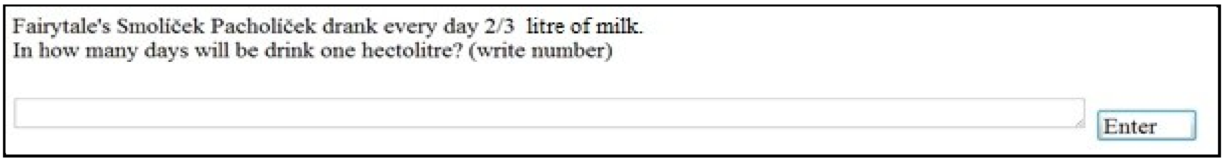
Fairytale's Smolíček Pacholíček drank every day 2/3 litre of milk.
In how many days will be drink one hectolitre? (write number)
Enter

Fig. 1: Number and variable in LMS

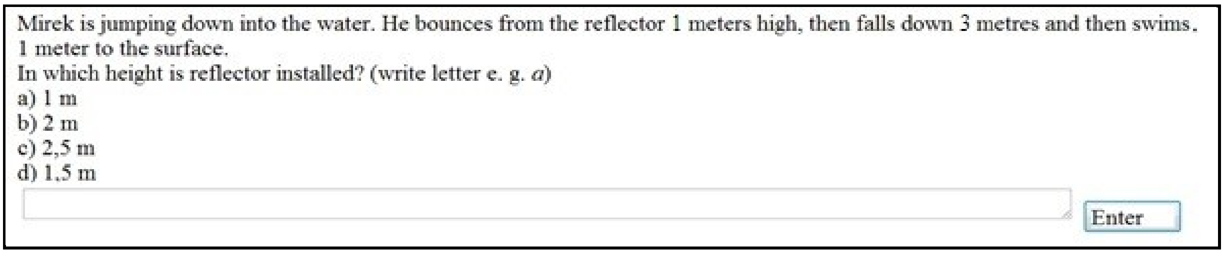
Mirek is jumping down into the water. He bounces from the reflector 1 meters high, then falls down 3 metres and then swims. 1 meter to the surface.
In which height is reflector installed? (write letter e. g. *a*)
a) 1 m
b) 2 m
c) 2,5 m
d) 1,5 m
Enter

Fig. 2: Expressions and equations in LMS

Algorithm of Electronic Adaptive Testing

To be able for the Barborka LMS to test students in the adaptive way, it was necessary to formulate requirements for electronic adaptive testing – to create an *algorithm of electronic adaptive testing*. Before the creation of the algorithm starts, inputs (the task) and outputs (the result) must be set. Inputs are the information about the tested student, tested subject, particular subject matter, particular task, and information about all possible system reactions – reactions of the Virtual Teacher to a student's answer. Outputs are the graduality of displaying of individual testing tasks according to a student's correct or incorrect answer (alternating the task groups of different difficulty), graduality of individual answers (correct answer chosen on a first, second attempt … incorrect answer chosen on a first, second attempt), different texts of reactions to answers (text of the systematic answer, text of the particular study material, text of the entire solving process with the correct result). The result of the entire test is displayed at the end.

Before the algorithm implemented into the Barborka LMS could be created, its course had to be simulated – how it reacts to the correct answer, how it reacts to several incorrect answers in a row, how the level of difficulty of individual tasks is converted, etc. Therefore, student's individual answers had been replaced by number encoding – 0 (for the incorrect answer) and 1 (for the correct answer) – and the algorithm was activated.

```
Program Adaptive_testing
const m=10;          // change of difficulty with correct and incorrect answers
      k=5;           // change of difficulty when incorrect answer is repeated
      u=20;          // range of points of one set level
var Difficulty, i, n, L, pocL, a, OPorN: integer;
    SPR: boolean;
BEGIN
```

```
pocL:=100 div u;      // number of levels of tasks
Difficulty:=50;       // start difficulty
i:= 1;                // counter task order
write('Insert number of tasks n: '); readln(n);
while i <= n do
BEGIN
   L:= Difficulty div u;       // calculation of the level of difficulty
   if L<5 then
    if Difficulty mod u <> 0 then
     L:= L+1;
   writeln;
   writeln('Following difficulty= ' Difficulty,', level L=',L,', task i =',i);
   SPR:=false;                 // correctness of answer
   OPorN:= 0;                  // order of incorrect answer
   while NOT SPR = true do
   BEGIN
     write('Insert your answer to task=',i,' levels L=',L,' [0/1]: ');
     readln(a);
     if a=0 then SPR:= false else if a=1 then SPR:= true;
      if SPR = true then
       writeln('Yes, this answer is correct')
       else
       BEGIN
         OPorN:= OPorN + 1;
          case OPorN of
          1: writeln('This answer is not correct, try again.');
          2: writeln('OReak or Go to 3');            // write a small hint
          3: writeln('Reference or Go to 4');        // switch to the appropriate interpretation
          4: writeln('Help or correct answer');      // write detailed HELP for task
          else begin writeln ('Help + Correct answer');     // explain and end task
                    SPR:= true;
               end;
          end;
       END;
```

```
    END;
    if OPorN = 0 then Difficulty:= Difficulty + m          // adjustment of difficulty according to
                                                                  the answer
      else Difficulty:= Difficulty – k*OPorN;
    if Difficulty < 1 then Difficulty:= 1
      else if Difficulty > 100 then Difficulty:= 100;
    i:= i + 1;
  END;
  writeln;
  writeln('Successful of test is', L, ' points', ' of the possible ', pocL);
  writeln('That's it, thanks for your cooperation');
 readln;
END.
```

Results and Discussion

The designed set of test tasks within the system of the Barborka LMS and the created algorithm of electronic adaptive testing are fundamental for launching the experimental testing in the 9th grade of elementary schools. Gradual realization of the first and second phases (questionnaire examination, electronic adaptive testing), analysis of the testing results, examination of student's answers in the questionnaire and confrontation with the result of testing may lead us to valuable and possibly surprising results.

The continuous development of the created electronic adaptive testing algorithm, remaking of the testing tasks in a way so that they are comprehensible for 9th grade elementary school students, and improving of the HELPs, were the reasons why the realization of testing was put back until after this article's deadline. However, by the time the conference takes place, the results and conclusions drawn from them should be processed.

Conclusion

The article introduces the term adaptivity, describes, on what principles adaptive systems work and introduces the issue of electronic adaptive testing. It points to the possibility of an effective use of the electronic adaptive system in the individual phases of the education process, particularly in revisiting the study material and self-testing. The basis for correct functioning of this system is a correctly and unambiguously formulated algorithm realizing electronic adaptive testing on the system's part, and a correctly formulated set of tasks reflecting the requirement for adaptive testing as well as adaptivity on the author's part.

Implementation of electronic adaptive testing into standard education should bring several advantages to both students:

- Motivation to self-education and to further study;
- Individual work tempo;
- Limiting the factor of fear of testing and bad results to the minimum;

- As a result of constant repetition, a chance to deal with more difficult tasks and match better students' results;

and pedagogues:

- Pedagogues have a chance to look into every student's process of testing, how he/she dealt with the individual tasks, which tasks he/she answered on a first attempt and which he/she could answer only after consulting the study material, which answers prevailed, etc.;
- As far as the less capable students are concerned, an improvement can be noticed, which can lead to their improvement in the given subject;

Last but not least, improving the quality of the entire education process.

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CREATIVE TASKS OF ELECTRICITY WITH THE EDISON 4 AT PRIMARY SCHOOL

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Abstract

The paper deals with creative tasks in teaching at the elementary school. There were established and tested creative tasks for EDISON 4 program for pupils of primary school. This is a creative job divergent. The article describes the creative tasks that can be used at primary school teaching Ohm's law and the teaching of the total resistance of the resistors. These resistors or bulbs (for clarity) are link up in the Edison 4 in parallel or in series. The first task is called "Find the perfect bulb“ and pupils can discover how to choose the bulb and practice Ohm's law, in the second task "Use the serial connection of appliances in practice", pupils discover how it is with electric current and voltage in series circuit and they will seek to apply this integration in their practice. The third task is called "The utilization of parallel connections in everyday life", and the pupils learn about the properties of electric current and voltage in a parallel circuit and where it can be used in everyday life. The last one is "Determine the total resistance of the resistor" it is designed to practice the Ohm's law, but also the calculation of the total resistance of resistors in series and parallel resistors. There were created worksheets for elementary school pupils.

Keywords

Creativity, divergent tasks, Ohm's law, serial connection, parallel connection, Edison 4

Introduction

Creativity is one of the qualities of each person, so it can be appropriate by activities to increase and develop. In physics, this can be achieved with the support of tasks that lead to pupils' creativity. This can get creative in the classroom environment, instead of an environment in which pupils will only acquire specific knowledge.

Creativity of pupils

Creativity in teaching of Physics we assess by the results of creating new by pupils. For those we will consider it for pupils to solve tasks that are completely new for them. If a pupil in attempts to solve the task himself appears essence of the phenomenon, it is a creative process, a factual understanding of the physics concept, or the law. This can be achieved with the active involvement of pupils in the creative process.

Divergent tasks with more treatment options we can consider those that strongly support the creativity of pupil. Always these depend on the particular pupil that exploits the possibilities of the task to develop pupil's imagination and creative abilities, or whether only the task solves normal procedure.

Creativity of pupils in physics

Tasks for the development of divergent abilities were divided by M. Jurčová, J. Dohňanský, J. Pišút [1] into six categories.

- ✓ ***Tasks for inciting readiness***

We want the pupils to be able to find as many attempts, the way the situation on the topic, phenomenon in these tasks. The purpose of these roles is to release pupil's thinking to be able to generate new ideas without restrictions.

- ✓ ***Tasks to encourage flexibility***

Pupils are looking for the most diverse uses of the phenomenon in these tasks. We want the pupils to solve the problem using a different approach to its solution.

- ✓ ***Tasks at stimulating new***

Feature of these tasks is finding alternative solutions when new situations arise, and it is not possible to solve this situation by pre-selected process.

- ✓ ***Tasks inciting originality***

The pupils are looking for as many ideas, but only one in these tasks. Here the emphasis is on the fact that the pupil had the most original idea on how to deal with the situation, or make use of the subject.

- ✓ ***Tasks inciting sensitivity to problems***

They are trying to get the pupils to monitor the essence of things to note also of what others would not notice problems that might arise if things did not work as they should.

- ✓ ***Tasks sense of detail***

We try to encourage the pupils to solve tasks that gets processed completely and in detail.

Interesting tasks to develop divergent abilities of pupils

Task: Find the most appropriate bulb

The task can be defined as tasks to *stimulate the sensitivity of the issues* where we want pupils to find the best bulb and determined the resistance, see Fig. 1.

Pupils will handle the task in pairs in a PC classroom.

Interpretation

Pupils link up circuit according to the diagram, see the Fig. 1 in software EDISON 4. Result linking is Fig. 2. Software Edison 4 bulbs shows how strong the bulb lights. We therefore want the pupils to check when certain electrical voltage source, what will happen to the bulb, if we change the voltage acros the bulb.

According to Ohm's law, how many times smaller the voltage acros the bulb than what is proposed, as many smaller electric current will pass through the bulb and the brightness will be less.

The role is focused on the manufacture bulbs for various voltages, even though we know that the grid voltage is 230 V. They are made bulbs with values 225 V, 230 V, 235 V, etc.

Tasks

1. Link up circuit according to the diagram, see the Fig 1. Value of the voltage source is to 5 V.

2. Increase the value of the lamp voltage from 5 V to 10 V gradually. Find out how to change the brightness.
3. Calculate the resistance of the bulb when the light clearly and approximately half brightness. How will be the resistance of the bulb?
4. Is it necessary to know what the voltage is at home when I buy bulb?

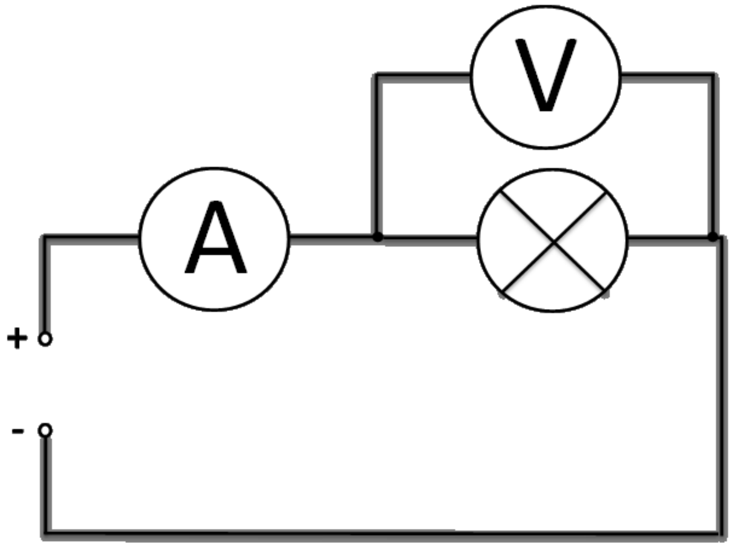

Fig. 1: Schematic diagram of the electrical circuit for the pupils in the system EDISON 4 in task 2.1

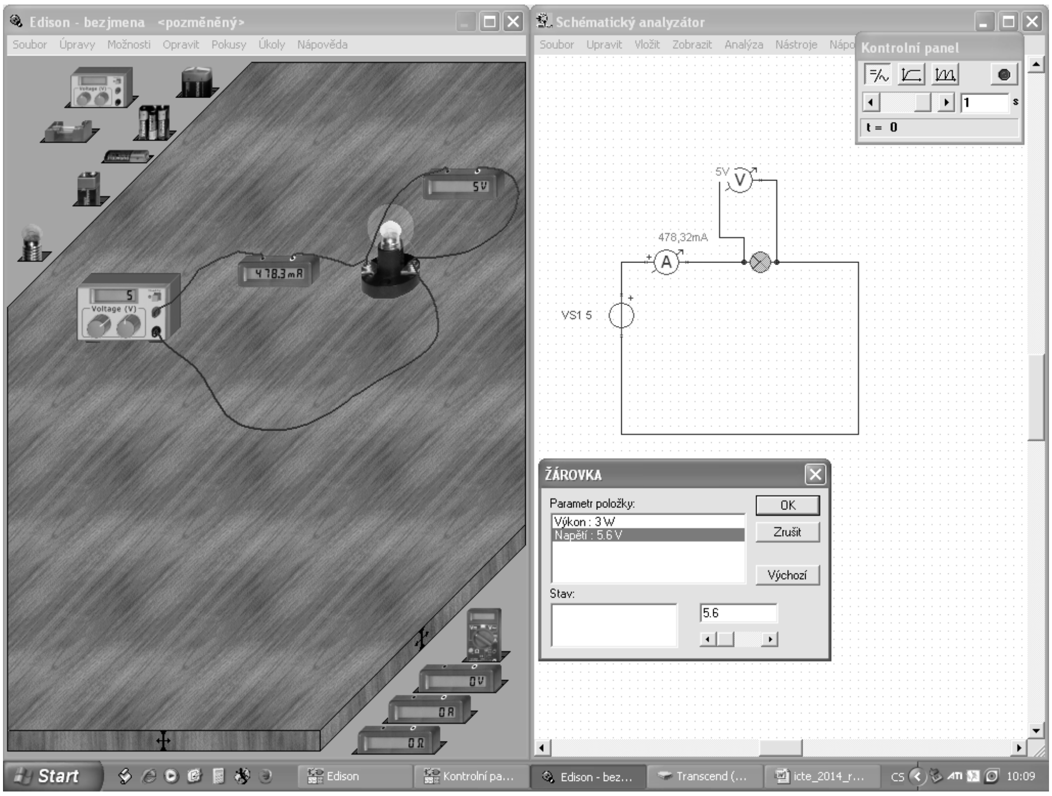

Fig. 2: Sample circuit involved in the EDISON 4 - the task 2.1

Task: Use the serial connection of appliances in practice

The task can be defined as tasks *of inciting readiness* when we want pupils to find as many ways to use the connection, based on identified characteristics of the circuit, see the Fig. 3.

Pupils will handle the task in pairs in a PC classroom.

Interpretation

Pupils link up circuit according to the diagram, see the Fig. 3 in the EDISON 4. Result diagram is shown in Fig. 4. EDISON 4 software displays bulbs to glows intensely.

The series connected lamps in all areas unbranched same circuit current. Various may be only the electric voltage across the individual lamps, if they are not identical.

Pupils will examine what happen to the voltage and current of the individual bulbs, if they change the value of the voltage on one bulb.

Tasks

1. Link up circuit according to the diagram, see the Fig 3 to get involved bulbs circuit to 9 V. Set the value of the voltage source to 10 V.
2. Reduce the voltage across one bulb from 9 V to 1 V gradually. Find out how the brightness of the bulbs changes. Watch also how change the voltage and current to the individual bulbs.
3. Can we use this wiring in everyday life? Find as many examples of the use of the diagram.

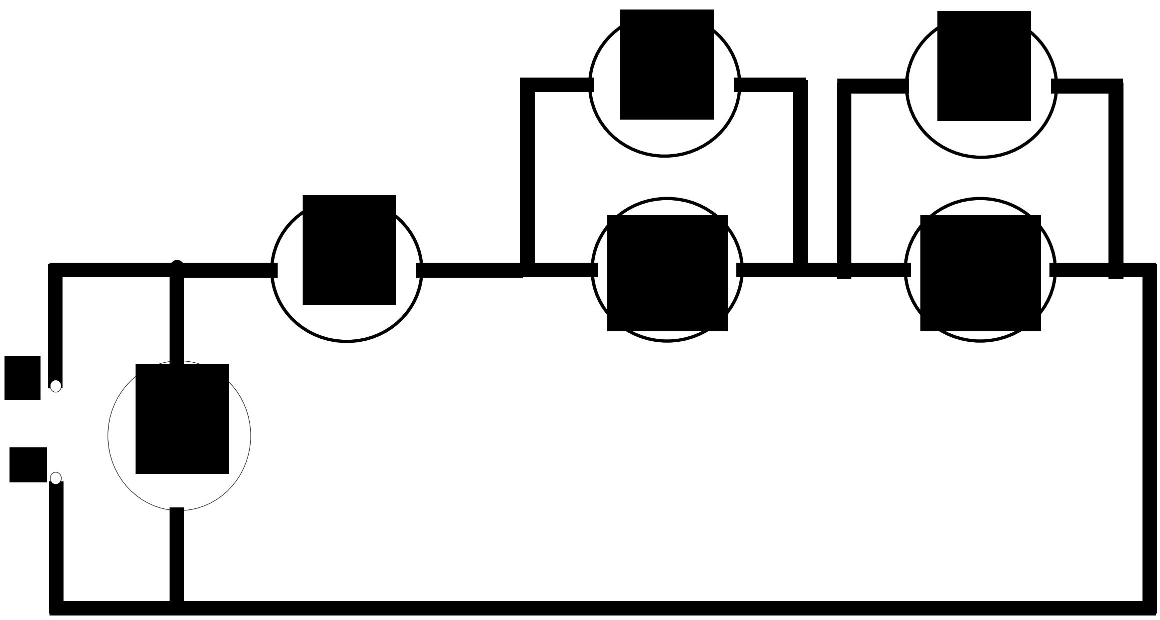

Fig. 3: Schematic diagram of the electrical circuit for the pupils in the system EDISON 4 in task 2.2

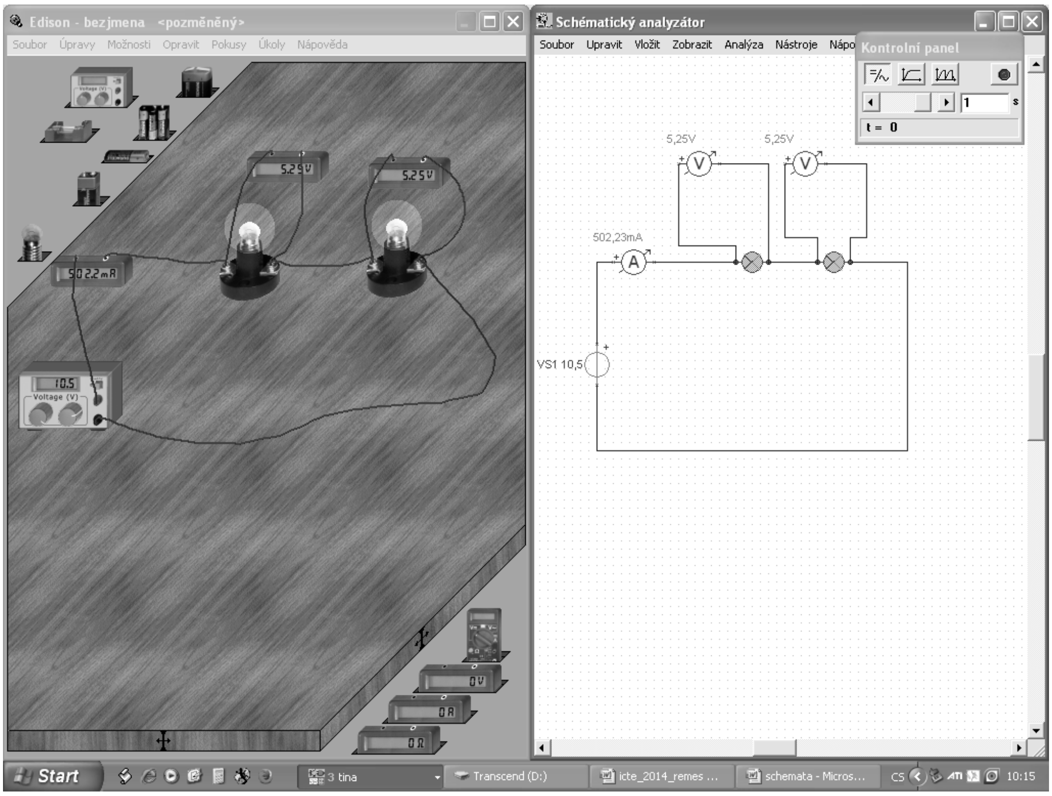

Fig. 4: Sample circuit involved in the EDISON 4 - the task 2.2

Task: Use the parallel connection in everyday life

The task can be defined as tasks *of inciting readiness* when we want the pupils found that most uses of the diagram see the Fig. 5 based on observed characteristics of the circuit.

Pupils will handle the task in pairs in a PC classroom.

Interpretation

Pupils link up circuit according to the diagram, see the Fig. 5. The result is shown in the diagram Fig 6th at the EDISON 4. Bulbs shows how strongly the bulb lights.

In parallel, the bulbs will be on individual bulbs of the same voltage as the voltage source. Any will only current flow in the individual branches of the circuit if the bulbs will not have the same characteristics.

Pupils will examine voltage and current in various branches of the circuit, if they will change the value of the voltage on one bulb.

Tasks

1. Link up circuit according to the diagram, see the Fig. 5 to get involved bulbs circuit with same voltage 6 V. Set the value of the voltage source to 6 V.
2. Increase the voltage on one bulb from 6 V to 12 V gradually. Find out how to change the brightness. Observe also how changes in the values of voltage and current in various branches of the circuit.
3. Can we use the wiring in everyday life? Find as many examples of the use of the diagram.

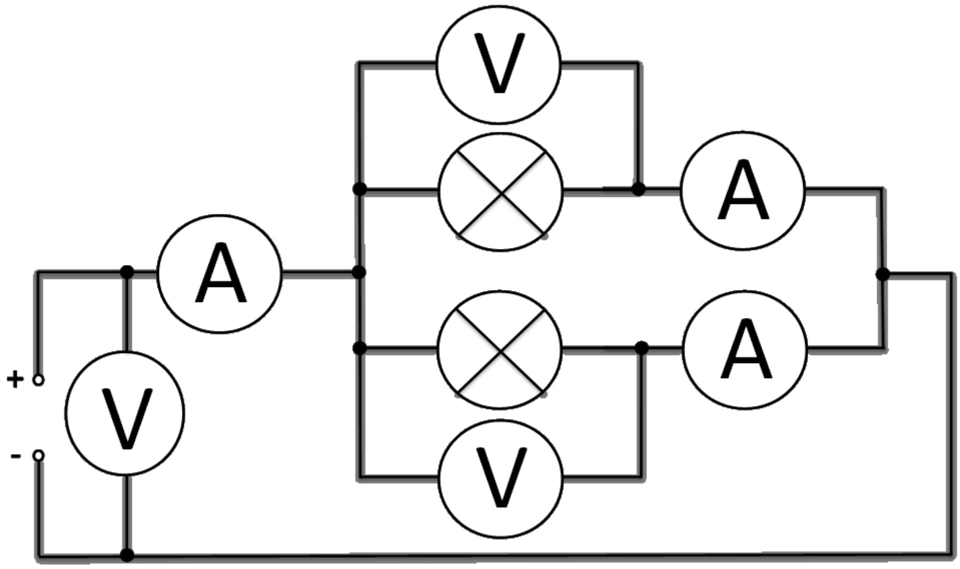

Fig. 5: Schematic diagram of the electrical circuit for the pupils in the system EDISON 4 in task 2.3

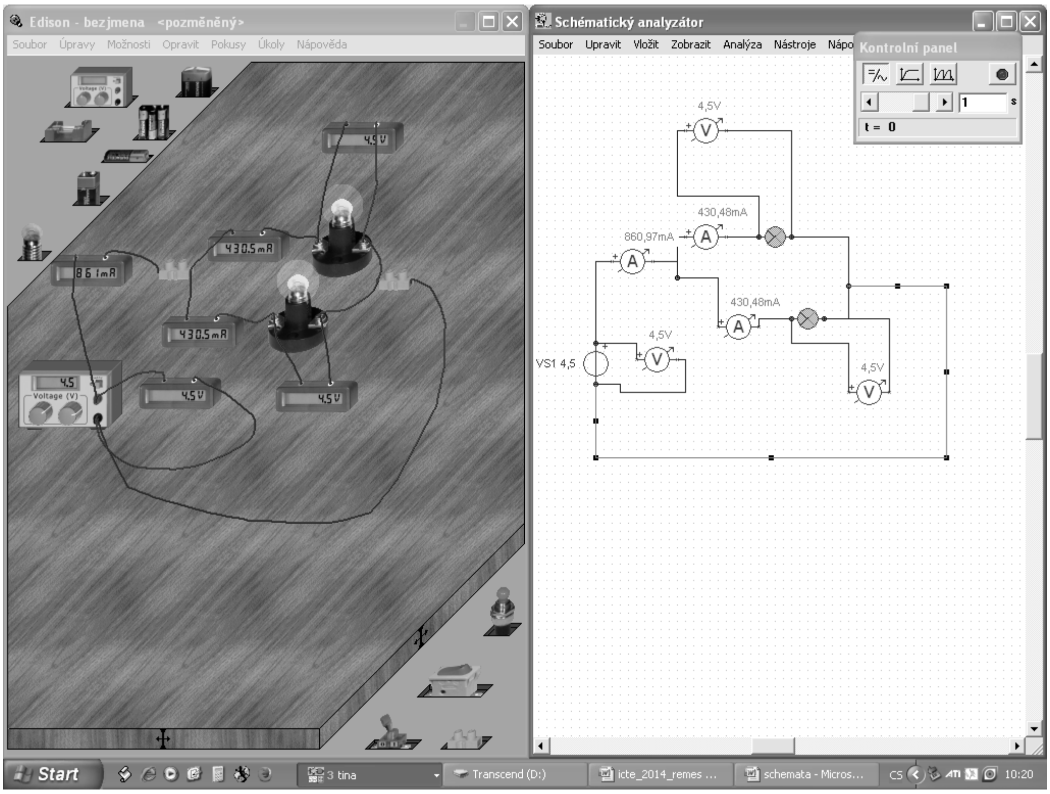

Fig. 6: Sample circuit involved in the EDISON 4 - the task 2.3

Task: Determine the total resistance of resistors

The task can be defined as the tasks *at stimulating new*, when pupils calculate the total resistance of resistors, see the Fig. 7.

Pupils will handle the task in pairs in a PC classroom.

Interpretation

The total resistance of resistors according to the diagram Fig. 7 would go easily solved using Kirchhoff's laws. Pupils do not understand these procedures in primary schools. They have to make it with the knowledge of Ohm's law and calculating the total resistance of resistors in series or parallel.

Pupils link up circuit according to the diagram, see the Fig. 7 in the EDISON 4. Result involvement is shown in Fig. 9. It is important that pupils set resistor values so that $R_1 = 2R_2$. Pupils calculate the total resistance of resistors according to Ohm's law after measuring the voltage and current.

The calculated value from the measured values is only a tool for pupils to solve a similar task, with the only difference that we want the total resistance resistors have calculated using the gained knowledge on the calculation of the total resistance of resistors in series and parallel. This is achieved in that the circuit redraws example, as shown in Fig. 8.

Tasks

1. Out circuit according to the diagram, see the Fig. 7. Sets the value of resistors R_1=20 Ω, R_2=10 Ω.
2. Measure electrical current through the circuit at a voltage U = 10 V. Calculate the total resistance measured values of resistors.
3. Find a way to calculate the resulting resistance resistors, without knowing the electrical current and voltage.

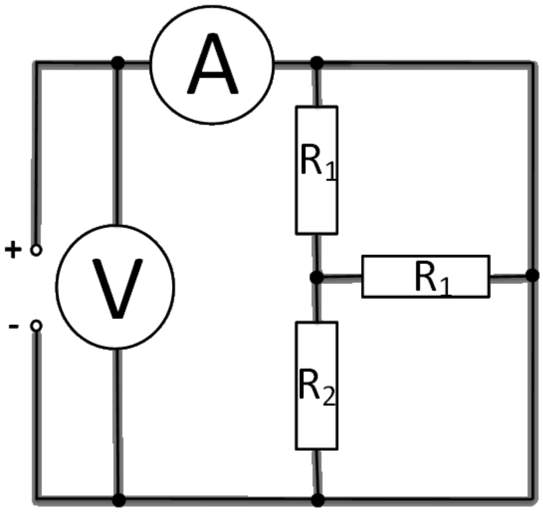

Fig. 7: The specified schema to solve for pupils

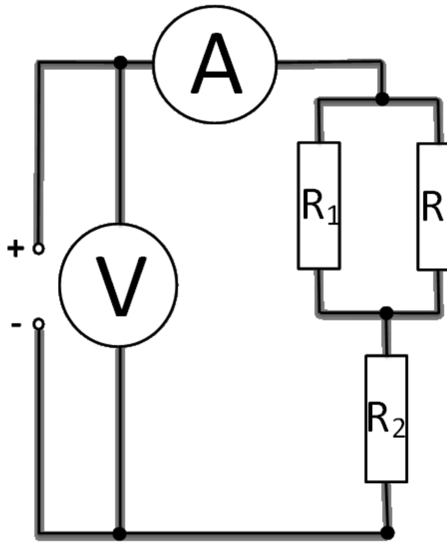

Fig. 8: Example redrawing el. circuit

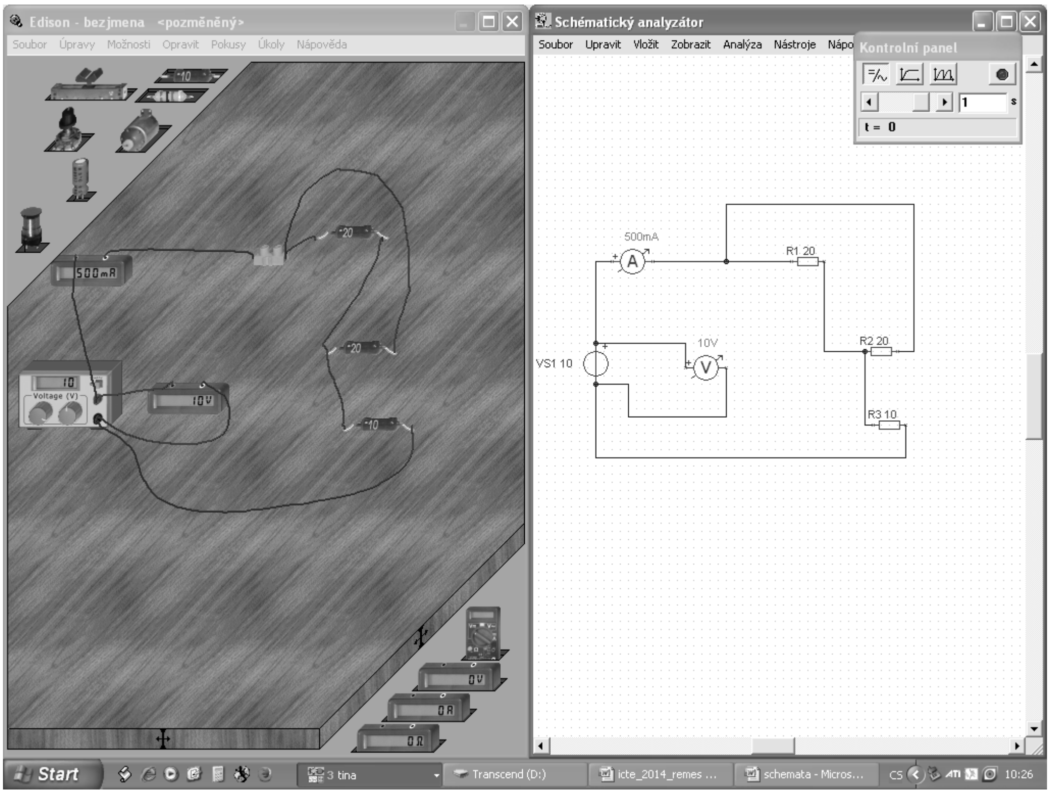

Fig. 9: Sample circuit involved in the Edison 4 - the task 2.3

Thanked

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Conclusion

The physics tasks develop not only of pupils’ creativity, but through solving similar tasks may be easier to understand physics for pupils. Moreover, the problems that pupils are processed on a PC using the EDISON 4, and attract more the pupils may discover in them the desire to discover as yet unknown.

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MEDIA SUPPORT IN UNDERGRADUATE EDUCATION AS TOOL FOR ASSESSING THE QUALITY OF TEACHING

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Abstract

Assessing the quality of teaching undertaken by undergraduate students involves many different aspects. To begin with, the training of teachers requires that an impartial observer evaluates teaching ability and skills; at a later stage, the teacher becomes able to evaluate his or her own teaching practice. This study describes the theoretical basis for such self-evaluation, using a suitable methodology for analysis, and deriving evidence from recorded media. Lesson evaluations are based on Flanders' system of categories, adjusted so as to include sixteen different categories of activity for observation. CodeNet custom software is a key component during the evaluation process. It is run as an internet application and allows students to apply structured observation techniques to assess their teaching. Using recorded media to support lesson evaluation has the potential to prepare teachers more effectively for entering the profession, and at the same time introduces them to some basic techniques of research work.

Keywords

Undergraduate students, self-evaluation, lesson evaluation, system of categories, recorded media, research techniques

Theoretical support

Concepts of teacher´s education aimed at reflection

Previous development and contemporary knowledge about education of future pedagogues indicate that some models stabilized, according to which preparation of education of the candidate of teaching is carried out. According to the accent "inside" of undergraduate education we can remind typology of teachers´ models e.g. according to Kinchloa (1993), who considers about behaviorist, personality, skill or constructive alternativity of teacher´s education. Another typology speaks about dominant of three approaches: models aimed at imitative action (leading to imitation of „model" pedagogical influence), models of applied science (increasing the professional and teaching readiness, based on mastered didactic transformation of ...contains) and reflective models (coming out from analytic self/knowledge of the teacher´s role in training and even real situations and actions). As their subpart we can mark educational drift significantly oriented on educational individual and revealing his/her possibilities with the attribute "self" (self-efficacy/Bandura 1977, Gavora 2010/, self-efficacy of own education /van Dinther, M., Dochy, F., Segers, M., 2011). It reveals that these socio-cognitive strategies lead to higher efficiency of teachers´ education under active students´ "self"-reflecting participation. If we pay attention in detail to just mentioned strategy of teachers´ education on the basis of reflective consideration of pedagogical reality and selfreflective revealing of our role and our possibilities in educational action, it shows that searching of the answer itself to the question: what is self-reflection in educational connections is not simple and does not lead to univocal content demarcation. Let us mention some evidence for this affirmation. The basic approach is offered by Průcha, Walterová and Mareš (2003), who see self-reflection as a view on our selves, on our acts, attitudes, generally as recapitulation of our own behaviour, action. Its aim is then to evaluate ourselves and decide, what was positive and what, on the other hand, was negative and select further strategy of action and activity.

We can think about (self) reflection at least on three levels: statistical (conceptual or norm setting assignment) or as about changing process, which has its levels. To the second one mentioned in our conditions Slavík and Siňor (1993) significantly contributed. They speak about reflection as a discursive (=awareness) process expressed in words. It is based on separate stages: l) repeated presentation of reflected phenomenon 2) its description 3) specification of the key elements 4) evaluation and explanation (in dependence on the aims), 5) on prognoses 6) prescription=determination of further procedure, which will lead to remedy of possible mistakes and another (more professional) direction to the aim. Korthagen (2011) mediates similarly about dynamics of self-reflection knowledge and he comes with an idea that reflection resembles a spiral, on its start is certain action, which is then backward analyzed with an aim to realize the substantial aspects of action and completed by forming alternatives and their examination in different pedagogical opportunities.

Frequent confusion of concepts of self-reflection (Švec, V., In Průcha 2009) witnesses about basic uncertainties in our topic. It does not contribute to greater setting down of needed theory. Level of reflection processes will be different at pedagogues engaged in school practice and will differ (significantly for our study) from the level of the students of teaching, and in addition in different stages of professionalism

Reflection methods in teachers´study

It shows that the models oriented at reflection in teachers´ education have a lot in common and come out from common presumptions of educational philosophy:

- acquisition of reflexive competencies in undergraduate education is a complicated act, which should respect professional trajectory of individual;
- should be gradual and in accordance with simultaneous theoretical and psycho-didactic education being in progress;
- from the beginning it is based on reflection of the followed teaching lesson (inspection of classes procedures), later aimed at reflection of action in the role of pedagogue;
- prudent reflection pedagogical practice is directed at the acquirement of reflection competences in different means: from the seminary training, simulation up to real and authentic pedagogical practice.

Therefore lot of teachers´ faculties included in study programme so-called reflection practices, which accompany the student from his/her school entry up to graduation. „Advantages“ of reflection practice we can see at least in three significances: as a reasonable connecting line between theory and school reality, as a effective tool for development of pedagogical methodology (it leads to acquirement of observation and classes inspection activity) and as formative feedback tool of structuralization and restructuralization of experiences (Korthagen, 2011).

A number of authors was interested in the techniques of development of reflection thinking in preparation of teachers. Let us pick up some references: among valid methods of development of (self)reflection PRŮCHA (2009) includes the following procedures: questionnaire investigations, analysis of video records, means of autobiography and case studies. At the beginning of new millennium we identify increasing interest in reflection techniques in teachers´ preparation; the evidence are activities Nezvalová (2000), who spoke about the following methods: suitably analyzed action research, professional commentary of case studies, aimed microteaching and further seminary activities, and also about analyses of pedagogical diaries and written self-assessments. Newly also student´s portfolio becomes the source of knowledge of reflection changes of student´s mediation (Píšová, 2007, Janík and Janíková, 2006).

In the conclusion of this part we can summarize that obtaining reflection competence in teacher´s study is an act, which should be by its total approach coming out from simple methods and then later in further stages of study more complicated and more demanding methods should be introduced.

Observation and evaluation of teaching in undergraduate practice

Already in the role of starting students of pedagogy the future teachers meet with class inspection activity, in which observation and subsequent analysis of recorded pedagogical reality leads to its understanding and evaluation. Also quality evaluation of lessons by help of reflection practice and class inspection is topic, to which pedagogical theory and practice return in retrospective in new connections. It is evident that it is described in the most contemporary publication of Janík et al. (2013), in which reader can learn beside other about alternative forms of class inspection activity, either from direct observation of the lessons or by mediation of video studies. Not only from this monograph it is evident, that observation and evaluation of classes under conditions of teachers´ education has three forms from methodological point of view: observation and record according beforehand given criteria in observation sheets, observation and evaluation of lessons „ad hock“ - it means authentically how the observer recorded them in the course educational act (e.g. identification and description of originated pedagogical situations) and last but not least so called categorical systems are more and more used for evaluation of school education. We will introduce them in the following text.

Categorical systems for description of school education

Categorical systems come out from so-called neobehavioral approach to research in social sciences, which are interested in it since 60th of last century and describe teacher´s and partially even pupil´s behaviour. It is investigation which primary aim is to describe educational processes and moreover in such detail, which are not possible with other methods. It is necessary to specify it, therefore we mention at least three known research procedures, which had and still have research respond even in present Czech research environment. Not only from literature are known till now investigations with utilization of A.A. Bellack system, who with his formula language described activity among the participants of education in class. Methodological experience in our conditions have with this system e.g. D. Tollingerova or H. Kantorová-Lukášová under our conditions. We can meet with another followed variables in research procedure of R. Balese, who tried to catch interaction in small groups and defined the share of communication among the participants of statement (Pelikán,1998).In the end the third representative of micro analytic research techniques is up to our days known and used Flanders system of interaction analysis, which uses beforehand determined categories of behaviour for description of teacher ´s leading of lessons, resp. interaction between teacher and pupils (Flanders 1970, Svatoš 1995, 2011 and 2013, Svatoš and Maněnová 2013, present knowledge of Janíková and Vlčková 2009 and others).

These methods brought new quality to empiric researches, based on coherent observation system beforehand determined activity categories. Let us add that principles of the methods are open, so they have potential “to live“ in further adjustments and modifications and a number of nowadays researchers utilize this potential, which is not weakened by time.

In spite to exist and in discussion non-defensive borders and limits of approaches, their application in contemporary education practice is beneficial, how we reveal the application of Flanders system interaction analysis in teacher´s education.

Methodology and research investigation

Characteristics of FIAS research method

It is necessary to introduce that the method to certain level reflected educational paradigma of its time, resp. that basic philosophic-research context came out from intention to describe teacher´s and partially even pupil´s behaviour in the models of lessons, which represented traditional concept of teaching and came out from significant asymmetry of relations (demonstrations) among main participants of education. Therefore the original FIAS method contained 10 categories of behaviour (mostly aimed at the teacher´s activity) and the task of the observing person was to adjoin to concrete activity in lesson corresponding category. It was the reason of strong discussion, if "only" ten parameters „is enough" for description of such complicated act, which takes place in lessons. And reaction did not wait so long: further systems were formed with more categories (our adjustment we introduce in the empiric part of our study).

Further discussed reality was that the observer had and have on identification and recording only 3 seconds and it forms question-marks concerning correct including of the phenomena to activity categories (it influences measure of subjectivity of coding and from higher position even validity of obtained data).

Processing of data and their evaluation in case of FIAS method can be carried out basically with three ways: the first one is based on original „grouping" in array record. The result of coding was a number of subsequent numbers, from which were formed separate number pairs, which were transfer to 10x10 array(more Maňák, Švec, Š. and Švec, V., 2005). The second way is rather visual and represents simple tabular or graphic expression of numerousness of the followed categories in the past time. It means that thanks to precise time identification of appearance of categories in time it is possible to summarize the results for the whole teaching lesson, but also only for certain time period (we speak about so called „time cut"). The third way is symbolic elaboration of the obtained data in the form of indexes (see Pelikán, 1998). The principle is fraction expression of the share of occurrence of added up categories (e.g. of teacher) against similarly added up categories (e.g. of pupils).

The last notes concern the conditions, under which we can successfully and effectively used Flanders method. The author himself introduces that for training 6 up to 10 hours (lessons) is necessary for training, then tests of consent among observers follow and after this independent coding is possible. Gavora (1997) writes that necessary consent should be on the level of 85-90% (it is case of so-called out reliability in consent of coding between two observers). Our experience of many years show that training procedure could be shorter (approximately 2 – 4 hours), especially in cases more simple applications of "Flanders" in undergraduate teacher´s education. The same experience led to forming of specialized code software CodeNet and thanks to this medial support utilization of this without any doubt valuable categorical system in standard preparation education makes some procedures easier.

CodeNet programme – medial support at observation and evaluation of teaching

We consider CodeNet for a useful tool supporting extensive utilization of categorical systems on the base of Franders method. Generating of code data and their basic statistical (quantitative) processing is one of the fundamental possibilities. The user could beforehand define up to 20 activity categories, which he wishes to code and he has possibility to set the code interval in wide time period. His activity in evaluation of the followed teaching is relatively simple: at observation (direct or medially arranged) to assign to the followed activities numerical code of corresponding category.

The result is represented by succession of numerical codes with which the processional page of teaching is written down. Tabular and graphic expression of the course and sum of followed activities is a final product, which could be transferred in known programme and further adjusted (e.g. in MS Excel).

If we are interested in the course and appearance of activities in certain time interval (e.g. in the first 10 minutes), it is possible to choose corresponding starting and final value of time „cut“ and after acceptation the programme will express sequence of occurrence of code activities and their frequency in this time segment – cut. Integration of video technique and computer technique brings boundless positive effects: it is a cheap and accessible way of data collection, based on true mediation of teaching processes and lessons. It is a complex source of later analysis, computer processing giving possibility of the most different coding, it is possible to reach greater inter-rater-reliability (repeated coding and training), it connects qualitative and quantitative research scientific approach and last but not least it has time independent documentary value (Janík, Janíková 2006). To negative points belong, beside other, problematic choice of suitable research sets, question of representativeness of scanned and recorded lessons, not solved legal protection and unclearness concerning the protection of personal data of respondents.

Example of utilization of CodeNet programme in teacher´s education

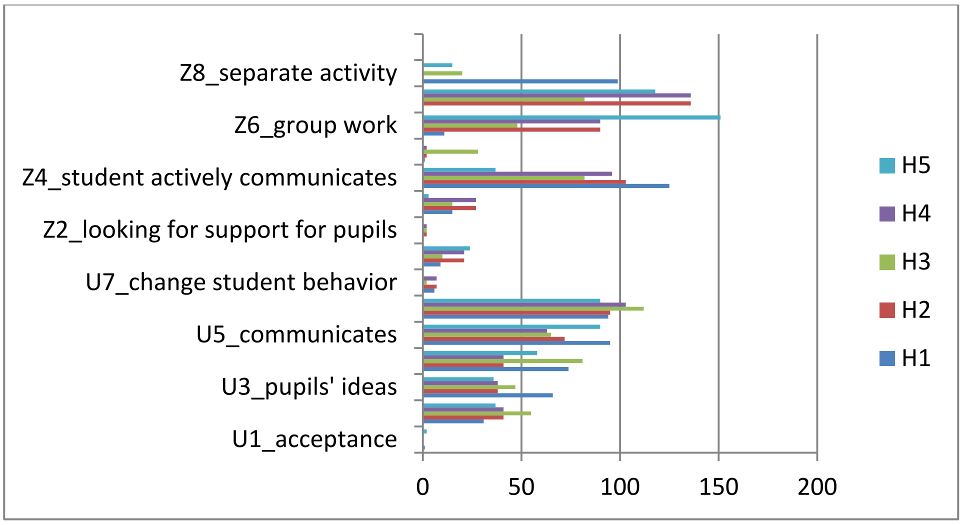
The aim was to observe and evaluate 5 teaching experiments of the student J.H. in conditions of so- called continuous pedagogical practice. It brings the students of fourth term (class) of magister study for primary education in situation, in which they have to master from didactic, professional, and commutative point pedagogical activities in the extent of whole teaching lesson. We tried to evaluate teaching with similar content of didactic structure in the same school environment.

We came out methodically from the concept of FIAS categorical system, which we adjusted to following 16 observed categories:

- **U1** – The teacher accepts pupil´s feelings, tries to show sympathy in constructive way.
- **U2** – The teacher evaluates pupils positively.
- **U3** – He uses, clarifies, develops or accepts the ideas proposed by pupils. The teacher repeats pupil´s statement to stress its value so the others could remember it better.
- **U4**- The teacher gives pupils questions, which concern discussed proceeding topic, way of work or organization matters.
- **U5** -The teacher interprets, tells, explains subject matter, introduces own opinions.
- **U6** – The teacher gives information, orders.
- **U7** – The teacher criticizes outcomes, answers, actions of pupils or their behaviour. He establishes his authority, he wants to change pupil´s unsuitable behaviour or activity.
- **Z1** – Pupil gives questions and seeks support and help from teacher
- **Z2** – Pupil gives questions, seeks support and help from his/her classmates
- **Z3** – Pupil states, explains and introduces own opinions – with „pressure“ and impact on teacher.
- **Z4** – Pupil states, explains, introduces own opinions – from own activity and motivation.

- **Z5** – Pupil sorts, modifies actions of others, offers help in activity of others. We included in this category introduction of presentation by pupil.
- **Z6** – Group work is proceeding, communication between pupils.
- **Z7** – Whole class discussion is being in process.
- **Z8** - Pupils carry on independent learning activity without evident interaction.
- **O1** – Silence or chaos in the classroom, breaks (unclear communication).

Students´ teaching experiments we recorded with digital camera and their visual reproductions were the starting point for subsequent coding with application of CodeNet programme. Let us add that coding was done by the students who were watching the lesson, later the performing student and at the end even experimental evaluation was done by faculty teacher of pedagogical practice. Further introduced illustrated results are just from expert documentation, which was transferred in student´s portfolio with corresponding reflection notes.



Graph 1: Interaction analysis of 5 teaching lessons

We will introduce brief commentary to graphic expression of interaction analysis in teaching of the student J.H. We reached to conclusion by statistical analysis that separate teaching lessons did not differ with statistically significant difference from the set of values from all 5 coding. It enables to think about emergent pedagogical style of the student in the role of teacher. Her dominant activities were connected with organization and directing of teaching (we would like to remind that it was case of teaching of pupils in the 3rd class on the first level of primary school) in such way to be able in the prepared way teach and cooperate with pupils. Significant phenomenon was stimulation of pupils with frequent questions and praising of their outcome. On the other hand her style of directing of teaching (and complementary even disciplined behaviour of pupils) did not ask for greater interventions into unsuitable acting of pupils. The second way how to work with the obtained data is expression of interaction between participants of education with already mentioned indexes of activity. We make it more specific in the following table (Svatoš, Doležalová, 2010, p.11):

Activity index	Title	Sum of categories
Ua	Index of teacher´s acceptance of pupil	(U1+U2+U3)/K
Uv	Index of teachers teaching activity	(U4+U5)/K
Ur	Index of teacher´s direction of teaching	(U6+U7)/K
Zo	Index of pupil´s search of support	(Z1+Z2)/K
Za	Index of pupil´s activity	(Z3+Z4+Z7)/K
Zp	Index of pupil´s assertion	(Z5+Z6)/K
Au	Index of teacher´s activity	Ua+Uv+Ur
Az	Index of pupil´s activity	Zo+Za+Zp
Ii	**Total index of interaction**	**Az/Au**

Tab.1: Activity indexes and their composition (Svatoš, Doležalová 2010)

Where K = total number of codes recording the whole teaching lesson, decreased about the number of codes of category O1 (silence, chaos or not communicating clearly).

It could be generally stated that if the index of interaction is Ii to 1, then teaching lesson is balanced either from teacher´ side or pupil´s side. If interaction index is bigger, it testifies about greater activity of pupils, if the interaction index is less than 1, it reflects about prevailing share of teacher in mutual communication and interaction.

We will show usefulness of indexing on the last example. In introducing pedagogical practice (with beginners of teaching study) we visited teaching lesson of Czech language at faculty primary school again in the 3rd class of the 1st level of primary school. We followed and evaluated with CodeNet programme teaching with the same content, but in two different classes, in which were teaching two teachers with different length of pedagogical practice. We can see "measured" interaction indexes in table:

Index	Ua	Uv	Ur	Zo	Za	Zp	Au	Az	Ii
Teacher with 2 years of practice	0,056	0,357	0,190	0,021	0,318	0,059	0,603	0,397	**0,682**
Teacher with 24 years of practice	0,061	0,299	0,186	0,025	0,412	0,018	0,545	0,455	**0,882**

Tab 2: Comparison of interaction indexes in teachers with different pedagogical practice

Brief commentary: The biggest deviation was at index Zp, which expresses amount of pupil´s assertion. This was bigger in teaching, which was led by less experienced teacher and was rather in connection with bigger liberalism and tolerance towards spontaneous pupil´s manifestations. On the contrary the teacher with many years of practice reached teaching aims with lesser direct teaching activity, she supported more cooperation forms of collaboration (between pupils themselves and between her and pupils). We selected only a fragment of knowledge for reflection, which index comparison enables. Nevertheless even this brief illustration shows usefulness of introduction of categorical procedures with media support in evaluation of teaching in undergraduate education of future teachers.

Conclusion

If present teachers´ education should be in relation with social expectation and needs of nowadays, it is necessary to come with new educational styles, in which centre is an interest about student, who is preparing for future profession. It is not an easy task, which is difficult to transfer into authentic university practice. Nevertheless the experience shows that one of the possible ways is application of models of teaching preparation with use of reflection and self/reflection. The principle is true presentation of school reality and an effort for its understanding, e.g. with suitable methods of class inspection together with methods based on categorical systems. Reflection techniques, in later stage of teacher professionalism are aimed at obtaining feedback information from students´ teaching experiments and their processing leads to partial answers: what type of teacher I will be, how I become rooted in professional role, with what ambitions or deficits.

In our study we pay attention to relation between reflection techniques and media. It is an interesting coexistence, which brings at least three benefits: liberates „observer“ from activities, which were a burden for him/her (hand coding and statistical processing), at the same time it accelerates the stages of investigation and in cases of audio visual records of teaching it enables time independent analyses directed at greater objectivity of assessing of pedagogical phenomena.

In spite to long term positive experience, a number of the unanswerable questions remain, let us mention: when to come with usual class inspection procedures, when completed them with more demanding methods – in relation to acquirement of theory and professional stages? How to prepare students for managing (mastering) of research methods and how to train the methods with them? How to lead students to positive relation to media and how authentically point to their benefit on the way from student to teacher.

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EVALUATION OF E-LEARNING SUPPORT BY MEANS OF SEMANTIC NETWORK OF TERMS

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Abstract

This paper concerns the proposal and use of a semantic network of terms, created above e-learning adaptive support by an author – a teacher. It briefly explains what adaptive learning is, describes the general structure and metadata of learning support, and the successive data and graphical structure of the semantic network of terms. It also shows the colour semantic network as an oriented evaluated graph with vertices and edges, representing different types of concepts and relationships between them, and lists the functions and methods appropriate for the teacher to work with this network. The paper also discusses various options of using visualization of relationships between important concepts to control their location in the text and any text optimizing in compliance with pedagogical principles in the creation of high-quality study support.

Keywords

Adaptive learning, adaptive e-learning, semantic network of terms, study support, metadata, visualization, evaluation

Introduction

Writing a textbook is not an easy author's work. Even with good knowledge of the area, it is also important to apply pedagogical principles and to know how to use them correctly for the issue. While creating a course in an e-learning environment, moreover with the possibility of adapting the course content, there are other rules which should be known and applied by the teacher in the process of creating learning support so that it could result in a high-quality, optimized course.

Within their works, the teachers and students of master and doctoral programmes of the Faculty of Education of the University of Ostrava have proposed and implemented adaptive LMS, designed primarily for pedagogical experiments. Part of this LMS is also the module with functions for working with semantic network of terms (SNT - Semantic Network of Terms) above the author's text. It serves both as a feedback for the author of the textbook to evaluate the text before it is made available for students, and secondly, to guide students with respect to the concepts related to the whole subject. This paper concerns the first phase of the process, when it is necessary to evaluate the appropriateness, usefulness and benefits of using the semantic network of terms to check and optimize the author's text.

The idea of semantic network of terms (Collins, Quillian, 1969, Sowa, 1992) and the structure of the text, expressed as a diagram that works with two basic elements - vertex and edge by which it is possible to construct a richly structured networks will certainly be useful for structuring and visualization of this structure.

Our task is to locate and describe the completed e-learning support stored in that adaptive LMS, and to describe the SNT structure, to automate its creation and then visualize it so that the author of the text checks compliance with pedagogical principles, or s/he is notified of the deficiencies and their specifications. Later, it should help students to use this network to remember the concepts and relations between them better and to be able to go through study text also in other than a linear path, in a similar way as in hypertext.

Classic hypertext links must be created manually, depending on the author and his/her experience, systematic work and time commitment to describe the structure of the text - and how many links s/he creates. This does not address the question of the completeness and correctness of the links described therein.

Theoretical bases

The principles of education

The teacher of nations Jan Amos Comenius (1592-1670) was the first creator of the original, philosophically anchored educational system in the Bohemian lands, he dealt with the general theory of education, didactics, created a special methodology of language teaching, and he wrote original textbooks himself. He is considered the founder of modern education, and virtually all other educationalists follow his work.

In the book Didactica magna (The Great Didactic, 1657) on the teaching methods, he formulates generally applicable teaching principles, which were revolutionary and breakthrough not only at that time and which he applied in the classroom himself - more details about principles of education are in chapter 0.

Over the last 350 years, these principles are still valid, only some of them have been reformulated and several others added. In (MALACH, 2003) didactic principles are defined as general recommendations for teachers, and if they are applied, the teacher in the classroom or the student during self-study can achieve maximum effectiveness and efficiency.

With the development of new pedagogical and technical possibilities, especially the development of ICT, teaching can not only be optimized by complying with the general guidelines, but also respecting the individuality of the student, his/her innate characteristics as well as characteristics acquired by upbringing and education.

Adaptive e-learning

Adaptive learning can be divided into several categories: adaptive interaction, adaptation of the content, discovering and composing the content and support for adaptive collaboration (PARAMYTHIS, 2003). Adaptation of the content changes the structure and presentation of the course in a way that suits the user's characteristics and optimizes the quality of learning and learning time. This type of adaptation involves dynamic selection of suitable components (presentation options) of the course and the dynamic changes in the order of sub-elements of the course (layers corresponding to the phases of teaching). We will continue to understand adaptive learning as just such an adaptation of the content.

The result of the research in adaptive e-learning (KOSTOLÁNYOVÁ, 2012) are the rules for the known characteristics of the student, influencing the learning process, and the known structure of learning support, recommending the optimal learning style, implemented by the so called virtual teacher. The virtual teacher is a programme in LMS, the learning management process (KOSTOLÁNYOVÁ, 2011a). The optimal learning style is the above mentioned selection of the optimal presentation option and optimal sequence of learning layers corresponding to the learning characteristics of each particular student.

The content of the learning text (including the multimedia and interactive elements), must be structured in some homogeneous elements - of the above mentioned layer, so that it could be adaptable.

The structure of adapted support

The teacher naturally divides his/her author's text in a particular course into chapters or lessons (teaching hours), lessons to elementary sections (paragraphs in the chapter), corresponding to a new concept or a group of related concepts. These elementary parts are called the frameworks in this text.

In order to modify instruction according to the student's individuality, two ways of responding to student characteristics are designed:

1. **Options of presentation of the framework content**: the most frequently cited characteristics of the student is the predominant form of sensory perception of information - verbal, visual, auditory or kinaesthetic. The second characteristics, known in educational practice, is the student's need for the details of the subject matter presentation. Both of these features are designed so that the content of each frame is treated in several different versions of the same content – in three "depths" of the detailed presentation and in four sensory options.
2. **Framework layers corresponding to the phases of the presentation**: the full cycle of education, based on the above mentioned pedagogical principles and recommended in the literature (e.g. Gagné, 1975) include: motivation and objectives, teaching, interpretation and relation to prior knowledge, practice, verification of knowledge, ending. Based on a more detailed analysis of these phases, they can be divided into the following layers, and each frame is then created from them (each its option):
    - **presentation layers**: theoretical, semantic, fixing, solved examples, examples from practice
    - **test layers**: theoretical issues, problems to solve, tasks of practice
    - **special layers**: motivation, navigation, layer of targets, literature.

    For students with different learning tactics (theoretical - practical type, detail-oriented - holist, etc.) it is advisable to use a different order of these layers.

One of the features of the virtual teacher, therefore, is to choose the optimum alternative of presentation for the student and the optimal order of the layers (KOSTOLÁNYOVÁ, 2011). However, because the student eventually goes through all the layers, it is only necessary that the author ensures the existence of all relevant layers.

Materials and Methods

The importance of the semantic network in adaptive e-learning

One of the two main tasks of SNT as the author's tool is to check compliance with some of the pedagogical principles, check the completeness of all phases of learning and check proper continuity of the introduced information. Grammatical and stylistic page can be checked by the author e.g. by means of functions such as MS Word. So far, however, there is no automatic teaching control of the text in the textbook. It is not possible to automatically check all the principles, or check the factual accuracy of the presentation. However, it is possible to analyse the structure of the text and a number of educational features. Before publicizing learning support, the author may be notified of any errors or passages to consider with respect to the content and its completeness.

The defined terms (a word or a phrase and or its synonyms) are determined by the author of the text in **the theoretical layer** while creating adaptive support. The concept will be automatically inserted into SNT and the network will be **automatically** completed with all other occurrences of the concept in the whole learning support, including their addresses. SNT will be automatically completed with links and metalinks between these and other defined concepts or their occurrences (ŠEPTÁKOVÁ, 2013).

The structure of the proposed SNT is a variant of the diagram – it contains vertices (concepts) connected by edges, i.e. links between concepts. SNT may have different types of vertices (the defined term, the occurrence of the term, synonyms) and different types of edges (a relation between the defined terms: *isSuccessor*, *isPredecessor*, the link between the occurrence of the term and its definition: *occurrenceBefore*, *occurrenceAfter* the concept definition: the link between the defined concept and its Synonym: *hasSynonym*).

The relationship of the type *isSuccessor* arises when the occurrence of a defined concept is also found in the definition of another concept - *the Successor* of the selected defined concept. Among the defined concept and the concept in whose definition the selected term occurs, i.e. there is a relationship *isSuccessor*.

Similarly, there is a relationship *isPredecessor* - when for the current definition of the particular concept a different (not elsewhere defined) concept is used, i.e. the *Predecessor*.

The relationship between the defined term and its occurrence anywhere in the text of the support before its definition is metarelation and we call it *occurrenceBefore* the definition. Similarly, there is a metarelation *occurrenceAfter* definition, and it means that the concept is placed in the text after the definition. Apparently, *occurrenceBefore* may be questionable in terms of teaching (and scientifically), if it was used without explanation in a presentation or a test layer. Conversely, *occurrenceAfter*, which is first defined and then used in another layer, is suitable for both logical sequence of the presentation and for phases of its theoretical use, repetition, practical use, or while resolving problems and tasks.

Graphical visualization of the network or its part makes it possible for the educator to check the structure of learning support in relation to the defined concepts and automatically found occurrences of these concepts. According to their possible non/existence in the potential individual layers, the author can optimize the author’s text to meet the pedagogical principles.

Results

Learning support of a subject processed for adaptive e-learning (i.e. in the structure divided into frames and layers) is used as terms of reference for the creation and subsequent visualization of SNT. It is important to realize that SNT just shows the structure of support. It does not have to (in the evaluation phase support) correspond to the actual relationships between concepts, its purpose is to notify the author of any discrepancies.

Entering concepts to SNT

While creating learning support the author determines the important defined terms and possibly their synonyms, which will be further used in the text. In the form *Layer Editing*, or *New Layer*, the user fills in information concerning the layer and s/he states a defined concepts or its synonyms.

Author’s functions and methods suitable for working with SNT

To work with SNT, the author has functions at his/her disposal, accessible from the menu. The first part contains references to the sub-lists already created by SNT for the subject in the form of a table - the list of defined terms, synonyms, automatically found occurrences, predecessors and successors to the concepts, occurrences of concepts before/after the definition of the concept. There is also a link for re/creation of SNT to the subject, the author can continuously monitor the growth of SNT with the growth of the number of defined terms. The links to a visual display of the selected SNT concept including the occurrence of the term elsewhere in the text are the last (SN Detail) or no occurrences of the selected term (SN Preview).

Visual preview of SNT concepts and relations between them

In Fig. 1 there is also a part of SNT related to the selected concept (red-darker vertex), additional concepts (blue-lighter vertices) and relations between the selected and other concepts.

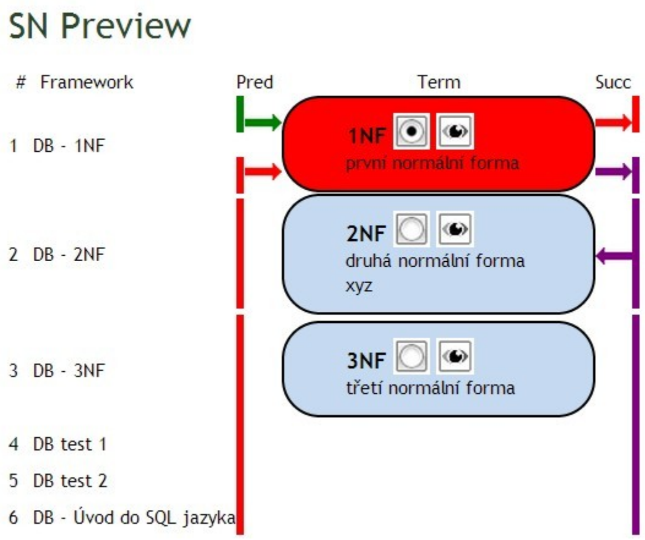

Fig. 1: Simple network of concepts between 3 concepts, the selected concept is 1NF, the concept 2NF is its successor (purple arrow on right)

The Fig. 1: from top to bottom shows the linear structure of the text, which corresponds to the fact that definitions are introduced gradually in (linear) text. In the left column, there are the names of frameworks, within a vertex, there are defined concepts with potential synonyms. On the right (predecessors and occurrences before) and on the left (successors and occurrences after) links of other frameworks are shown by edges with the selected term. In the SNT diagram there is a selected vertex marked in red (darker), the green edge (on the left above the selected vertex) represents the relationship isSuccessor and combines two concepts - the predecessor of the defined concept and the defined concept. In the Fig. 1:, the concept 2NF is the successor of the concept 1NF. The purple arrow (on the right under the selected concept) shows the relationship isSuccessor and combines two concepts – the defined concept and the subsequent concept. Other arrows are red colour and mark "suspicious" ties, i.e. successors used before the definition or predecessors used after the definition.

Icons in the individual ovals represent a selection of the current vertex (the icon with the target) as a selected and a preview of the particular layer (icon in the shape of the eye).

The Fig. 2: differs from the previous one by extended representation of occurrences of a selected concept in particular layers of the selected concept and other concepts. With occurrences, their numbers are displayed in the individual types of layers. By clicking on the occurrence of the term – a letter of the layer type on right in the diagram - a preview of the particular text of support is displayed.

Both diagrams include links to view the definition, selection / change of the current concept and redrawing the diagram, a preview of the definition, in the case of one occurrence in the particular context and in the layer – a preview of the layer with the occurrence of the selected concept. In the case of multiple occurrences - a list of occurrences with links to previews of the individual layers is shown.

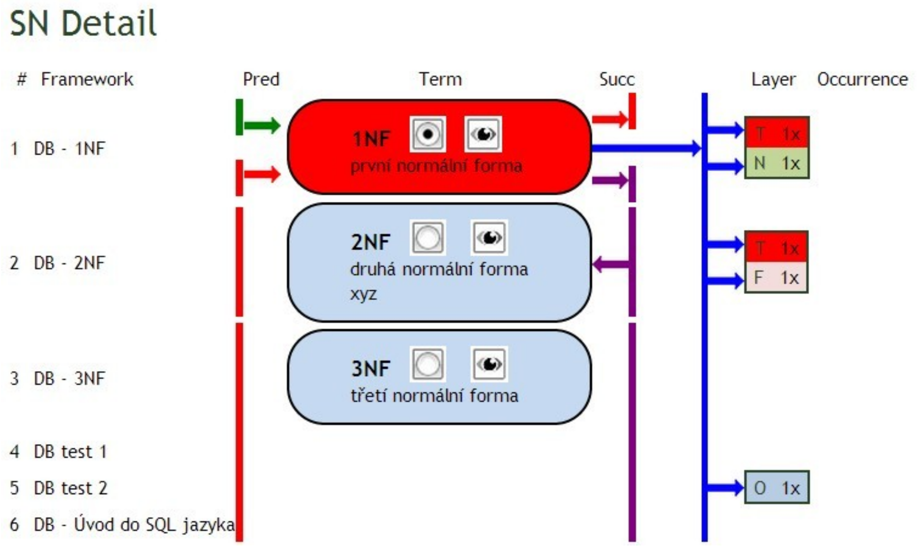

Fig. 2: SNT with occurrences of selected concept in framework layers

A preview of the individual layers has the same format as in the case of teaching the student, i.e. including the support structure in the left menu.

Discussion

Now we are interested in how pedagogical principles are reflected in the text support and how SNT can check the violation of certain principles. If SNT finds violation, it can write informative error message or warning message about a suspected error due to a breach of a principle. This notifies the teacher who can eliminate the errors on the basis of reports, or s/he can decide that the message is unjustified.

Pedagogical principles checked by SNT

Not every principle can be checked automatically. We present those which can be checked, and the way of checking them.

The principle of clarity - one of the most frequently cited of the student's learning characteristics is his/her sensory preference of perception and processing of information. Therefore, it is important that the author properly covers all sensory forms with options. This is partially solved by adaptive e-learning itself. Check by SNT - in case of the absence of presentation or test layers, or if the term does not appear in all presentation and test layers of the framework, an informative message appears, specifying which types of layers should be completed for the selected term.

The principle of orderliness and continuity - the principle: first the term should be defined, then used. Presentation should be complemented by practical examples. Continuity can be supported by adding information to the navigation layer for each lesson about the time required to study the lesson, about the knowledge acquired by the student after studying the lesson; the educator will also add information about further study in the navigation layer – the next week, in the next chapter, lesson, to motivate the student to continue in his/her study. In the semantic network, occurrences of the concept before the definition in the presentation and test layers are marked red as erroneous. If the term occurs, e.g. in a task or as a practical example before the definition of the term, it is necessary to move these in the author's text after the definition of the term. Conversely, if the concept occurs in a special layer before its definition, it is not a mistake - the author wants to highlight the most important concepts further discussed in the text. SNT shows a error message that the concept occurs before the definition, or the absence of special layers or examples from practice.

The principle taught from simple to more complex - this principle could be included in the previous point, but how this can be checked using the SNT. The teacher chooses the "cornerstones" - simple, familiar subject matter, and on this basis s/he builds more complex theories, procedures. Assuming that to acquire the knowledge of a complex concept, it is necessary to know more previously defined concepts, a preview of SNT of the selected term suggests its complexity according to a number by its predecessors, and it makes it possible to check that all predecessors are defined in advance. SNT stores information about the number of predecessors of each defined term. It can be checked whether the successor to the selected term has more predecessors than the selected term (understood recursively, including concepts hidden in the definitions of immediate predecessors). If not, it shows an informative message.

The principle of vigorousness and awareness - the teacher proceeds from the theory of motivation (ČÁP, 2007) and lets students study some parts of the curriculum independently from other sources in the form of separate individual tasks. Completed assignments may be disclosed and provoke discussion / chat among students. The text should include solved examples and case studies, as well as tasks for separate solutions including practical tasks. The target layer should contain information about the purpose of the particular part of the text and how to reach this goal. SNT highlights the possible lack of layers with examples, test layers and target layers and the individual layer to the individual concepts - the possible absence of the concept in these layers.

The principle of permanence - for the permanence of knowledge it is important to revise the subject matter frequently in different situations. In learning support it means using the terms also in other frameworks and their different layers, and in the following lessons. This can be easily checked by using semantic network - the term occurs in all types of layers of the particular framework and other frameworks of the lesson or the subject. Obviously, there should be a sufficient number of examples, questions and test questions. In case of failure to meet these requirements, an informative message is sent concerning a violation of the principles of sustainability and the reason for it.

The pupil has to be a teacher at the same time - the teacher should include a part in the teaching where each student will study separately, or presents to his/her classmates part of the subject matter - see the principle of vigorousness. Adaptive e-learning support includes layers with examples and tasks from practice. In the absence of the above mentioned layers, SNT shows an informative message. Obviously, a separate presentation of the student is not checked by STN.

Teaching should be fun - the teacher inserts various multimedia elements to e-learning support. The existence of multimedia - movies, videos, interactive features, etc. strongly supports this role of teaching. A suitable motivational layer can also support the interest in learning. SNT shows informative messages when there is no motivational layer to a given concept, or if there are not any multimedia elements - unfortunately, their contents are not checked automatically.

The principle of linking theory with practice - the text should include examples from practice and case studies and in the target layer it is highlighted, where new knowledge and skills can be applied. SNT only checks the existence of the above-mentioned layers, then displays an information message about their absence.

The principle of individual approach - individual approach to each student is guaranteed by the philosophy of adaptive e-learning itself, where the virtual teacher selects the optimum options and various sequence of educational strata. Obviously, each student can progress at his/her own pace. However, the author must ensure the existence of all kinds of options and layers for full coverage of adaptability.

The principle of emotionality - the existence of special layers has a special effect - when the student receives instructions in the navigation layer on how to proceed and what to expect, in the motivation layer he learns, for example, where he will apply the newly acquired knowledge, in the reference layer he learns about additional resources for the study, etc. SNT shows an information messages on the absence of special layers. Their contents, however, cannot be checked automatically.

The principle of feedback - the feedback is primarily provided by checking the knowledge acquired by the student. The support should therefore contain a substantial amount of test layers. In case of their absence, a message is shown.

The following principles cannot be automatically checked by SNT: **the principle of proportionality, the principle of comprehensive development of the student, the principle of scientism.**

Conclusion

The main objective of the research is to visualize the structure of the learning text in adaptive LMS using a semantic network of terms such as feedback for the author of the text. The draft version of SNT describes the author's text of learning support, concepts and their links within the text. These may not correspond to reality or pedagogical principles before the text is firmed up. SNT is supposed to help detect these deficiencies.

The introductory chapter outlines the context, which concerns the subject of the article. The first chapter lists the pedagogical principles that every teacher should know and use while creating learning support. The next part describes the structure of adaptable support and meaning of SNT in adaptive LMS.

The last but one part is a demonstration of practical solutions of SNT, it lists and describes functions and methods appropriate for the teacher to work with SNT, either in the form of tables or visual display of concepts and relationships between them.

The main part of the paper discusses the pedagogical principles, how these principles should be manifested in the text of support and how SNT can check the violation of these principles. The main output of SNT is to draw the author’s attention to any violations of universally applicable educational principles.

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SCRATCH AS A GLUE FOR FUNNY PROGRAMMING, CURIOSITY AND MUSIC CREATION

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Abstract

Scratch is a very promising constructionist environment enabling both learning programming in new more collaborative manner and developing creativity, curiosity, critical thinking. Thanks to Scratch portal more than 5.5 million shared projects are available and useful not only for their authors but also for many pupils, teachers, parents and others. This paper presents constructionist approach how to learn programming with the help of sounds and music with the aim to develop creativity, curiosity and critical thinking of pupils. The core of our methodology are 4 types of projects – motivational, bridging music and programming concepts, researching sound and musical abilities and music composition. These results are based on our experience in programming multimedia Scratch projects and also on teaching programming in Scratch for gifted lower secondary pupils and pre-service computer science teachers. In addition to creating and refining methodologies in Scratch programming we consider very important and crucial to spread them to computer science teachers and help them to exploit Scratch in the best possible way.

Keywords

Programming, sounds, music, Scratch, constructionism, teacher training.

Introduction

According to Seymour Papert (1993), people learn better through the active engaging in process of constructing artifacts shared with and be critiqued by other people. There are several followers of Logo culture supporting constructionist approach to learning, e.g. Scratch, NetLogo, SNAP!, App Inventor. Scratch is a very promising constructionist environment developed and managed by the Lifelong Kindergarten Group at the MIT Media Lab, led by Mitchel Resnick. Scratch enables youngsters – "digital natives" to be more digital fluent, to be not only digital consumers but also digital designers and creators. It satisfies a triplet of good properties for programming language for pupils – low-floor, high-ceiling, and wide-walls. Scratch developers follow three core design principles for Scratch: Make it more tinkerable, more meaningful, and more social than other programming environments. Thanks to the official Scratch website (http://scratch.mit.edu/) there is an online community of Scratchers, who share, discuss and remix their artifacts (interactive stories, games, animations, and simulations) each other. For educators there has been established an online community ScratchEd (http://scratched.media.mit.edu), where the educators share their ideas, teaching experiences, and lesson plans for Scratch (RESNICK, 2009).

In Slovakia there is not known any survey about using Scratch in primary and secondary schools. From Scratch web site with statistics (http://scratch.mit.edu/statistics/) we can find out only the number of Scratchers from Slovakia (total 2979 among 3.3 million people). There are known several web pages where teachers publish their Scratch projects and various teacher aids. At universities which prepare future computer science teachers are taught subjects regarding programming in Scratch, led PhD and diploma theses on teaching programming in Scratch, organized summer camps for pupils, children's universities, and workshops for computer science teachers from primary and secondary schools. In May 2014 Comenius University in Bratislava will organize new programming competition in Scratch called Scratch Cup (http://edi.fmph.uniba.sk/~tomcsanyiova/ScratchCup/) for lower secondary pupils.

In our faculty since 2012 we teach subject Children's programming environments with a predominance of programming in Scratch and App Inventor, organize children's university, summer camps, and computer science ring for gifted secondary schools pupils oriented to Scratch and App Inventor programming. We also prepare and refine methodologies on Scratch programming with various teaching aids and organize workshops for computer science teachers on teaching Scratch programming in the frame of Club of computer science teachers.

Due to the constant and rapid development of children's programming environments and also methodologies of their teaching we live in our permanent "beta" working life full of changes, learning from each other with joy (also from students) and showing our students not only how we teach but also how we learn and overcome problem situations. Many ideas about constructionism and inspiration for our teaching and learning we have acquired from reading the papers of the important constructionist authors in journals and conferences (e.g. ICTE, ISSEP, Constructionism) and also from discussions with Ivan Kalaš and his colleagues from Comenius university in Bratislava. Another source of good teaching practices and learning ideas are the papers on the inquiry based learning and discussions with methodologists of science from our faculty participating in 7FP ESTABLISH (JEŠKOVÁ, 2012). These ideas we apply to our teaching and share in the mentioned target groups what enriches both sides.

Learning programming by sounds and music

Related works on learning programming by sounds and music

Ideas about the teaching of programming with the help of sounds and music we can find in several publications. Erich Neuwirth introduces in (2007) his toolkits for making music with Logo and also MS Excel and compares music representation in these different environments. Peter Tomcsányi describes possibilities of using speech input and output in Logo programming (2001). Michael P. Downton with his co-authors describes in (2010) their study how children develop musical understanding through cross-cultural activities composing music using Impromptu environment developed by well-known MIT researcher Jeanne Bamberger. Wallace Feurzeig and Eric Neumann describe in (2010) the design of a software environment SoundLab and a set of laboratory tools enhancing students learning through hands-on explorations, investigations, and research projects in the domain of musical acoustics. Viera K. Proulx describes in (2010) new library that allows the beginner Java programmer add musical background and sound effects to their games. For computer music composition Victoria Hart's paper (2009) describing connections between mathematical and musical symmetry is very inspirational. Gerhard Nierhaus's book (2008) brings detailed overview of prominent procedures of algorithmic composition in a pragmatic way (Markov models, generative grammars, transition networks, chaos and self-similarity, cellular automata, genetic algorithms, neural networks and artificial intelligence) for math enthusiasts.

Our approach to learning programming in Scratch by sounds and music

In our methodology we follow several learning objectives:

- to understand commands in Scratch for playing sounds (e.g. play sound, play note, play drum, rest), setting and getting sound parameters (e.g. instrument, volume, tempo) and to apply them for programming of sound and music projects,
- to strengthen basic programming concepts (e.g. variables, loops, branching, procedures, lists, recursion, concurrent execution of code, broadcasting),
- to develop musical skills and creativity of pupils by creation of useful and valuable musical artifacts,
- to develop inquiry skills and understanding of basic concepts of physics, music, languages by development of tools in Scratch for data visualization and audialization,
- to learn more about pupils' abilities in perception and making of sounds and music,
- to develop communication and team skills, thanks to publishing, commenting, sharing and remixing projects in Scratch community.

The mentioned objectives can be achieved by:

- inducing creative, open and pleasurable atmosphere in a class, where pupils can solve their own problems with none or little help from a teacher and discuss freely,
- preparing collections of interesting and valuable projects which are suitable for ordinary pupils not only for audio and music enthusiasts,
- preparing various types of teaching aids, e.g. motivational video, stories and ready-made projects, half-baked projects (for further completion by pupils), worksheets,
- using heuristic dialogues which support pupils' understanding of subject matter and also their inquiry skills,
- establishing of Scratch studios on Scratch portal where teacher and pupils can publish, comment and remix projects with sounds and music.

Collection of Scratch projects using sounds and music

The core part of our methodology is a collection of projects, part of them are published and shared at Scratch portal in our studio Let's do music (http://scratch.mit.edu/studios/274071/). These projects cover one or more of the following aspects:

- motivation to make sound and music projects (demonstration of ready-made projects with sounds and music and creating own initial simple projects),
- discover analogy between programming and music (use ready-made or half-baked projects),
- inquire of pupils' abilities in perception and making of sounds, tones, rhythms (utilize ready-made or own projects),
- musical and programming creativity (presentation of own programmed music compositions).

Motivational projects

For good motivation we recommend to use following types of projects:

- Animated and musical greetings cards, e.g. Christmas greetings with own animation and own three-voices singing of a carol (http://scratch.mit.edu/projects/16003087/). Other alternatives of greeting cards can be Mothers' day, Valentine's Day, Easter.
- Jokes and stories, e.g. animated and spoken joke about enteritis (http://scratch.mit.edu/projects/13874460/) or animated and spoken Aesop fable about a sick donkey and wolf (http://scratch.mit.edu/projects/13873580/).
- Multimedia dictionary, e.g. touching and speaking dictionary of fruit and vegetables with the support of Makey-Makey (http://ics.upjs.sk/~snajder/scratch/slovnik/) – solution and working files (sounds, pictures, half-baked project). Programming of the project by a pupil and students you can see on fig. 1.
- Musical instrument, e.g. piano with three way of control – keyboard keys, mouse and webcam (http://scratch.mit.edu/projects/13854802/). Dual displaying of piano player and piano keys you can see on fig. 2. With Makey-Makey we can build alternative musical instrument on a sheet of paper with "keys" drawn by pencil or simply using hands of our friends.

Fig. 1: Touching and speaking dictionary of fruit and vegetables (left – nine year old programmer from Košice, right – university students from Liberec).

Fig. 2: Piano with three way of control – piano keys are displayed with piano player in a style of augmented reality.

For creating initial simple projects we recommend to choose some of the following types of projects:

- Multimedia visit card (dancing avatar with speaking bubbles, image background and music picked from the built-in multimedia library and then using of own picture from web-cam, own image background painted in the built-in graphical editor and own sounds recorded in the built-in sound editor).
- ZOO (clickable animals with costumes and sounds from the built-in multimedia library).
- Multimedia encyclopedia of musical instruments (clickable pictures of well-known and also exotic musical instruments with their sounds).
- Jukebox (music box with favorite folklore or classics or own original songs).

2.3.2 Projects bridging music and programming concepts

Can you see any analogy between music and programming, music notation and program code? Can you see any programming concepts on fig. 3?

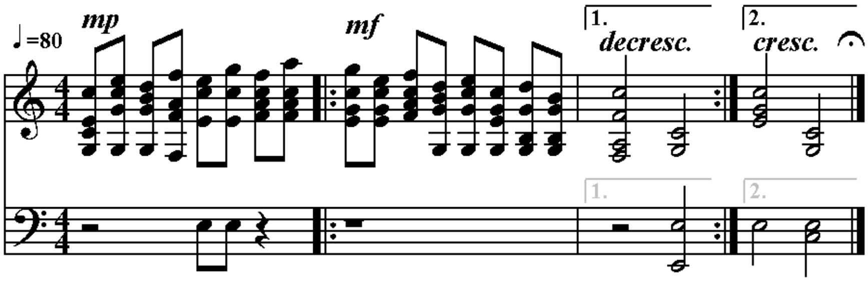

Fig. 3: Music notation of a singing warm-up with additional harmonization.

You can find example pairs: playing chords – threads (parallelism), sequences of notes – data structure list, repetition of notes – loop, prima/seconda volta – branching, etc. In written form of songs we can recognize another nice pair: song refrain – procedure.

The well-known number songs (e.g. Ten Little Indians, Ten Green Bottles, Five Little Monkeys) are good not only for kindergarten children but also for programmers for training of pattern recognition, using loops, discovering some kind of data compression. Good example of infinite song with finite notation is “Byl jeden Číňánek”, which can be described in the form of infinite tail recursion.

For better bridging of musical and programming concepts we recommend using some of following projects:

- Karaoke of a children song (http://scratch.mit.edu/projects/2669976/) – procedures.
- Jingle (http://scratch.mit.edu/projects/13870063/) – parallelism.
- Colored rock-n-roll (http://scratch.mit.edu/projects/13844664/) described on fig. 4, visualized own song in style of toccata (http://scratch.mit.edu/projects/13845210/) – loops, lists.
- Singing binary tree (http://scratch.mit.edu/projects/13811131/) – recursion.

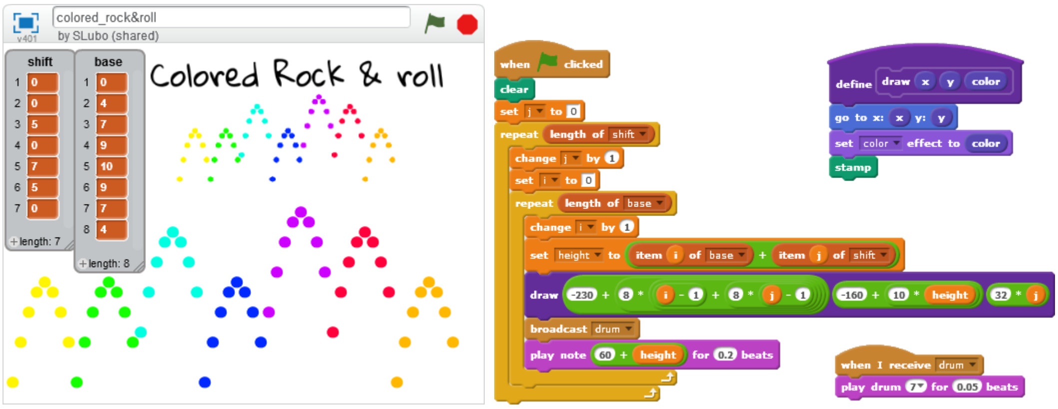

Fig. 4: Rock-n-roll described as a structure with two lists (base, shift) which can be played and visualized too.

Fig. 5: Audialization of recursive binary tree drawing.

Sound and musical abilities research projects

What is my vocal range? What is my sense for rhythm? What loudness level from surrounding environment is even acceptable for me? How can I warm-up my voice before singing? These or similar questions regarding detection and improvement their sound and musical abilities can be posed by curious pupils and also by teachers.

Pupils can find answers for these questions by scientific inquiry supported by the ready-made audio software (JEŠKOVÁ, 2012) or by programmed own software tools (ŠNAJDER, 2011). Teachers can improve pupils' inquiry skills by well-chosen topics for inquiry and by just-in-time questions and answers.

We suggest a set of projects which can be helpful in the study and improvement of pupils' sound and musical abilities:

- What is your vocal range? (http://scratch.mit.edu/projects/13834859/) – measuring of a vocal range. (See on fig. 6)
- Vocal warm-up (http://scratch.mit.edu/projects/13847549/) – warm-up training of a voice.
- Sound pexeso – matching pairs of notes with equal pitch.
- Sound quizzes – measuring and training of recognizing note intervals, type of chords.
- Rhythmic clapping game – measuring and training of sense of rhythms.

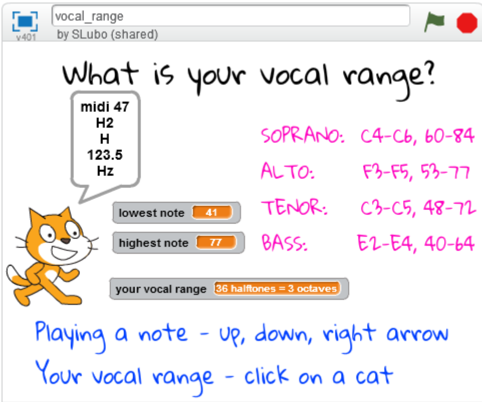

Fig. 6: Measuring a vocal range and assign it to some of listed types of singing voices.

Music composition projects

Some pupils and also teachers can join programming and music composition creativity and create songs with the help of programming, e.g.:

- 5-voices song (http://scratch.mit.edu/projects/14862688/) described on fig. 7. – song with 5 harmonized voices which can be selected for playing.
- Jingle (http://scratch.mit.edu/projects/13870063/) – midi-like composition with 1 leading melody and 3 drums.
- DJ (http://scratch.mit.edu/projects/17104777/) – song with 4 scratching sound effects.

Fig. 7: Song which can be played by some of chosen voices. Thanks to binary numbers we can play this song with total 2^5-1 combinations of singing voices.

We can program a random music composition using some mathematical rules from the simple one (e.g. random playing of selected small set of notes) to more sophisticated which can be found in (NIERHAUS, 2008). To each song we can add animated graphics and thus create animated music clip. Cloud nature of the Scratch portal enables to create collection of cooperative and collaborative musical compositions, e.g. in the frame of our studio Let's do music (http://scratch.mit.edu/studios/274071/).

Conclusions

There are many programming paradigms, environments, and also approaches to teaching programming. Our methodology of teaching programming with the help of science and music covers not only development of programming skills, but also musical creativity, inquiry skills, deeper conceptual understanding, self-knowledge, social skills. New programming environments like Scratch are very demanding for teachers and teacher trainers who have to learn new programming language, prepare collections of problems and teaching aids in short period. Therefore, we create and refine our methodology in design cycles – studying, programming, preparing teaching aids, teaching, discussing and publishing results. Very important for us is the cooperation with in-service computer science teachers who review our methodology and give us feedback from their teaching. We present our results to in-service teachers and teacher trainers in educational conferences (e.g. ICTE, DidInfo, ISSEP), seminars (Club of computer science teachers in our faculty), teaching stays (e.g. in Radom, Prague, Liberec).

We are going to elaborate our methodology in more detail and refine it with deeper cooperation with the secondary school teachers who are our partners in the project APVV-0715-12.

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ENTROPY

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Abstract

The article states reasons for introducing entropy *S* in physics teaching into secondary schools in the Czech Republic. The article provides basic information on entropy information in modern information theory. It features examples of linking physical entropy *S* in other subjects than physics in secondary schools in the Czech Republic. On the basis of a teaching experiment, in which 136 students from primary schools in the Czech Republic participated, and which was held in 2009, the lesson scripts were adapted for students of the 2nd year of secondary school. The article is published in its final version. The aim of the teaching scripts for Entropy lessons was to put in place a physical quantity of entropy *S* on the basis of events that students are surrounded with, and that would reflect the political and economic changes in the world. The result of the teaching experiment was that entropy *S* can be introduced into the teaching of basic physics at schools. At present, it appears preferable to introduce entropy *S* into the teaching of physics in secondary schools. The use of the Socrative 2.0 application is a part of the script. It is possible to create questions in advance that will be answered by the pupils in class on their tablets.

Keywords

Entropy, change entropy, equilibrium state, secondary education, scripts for teacher education in physics.

Introduction

In the Czech Republic, it is not part of the curriculum, or physics textbooks for primary and secondary schools, for there to be a physical quantity for entropy *S*. Entropy *S* is a state variable. Among state variables are also the thermodynamic temperature *T* and internal energy *U*. Heat *Q* and work *W* are procedural variables.

After didactic analysis of textbooks in the Czech Republic, it was found that in primary schools, the majority of thermals are explained by the use of heat *Q*, thermodynamic interior temperatures *T,* and internal energy *U*. This approach is based primarily on historical developments and discoveries in thermals. At secondary school, in thematic sections and molecular physics, an important role is played by work *W* in thermodynamics. Entropy *S* is placed in this context, although its importance extends to other science subjects, and even our daily life.

Theoretical bases: Entropy and information

In 1948, Claude Elwood Shannon published the article "A Mathematical Theory of Communication". The article introduced information entropy. His model is considered the "mother of all models" and is a part of modern information theory. The practical results of the theory information can include lossless algorithms such as ZIP, loss compression algorithms, e.g. MP3 (Wikipedia, 2013). A number of publications have been written about information entropy. In the article, we refer to three articles in which the authors put in perspective entropy, physics, modern theory information, and education (Ben-Naim, A., 2012), (BR Frieden, S. Luo and A. Plastin, 2007), (Singh, V. A., P. Pathak, and P. Pandey, 2009).

In the article (BR Frieden, S. Luo and A. Plastin, 2007), the authors asked a fundamental question: "How can the teaching of physics be improved in this information age?" And the answer: "We propose a direct answer: Formally introduce the concept of information, in its various quantitative forms, into introductory physics coursework. That is, augment the "physicalist" viewpoint of today's physics curriculum with the knowledge-acquisition viewpoint of information theory."

Entropy S is a physical quantity which "allows the mathematical formulation of the second thermodynamic principle, and thus to quantify the condition for irreversible processes" (Mechlová, E. and K. Košťál, 1999, p 243). "Entropy S can be defined from two perspectives, and these are thermodynamically (definition ΔS), or statistically, for example with the Boltzmann relation.

Materials and methods: Entropy in teaching in the Czech Republic

The physical quantity entropy S is introduced into physics courses at universities. Students, however, can already come across this in some secondary schools in the classroom (Jelinek, J. and V. Ticháček, 2002) and in chemistry (Břížďala, J. and al., 2012). Specifically, in the textbook (Jelinek, J. and V. Ticháček, 2002), on page 346 in the subsection titled "*The thermodynamics of living systems"* and on page 363 "*Using the theory of thermodynamics in ontogeny and phylogeny"*. The portal EChemBook.eu shows the following information: "*The multimedia chemistry textbook*" is a Czech educational portal, which provides a comprehensive overview of the secondary school chemistry curriculum. The authors explain entropy S in the section *General Chemistry in chapter 6 Thermochemistry,* in chapter 6.1 *Fundamentals of thermodynamics*, and in chapter 3.2 *The second law of thermodynamics*. Entropy S is explained without the use of mathematical tools.

In addition, this physical quantity is used by sociologists and economists. The concept of entropy S can also be found in the publication (Plzák, M., 2002).

Results: Research on the introduction of entropy into primary and secondary schools

In the Czech Republic, the aim was to introduce entropy in physics teaching at secondary schools (Prokšová, J. and J. Obdržálek, 2007). Further research regarding the introduction of entropy into the teaching of physics at primary schools (Kubincová, L., 2009) was carried out in 2009. A total of 136 primary school pupils participated in the pedagogical experiment, which took place at three primary schools. The aim of the experiment was to introduce into the teaching of physics at the primary schools the terms "reversible" and "irreversible process", the physical quantity of entropy S.

Results

Based on the results of the pedagogical experiment, it showed that it is advisable to introduce the concepts of reversible and irreversible process in primary schools. The physical quantity of entropy S is appropriate for attempting to introduce the teaching of physics in schools. We present a script for a physics class for the introduction of entropy to the second year pupils at secondary school. Biologists generally explain the imbalances as a peace arrangement, therefore, it is designed to bring about change in ΔS entropy from a statistical point of view. Some authors define the entropy change ΔS as a measure of system disorder, e.g. (Dvořák, D., 2004).

It is not possible to recommend the introduction of the latest formulation of entropy change ΔS, because during the interpretation in the pedagogical experiment, it showed that students associate the term with disorder of internal energy U, and they confuse the entropy change ΔS with a change in internal energy ΔU. It proved more suitable to explain entropy S to students on the basis of its "properties" in an isolated system.

a) Cross-curricular links

In that script, the lesson emphasis is placed on the student experience. Examples and thought experiments are based on the daily life of students. The lesson script was designed to show the link between physics and other subjects. In the following lesson, physics was linked with civics, history, and economics. An integral part of the class is a discussion in such a form that first the students discuss in pairs, and then they present their findings to the teacher and their classmates.

In the Socrative 2.0 application, the teacher prepares 4 questions in advance that will be answered by the students during the class. It is also possible to use a quick vote in the application. The application may be used with tablets, smartphones, or laptops.

b) Entropy lesson script

The Entropy lesson script includes physical concepts that are explained in the textbook (Bartuška, K., 1994). The script can be integrated into teaching after discussing the second thermodynamic law. During lessons, the pupils and the teacher use ICT.

The student should know the following terms, and show examples of those concepts in practice: thermodynamic temperature t, change of thermodynamic temperature Δt, the equilibrium state, the equilibrium state of the system as a state with the highest probability of occurrence, isolated systems, thermodynamic system.

Terms that the student will become familiar with in the script: entropy S, entropy change ΔS, growth of entropy S.

Lesson objectives: the student should be able, for processes that are familiar from everyday life, to determine whether the entropy changes or remains constant.

Teaching methods: Method of problem interpretation.

Organizational form of teaching with respect to the student's personality: mass education, work in pairs, or group lessons.

Organizational form of teaching according to the nature of the learning environment: classroom teaching, work in pairs, or in groups.

Material didactic resources: School tablets, internet access, the Socrative 2.0 application.

Comment: Prior to the class, the teacher creates a room with open-ended questions, using the Socrative 2.0 application at: http://b.socrative.com/login/teacher/. The instructions on how to work with this application may be found at: http://www.socrative.com/features.php. The teacher sets the test in such a way that a pupil needs his approval to continue to the next question. The questions suitable to be entered into the Socrative 2.0 application are listed in the script. They come with instructions on how the teacher should enter them into the application, and one correct answer is offered. Because there may be more correct answers, it is necessary to have a discussion with the pupils, and stress the fact that the teacher wants to know their opinion, and that every opinion is is important.

Course schedule:

Experiment: The teacher holds keys in his hand. He asks the students: “What will the keys ‘do’ if you hold them in your hand, and you drop them?” The students answer “They fall on the ground.” Teacher: “Now, let's try it.” He lets go of the keys.

Teacher: “Yes, you're right. I’m sure you all remember how it smelled in your home when your mother and grandmother were baking Christmas biscuits. When your mum took the biscuits from the oven, the aroma of the biscuits spread throughout the whole flat. Now you may say, why is the teacher asking about this, when it is something that even a small child knows. All the above processes are carried out only in one direction, and therefore are irreversible processes.

Teacher: “We may describe all listed processes using a physical quantity called entropy *S.* We consider entropy *S* as the "arrow of time." (Halliday, D., R. Resnick and J. Walker, 2000, p.553)
“From a statistical point of view, it transitions from a state with a lower thermodynamic likelihood to a state with a greater thermodynamic likelihood, viz the Boltzmann relationship (Mechlová, E. and K. Košťál, 1999, p 243).”

Teacher: “Think about the two previous examples. The first example: I let the keys fall to the ground. We could make a line in the air through which the keys fell, and mark points along the way. They agree that the key passed through the point with the smallest probability to the point of most likelihood i.e., when they fell to the ground and remained still. In advance, you assumed that they would fall. Their movement ended in the most likely spot.

Every point on the line is assigned a value of entropy. The smallest entropy will be held by the keys at the moment when they are released. It is very unlikely that they will hang in the air. During the fall, entropy *S* of the keys will increase until they reach the ground. At that point, they will have the biggest entropy *S*, because it is a place where they will most likely be located. Entropy *S* will be maximal, because the keys will be in a steady state.
The second example: My mother took the biscuits out of the oven, and the smell of the biscuits is beautifully spread throughout the flat.

The aroma can be smelled throughout the flat. Also, smell passes from a state which is less likely to a state with the highest probability. It has never happened to you that the aroma just stayed around your mum, and you didn’t smell it in the living room. The smallest entropy *S* will be for the aroma when your mum opens the oven, and the smell spreads around. The largest entropy *S* will be at the moment when the aroma of the biscuits can be smelled throughout the flat.

When describing a process, of course, it seems that the system (in the first case, the keys and the ground, and in the second, aroma of biscuits at home) is initially in a state with a lower probability, and continues to a state which is more likely, to a situation where the system is the most likely state, and has the largest entropy. If the system is in the “most probable state”, this state corresponds to the equilibrium state, and in this state, entropy *S* is already the largest and cannot grow further.

Comments for teachers: “In isolated systems, only those processes run in which entropy increases, entropy growth stops, reaches the isolated system equilibrium, which is characterized by its maximum entropy under the given conditions (Mechlová, E. and K. Košťál, 1999, p 243).”

Comment: The teacher enters question Nos. 1-4 into the Socrative 2.0 application. First he asks the pupils a question, the pupils may discuss it in pairs, and then each student must answer the question in the system. We recommend using tablets. The teacher asks four pupils to answer the question, and then he says the correct answer and explains it. This way, he discusses all four questions one by one.

Teacher: Think about the example with the keys. How would the keys have to behave so that the entropy *S* would be decreasing? Discuss it in pairs, and type in the answer into the Socrative 2.0. application at: http://b.socrative.com. Once you answer the question, we will discuss the answer.

Comment: The teacher says the number of the room into which the pupils have to log in.

Question 1: How would the keys have to behave so that the entropy *S would be decreasing*?

Correct answer: When the keys fall to the ground and they return to their original state themselves. The entropy *S* will be decreasing from the moment the keys themselves leave the ground. Note: Such a situation can never occur in the real world.

Question 2: How would the smell of cookies have to behave in a room so that the entropy *S* would be decreasing?

Correct answer: The smell of cookies would have to go back into the oven.

Question 3: When is the entropy *S* of the falling keys constant.

Correct answer: When the keys fall to the ground.

Comment: The only possible correct answer.

Question 4: When is the entropy *S* of the smell of cookies in a room constant.

Correct answer: When the aroma may be smelled throughout the flat.

Comment: The only possible correct answer.

As for the irreversible processes, people are interested in entropy changes ΔS, which describe the state of the system at the start of the event and at the end of the event. You have already dealt with the change in temperature Δt, the change of internal energy ΔU, or the change of kinetic energy ΔE_k. "

Teacher: “Give me an example of how to calculate the temperature change of a system, such as water in a beaker.”

Student: “The change of temperature, calculated by measuring the temperature of the water at the beginning, before it starts to boil, and when it boils. The difference in temperatures is the change of temperature Δt”

Teacher: “The entropy change ΔS is also the entropy difference ΔS. Maybe some of you think it is clear, so why am I teaching it? Now we will consider some more complex situations.”

Question for students: "Have you ever been to a football match? Describe how fans can behave during the match. Discuss in pairs. "

“Let's analyze situations that may arise. Before the start of the match, the spectators are sitting on their seats, chatting, and waiting for the match. If it is a game that has a larger attendance, part the audience stands, and their behaviour is normal.

On the arrival of the players on the field, some of the fans perform a “Mexican wave”, other fans join them for some time, get bored, and turn back to behaving the same as before the game.

After the first goal, a small group of "hooligans" throw cans on the pitch. The police arrest them and take them away. The football match continues. After the match, the audience, accompanied by the police, leave in a peaceful manner.

Imagine, however, that after the first goal another situation occurs. In addition to the "hooligans" throwing cans on the pitch, they begin throwing them at the fans of the second team. They, of course, don't just sit there and take it. Because the police are between the two groups, there is a physical conflict between the police and the fans. The police can't control the situation, so "Chaos" reigns at the stadium. The organizers are forced to end the match.

A state of equilibrium

"Physically, we consider the stadium with its visitors as a set. Before the match, the system is in a state of equilibrium. When the players came onto the field, the spectators began doing the Mexican wave, observable behavioural changes that we consider deviation occurred in the audience.

After a while, the audience become bored with the "Mexican wave" and return to its original behaviour. The set returns to the equilibrium state, or **to a state of equilibrium**.

After the first goal, we described two situations. The first possibility can be explained as in the "Mexican wave", the police managed "hooligans'" conduct, and the rest of the audiences behaved the same as at the beginning of the match. The set returned to equilibrium. The second option is more interesting. There was a change in the behaviour of the spectators, who did not behave the same as at the beginning of the match. The system became unstable. **Audience behaviour is markedly different from the original behaviour of the set, skipping to a new equilibrium**.

Entropy and its application not only in physics

Teacher: "Now you may wonder if we can predict whether the police can handle such situations or not. The answer is: Yes, we can, using **entropy and entropy changes**. "

Comments for teachers: In social systems, the focus is on the production of an entropy system, i.e. the change in entropy over time *t*. We will therefore mainly concentrate on the increase of entropy.

Teacher: "If the organizers and the police closely monitor the behaviour of fans during a match, they can assume how the match will develop. Some changes are more likely to occur, and some less, thus introducing a new physical quantity of entropy.

In the case of stadiums in the Czech Republic, organizers and the police work according to their previous experience, but in the case of e.g. stadiums in Pyongyang, the capital of North Korea, which has a capacity of 150,000 visitors, it is necessary to have models that simulate the behaviour of visitors. Stadiums, from a physical point of view, can be considered as a system, and visitors as particles, and then we **can very simply say** that the state of the system can be predicted by monitoring changes in the system. Models that simulate the behaviour of crowds are also created for enclosed spaces, such as the underground."

Questions for students: "Give an example of when the disintegration of the state resulted in civil war. Provide an example of when the disintegration of the state **has not resulted** in civil war. Discuss in pairs. You may use the internet."

"After 1989, many states in Europe broke up. The worst situation occurred in the Balkan.

Peninsula, where the crisis resulted in civil war. We know that not every division of the state was accompanied by armed conflict. An example is the division of the Czech and Slovak

Federative Republic (Czechoslovakia), the creation of two separate states: the Czech Republic and Slovak Republic.

Even the rise and fall of states can be anticipated by monitoring changes in entropy in the system."

Teacher: "Look on the internet for when the division of the Czech and Slovak Federative Republic (CSFR) was." Student: "1st January 1993".

Teacher: "Another application of entropy can be found in the economy, if we want to know if a company can solve its financial problems or go bankrupt. Of course, your task is not to foresee these situations. The aim was to get an overview of where all this is a physical quantity application, and understand its importance not only in the field of physics."

The teacher distributes the tasks among the students. The tasks can be solved by students in pairs, using the Internet.

Tasks:

1. Provide an example where the organization of the company "jumps" to a new state of equilibrium.
2. When does entropy *S* stop growing?
3. Provide examples where some states in Europe have solved the financial crisis within the last six years. Find them on the Internet.
4. Provide a link between "financial collapse" of the state and equilibrium of the state.

The teacher projected the tasks on the board, and calls on each pair. Neither the teachers nor the students interrupt their classmates when communicating the results of the tasks.

Discussion

The aim of the script was to show that the physical quantity, the entropy, is not as difficult for the pupils as it might seen at first glance. The script of the class: *Entropy,* introducing a new physical quantity, the entropy, to the pupils in the physics class at a secondary school. The script was applied during the teaching of physics at a primary school during the pedagogical experiment in 2009. Pupils around 14 years old participated in the experiment. Based on the results of the pedagogical experiment, the script was modified for 16-year-old secondary school pupils. At the same time, the script reacts to the changes in the Czech school system and work with tablets, as well as the Socrative 2.0 application being incorporated into classes.

Conclusion

In the current education system in the Czech Republic, entropy *S* in the teaching of physics can be recommended for introduction first to secondary schools for pupils approximately sixteen years of age. In physics courses at university, state the connection between entropy in physics and in modern information theory. The contribution of the use of the Socrative 2.0 application in the mentioned script can be summarized in three points: 1. All pupils will participate in class. 2. The teacher gets immediate feedback, and gains an overview of pupils' misconceptions. 3. When using this application, the teacher and the pupils can both see the results of the test with the highlighted correct and incorrect answers. Pupils' consolidation of the gained knowledge and removal of the incorrect of the incorrect misconceptions occurs..

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IMPLEMENTATION OF COMPUTER MODELING IN PHYSICS EDUCATION

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Abstract

The fast development of digital technologies and results of pedagogical research results in implementation and use of computer-based laboratory tools in order to support inquiry-based science education. The integral part of science as well as science education is experimentation; however it is always complemented with modeling that leads to creating theory to describe observed objects and phenomena. The contribution analysis mathematical modeling of physical phenomena with the help of computer tools with emphasize on dynamical modeling in text or graphical mode. The analysis is carried out with regard to high school teachers and their students as well as University students. The important assumption of successful use of modeling is a teacher educated in this field who is able to implement computer modeling into teaching. The existing teacher training course Active inquiry in computer-based laboratory involves also modeling of scientific processes and phenomena. A group of teachers have participated at the course and their attitudes and skills in modeling have been analyzed. The dynamical modeling was implemented at high school as well as at introductory physics course at University level. The experience and results gained from the implementation is presented and analyzed.

Keywords

Modeling, models, physics education, teacher training

Introduction

Nowadays we experience very fast development of digital technologies that surround us in everyday life as well as at school and at work. We can hardly imagine our life without a computer, smartphone or tablet. Pupils at schools are often better educated in the field of these technologies than the adults are. They can handle these tools easily and they often use them more than we would like them to do. Nevertheless, their powerful properties can be utilized in education and in science education, in particular. For science education, there are many tools available that support the experimental as well as theoretical nature of science. Dataloggers complemented with different sensors can collect experimental data; educational software enables to process and analyze them and there are also modeling tools available that can help in developing models and theories of scientific phenomena and processes. Computer modeling tools can help a great deal in creating mathematical models of simple or even more complicated phenomena and simulate them under different conditions that even students with high level of skills in mathematics and physics would not be able to create and analyze using just a piece of paper and pen. Nevertheless, the implementation of computer modeling into physics education comes across many problems connected with teachers who are usually not educated enough in this field and students who has a lack of mathematical skills for reasonable use of these tools.

Mathematical modeling

The word model can be understood in many different ways. Asking about models in physics, there would be certainly the Solar system model, four-cycle engine model or model of atom mentioned or we may hear about ideal gas or fluid model. There can be found some common features of these examples that make them to be a model. In general, physicists share several common ideas about models (Etkina et al., 2006):

a) A model is a simplified version of an object or process under study, a scientist creating the model decides what features to neglect,

b) A model can be descriptive or explanatory, explanatory models are based on analogies – relating the objects or process to a more familiar object or process,

c) A model needs to have predictive power,

d) A model´s predictive power has limitations.

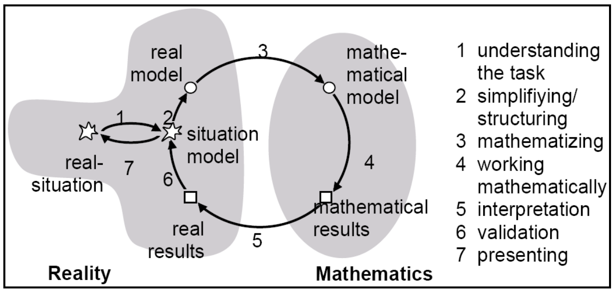


Fig. 1: Modeling cycle of Blum & Leiß (2005).

Models can be classified according to different criteria. When we try to quantify models of systems and processes, we usually get to mathematical expressions presented usually in the form of equations in which each parameter corresponds to a physical quantity describing a certain property of the system or interactions. Such mathematical models are usually represented in a form of equations and graphs. When solving mathematical equations, calculations can be carried out with the help of computer software. Generally, there are can be two approaches used, i.e. statical modeling when the result of equations´ solving is known and computer creates a graphical representation of modeling phenomena based on the mathematical function. On the contrary, dynamical modeling can be used when we (students) are not able to solve the equation (differential equation) and the calculations are done stepwise with a constant step. The process is iterative, it is repeated many times in order to obtain values for the variables. During the interval usually corresponding to the time-step, the values of variables are assumed not to change. As a result of this simplification we get approximation that's accuracy increases if the time-step is sufficiently small. Current powerful computers enable to carry out large number of calculations very quickly and so that we can get the accurate approximation in a reasonable time. This way even high school students can solve quite difficult problems that they would not be normally able to solve based on their mathematical knowledge.

In the available modeling software (e.g. Modellus, Stella, MS Excell, COACH) static and dynamical models can be developed. The COACH 6 system supports modeling in text and graphical mode (fig.2). The text mode is based on equations for calculation of the model variables according to the selected iteration method. In the graphical mode the variables are represented by a graphical symbol. In fig. 2 there is a dynamical model of a parachute jumper with the changing value of total force acting on him during the fall. This is a typical example of realistic motion; however high school students may describe the motion under the changing force intuitively, but the exact mathematical description is not possible at this level. As it can be seen from the dynamical model, the instantaneous acceleration is calculated from the 2nd law of motion. The velocity v (flow_1) and acceleration (flow_2) are considered to be constant over the time-step *dt* and the values of position, velocity, total force are calculated over these small time periods resulting in good approximation of motion.

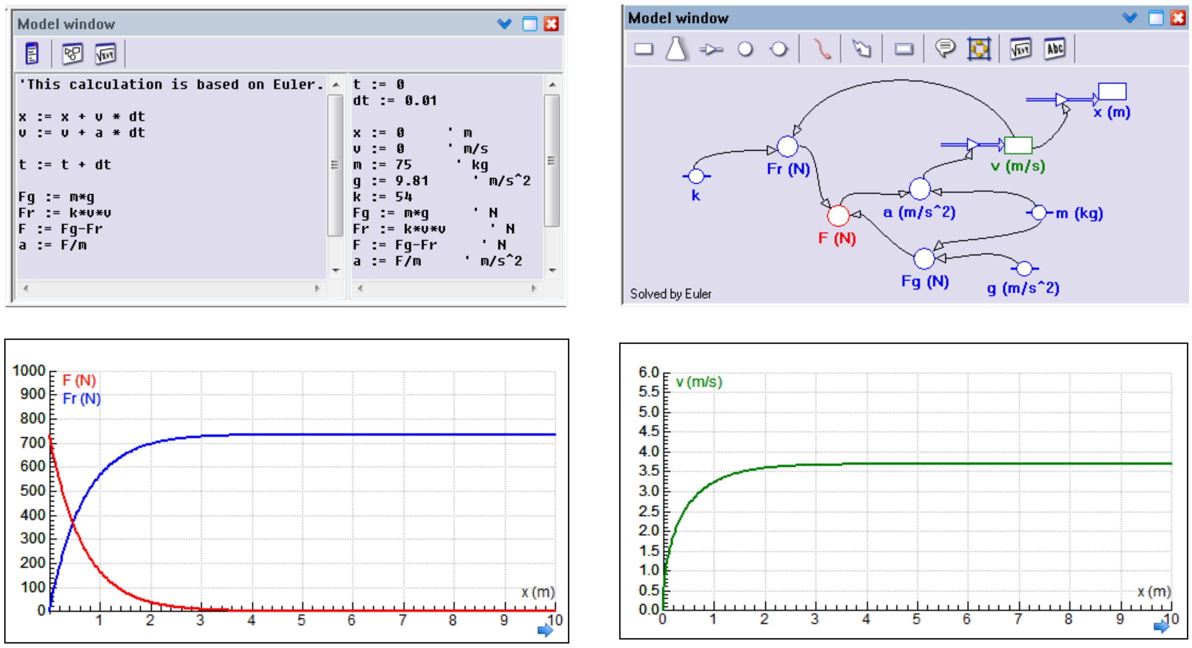


Fig. 2: Model of a parachute jumper in graphical and text mode with corresponding force vs. time and velocity vs. time graphs (COACH6)

Teachers and modeling

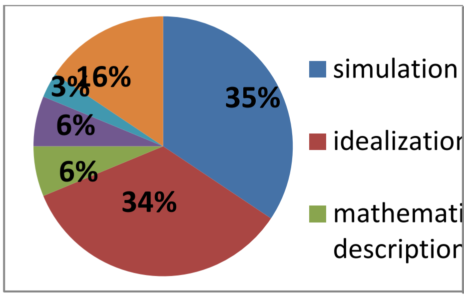
Successful implementation of modeling into teaching depends a great deal on how teachers master the modeling process. Most teachers who graduated long time ago have almost no experience with this method. In order to educate teachers in the field of innovative teaching methods we have developed a teacher training course that took place at Faculty of Science, Pavol Jozef Šafárik University in spring 2013 (Establish teacher training course on integration of ICT in IBSE, Establish project, Sails project). The course main goal was to educate teachers in the field of the use of digital technologies to enhance inquiry. The course involved five modules, i.e. datalogging, processing and analyzing data, videoanalyzing and modeling tools and implementation of these tools into education.

Teachers attitudes towards modeling

In spring 2013 we carried out a research on modeling and its use at secondary schools´ physics lessons. There were 32 physics teachers who answered a questionnaire and most of them later took part at the teacher training course Active inquiry in computer-based laboratory. One of the first questions concerns the description of scientific approach in four key words. The answers are presented with the help of word cloud. The greatest prominence is given to the word Experiment. However, we were wondering about the position of the word Modeling. This word appears in the cloud, however with quite a small frequency.

Fig. 3: Word cloud – Key words typical for scientific approach to problem solving

The other questions concern what teachers think the model is (fig.4) and what computer modeling means. In the latter question 16% of teachers were not able to describe what computer modeling means while for the rest 84% it means simulations. Considering the use of computer modeling there is only 1/3 of teachers who have ever used modeling like simulations and applets in the class (fig.5).



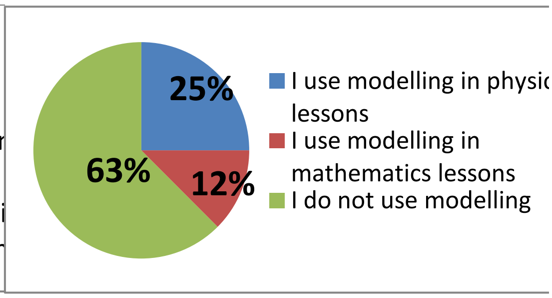


Fig. 4: Teachers´ understanding of the word model

Fig. 5: Use of computer modeling in the class

The other questions revealed the fact that even though teachers know about simulations; their real use in the classroom is not so straightforward for them (fig.6). More and more difficulties appear at the moment when teacher is expected to make a small change in the existing model or developing a new model, in particular. The influence of students´ ability to use modeling is not considered so important compared to that of the teachers. At the same time teachers consider the availability of supporting teachers´ and students´ materials very important factor in the use of modeling (fig.7).

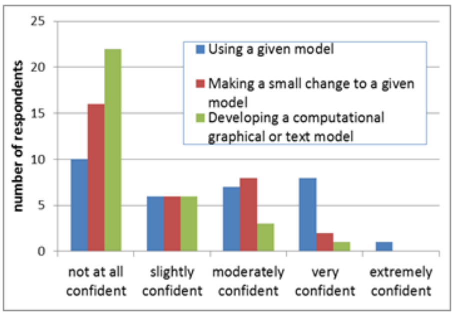


Fig.6: Number of respondents that is able to use modeling

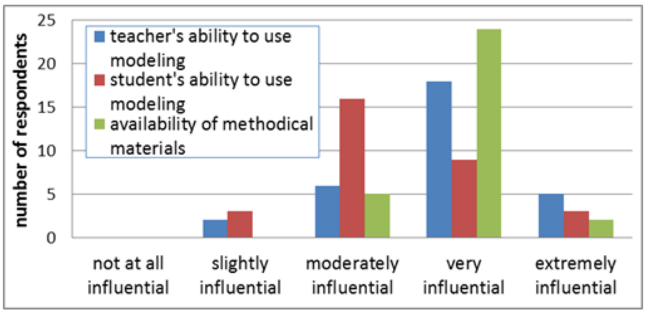


Fig. 7: Influence of different factors on the use of computer modeling in the class

To sum it up shortly, generally teachers are not familiar with the computer modeling and they use it very rarely in the classroom. While teachers are well aware about the role of experiment in physics teaching, the modeling is not an integral part of their teaching at all. We see the reasons in the lack of attention to this method during teachers' pre-service education. They come across this method within the in-service teacher training courses, however, in a short time of the course they are usually not able to understand the modeling process deeply and gain skills and confidence for the regular use in the classroom. Another factor lies in the lack of supporting tailor-made materials that would be available for teachers.

Teacher training course Active inquiry in computer-based laboratory

In spring 2013 there was a teacher training course Active inquiry in computer-based laboratory running. The course has been developed in cooperation with CMA Amsterdam. There were 33 teachers participating. They took part at 24 hours of present and 6 hours of distant learning. The course involved five modules, i.e. datalogging, processing and analyzing data, videoanalyzing, modeling tools and implementation into education. All the supporting course materials were available e-learning Moodle platform. Within the modeling module there was an introduction to modeling presented explaining the basic concepts and examples of modeling activities in science education. We used dynamical modeling in graphical mode. Teachers knowing the basic concepts then worked with exemplary models in physics, biology and chemistry showing the easiness of their use. We showed teachers that already prepared model can be used easily at the level of simulation under the different conditions. This first contact with models was followed by tutorial activities. In the first step teachers investigated the bathtub model in which water flows in and out at constant rate. Thereafter they learned to change the existing bathtub model to more realistic one where water drain depends on the amount of water in the. Gradually different tools were introduced and trained. With the help of the tutorial teachers guided by the trainer developed different models, e.g. a model of a cyclist, shuttlecock fall, thermal exchange, bouncing ball, charging of a capacitor, etc. The last part was aimed at the discussion about educational benefits and classroom implementation. Within the distant learning part teachers were asked to develop a model based on their own design and suggest their possible implementation in the classroom. This proved to be the most difficult home assignment of the whole course. Teachers were offered individual consultations that most teachers took part at. As a result all the participants developed a model of various level of difficulty. The models distribution is presented in fig. 8. We ranked models into three categories:

- Very simple – these models were created on the basis of existing models available in the COACH directory. Teachers modified them their own way or they developed a very simple model, e.g. model of uniform motion.

- Middle level models - these models also originated in existing ones, however their modification was more sophisticated and very reasonable suggestions on their implementation.
- High level models - the models were developed by teachers and were not created on the basis of existing models.

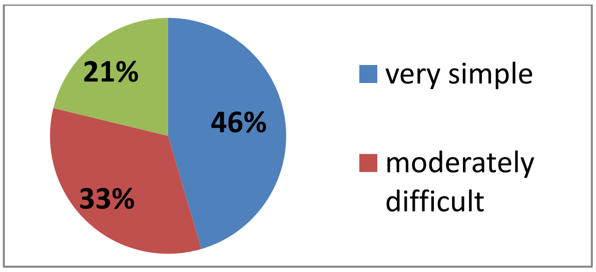
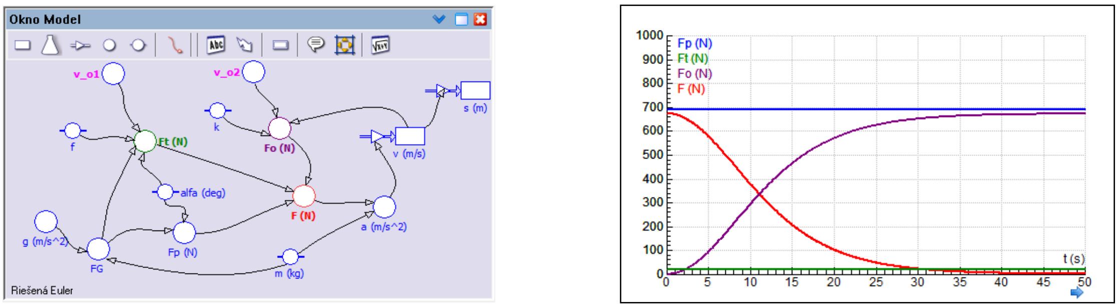


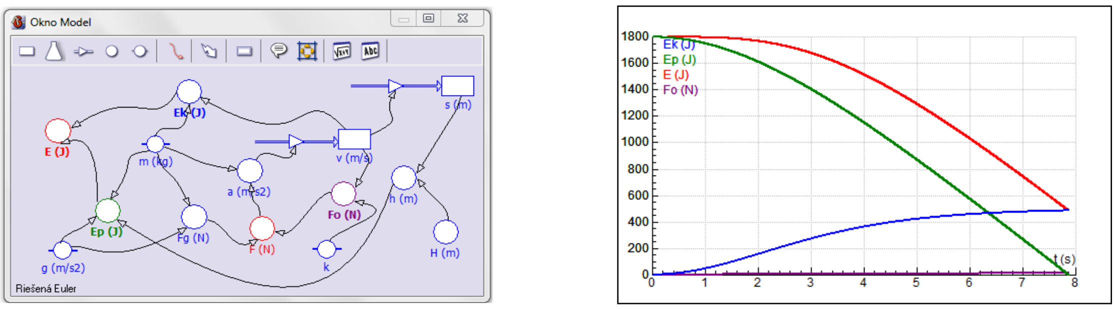
Fig.8: Home assignments models ranked in three categories.

It can be seen in fig. 8, most teachers fall into the first category of very simple models. Only 1/5 of teachers developed more sophisticated models and 1/3 of teachers went the middle way. These were the teachers who consulted the model development with the trainer. The smallest category of difficult models developers worked mostly on their own and they mastered the technique at high level.

Examples of the best models involve analysis of the motion of the skier sliding down the hill (fig.9a) and energy model of the falling object neglecting (not neglecting) air resistance (fig.9b).



a) Model of the skier motion

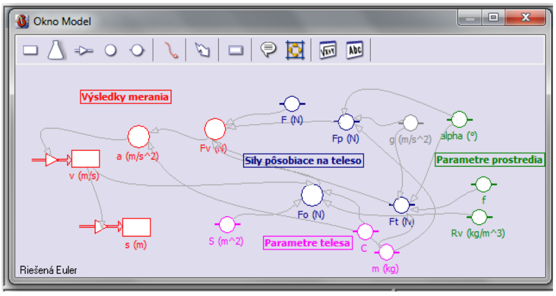


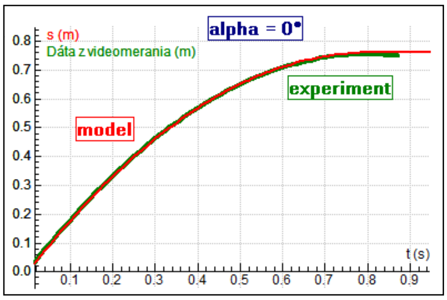
b) Energy model of the falling object

Fig. 9: Examples of modeling activities of teachers

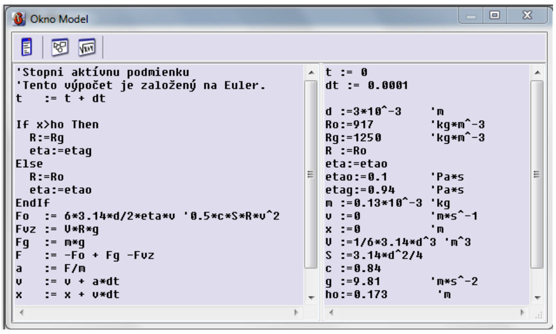
University students and modeling

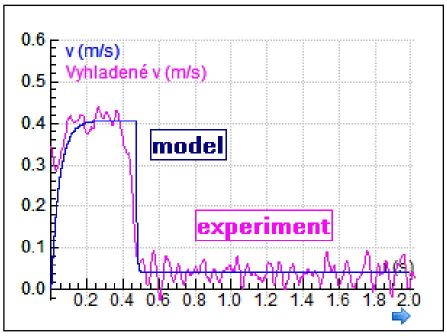
Within the introductory course on General Physics in the school year 2013/14 we have implemented modeling activities with the help of computer. Firstly students were introduced basic ideas about dynamical modeling, however compared with teachers, except from graphical modeling there was also a text mode modeling introduced. During the course models in both modes were expected to be prepared. Within the project assignment students working in groups of 2-3 should have developed an activity on motion. We expected from the students to analyze a motion using datalogging or videomeasuring tools and processing tools and to develop a corresponding model in order to show that the theoretical model corresponds to the experimental results. The results of their projects were presented by students in front of their peers and the teacher. Similarly to teachers, all the supporting materials were available through e-learning Moodle platform and individual consultations were provided if needed. As far as the models level we insisted on the middle level models that was accepted by most of the students.





a) Model of motion on an incline (result for 0° incline)





b) Model of the object falling through two different kinds of oils

Fig. 10: Examples of modeling activities of University students

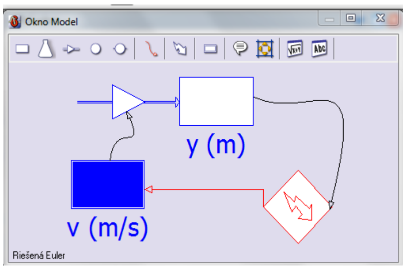
One of the best elaborated models involved model of the motion on an incline taking into account the friction as well as the air resistance based on the experimental results gained from the videorecording (fig.10a). Another sophisticated model was created on the motion of a sphere falling through two different kinds of oils that has been videorecorded and then analyzed (fig 10b). The corresponding model takes into account different properties of liquids and hence different drag coefficient. This motion corresponds to the fall of a parachute jumper who opens his parachute after certain time after jumping out from the plane.

High school students and modeling

From the school year 2012/13 a new interdisciplinary subject was introduced at one of the high schools in Kosice for the 1st grade students. The main goals of the subject involve developing inquiry and digital skills using ICT in physics and programming skills in the field of informatics. The activities were developed in order to complement the topics of regular physics lessons that include mainly mechanics. The lessons are carried out in a computer lab equipped with the COACH6 system. Over the physics part of the course students carry out inquiry activities at different levels of inquiry in order to enhance conceptual understanding and developing inquiry skills, mainly in the field of doing investigation and modeling.

Apart from regular week activities, high school students in groups of 2-3, similarly to University students, are expected to work several months on the projects aimed at selected motion analysis with the help of datalogging or videomeasuring tools and processing tools as well as developing a corresponding model. At the end of the school year they present their results in front of the whole class.

Based on the students’ projects evaluation about 80% students in the school year 2012/13 succeeded in analyzing the motion with the help of datalogging or videomeasuring tools. However, only 50% of students were able to prepare a correct model of the analyzed motion. Our experience in the school year 2013/14 is very similar. Even though the dynamical model does not require any complicated use of equations, just those describing uniform or uniformly accelerated motion, students have significant difficulties in developing correct models. Examples of the best projects involve analysis of remote-controlled formula car and determination of the highest achieved acceleration. Students videorecorded the formula car motion, created a model of uniformly accelerated motion and based on the comparison between the model and experimental results they determined the value of the car acceleration. Another successful project involves the kick of the ball and the consequent change of the direction of its motion. Students created a model of the motion involving the kick and calculating the acceleration gained during the kick they determined the force acting by the leg (fig.11).



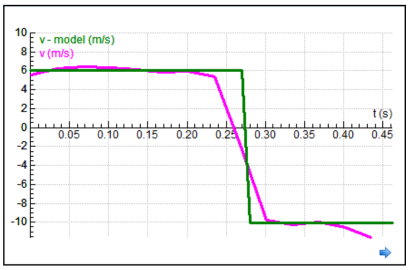


Fig. 11: Model of the ball kick

Conclusion

Successful implementation of computer modeling into education requires several conditions to be fulfilled. First of all there is a well-educated teacher who is aware of the benefits and role of modeling for science education. Then, there are well-elaborated supporting teachers´ and classroom materials needed. Last but not least the students to whom the modeling activities are addressed should have basic skills concerning simple programming as well as mathematical literacy. However, as far as the high school students are concerned, we feel that sometimes also the conceptual understanding of physical concepts connected with motion and laws of motion are missing or are insufficient. Comparing the three investigated groups (teachers, University students and high school students) we can conclude: Teachers are well aware of the concepts involved in the model, however they still suffer from the lack of confidence when working with computer and computer environment where simple programming skills are needed. University students represent a group that has reasonable level of computer and mathematical skills and they have mainly good understanding of the physics behind the model. On the contrary, many high school students do not have deep understanding of the concepts and laws of motion that is a necessary assumption of the good model development. However, they have sufficient computer skills but lack of mathematical skills. Nevertheless, we are optimistic and we still think that computer modeling belongs to physics curriculum and with gradual and repetitive use of this tool the students will understand its important role in science.

Acknowledgment

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Research Instrument to Study Students' Beliefs about eLearning, ICT, and Intercultural Development in their Educational Environment in the Framework of the IRNet Project

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Abstract

This article represents a diagnostic instrument for conducting survey within the European IRNet Project: *International Research Network for study and development of new tools and methods for advanced pedagogical science in the field of ICT instruments, e-learning and intercultural competences*. The tool is purposed to retrieve data on students' beliefs and expectations about ICT-enhanced learning, and their emerging needs for intercultural development. The expected result is the analysis of the students' views and attitudes towards various educational processes within the scope of their academic study, entailing ICT, intercultural and professional competences.

The study targets students in Poland, The Netherlands, Spain, Portugal, Slovakia, Czech Republic, Australia, Russia, Ukraine, and Turkey. The retrieved data in the research will allow to examine the state of the art in ICT-, learning- and intercultural competences. On top of that cross-cultural analyses will be conducted. At a later stage recommendations for Higher Education in the included countries will be formulated.

Keywords

E-learning, International Research Network, Survey, ICT Skills, E-learning and Intercultural Competence

Introduction

Western Society nowadays challenges education, as well as the ambition of the young generation. Students live and work in a globally-interconnected society - the network society; Castells, 2000). Therefore, in the Recommendation of the European Parliament and of the Council of 18 December 2006 there were named eight key competences: communication in the mother tongue; communication in foreign languages; mathematical competence and basic competences in science and technology; digital competence; learning to learn; social and civic competences; sense of initiative and entrepreneurship; cultural awareness and expression.

In a view of the rapid development of technologies that are entering each sphere of the modern human beings' life, the digital competence is considered as one of the key competences required for successful employment and prosperity. But in spite of the urgency conditioned by the fact, that almost all jobs in the future will require at least basic digital skills, many school pupils still lack access to the digital technologies and content needed to acquire them, and a large number of adults lack digital skills altogether. The problem turns to be even worth because school administrators, curriculum developers and educators tend to be exposed to insufficient information regarding main streamlines and strategies of digitally–enhanced learning and training which would provide their students with appropriate content through correspondent tools and techniques (Sekret, Kommers, 2014).

The importance of social and societal competences, the readiness of a person to be constructive and productive is today declared at the level of the international community, and it is reflected in a number of documents and projects (Sekret, Kommers, 2014).

Based on the analysis of the documents of the countries participating in the IRNet project conclusions can be drawn on the formulated requirements for life in a global society: they are abilities to participate in self-government, societal awareness, tolerance, intercultural cooperation, readiness for dialogue and teamwork.

Conception of the IRNet Project

One of the providers to meet challenges of the digital society, will be the international scientific project **IRNet**.

The project has been financed by the European Commission under the 7th Framework Programme, within the Marie Curie Actions International Research Staff Exchange Scheme. Grant Agreement No: PIRSES-GA-2013-612536. Duration of the project is 48 months: 1/01/2014 until 31/12/2017.

Nowadays, we can observe a rapid transition of the knowledge society to the "society of global competences", in which both the global economy and the education systems are undergoing significant changes. It is evident that without an active implementation of innovations into education these objectives cannot be successfully achieved. At the same time we should identify the existing problem – the fact that e-learning methodology is not yet fully developed and specified, both within the EU and outside.

Development and implementation of the systems designed to enhance ICT competences of a modern specialist, in particular future teachers, in-service teachers, and educational managers, based on the systematic use of Internet technologies (LCMS systems, Massive Open Online Courses, "virtual classroom" technology, social media, other selected Web 2.0 and Web 3.0 technology) will positively contribute to the development of skills in the area of ICT and intercultural competences.

The IRNet project aims to set up a thematic multidisciplinary joint exchange programme dedicated to research and development of new tools for advanced pedagogical science in the field of ICT instruments, distance learning and intercultural competences in the EU (Poland, the Netherlands, Spain, Portugal, Slovakia, Turkey) and Third Countries (Australia, Russia, Ukraine). The programme will strengthen existing collaboration and establish new scientific contacts through mutual conducted research and secondments of the researchers. The main objectives of the project are: 1. to exchange expertise and knowledge in the field of the innovative technologies of education between EU and Third Countries and suggest effective strategies of implementing new tools in their profession; 2. to analyse and evaluate social, economic, legal conditions, as well as methodologies and e-learning technologies being developed in the European and Third Countries involved.

Work Packages 2. Main aims, research tools, expectation of the results

One of the 7 Work Packages is WP2 titled "*Analyses of legal, ethical, human, technical and social factors of ICT and e-learning development and intercultural competences state in every partner countries" (1-8 months of the project)*. The most important WP2 tasks (http://www.irnet.us.edu.pl/documents/wp2, 2014) include:

- Mapping and developing an account of factors involved in a process of globalisation and regionalization in developing key competences, including their interests, scales of influence, and temporal horizons.
- Examining the role of higher education policy in globalisation processes (e.g. shifts from servicing to driving development of a knowledge society, and from aid to e-learning as a means of competences' building) and the role played by higher education institutions and their projects as potential models for other world regions.
- Identifying the role of leading international higher education institutions in policy development of the key competences and in new forms of the international cooperation.
- Analysis of processes of the competences development – e.g. processes operating simultaneously on different scales, contemporary trends and previous research.
- Analysis of legal, ethical, human, techniques, social factors of Development ICT, e-learning and intercultural development in every partner's countries.
- Researchers will be engaged in individual/joint-research in the visited institutions. If it is in a city they happen to be researching they will be able to carry out fieldwork and/or archive research.

Research method

Participants

For this study, more than 10000 students from project universities (The University of Silesia in Katowice (US), Poland, Beneficiary 1 (Coordinator)), University of Twente (UT, The Netherlands (Beneficiary 2)), University of Extremadura (UEx, Spain (Beneficiary 3)), Constantine the Philosopher University in Nitra (UKF, Slovak Republic, Beneficiary 4), Lisbon Lusíada University (LU, Portugal, Beneficiary 5), University of Ostrava (OU, Czech Republic, Beneficiary 6), Curtin University in Perth (CU, Australia, Partner 1), Borys Grinchenko Kyiv University (BGKU, Ukraine, Partner2), Dniprodzerzhinsk State Technical University (DSTU, Ukraine, Partner 3), Herzen State Pedagogical University of Russia, St. Petersburg (HSPU, Russian Federation, Partner 4)), and the students currently studying in Turkey are invited by e-mail or by social media or during classes by lecturers to take part in an online questionnaire.

It is planned to invite more than one thousand students-respondents from Pedagogical and ICT faculties as well as other faculties and countries, those who are gaining higher education nowadays, and those who have already graduated from universities. The survey is going to be conducted anonymously.

Research instrument

To achieve the aims of the project the research group developed a questionnaire which is purposed to gain data on the students' views and attitudes towards various educational processes in their educational environments, entailing modes of ICT implementation, intercultural and professional competences.

The diagnostic research instrument of more than 60 questions was translated in students' native languages (Czech, English, Netherlands, Polish, Portuguese, Russian, Slovak, Spanish, Ukrainian) and presented in on-line versions by university survey system and by Google Drive.

The questionnaire covered the following topics:

1) Sociological data required for the purposes of the research (Country, Nationality, Sex, Age, Name of the university, Field of study, Specialization, Year of study, Level of studies (Bachelor's degree, Master's degree)
2) The group of questions, in the area of intercultural competences.
3) The group of questions, concerning ICT competences, using social media for extracurricular activities of students.
4) The survey questions which are reflective in nature, revealing students' opinions about the courses and their assessment in terms of substantive, methodological, technological, organizational aspects, and e-learning as a technology, method and a form of obtaining education.

Today, the broad information environment encourages social and civic activities of young people. The information environment transforms social and civic activities in the new ways. Young people receive new forms of creating and promoting their communicative identity manifested through various options for political activity (participation in elections, membership in voluntary associations, participation in political activities), as well as socio-cultural activity (accessory to informal youth movements, subcultural communities, creative networking) (Noskova, Yakovleva, 2013).

Today researchers are facing a lot of questions. How does the information environment reflect the social and extracurricular activities of young people? What determines positive and negative activities of young people? From the general point of view the forms of social and extracurricular activities depend on ICT competences, intercultural competences, as well as social inquiry of the youth. Of particular interest is the manifestation of these competences in the information environment of the educational institution. It is important to understand the range of possible motives for social extracurricular youth activities: there may dominate material, social and spiritual motives. There can be named in multiple directions, reflecting the social and extracurricular youth activities: information resources of educational institutions (sites, portals); communication resources of educational institutions on the basis of social media (social networks communities); network resources for joint activities (wiki, resources of crowd sourcing and crowd funding) (Noskova, Pavlova, 2012). The degree of students' involvement in using these resources reflects not only their ICT competence, but also communication, and intercultural competence. At the same time the activities of teachers, managers and moderators are being reflected: if the can provide students with a basis for their joint activities and discussions; and whether they can maintain and moderate the environment.

Today, with the development of global world, cross-cultural studies of students' social and extracurricular educational activities are needed. For this purpose, there was made a block of questions of the questionnaire. The main objectives of this unit are: the detection and definition of the main characteristics of information and communication preferences and behavior of students in the context of their social and extracurricular educational activities. The block contains several parts of questions. The overview of the block is presented below.

The first part of the questions is aimed at identifying the preferred method for students to obtain information about educational and extra-curricular activities. Here are the examples of the questions.

Where do you often learn about planned university events and activities most often?

- University website
- University page on the social network
- Personally from other students
- Personally from teachers

Evaluate to what extent you personally use the information available for students on the university (faculty) website:

- I often learn a lot of new, interesting and important for myself
- I rarely use this information. I find important information in other sources

The second part of the questions is aimed at identifying the prior ways of students' extracurricular activities. Here are the examples of the questions.

Which sections of information for students on the university (faculty) website do you consider most important?

- Employer information and suggestions for work
- Invitation to participate in events
- Resources for distant learning and other educational resources

The third part of the questions is aimed at detecting the level of student communication activity in a virtual environment. Here are the examples of the questions.

How do you use the social networks pages of your university (faculty)?

- Comment
- Add your content (photos, videos, etc.)
- Just read and watch
- Rarely or almost never use

What are the main purposes you reflect your activities as a student on your personal pages in social networks (awards, achievement, participation in activities, studies):

- Show my achievements to teachers
- Show my achievements to other students
- Show my achievements to potential employers
- Do not express my student's life in social networks

Are you an active participant of online communities (groups in social networks) of your university (faculty):

- Actively participate in groups 1-3 (commenting, adding content - photos, videos, links, etc.)
- Actively participate in three or more groups (commenting, adding content - photos, videos, links, etc.)
- Do not participate or act just as a "spectator"

The fourth group of questions is aimed at identifying the attractiveness criteria of an information and communication resource for a student as a representative of young consumers and producers of content. In this case, there were used open question types. Here are the examples of the questions.

What kind of information is primarily important for you as a student? What would you like to see on the website of the university (faculty) in the section for students?

The fifth, a very important group of questions, related to students' attitude towards a teachers' activity in the information and communication environment. Here are the examples of the questions.

How important for you are your teachers' activities on the university (faculty) site and the university pages in social networks?

- It is interesting what teachers do
- Activity of teachers motivate my activity
- Activities of other students are especially important for me

Thus, it is planned to obtain data on the basic characteristics of information and communication preferences and behavior of students of all countries participating in the project. It is assumed that the obtained results will reflect cultural and national characteristics of information behavior of students. Moreover, the data will be important for teachers. They will make it possible to correlate the information provided by students with their requests and needs, as well as the challenges of the 21st century.

The group of question, in the area of intercultural competences

Based on the Webster's Revised Unabridged dictionary and the Oxford English Dictionary, "competence" may be defined as a condition or quality of effectiveness/ability, sufficiency or success (Elliot & Dweck, 2007). In the sense of conducting a professional activity competence is viewed as an individual's ability to fulfill specific tasks on the base of the situation adequate interpretation and individual's possession of the necessary repertoire of the behavior strategies (Sekret, 2012). "Developing competence" is defined as a continuous process of acquisition and consolidation of skills needed for performance in one or more life domains at the journeyman-level or above (Sternberg, 2007).

The theoretical and methodological framework of this research marks basic conceptual categories of experience, value, intercultural competence and borderland. In the analysis of their educational context, some pedagogical assumptions have been adopted (the perspective of cultural context in intercultural research), as well as some attitudes of cognitive psychology (including its cognitive-developmental theories), axiology (oriented towards phenomenology), and social and cultural anthropology (with special reference to its anthropocentric-cultural current).

The existing standards of teachers' professional competences, comprised in the arrangement of key competences: moral, praxeological, communicative, cooperative, creative, and computer ones, seem to be insufficient in educational undertakings conducted in culturally differentiated environments. Currently, these standards should be enriched with intercultural competences which involve:

– **personal competences** (cognitive, emotional, motivational, self-creative) – expressed by experience and engagement in one's own and others' professional development that is based on the awareness of diversity, which means the knowledge of the own and other cultures and of the significance of cultural determinants for educational processes

A sample questionnaire entry concerning this group of competences:
Which forms offered by university studies give you the possibility to acquire intercultural competences?
key: definitely not, rather not, hard to say, rather yes, definitely yes

1. *International exchange programmes (e.g. Erasmus+)*
2. *The subject intercultural education (if it is in the curriculum)*
3. *Issues of intercultural education implemented in other subjects*
4. *Formal contacts – initiated by university*
5. *Informal contacts with foreigners*

– **competences to intercultural communication** – enhancing the negotiating attitude, aiming at broadening subjectivity of others, comprising mostly socio-cultural and interactive abilities which are manifested in linguistic and non-linguistic skills in social behaviour

A sample questionnaire entry concerning this group of competences is presented below:

How do you evaluate your competences in the following points in regard to the country which you know best in the field: ***knowledge*** *(how much I know about this subject)****, skills*** *(to what extent I can use my knowledge),* ***motivation/attitude*** *(to what extent I want to do this)*

key: 1 – very low; 2 – low; 3 – average; 4 – high; 5 – very high

1. *Communicating in the chosen country (e.g. knowing the language, understanding colloquial speech)*
2. *Easiness in contacting representatives of the chosen country*
3. *Familiarization with the material culture of the chosen country (history, monuments, architecture)*
4. *Familiarization with the social culture of the chosen country (behaviour, customs, stereotypes)*
5. *Familiarization with the symbolic culture of the chosen country (values, language, tradition, religion, art, literature)*
6. *Familiarization with cultural differences*
7. *Familiarization with religious differences*

- **competences to identity behaviours** – involving the knowledge and abilities which enable cognitive and evaluative behaviours in six identity fields (T. Lewowicki's theory of identity behaviours)

A sample questionnaire entry concerning this group of competences:

Who do you feel you are?

key: definitely not, rather not, hard to say, rather yes, definitely yes

1. *A world citizen*
2. *A resident of my continent*
3. *A member of my nation*
4. *A resident of my region*
5. *A resident of my town/village*
6. *A follower of my religion (write down which*)

- **competences to tolerant behaviours** – manifested in some specific abilities to apply attitudes of tolerance in multicultural surroundings, such attitudes which take into account permanent components (*values, working knowledge, evaluation* and *behaviours*) specifying the actual attitude to a phenomenon

A sample questionnaire entry concerning this group of competences can be found below:

Are you of the opinion that in one country there can live people who:

key: definitely not, rather not, hard to say, rather yes, definitely yes

1. *Belong to different nationalities?*
2. *Inhabit regions of different cultures?*
3. *Follow different religions?*
4. *Differ in economic status?*
5. *Differ in religious views?*
6. *Differ in social views?*

- **competences to transgression and emancipation behaviours** – related to: the abilities to interact with the surrounding conditions, including multicultural surroundings; the abilities to free from prejudices and stereotypes by conscious transforming oneself and others in mutual cultural learning; enduring the consequences of one's own activity which frequently goes beyond traditionally accepted norms and values of the community and which transforms a particular (multi)cultural reality (Ogrodzka-Mazur, 2007; Ogrodzka-Mazur, 2013; Gajdzica, 2013)

A sample questionnaire entry concerning this group of competences is provided below:
How do you evaluate the possibility of entering closer cooperation/exchange with students from the following countries:
Australia, Spain, Netherlands, Poland, Portugal, Czech Republic, Russia, Slovakia, Ukraine
key: positively, this is indifferent to me, negatively

Next group of surveys questions are reflective in nature while the evaluation related to the students' opinions about the courses and their assessment in terms of substantive, methodological, technological, organizational aspects, and e-learning as technology, methods and forms of learning. The students expressed their preferences regarding the class mode (traditional, presence, on-line via Internet, other) as well as the reasons for their individual choices. The survey questions were answered by more than 1000 first-year full-time students. The survey was anonymous, and was accessed on the survey services at the server of the university of Silesia. This paper includes several questions. In the authors' next publication, all results and its analyses will be provided. The first group of the questions, concerning students' preferences regarding a mode of classes and the reasons for this choice. For example,

- *Please indicate what classes you prefer:* via the Internet, via the Internet, assuming that they are carried by the same person, traditional, traditional, assuming that they are carried by the same person);
- *What are the reasons for this choice?*

Second group of questions directs on research of the students' opinion about the purposes for which they most often use the Internet, for example:

- *In preparation for classes, I frequently use:* (traditional libraries source, digital libraries source, public Internet resources, open sources (free of charge), educational portals, social networks, educational and scientific materials (with additional charge), materials provided by the lecturers, other (please specify)..)
- *Looking for interesting materials on the Internet, you use most frequently:* (search systems, for example, Google, Wikipedia, electronic catalogues (bibliographical references and data bases), references to other web sites, placed on the pages, social networks, reliable and well-tested portals, blogs, other (please specify))

Next group of the questions concerning knowledge and experience of the students in the field of the distance learning platform at their school, faculty, university. Among questions these groups are:

- *Has your secondary school a distance learning platform?* (Yes, What is it? ________, No, I do not know)
- *Do you know what system is used for the support of the distance learning platform in your faculty*: (Moodle, Claroline, Dokeos, WebCT, IBM Lotus Space, Black Board, Ilias, Sakai, other..............., I do not know)
- *Do you think that web-technologies can be a useful tool for achieving educational goals and providing access to training materials in different subjects?* (Yes, No, I do not know)
- *If you answered YES, what % of classes in your opinion should be carried out in the remote (distance) mode:* (up to 30%, 30% - 60%, 60% - 90%, up to 100%)

The end of the survey includes the last group of questions in the research area of the students' opinions about preferred methods of communication with lecturers and study methods, supported with ICT-technologies, and their suggestions for and expectations from improved forms of teaching and learning based on web technologies.

Conclusion

The results of the answers, which will be received in a frame of conducting this survey will be published in the next authors' publications, after their additional analysis, systematization, comparing and generalization. Besides, the received results will used to develop details of the further stages of the projects research.

To sum up it should be stressed that, first of all, international cooperation, joint projects, exchange of experience in Europe and the world as for the theoretical and practical aspects of the distance learning will enable creating an efficient, optimal strategy for the implementation of e-learning and continuous improvement of the innovated education in order to adapt it to the modern society needs and students' expectations.

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WEB BASED DYNAMIC MODELING BY MEANS OF PHP AND JAVASCRIPT - PART III

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Abstract

The paper and the realized research deal with a problem of the making and use of computer models in school teaching. Work with models and even with the computer can be understood as an inter-subject binding, for example, between physics and mathematics, computer science, technology, or other objects. Modeling of phenomena or processes is used in engineering and science; however we can also take advantage of his strengths in education. Computer models work with graphs and other visual means to help to students to understand of phenomena and processes. The paper presents an extended Web dynamic modeling in physics developed by using PHP and JavaScript. It is an easily accessible tool for teaching at all levels of education. This tool was created based on our research among teachers. The research survey was conducted through an e-questionnaire. The aim of the research was to determine the current status of the development and use of computer models in education at primary and secondary schools in the Czech Republic. Based on the research results we proposed the course how to create computer models for teachers. The paper will present basic keys of it.

Keywords

Dynamic model, modeling, web, ICT education

Introduction

As we mentioned in our previous papers (Válek, 2012), (Válek, 2013), we study the situation in use and development of computer models in physics education. Especially, we focus on dynamic (mathematical) modeling. The topic is interesting because of the ever increasing prevalence of digital technologies and their strong penetration in education.

In the mentioned published papers we reported in detail why this is the appropriate method to promote learning. Now, we briefly summarize some of these reasons.

Man learns through interaction between thought and activity. This process takes place regardless of whether it is supported by information and communication technologies (ICT). However, today's youngsters use ICT intuitively and often from early childhood. For this reason, it is advisable to incorporate ICT into teaching as an integral part, not only as a tool. One of the ways to combine pedagogical, didactical and technological tools and to gain an effective output is dynamic modeling (OECD, 2008).

Dynamic modeling encourages research activities of students. This has the effect of transforming the student from a passive recipient to an active and helpful member of the research team. Creating dynamic (mathematical) models and their progressive refinement thus plays a very important role in the learning process and science. It is therefore imperative that students fully understand the subject matter at a given level of education, and know how to analyze natural and technological phenomena and events around them. At this moment they start to transfer the acquired natural science skills into practice (Hejnová, 2010).

To fulfill the above objectives, it is necessary to have well-prepared teachers. One part of teachers had to learn the application of computer support for the development of dynamic models through continuing self-education. The younger age group encountered the computer modeling during undergraduate studies, however in the integrated development environment (IDE), what was available at a particular university. Specific IDE may not be freely available and can also be a subject to upgrades which often require additional education of users. The aim is to offer a solution that is freely available to all and is relatively stable and not too demanding on the user's knowledge (Hejnová, 2010).

Modeling in Physics

The term "*model*" is associated with the modeling process itself. It means process where calculations are used for modeling the physical properties of real objects and of ongoing processes. Modeling is realized by suitably simplified mathematical description of studied systems and bearing in mind physical principles. Modeling generally means creating models for studying of such properties, which are significant for a given problem. Looking on majority of models we find that the equations describing many physical situations are simplified mathematical description of reality.

By modeling we introduce a functional dependency between studied physical quantities. These functional dependencies are mainly represented by differential equations. Analytical solutions of such equations, i.e. generally accurate solutions can be obtained only for specific cases. For this reason, numerical procedure is one of the most used methods for solving differential equations. This is an approximate solution of differential equations. As it was already mentioned, this way of solving differential equations incorporates partial simplification of the problem and the obtained solution is approximate. At present, ICT is often used for such calculations.

In school, dynamic modeling in physics presents very effectively results of the studied problem what the pupils are not yet able to calculate themselves. They can partially predict the result of the problem and they can estimate values of some quantities. If the model is created in such a way that the students can vary some input data themselves, it serves completely its purpose.

Sometimes, the result is computed in advance and we already show a graphical output. We prefer mathematical model which is able to dynamically respond to changes of initial conditions, constants characterizing a given physical system or environment. To create a dynamic model is necessary to know the basic equation and initial conditions (Vachek, 1980) (Lepil, 2007). We select one variable from this equation and we vary (increase or decrease) the value of the chosen variable in steps and we observe the behaviour of the result on this value. For better clarity we present the obtained values in the graph.

Research Process and Results

Teacher as a research object

Creator of such models must well know the physical nature of the modeled problem and at the same time he/she must also know mathematics, programming language and used IDE at the required level. If he/she wants both numerical and graphical output, he/she needs to master programming at a higher level than is the standard for students of teaching physics (Vachek, 1980) (Lepil, 2007), (Kalakay, 2001).

The aim of the research is to characterize the teacher as a creator or user of computer models in teaching physics and at the same time to identify the process of creating computer models and their implementation into the teaching process.

In this paper, we focus on the teacher as a creator of dynamic models, and his ability to work in different development environments (IDE) for developing models and how he is prepared for it at the university.

State of the art

Nowadays, computer models and IDE are more available than real models for school education. In addition, computer models offer options that cannot be often achieved in physical models. However, in many cases, computer models are not fully suitable for specific lesson – teachers need to modify it – change, reduce, extend or propose new models with respect to the situation in a particular lesson, class, subject matter.

Teacher needs to master IDE for such modification or creation of models. We performed research study to obtain a characterization of the teacher as a creator or user of computer models in teaching physics at schools, as well as to identify the actual process of creating computer models and introducing them into instruction.

Our research shows that applied development environments (IDE) are very diverse. This leads to a fragmentation of knowledge of students, future teachers in the field of modeling. At the same time it introduces a large incompatibility between different modeling development environments (IDE). In the case of commercial (paid) software it also depends on what the school has purchased. It happens that the new teacher is not familiar with software available at school and there is nobody who controls this IDE. Furthermore, there is a large group of teachers who do not use modeling for its apparent difficulty. There is also a large amount of teachers who teach physics without required qualification. Knowledge of IDE is influenced by the time of teacher´s graduation. The situation is more complicated by no compatibility of older applications, primary developed for 8 and 16-bit processors, at recent PC.

There is IDE which is relatively stable and available for free to all Internet users: Hypertext Preprocessor - (PHP: PHP.NET. Hypertext Preprocessor, 2010). Due to the relatively long development of PHP and its compatibility, PHP represents a good choice for a development environment suitable for dynamic modeling. Model created in an earlier version properly runs in current versions. The benefits of using PHP and JavaScript when creating models were reported in our previous papers (Válek, 2012), (Válek, 2013). Another indisputable advantage of PHP is that it works regardless of PC platform.

It is desirable to help teachers who do not use computer models at all or help those who till use older IDE to master a PHP modeling. We see two ways how to raise skills on creating own models: direct in the university education of future physics teachers and in courses of further education of teachers (CED).

Research

From the available sources, we do not know that a similar problem, modeling in PHP and JavaScript was ever dealt with. In the U.S. surveys were conducted regarding the use of mobile devices in teaching, but did not correspond with our goals (Tapscott, 1999), (Stephenson, 2006).

During 2013, we performed the research study and we collected data on the state of development and use of computer models among physics teachers in primary and secondary schools in the Czech Republic and partially in Slovakia. Research questions and hypotheses were set in order to achieve the determined research goal. In a series of articles (Válek, 2012), (Válek, 2013) we interpreted the results of educational research in detail. The frequencies of responses were analysed and subsequently hypotheses on a mutual relation between the data acquired were tested.

The questionnaire survey was designed to obtain information on the current status of the use and development of computer models of the Czech and Slovak schools, for this reason no question testing any knowledge was present. To verify the hypotheses were selected 30 questions. The questionnaire was developed according to the methodology of questionnaires (Chráska, 2007). As introduction to questionnaire the letter to the respondents (teachers) explains the aim of research and gives the assurance of anonymity of obtained responses. Prior the research questions to test hypotheses we ask the questions to determine demographic data about the respondents. The time required to complete the questionnaire was approximately 10 minutes. Participation of respondents was anonymous, voluntary and without any reward. For further generalization, it is necessary to take into account the fact that the respondents are a group of teachers of physics that has an interest and willingness to use dynamic modeling in school practice.

The questionnaire was completed by 166 respondents mainly from Vysočina and South Moravia regions, 96 men and 70 women. The age distribution of respondents is in Figure 1. The period of teaching experience of the respondents is shown in Figure 2.

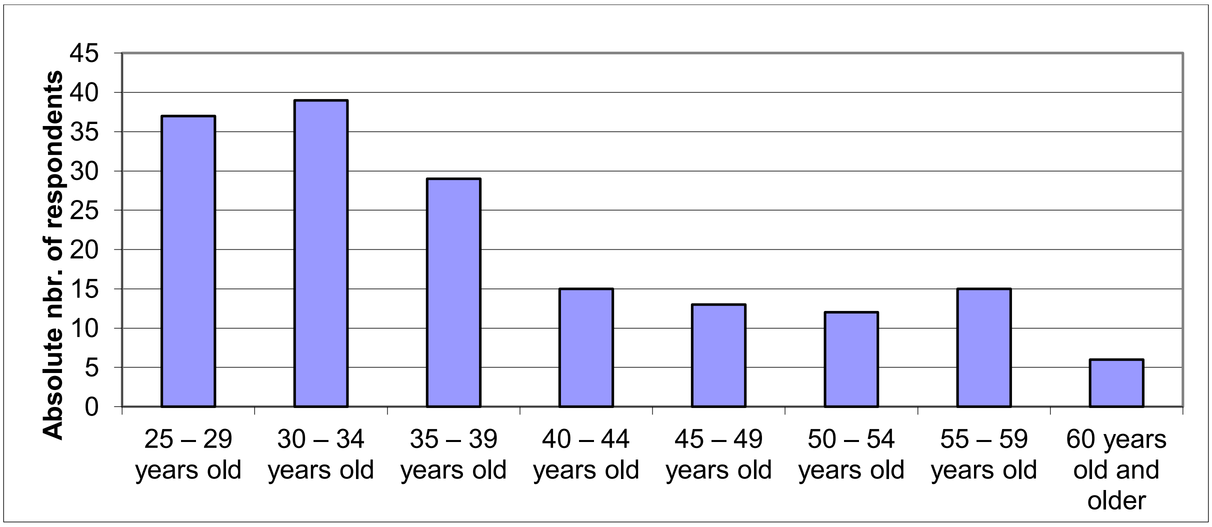

Fig. 1: Distribution of respondents by age

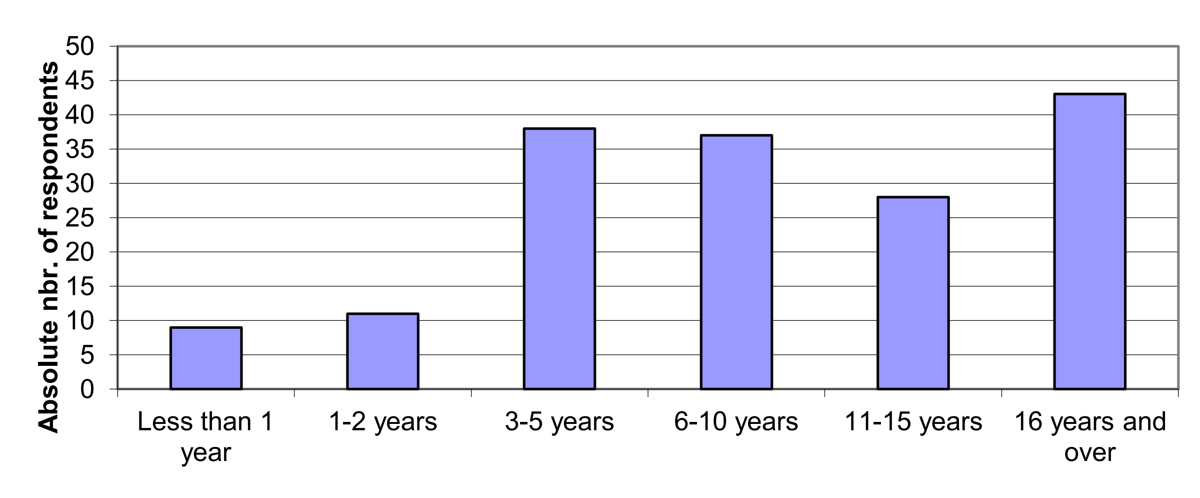

Fig. 2: Distribution of respondents with respect to their teaching experience

Hypotheses

Earlier (Válek, 2013) we presented three of the six hypotheses. All hypotheses are focused on the development and use of computer models in physics education. In the same paper research questions were presented to the relevant hypotheses.

In this paper we present the results for the hypothesis H3. Since the mentioned paper, the number of respondents increases.

H3: Teachers who create computer models only use the development environment (IDE) which they learned to work with at the university.

We assume that teachers elect their IDE intentionally. Working in such IDE is much easier than in the new environment for them. At the same time, we suppose and the practice confirms that teachers use preferably models created during their university studies. Another reason for this hypothesis is an uniform character of models presented to the pupils, which goes hand in hand with another aspect, namely the requirement for the minimum user knowledge of more IDE.

Hypothesis Evaluation and Discussion

The data obtained from the questionnaire was transferred to a table (Tab. 1). Subsequently, on the basis of the questions and answers of respondents filtered and transferred to a two by two table (Tab. 2). For Table 2 was calculated χ-square test and Yule's Q association coefficient.

For evaluation the hypotheses we used chi-square test (Chráska, 2007) according to established methodology and relationships prescribed for it, the significance level was set at $p \leq 0.01$ and the number of degrees of freedom ($f = 1$) to be $\chi^2_{0.01}(1) = 29.429$. As the calculated value is significantly lower than the critical value, we do not confirm the H3 hypothesis. That is why the data from the Table 1 was converted into two by two table (Tab. 2). To increase the accuracy of the calculated variables also Yule's coefficient was calculated ($Q = 0.77$), which provides information about the one-sidedness of the examined phenomenon (Chráska, 2007).

From the obtained data, we can say that the hypothesis was not confirmed. Teachers who create computer models use not only the development environment which they have learned to work with at university.

	worked at university	used in practice	intersection
Excel	35	37	19
Famulus	39	16	10
Interactive Physics	8	3	3
Phun	3	2	1
Modellus	5	3	0
ActivBoard	2	2	2
Yenka	0	1	0
Visual Basic	1	1	1
PowerPoint	0	2	0
Java	4	1	1
Geogebra	0	1	0
Flash	0	1	0
IP Coach	3	0	0
Pascal	3	0	0
Σ	103	70	37

Tab. 1: Absolute numbers of respondents according to the IDE they worked in: at the university and in their practice and the intersection of them

	worked at university	don't worked at university	Σ
used in practice	29	12	41
don't used in practice	30	95	125
Σ	59	107	166

Tab. 2: Two by two table with absolute numbers of respondents according to the IDE use and creation of models at university and in teaching practice.

The results presented here apply only to addressed respondents. With respect to the number of respondents and to the distribution of other parameters of tested group obtained data cannot be generalized to the entire population of physics teachers in the Czech Republic. However, when we bear in mind the estimated number of physics teachers in the concerned regions (number of primary schools in Vysočina and South Moravia regions), we can get a rather good picture of the state of art on that topic.

The data acquired from the respondents show that some of them worked with selected IDE during their studies at university. Many of them, however, learned to work in new IDE too. This can be explained by the fact that some IDE were created for operating systems that are no longer supported today. Thus means that at the present, it is impossible to start them up without the emulator of an older operating system and it is impossible to utilize their full capacity adequately.

Another role may play the availability and the properties of existing and new development environments (eg: new possibilities of analysing studied phenomena, new possibilities as far as modeling outputs, etc).

Proposed Solution to Improve Teacher´s Skill

Based on the results of research, we prepared one day course of creating computer models for teachers at our faculty. Hereafter we present some of its key points.

Entry requirements for participants: Basic knowledge of some programming language, the capability of analytical thinking, advanced knowledge of mathematics and physics.

The aim of the course is a basic introduction to the technique of computer modeling. The training is focused on understanding and suitable use of algorithms by means of which models are created. This fundamental feature will permanently be the same, no matter which development medium is used. Basically, it represents programming at elementary level. It is also expected that course participants are trained in basic mathematical operations included in the curriculum of higher mathematics.

The course is focused on the online application, PHP and JavaScript. These IDE are available to everyone free of charge and what's more, they run on the present servers quite natively.

During the course such methods and computer modeling techniques will be taught what are applicable in practice. Those will always be applied to simple examples. These examples will serve the students for checking up whether they understood correctly the principle of functioning of the discussed methods of computer modeling. The content of the course will cover the participants´ areas of interest and applications suitable for teacher's practice.

After completing this course, the participant will be able to construct a simple physical model using a computer and interpret its output. He/she will continue to develop the acquired knowledge and will learn to apply them to model situations. The created models will then be used in teaching at different school levels.

In addition, it is created on-line support for the creation of dynamic models in PHP (Válek, 2009).

Conclusion

Requirements for the use of digital technologies in everyday life are also reflected in the learning process. Our research shows that teachers rarely use computer models in their classes. This is unfavourable because computer modeling helps to get a review on the whole process of discovering and learning the laws and phenomena of the nature and technique. The "Step by Step" method is the most common way to represent the behaviour of quantities with varying parameter.

In series of our papers (Válek, 2012), (Válek, 2013) we show that this approach can replace the lack of student's mathematical knowledge needed to solve the studied problem. In addition, this approach will enhance the student's ability to identify the basic physics of processes and phenomena that are familiar from everyday life, regardless of the level of the student's analytical and logical thinking.

Future teachers at universities should become familiar with the tools for the development of computer models. Then the information about the applications in which it is possible to create models spreads more quickly. This is a result of the community – exchange of information, "how-to" and mutual assistance can learn better management of applications. Therefore, it is advisable to choose a development environment (IDE) for teacher (graduate as well as pregraduate) training in modeling which is on-line, free of charge and without having to install on the user's computer. With regard to trends in education and ICT, it is appropriate to create and place models directly on the website. To facilitate greater dissemination of modeling in our schools, we have introduced the concept for the development of computer models using Hypertext Preprocessor – PHP. The chosen solution is simple for the average user. This gives him an opportunity to work with models in computer, mobile phone, or tablet. Bearing in mind the above findings we proposed a new PHP modeling course for teachers. Some examples of modeling using PHP see on webpage www.ped.muni.cz / modely.

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MODERN FORMS OF EDUCATION AT UNIVERSITY WITH THE HELP OF MOBILE TECHNOLOGY FOCUSING ON THE IPAD

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Abstract

Tablets are currently already frequent material resources at primary, secondary and grammar schools. The type of schools tablets purchased in various projects or finance obtained from their founder. Use of tablets is not common at universities in the Czech Republic. This is paradox with respect to the education of future teachers. Future teachers should to come equipped with the relevant skills for working with this type of device to practice. The paper is focused on presenting the the possibility of using mobile technology (tablet - the type iPad) in education at the University of Ostrava. Gradually are created materials for iTunes U for the subject "ICT in vocational subjects". The paper also refers to the advantages and disadvantages of using iPads in education.

Keywords

ICT, tablets, iPad, education at university

Introduction

Information and communication technologies have gone through important changes since their first implementation into the education process – from commercial computers to personal computers to mobile devices. In each of the development periods new technologies in education were introduced. In connection with the new ICT-based technologies, Vališová and Kasíková (2007) write about the electronization of the education process.

Current trends in education, be they related to goals, methods, or forms, are more or less connected to information and communication technologies (ICT). ICT in education underlie trends set by companies producing various devices that are supposed to make work easier for people. Concerning information, ICT are significant in gaining, processing and using data (Kalhous, 2002).

Průcha, Walterová and Mareš (2008) define new technologies in education as modern instruments of didactic technique, didactic programs and new forms of education that are inspired by them: networks, multimedia, mobile devices and approaches supporting flexischooling and other forms of distance learning. Průcha, Walterová and Mareš reflect the current trend in education, which promotes not only knowledge gain in the school environment, but also self-study with the use of modern technologies. Průcha (2009) argues that educational technologies stem from classical didactic instruments.

The inherent portability of mobile devices is a key aspect in their potential use in education. Therefore, students do not have to learn only from printed sources or be dependent on non-portable devices, but they can learn wherever and whenever they want. The trend of massive implementation of mobile devices is no longer fiction, but a real intention of the Ministry of Education, Youth and Sports (MEYS). MEYS has prepared a plan of how to draw subsidies not only on new electronics (which would be related to mobile devices), but also on the schooling of at least 20.000 teachers for working with these technologies. Gradually, the position of mentor, who will help with the implementation of computers and other electronics into education, will be created at elementary schools and high schools.

Mobile Devices

"Mobile device" is a vague title as it contains everything which is not stationary and which can be easily transported and used. In general, mobile devices are laptops, pocket computers (PDA), tablet computers, tablets, cell phones (smartphone), MP3 players, iPods, USB flash drives, portable videogames, and eBook readers.

From the abovementioned examples, tablets are the most common in education. Tablet is a portable computer with a touch screen, which enables the user to control the tablet. A touch screen can be controlled either by a finger or by a stylus. There are many companies on the market which produce and distribute tablets. The differences between individual tablets are in their size, processor, operating system, memory size (RAM and inner memory), and other hardware elements. There is an organic connection between hardware and software, which differs according to hardware parameters and operating system in which the applications operate.

The use of tablets in contemporary education is individual. There are concepts of tablet classrooms which enable sharing of materials between the teacher and students (Slípek, 2014), using of measuring sets and tablets for research-oriented education (Böhm, Jermář, 2014), using of already existing tablet applications, or creating of new applications or curriculum.

Apple Inc. is currently producing many types of hardware, which are compatible with one another. These devices are desk computers (iMac, Mac mini, Mac Pro), laptops (MacBook Air, MacBook Pro), multimedia players (iPod), cell phones (iPhone), tablets (iPad, iPad mini), adapter for visual projection (Apple TV), backup (Time Capsule), AirPort and peripheries for controlling the abovementioned devices (Apple keyboard, magic mouse, magic trackpad).

While Apple Inc. does not produce as many devices as competing companies, it takes pride in their devices being precise and compatible with one another. At the same time, this strategy prevents the devices from becoming outdated (as happens to the devices working with the Windows operating system) as even the older devices working with the iOS operating system are still able to work without problems. For example, 4-year-old iPads have no problem functioning in the current iOS operating system. Tablets as well as the other Apple devices have both advantages and disadvantages.

Advantages of the iPad use are:

1) The speed of iPads with many applications stored in the AppStore. Now the number of applications is approximately 476.000.
2) The use of multi-touch, which is used not only for book reading but also for working with applications or browsing the Internet.
3) Long battery life. iPad can work 9–10 hours on a single charge.
4) Documents are available everywhere where there is Wi-Fi.
5) Possibility to adapt educational materials to individual study needs. Personalization. Possibility to repeatedly revise the curriculum until it is fully understood.

6) University students as well as high school teachers (when preparing for teaching) can use iTunes U.
7) It can be connected (through Bluetooth) to other technologies such as scientific probes, keyboards, or digital microscopes.
8) Possibility to use educational applications from AppStore, e.g. for creativity development, help with the organization of study, etc.
9) Book reading in the iBooks application with the access to a dictionary or to interactive study applications.
10) Many cooperating work tools in one – the Internet, e-mails, diary, notes, etc.

As all devices, iPads also have disadvantages. The first disadvantage is the fact that it is a device that constitutes a closed Apple group and is in some regards incompatible with other devices and applications. The typical case is occasional incompatibility with Flash Player, which can be repaired by the purchase of applications that make videos and animations based on Flash Player available. Applications as such are another disadvantage. All the applications are obtained through the AppStore which offers both free applications (FREE) and applications that are free but in their trial (restricted) version (FREE+). Paid applications are the last alternative. The restricted versions of applications (FREE+) offer a part of the application for free but the complete version is paid. The price of the application differs but it is no more than a few dollars. However, there are advantages in the purchase of applications. All the purchases are linked to the user's ID. Once an application is bought, the user does not have to pay for it even if they uninstall it from their computer and then install it again. On the other hand, the price of the application can be perceived as a disadvantage as it is higher than the price of competing businesses' applications.

Study Concerning Implementation of Tablets into Education

Studying with tablets is more comfortable. When tablets are available, they are used more than other technologies (e.g. laptops) in full-time study. It is because visual perception leads to better understanding. Tablets are one of the technologies that not only influence contemporary education, but also encourage the future approaches to education. Innovation of teachers' approach to education of students and to creating of study materials is also very important (van Oostveen et al., 2011).

Valstad (2010) argues that iPads have an enormous pedagogical potential. As advantages of use he cites the following:

1) The use of iPads from the pedagogical point of view:
   - Individualization of education;
   - E-learning;
   - Note-taking;
   - Use of more sophisticated notes (through the use of other interconnected applications);
   - Data backup;
   - Presentations with the use of iPads;
   - Effective cooperation;
   - Education with the use of jailbreaking;
   - Podcasts and iTunes U – universities create and share courses;

- Unified study environment;
- Conceptual framework for computer-supported cooperative learning;
- Creation of educational games;
- Applications for education.

Valstad (2010) argues that the following are crucial for successful implementation of iPads into education:

- Level of teachers' ICT literacy in a particular field;
- Level of iPad tools knowledge, which can be used by a teacher;
- Regular feedback between a teacher and students;
- Appropriate choice of mobile devices and software;
- Technical and pedagogical support.

Examples of the iPad use in the classroom (Valstad, 2010):

- Browsing through different information sources in the classroom's individual groups;
- Students' cooperation with the use of iPads, e.g. in the form of discussion groups on a blog;
- Search of new educational materials for iPads, e.g. within the scope of Podcasts and iTunes U;
- Subscription of newspapers and publications, browsing through them and discussing particular topics;
- Improving the presentation skills through the use of Keynote and other presentation applications;
- Active use of Google documents and DropBox for cooperative learning, multimedia production and brainstorming;
- Out-of-school communication between students and a teacher with the use of IM and audio conferences;
- Support of students with disabilities through the use of the new IT;
- Use of available and appropriate applications can improve learning;
- Use of iPads both inside and outside of the classroom is more dynamic than working with a laptop;
- Mutual work on projects;
- Teaching of foreign languages with the possibility to speech recording and pronunciation check.

Key aspects for the use of ICT in schools (Valstad, 2010):

- Used mainly by students, this use is supposed to be creative and explorative;
- Teaching of practical applications;
- Information and computer literacy of teachers;
- Computers and the Internet are no longer new technologies, new technologies are iPads, tablets in general and cloud applications on the basis of Google Docs and DropBox, or applications of mutual cooperation – IM and social networks (Skype, Twitter, Facebook).

Hogue (2012) describes the use of iPads within the scope of iPDP (iPad Professional Development Program), which has three parts:

- Online sources – preparation of sources for classical computers and iPads, it includes links to sources regarding the use of iPads, problematic learning, specific work techniques;
- Entering workshop (iPedagogy) – F2F (approximately 90-minute blocks), mastering knowledge and skills of working with iPads, stating the reasons why to choose iPad and not any other product;
- Sharing of information – based on the principle of cooperation in small groups.

Murphy (2011) sees the following advantages in the use of iPads and tablets in general:

- Possibility of the "omnipresent" access to education;
- Notes, note management, working with data;
- Student-student and student-teacher cooperation,
- Research connected with sharing of information between workplaces;
- Improving work productivity.

The results of the Hall and Smith team research (2011) did not prove any differences in the study results of students working with and without iPads respectively. However, the difference was found in the comfort and flexibility of studying, which was higher for the students working with iPads. Moreover, students valued the influence on the sustainability of the environment. The research was aimed at the study of the MBA program. Hall and Smith team research (2011) stress that iPads offer the possibility of both synchronic and non-synchronic education. There is also a possibility of educating through the use of courses with video sequences and through the use of games as a simulating tool (the Hotel Tycoon game). The following have also proven to be advantages:

- iPad's weight when compared to a textbook;
- Tablet's battery life - approximately 10 hours;
- Mobility;
- Lower price of eBooks;
- Possibility of collaborative learning.

Optimization of effective learning (Hall and Smith, 2011):

- Integrated view of a course;
- Possibility of rich content and immediate feedback;
- Creating a course for students with special educational needs;
- Possibility of integration and teamwork;
- Education quality support;
- Online work (searching, working with electronic sources);
- Supporting the environmental, economic and energy sustainability.

Other advantages from the point of view of university students (Manuguerra, Petocz, 2011):

- Effective and intuitive education;
- Not only static shots, but also video sequences and practical examples right in the classroom;

- Possibility of feedback through the use of online materials;
- Possibility of more intense education of external students or students on internships (providing them with study materials and educational video sequences);
- Need to provide immediate feedback and to determine a mistake; the possibility of immediate work; creating of electronic materials; the possibility to modify the materials from anywhere; attaching notes; creation and modification of audio and video sequences; the availability of materials on the network drive.

The Use of iPads in University Education on the Example of the "ICT in Specialized Subjects" Course

In the Czech Republic iPads are now being used at elementary schools and high schools. The implementation of iPads into university education is occasional with the usual problem being the availability of material equipment on the part of both universities and users – students and academics.

The study material has two parts:

a) The creation of the electronic course through the iTunes U interface;
b) The creation of digital materials through iBooks Author.

Since the iTunes U interface is less materially demanding than iBooks Author, it has been chosen for the creation of the electronic version of the "ICT in specialized subjects" course.

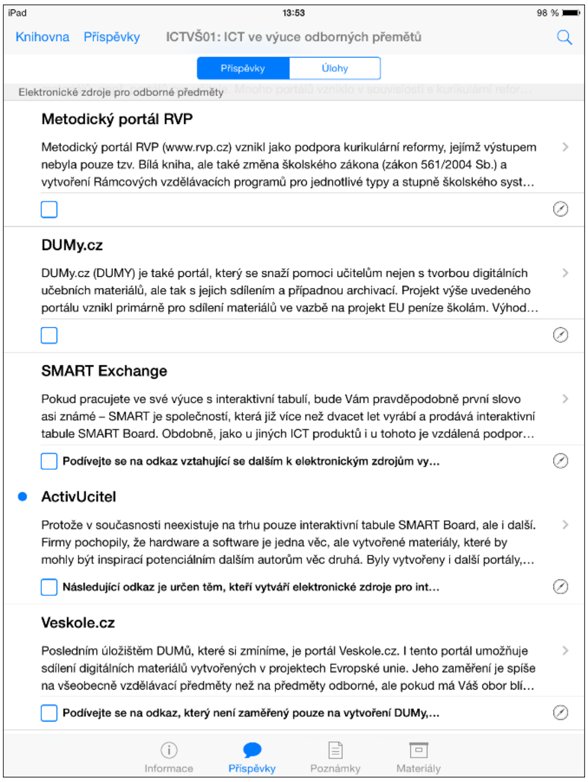
The iTunes interface is intended for educating students, university students, but also general public. Recordings of lectures and additional materials such as files, presentations, parallel texts, legends, and website links can be inserted into the courses placed on iTunes U. Nowadays, there is no university in the Czech Republic that would create courses specifically for iTunes U – if there is such a course, it is designed individually. The advantage that electronic courses placed on iTunes offer is the possibility to download individual lectures or materials to a computer or a tablet (or to subscribe for lecture updates). As far as video sequences are concerned, there is the possibility to download them and then watch them while traveling.

The advantage of iTunes U is that it can be used on any tablet type while materials created in iBooks Author can be used only on the Apple devices.

The created "ICT in specialized subjects" course is divided into three parts:

a) Electronic sources for specialized subjects – this part is aimed at general sources that can be used in specialized subjects;
b) ICT in selected specialized subjects;
c) iPads in specialized subjects – applications that can be used in selected specialized subjects.

The user, who signs up for the particular course, first acquires elementary overview of the course (the "Information" section). There they can find the course description, basic information about the teacher and the syllabus of the course. This part is intended as an overview so the information can only be switched between. "Contributions" is the key section, which is further divided into individual contributions. In the top part of the section the user can browse through the individual chapters of the course, to which the contributions are assigned. Inserted tasks (that are defined in advance by the teacher) are also part of the contributions. The last but one option is notes, which the user can assign even if it means adding the text or audio/video notes. The last option is the “Materials” section, which is a set of all materials in the form of pictures, audio files, video sequences, but also hypertext links that are assigned to the course.



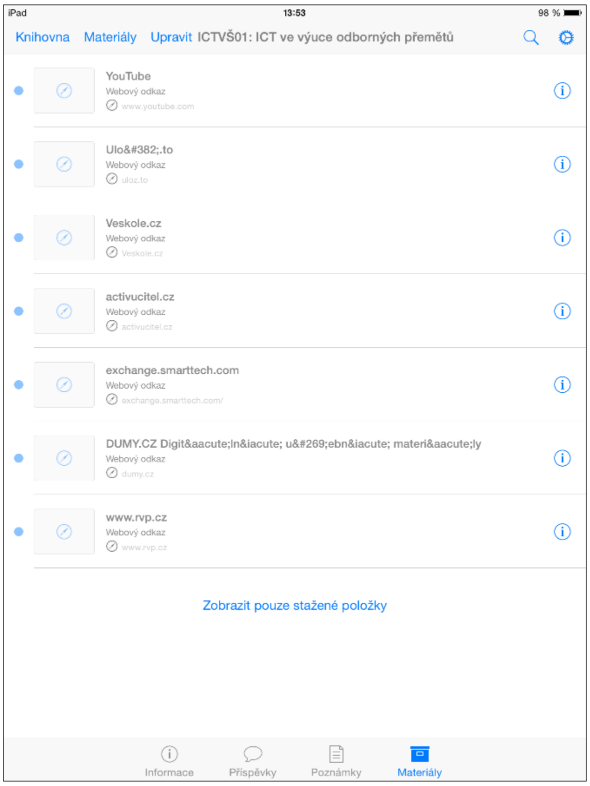


Fig. 1 and Fig. 2: Screenshots from the course „ICT in Specialized Subjects”

All materials that the user inserts into the course are immediately visible to the user who is subscribed to the course. It is true this is not a course similar to the ones in the LMS Moodle environment, but it can serve as an alternative of self-study for university students (with inserting of materials for a particular subject/course/module).

Conclusion

The electronic version of the “ICT in specialized subjects” course created in the iTunes U environment is one of the partial courses that are created at the University of Ostrava. It is now being prepared for its implementation into the education process.

The aim of the particular pilot testing is to show academics that it is not necessary to have the Apple material equipment for creating and implementing of the materials created in the iTunes U environment, and that using the Apple technologies only allows for more possibilities.

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