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Department of Chemistry and Chemistry Education

PROJECT-BASED EDUCATION AND OTHER ACTIVATING STRATEGIES IN SCIENCE EDUCATION XVI.

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Martin Rusek, Karel Vojíř (Eds.)

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ICT-supported Interactive Tasks in Chemistry teaching at the ISCED 2 Level as a Method of Active Teaching

Timur Sadykov, Hana Čtrnáctová

Abstract

The purpose of this paper is to present created and tested interactive tasks for lower secondary schools based on the characteristics of interactive ICT-supported education. The use of ICT allows the teachers to create interactive tasks in various programs such as Hot Potatoes 6 or Learning apps - allows the students to use them on their own devices. This way of teaching enhances interactivity and adaptability within a lesson by providing the possibility of feedback to all participants. Furthermore, we developed and adapted interactive tasks for lower secondary schools which could be used in various parts of chemistry lessons. The students' attitudes toward interactive exercises were tested using simple questionnaire survey.

Key words

ICT Enhanced Teaching and Learning, Secondary School, Chemistry, Student Interest

INTRODUCTION

One of the main problems of chemistry education is finding ways to increase the students' activity during lessons. Active students acquire knowledge better, and they are generally more interested and motivated – as long as their tasks are somewhat related to the problems they face in their everyday lives and as long as they make use of modern technology (Koc, 2005).

Interactive learning is the ability to communicate or be in dialogue with someone (e.g. a person) or with something (e.g. a computer) (Maňák, 2003). Petruţa (2013), Kinash and Brand (2012) in their works describe using interactive methods and technologies of teaching, possibilities and practical value in the system of education. The main advantages of interactive forms of teaching and learning are widely known (Anisimova & Krasnova, 2015):

- improving the quality of knowledge, because students are actively involved in the learning process;
- increase the motivation of students in the educational process, acquisition of new material by not as passive listeners but as active participants;
- brings flexibility and creation of favourable atmosphere at studies;

- development of skills for mastering modern technical devices and information processing technologies.

The main disadvantages of interactive forms of teaching are:

- the instability of the system
- the insufficient ability of participants to work with technology
- teacher‘s weak ICT skills
- limited access to technology (in particular, overly expensive application programs) (Brdička, 2003).

This topic has been addressed also by authors of the PBE conference (Stárková, Rusek & Metelková, 2014) in its general form where technology enhances learning. Stárková and Rusek (2015) then discussed the use of m-technology as a phenomenon built on the premise that almost every member of the society has a portable, quite efficient computer on her most of the day.

INTERACTIVE TASK AS A METHOD OF ACTIVE LEARNING

Interactive tasks actively involve students in the learning process and provide them with information about their success; the students are to clarify, complete and systematize the knowledge they acquired during the lesson. Thanks to the way, their interest can be increased and their intellectual abilities stimulated (Petruţa, 2013). The students are allowed to use their own devices and the teachers are also able to see the students' results on their own device. This is referred to as the Bring Your Own Device (BYOD) or Bring Your Own Technology (BYOT) model. Using the BYOD model parents provide the technologies for their children's use in similar ways to other educational resources such as books (Falloon, 2015). Research undertaken in secondary schools highlights the importance of relationships between parents, students, teachers, IT technicians, principals, and the wider community in contributing to a successful mobile-learning program (Ng & Nicholas, 2013).This way of teaching enhances interactivity and adaptability within a lesson by providing the possibility of feedback to all participants. The use of ICT allows the teacher to create interactive tasks in various programs such as Hot Potatoes 6 or Learning apps (Sadykov & Čtrnáctová, 2017).

Hot Potatoes 6 is a program that enables creation of interactive web-based tasks of several basic types. All that is needed is to enter data - texts, questions, answers. Then they can be posted them on a website. The Hot Potatoes suite includes several applications:

- JQuiz – multiple-choice, short-answer;
- JClose – to create text exercises;
- JCross –online crossword;

- JMatch – matching/ordering and gap-fill exercises (Hot Potatoes 6, 2017).

Created on the service **learningapps.o**rg are didactic tasks, which could be used in all stages of the lesson: warm-up, introduction, presentation, practice, evaluation. It‘s also possible to create individual tasks for students of different difficulty levels. The program includes various templates (matching pairs, group assignment, free text input, close text, matching pairs on images, multiple-choice quiz, audio/video with notices, the millionaire game, crossword) into which the user can upload their own content, and thus create into their own tasks (Learningapps.org, 2016).

We would like to show **two examples of interactive tasks** using these programs suitable for chemistry teaching at ISCED 2 level.

INTERACTIVE TASKS WITH A SHORT VIDEO

Digital video is an effective teaching method by which we can engage students' interest, help them understand a difficult concept, or improve their long-term retention of knowledge (Bell & Bull, 2010). Lopes and Soares (2016) found the opportunity to do online exercises and have access to the solutions (explained step by step) is crucial for students. The integration of the online video tasks into the educational process leads to an increase of students' motivation and interest for studying Financial Mathematics.

The short video can be used to introduce new chemical concepts and processes or other contexts in the real world and engage students in expressing their understanding of chemistry as they think about what has been said or displayed (Fig. 1-2).

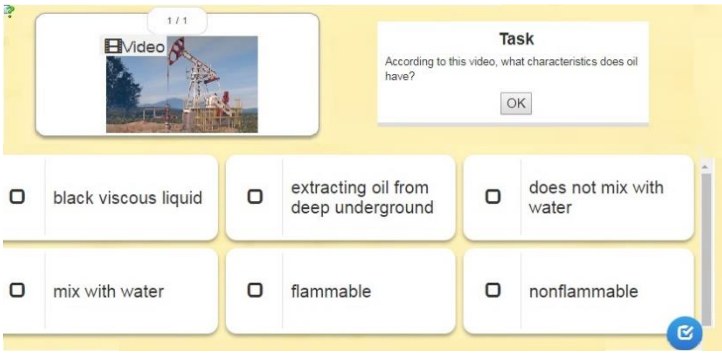

Fig. 1 Interactive exercise with a short video – question, source: authors.

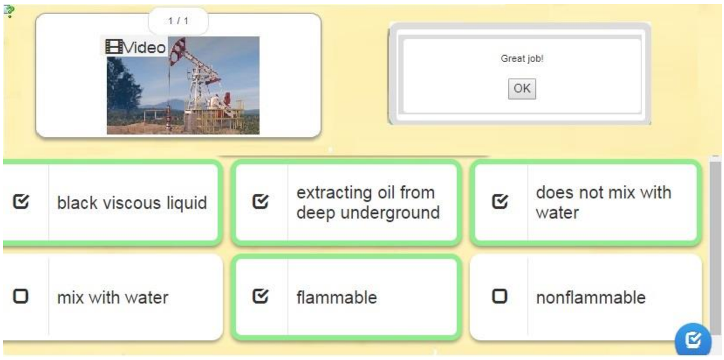

Fig. 2 Interactive exercise with a short video – answers, source: authors.

INTERACTIVE TASKS WITH STUDENTS' LABORATORY WORK

Lab experiments and other tasks carried out in school labs are considered a significant part of the teaching process in Science Education. Several design-based studies have scrutinized how various forms of digital support tools can support students' lab- and experiment-based work in school science. Digital tools in the form of simulations and tools aimed at supporting student reflection have been in focus (de Jong, 2006; de Jong et al., 2013). Starting with simulations, findings have indicated that a combination of physical and chemical lab experiments and support provided by virtual labs, often containing interactive simulation tools, can enhance students' conceptual understanding (de Jong et al., 2013; Smetana & Bell, 2012). Olympiou and Zacharia (2011) documented positive effects and showed that a combination of lab experiments and virtual tools enhanced students' conceptual understanding of light and colour more than the use of lab experiments or virtual tools alone. In this case, we use computers, laptops, tablets or mobile phones (e.g. to look up additional information about the reactants or to record an experiment and evaluate its results)

Laboratory work (General properties of mixtures) is aimed at establishing a relation between the structure of substances and their mutual solubility. Understanding this relationship allows students to predict the solubility of substances in different solvents (Fig. 3).

Fig. 3 The substances are present in the laboratory work, source: authors.

Before starting the laboratory work, students need to solve an interactive task (based on the substances, which are present in the laboratory) (Fig. 4-5).

Students try to answer the question, which of the properties of the analysed liquids is crucial for their mutual solubility in the interactive tasks (Fig. 6). Students will test the hypothesis by conducting an experiment.

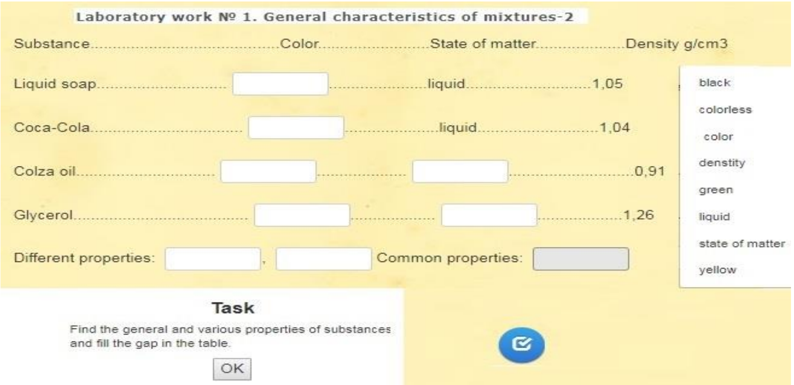

Fig. 4 Interactive exercises before laboratory work of students (task), source: authors.

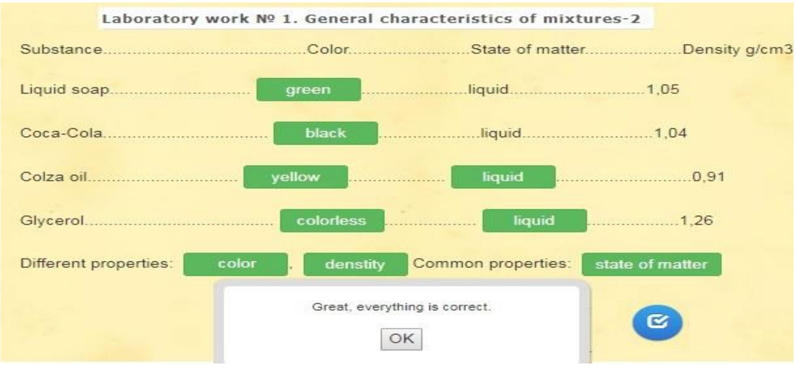

Fig. 5 Interactive exercises before laboratory work of students (student responses), source: authors.

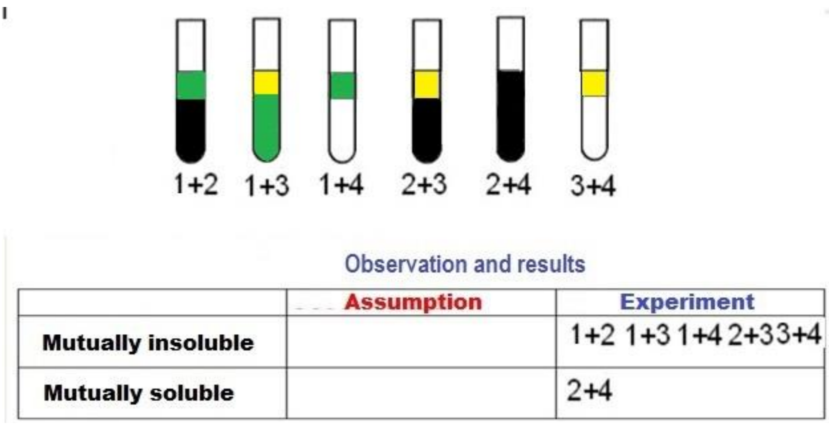

Fig. 6 Interactive practical task related to laboratory work and writing results of students, source: authors.

RESEARCH

We have created a questionnaire to find out the students' reactions to use of these exercises in the lessons with the help of laptops, tablets or mobile phones. The questionnaire used in this study consisted of three closed questions. It was adopted by the researchers mainly for practical reasons, as well as because of the effectiveness of codified answers in such types of questions. A five level non-comparative continuous balanced rating scale was selected as being the most appropriate to measure participants’ attitudes and views in the form of «strongly agree», «agree», «neutral», «disagree», «strongly disagree» answer types.

First verification was carried out on specialized school-board information technologies in Karaganda (Kazakhstan). The main objective of the educational program of the school is development of individual, creative and research abilities of students in the active study of the use of information and communication technologies. This school services 292 students in grades 7–9 (2 classes in Russian language and 2 classes in Kazakh language are taught in each year). The specialized IT school board is located in a large town (Karaganda), but despite this, the participating students came from rural as well as urban areas, and there was no selection as regards their intellectual or achievement level for them to participate.

Three classes were randomly chosen, in total **69 respondents** participated (**26 female and 43 male students**). Two classes of eighth grade consisted of 9 female and 14 male students. One class of ninth grade consisted of 8 female and 15 male students, which entailed a total of 4 hours of experimental action per student. Their age ranged from 14 to 15 years old. For the instruction phase, students were informed about the purpose of the research, as well as their expected role in it.

RESULT AND DISCUSSION

The results of the analysis of the questionnaires are herein presented, in the form of figures.

Question 1: Do you think that solving the tasks in this way is more interesting than the traditional solving?

The students' answers to question were as follows: («strongly agree» – 57 students out of 69 chose this option - 82,61%; «agree» and «neutral» – 6 students, 8,7% for each option). None of the students chose the options: «disagree» or «strongly disagree». There was no significant difference between the three groups regarding question 1 (Fig 7.).

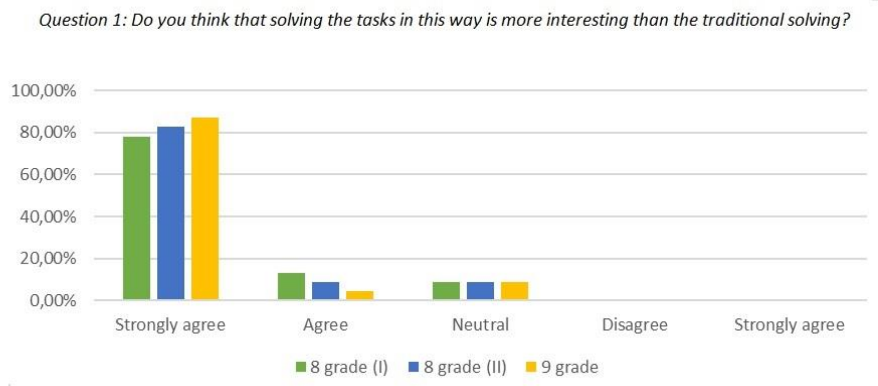

Fig. 7 The students ' answers to question 1, source: authors.

Question 2: Were you interested in solving the tasks using a mobile phone or a tablet?

The students' answers to question were as follows: («strongly agree» – 54 students out of 69 chose this option – 78,28%; «agree» and «neutral» – 7 students, 10,1% for each option; «disagree» – 1 student, 1,45%. None of the students chose the option «strongly disagree». It can be seen from figure 8 that eighth grade students are more interested than ninth grade in using mobile phones or tablets.

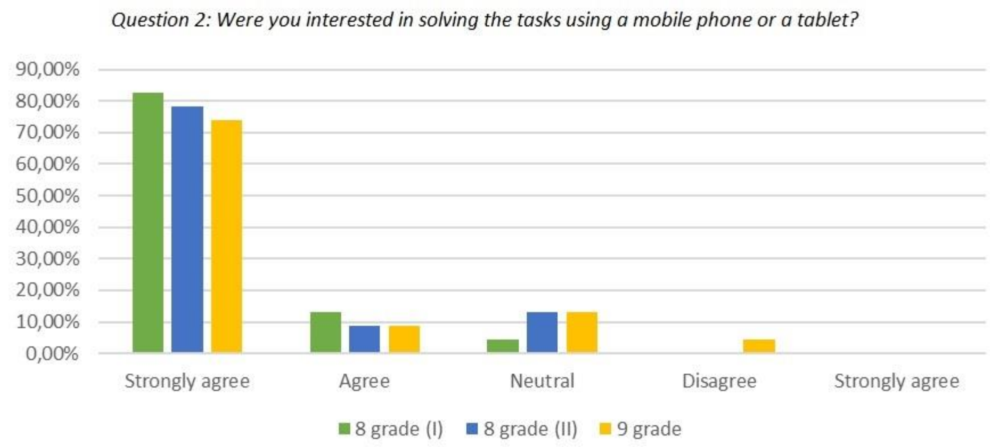

Fig. 8 The students ' answers to question 2, source: authors.

Question 3: Would you like if chemistry tasks like this could be solved more often?

The students ' answers to question were as follows: («strongly agree» – 54 students out of 69 chose this option – 78,25%; «agree» – 4 students (5,8%); «neutral» – 6 students (8,7%). The answer «disagree» – 5 students (7, 25%), due to their low frequency, cannot attach great importance. None of the students chose the option «strongly disagree» (Fig 9.).

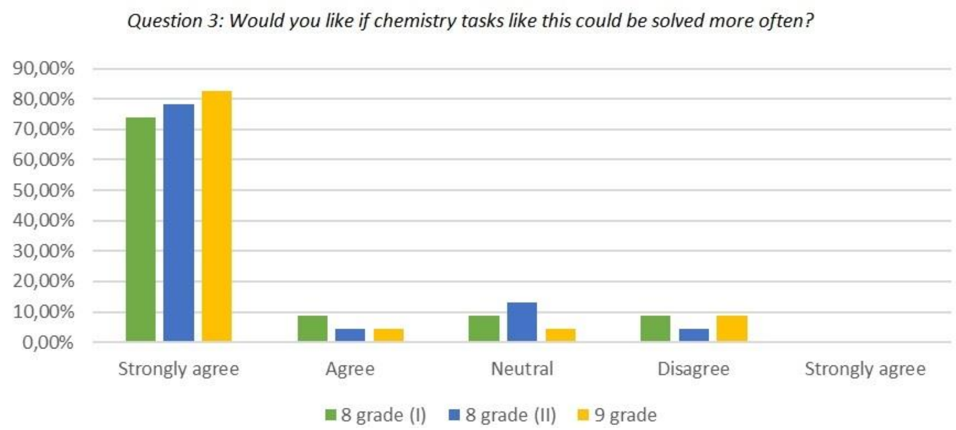

Fig. 9 The students ' answers to question 3, source: authors.

It can be seen from figures 7-9 that the interactive tasks can be accepted by more than 85% of students. More than 80% of the students like using a mobile phone or tablet while solving interactive tasks and want to solve new tasks.

Based on the review of the literature that we have conducted, only a few studies attempted to indicate attitude students towards the interactive tasks. Traykov and Galcheva (2017) stated that students from 9th grade at the "Dr. Petar Beron" School of Mathematics in Varna enjoy working in an interactive environment (69%) and this positively affects their attitude towards the tasks. Wijtmans et al., (2014) have examined several types of tasks that can be electronically enacted in classes and practical courses using these devices: multiple choice (MC) questions; open-ended questions; and 3D visualization of (bio)molecules and complexes.

We believe that combination of mobile phones and tablets allows several students to perform the activities at the same time, and this encouraged them to interact with each other. For instance, they discussed the correct answers of the activities, and they willingly helped their partners if they did not know the correct answer.

CONCLUSION

Firstly, we have defined and described the interactive tasks supporting an increase in the cognitive activity of students and the effectiveness of the learning process using ICT.

Furthermore, we developed and adapted interactive tasks for lower secondary schools, which could be used in various parts of chemistry lessons. The results showed that students enjoy working with interactive tasks and this positively affects their attitude towards the subject. It is clear that these results have to be considered preliminary because of the characteristics of the chosen school. Gradually, new tasks were created for most of the chemistry subject themes for lower secondary schools. In the next part, we will therefore focus on verification of the use of interactive tasks in other schools in both Kazakhstan and the Czech Republic.

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Inovace kurikula biologie a geologie: názory učitelů a hlavní principy pro budoucí vývoj kurikula

Biology and Geology Curriculum Innovation: Teachers´ View on Curriculum and the main principles for the future curriculum development

Vanda Janštová, Jakub Holec

Abstract

The Czech national curriculum defining the main principles, goals and outcomes for all educational stages in the Czech Republic is currently undergoing revision of all learning areas including science. We present a research of in-service teachers' and researchers' (n = 112) experience and needs connected to biology and geology curriculum. 88 teachers from different stages mostly want small or none changes. Some appreciate the freedom given by current curriculum, others would prefer detailed specifications of the content and time frame. Teachers from different schools have different views.

Key words

Curriculum, Biology, Science Education, Science Education Policy

ÚVOD

V současné době byl započat proces revizí Rámcových vzdělávacích programů (RVP), což poskytuje příležitost pro diskuze mezi učiteli z praxe, didaktiky i výzkumníky a další odbornou veřejností nad nejvhodnějším pojetím vzdělávání o živé a neživé přírodě. Jak poukazují různé studie, reforma zavádějící stávající RVP byla často učiteli přijata pouze formálně, aniž by nutně změnila obsah, či formy a metody výuky (Dvořák, Starý, & Urbánek, 2015; Janík, 2013; Janík et al., 2010; Štech, 2013). Jak poukazuje mj. Straková (2013), je to pravděpodobně dáno i tím, že byla podceněna diskuze mezi učiteli, výzkumníky a širší odbornou veřejností, která by reformě předcházela. Je také nutné, aby učitelé dostali potřebnou metodickou podporu (Straková, 2013). Revizím RVP proto předchází příprava podkladové studie, která obsahuje analýzu existujících zahraničních kurikulárních dokumentů, vybraných Školních vzdělávacích programů (ŠVP), učebnic biologie, výsledků výzkumu v didaktice biologie, relevantních strategických materiálů a analýzu podnětů zainteresovaných aktérů. Součástí posledně zmíněného je také on-line anketa pro učitele, jejíž výsledky jsou prezentovány v tomto příspěvku. Cíl, který jsme si kladli, byl následující: Zjistit, jak učitelé vnímají současný RVP.

METODIKA

Učitelé všech druhů škol vzdělávající na všech stupních v rámci přírodovědy, přírodopisu, biologie a geologie o živé a neživé přírodě byli v přípravném týdnu na školní rok 2018/2019 osloveni prostřednictvím elektronické ankety. Ta byla vytvořena v prostředí GoogleForms, odpovědi byly sbírány od 28. 8. 2018 do 7. 10. 2018. Anketa byla e-mailem rozeslána vyučujícím v síti škol spolupracujících s Národním ústavem pro vzdělávání, Přírodovědeckou fakultou Univerzity Karlovy, Univerzitou Jana Evangelisty Purkyně, Univerzitou Palackého, vzdělávacím centrem TEREZA a učitelům sledujícím web Přírodovědci.cz. Dále byla anketa sdílena v rámci skupiny sdružující učitele přírodovědných předmětů na sociální síti Facebook. Vyučující byli dotazováni na délku praxe a stupeň školy, na které respondenti učí a pohlaví. Dále jsme chtěli získat odpovědi na tyto otázky: Podle čeho učitelé sestavují tematické plány?; Kdy/v jakých případech učitelé pracují s RVP?; Čím je pro učitele RVP?; Jaký rozsah změn by učitelé v RVP chtěli a uvítali?; Měl by RVP zachovat volnost, nebo směřovat k pevným osnovám?; Má RVP nějaká problematická témata? Pokud ano, která to jsou? Některé otázky obsahovaly výběr z možností odpovědí vždy s možností „jiné“, některé otázky byly otevřené. Podoba otázek vycházela z potřeby získání názoru na současnou podobu RVP a byla inspirována dotazníkem rozeslaným učitelům fyziky v roce 2018 (Dvořák et al., 2018). Odpovědi byly sjednoceny (např. velká a malá písmena, překlepy) a vyhodnoceny jako četnosti odpovědí k jednotlivým otázkám. Vyřazeny byly odpovědi respondentů, kteří neučí na žádné škole ani ve školském zařízení. Byly ponechány odpovědi respondentů, kteří např. v současné době neučí přírodopis ani biologii, pracovníků školských zařízení a podobných organizací, kteří se věnují environmentální výchově, a lze tedy předpokládat, že při přípravě programů pro školy s RVP pracují. Vyřazeny dále byly zjevně neúplné odpovědi, u kterých byly vyplněny pouze první dvě či tři otázky. V případě, že u konkrétního respondenta chyběla odpověď na konkrétní otázku, byly vyhodnoceny odpovědi na zbylé otázky. Protože u některých otázek byla možnost volby více možných odpovědí, součty jednotlivých odpovědí nejsou vždy totožné s celkovým počtem respondentů. Z tohoto důvodu jsou uváděny absolutní, a ne relativní četnosti odpovědí.

VÝSLEDKY

Odpovědělo celkem 117 respondentů, z těchto odpovědí bylo 112 vyhodnoceno jako platné (87 žen a 25 mužů). Většina respondentů učí 10 a více let, přičemž se jedná především o učitele základních škol (Tab. 1, 2).

Tab. 1 Počty respondentů podle délky praxe, zdroj: autoři
Respondenti, kteří jsou v kategorii „neučí“ neučili přírodopis ani biologii v daném školním roce, ale na škole působili, nebo byli pracovníky školských zařízení.

	Neučí	Do 3 let	3 až 9 let	10 a více let
Počet respondentů	4	17	28	63

Tab. 2 Počty respondentů podle délky praxe, zdroj: autoři
Respondenti mohli vybrat více možností, celkový počet odpovědí tedy převyšuje počet respondentů. Nejčastější kombinace byla nižší a vyšší gymnázium, zvolilo ji 7 respondentů. Použité zkratky: MŠ mateřská škola, ZŠ základní škola, NG nižší gymnázium, VG vyšší gymnázium, SŠ jiná střední škola, VŠ vysoká škola

	MŠ	ZŠ	NG	VG	SŠ	VŠ	neučí
Počet respondentů	19	80	10	11	8	10	4

Při sestavování tematického plánu vyučující nejčastěji vychází ze ŠVP, se kterým aktivně pracují (79 % respondentů, na otázku, podle čeho sestavují tematické plány; odpověděli všichni respondenti, kteří učí). S RVP při tvorbě tematických plánů pracuje 36 vyučujících, srovnatelně s počtem těch, kteří využívají plány z předchozích let (Tab. 3).

Tab. 3 Zdroje informací používané při sestavování tematických plánů, zdroj: autoři
Respondenti mohli vybrat více možností, celkový počet odpovědí tedy převyšuje počet respondentů.

	ŠVP	RVP	Předchozí roky	Kolega	Jiné
Počet odpovědí	86	36	34	6	16

Jak je jejich povinností, RVP používají učitelé nejčastěji při tvorbě ŠVP, 38 % respondentů uvedlo, že s RVP pracuje během školního roku opakovaně (na otázku v jakých případech pracují s RVP odpověděli všichni respondenti, kteří učí), alespoň na začátku školního roku RVP otevře 22 učitelů (Tab. 4).

Tab. 4 Příležitosti využívání RVP, zdroj: autoři
Respondenti mohli vybrat více možností, celkový počet odpovědí tedy převyšuje počet respondentů. ČŠI – Česká školní inspekce.

	Tvorba ŠVP	Opakovaně	Na začátku školního roku	Nikdy	Při hodnocení ČŠI	Jiné
Počet odpovědí	61	41	22	8	4	5

Učitelé všech stupňů škol i respondenti, kteří neučí, vnímají RVP rozporuplně. Při hledání odpovědi na otázku „Čím je pro Vás RVP?“ se ukázalo, že polovina vysokoškolských učitelů vnímá RVP velmi kriticky. Tito vyučující odpovídali, že RVP je hloupost, či vede ke zkáze daného oboru (geologie). Velmi kriticky vnímalo RVP celkem 8 respondentů (níže v Tab. 5 „blábol“ a „nutné zlo“). Druhá polovina vysokoškolských pedagogů považuje RVP za určité vodítko, nebo uvedli, že na otázku nemohou kvalifikovaně odpovědět. Učitelé nižších stupňů škol obecně vnímali RVP nejčastěji jako dokument, který jim je zároveň inspirací i nutnou formalitou a poskytuje dostatek volnosti (Tab. 5). Nízké očekávané četnosti odpovědí v jednotlivých kategoriích neumožnily statistické testování případných rozdílů mezi vysokoškolskými a ostatními pedagogy.

Tab. 5 Četnosti odpovědí na otázku Čím je pro Vás RVP?, zdroj: autoři
Respondenti mohli vybrat více možností, celkový počet odpovědí tedy převyšuje počet respondentů.

	Inspirace, volnost	**Formalita**	**Základ, rámec, návod**	**Nutné zlo**	**Blábol**	**Povinnost**	**Jiné**
Počet odpovědí	31	30	29	6	2	2	5

Ukázalo se, že potřebnost změn RVP vnímají učitelé také velmi odlišně. Čtvrtina respondentů nepožaduje prakticky žádné změny, polovina malé změny. Takto odpovídali většinou učitelé mateřských, základních a středních škol. Dalších 13 respondentů by chtělo výraznější změny, podle 11 je nutné RVP zcela přepracovat. Mezi ně patřili zejména učitelé VŠ. Zbylí respondenti volili možnost jiné s komentáři např. zrušit a obnovit osnovy.

Nejednotnost odpovědí panovala i v otázce míry volnosti. Zhruba 40 % respondentů by chtělo co největší volnost (n = 48), zbylí by naopak přivítali změny, které by pevně zařadily témata do ročníků (n = 51) a přesně určily počet hodin, které je nutné věnovat jednotlivým tématům (n = 37). Zbylí vyučujících ve svých odpovědích zmiňovali potřebu zdůraznit vybraná pojetí výuky, konkrétní metody a její formy (praktická cvičení, terénní výuka, bádání, propojení výuky a praktického života žáků apod.). Někteří učitelé poukázali i na volnost, kterou RVP poskytuje, tedy že vyučují metodami a formami, které jim přijdou nejvhodnější.

Vyučující uváděli velmi různorodý výběr problematických biologických témat obsažených v RVP. Malý důraz je podle nich kladen na ekologii, ochranu životního prostředí a poznávání organismů (n = 12, resp. 7). Respondenti by omezili geologii a systematiku (n = 7, resp. 6), nejvíce učitelů si myslí, že v RVP žádná témata nechybí, ani by žádná neomezovali (n = 22, resp. 14). Jako odpovědi na tyty otázky vyučující často uváděli náměty, které se z podstaty netýkaly RVP, ale popisovaly spíše situaci na školách (špatné materiální vybavení), učebnice, případně ŠVP (příliš velký rozsah učiva, malá hodinová dotace pro konkrétní témata, pojetí systému organismů, zahájení výuky buněčnou biologií).

DISKUZE A ZÁVĚR

Výsledky provedeného dotazníkového šetření ukázaly, že RVP je vnímán rozporuplně. Většina vyučujících sice uvedla, že by současný dokument měnila málo, nebo vůbec, je ale možné, že to pramení z nedůvěry k budoucím změnám, i vzhledem k tomu, jak (ne)byla komunikována poslední reforma (Janík et al., 2010; Straková, 2013). Řada učitelů by naopak uvítala zásadní změny ve smyslu ukotvení učiva do konkrétních ročníků, či dokonce návratu k pevněji předepsaným hodinovým dotacím konkrétní témata. Tento rozpor může být dán tím, že učitelé cítí potřebu změny, ale pokud nevnímají možnost se na ní aktivně podílet, tak se se změnou vnitřně neztotožní (Dvořák et al., 2015). Straková, Spilková, Simonová, Friedleandaerová, & Hanzák (2013) také poukázali na velký rozptyl názorů učitelů na to, jak by změny měly vypadat. Výsledky ankety ukázaly, že někteří RVP považují za inspirativní dokument, který v praxi používají, a poskytuje jim potřebnou volnost. Jiní ho vnímají jako formalitu v souladu se studiemi Dvořáka et al. (2015) a Janíka et al. (2010). Konkrétní připomínky vyučujících se často netýkaly RVP, ale spíše ŠVP, situace na školách, či nedostatku aktuálních učebnic biologie, na což poukázali mj. Papáček, Čížková, Kubiatko, Petr & Závodská (2015). Zajímavý rozdíl byl mezi vnímáním RVP vysokoškolskými pedagogy, kteří dokument vnímali více kriticky, a učiteli z nižších stupňů škol, kteří pro změnu oceňovali především volnost, jež dokument poskytuje. To může být dáno například tím, že učitelé nižších stupňů škol kladou důraz především na žáka, zatímco učitelé vysokých škol a vyšších stupňů škol vnímají především důležitost vlastního oboru a znalostí, které daný obor nese. V tomto směru se jim možná obsahově velmi specifické osnovy jeví jako lepší volba ve srovnání s obsahově rozvolněným RVP, který dává do velké míry autonomii učitelům a školám v tom, co a kdy učit.

Jsme si vědomi limitů studie, které plynou z podstaty způsobu oslovování respondentů, kdy se jednalo o vybrané spolupracující učitele, ne o náhodný reprezentativní vzorek. Šlo o vyučující, u kterých lze předpokládat, že jsou spíše aktivní a zapojují se do spolupráce s vysokými školami či vzdělávacími centry. Protože jsme neměli k dispozici přesné seznamy oslovených osob, nebylo možné vyhodnotit případný překryv seznamů adres, na které byla žádost rozeslána, a tedy celkový počet oslovených. Z tohoto důvodu není vyhodnocena návratnost. Toto vše vede k tomu, že výsledky přináší pouze omezený vhled do názorů skupiny vyučujících a nelze je zobecnit.

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Hands-on activities in biology: students' opinion

Vanda Janštová, Jana Míková

Abstract

The study focuses on students' opinion on hands-on activities used during biology practical courses. Among the best rated activities were those connected to animals as dissections, recognition and microscopy, together with activities requiring students' invention. The worst rated were natural objects (e.g. rocks and minerals) recogniton and calculations. Most of the activities were considered better by girls: The difference was significant in the case of animal recognition, microscopy and inventing of own experiments. Boys regarded calculations more.

Key words

Biology, practical work in science, laboratory work in science, student interest, student opinion

INTRODUCTION

Practical courses can bring pupils to science (Stohr-Hunt, 1996) if they are well prepared and taught (van den Berg, 2013). This is of course true for other methods during which pupils can be active and express their own opinion (Freeman et al., 2014; Janštová & Rusek, 2015). When it comes to biology contents, animals and human biology are the most liked ones (Chudá, 2007; Malcová & Janštová, 2018; Prokop, Prokop, & Tunnicliffe, 2007) and even dissections can motivate students toward biology (Janštová, 2017). Practical work with animals can also reduce students' fear and disgust (Prokop & Fančovičová, 2017; Randler, Hummel, & Prokop, 2012). Zoology is the most favourite field even among students interested in biology who evaluate integrative biology fields like ecology, cell biology and evolution better (Janštová, Jáč, & Dvořáková, 2015). Geology (mostly taught as a part of biology in Czech Republic and Slovakia) is the worts rated one (Malcová & Janštová, 2018; Prokop & Komorníková, 2007; Veselský & Hrubišková, 2009) together with mycology and protozoology (Malcová & Janštová, 2018). Boys and girls evaluate some fields differently with girls giving better scores to botany (Prokop et al., 2007), human biology (Malcová & Janštová, 2018; Uitto, 2014), zoology and genetics (Malcová & Janštová, 2018). Also, teachers have their favourite fields to which they are likely to devote more time and energy upon (Bukáčková & Janštová, 2017). Biology contains quickly developing fields like molecular biology which should by part of school biology as well, but it is often not the case in Czech Republic (Janštová & Jáč, 2015; Vařejka, 2006). At the same time, the content can not only grow bigger without reconsidering what to reduce in school biology content (Škoda & Doulík, 2009). One possibility might be to integrate biology into big fields like genetics, evolution and cell biology with physiology (Wake, 2008), and simply to devote more time to favourite fields like human biology (Trumper, 2006) and leaving something else out.

In this study, we wanted to answer the following question: What is upper secondary school students' opinion on different hands-on activities connected to biology fields? We were also interested in whether the rating is influenced by gender and mark from biology obtained in previous year.

METHODOLOGY

We asked 88 upper secondary school students (n = 56 girls, n = 32 boys; 42 students with mean of 2 last marks from biology 1; 16 with mean mark 1.5; 24 with with mean mark 2 and 1 student with each mean mark 2.5; 3.5; 4) who experienced all the different types of hands-on activities (if not, they did not rate it) to rate different types of hands-on activities divided also by biology field on a 5 point Likert scale (1 – the best rating, 5 – the worst one). All rated activities were taught by tree biology teachers on two different upper secondary schools. The students rated following activities: dissection, plant recognition, animal recognition, microscopy of live organisms, microscopy of dead objects, natural objects recognition, planning experiments, conducting experiments, reasoning the results of experiments, human physiology, creating models (e.g. a cell, mitosis), role play (e.g. photosynthesis) and calculations. Non-parametric tests (Friedman ANOVA, Wilcoxon pair test) were used to calculate the differences among rating of biology fields using Statistica 12 (StatSoft). The differences were considered significant when $p < 0.05$. Effect size (Morris, 2008) was calculated for difference in rating between girls and boys (Lenhard, W. & Lenhard, A., 2016) and the effect was considered none if $d < 0.2$, small if $0.2 < d < 0.5$, intermediate if $0.5 < d < 0.8$ and large if $d > 0.8$.

RESULTS

All but one student experienced and gave opinion on life microscopy. Plant recognition was the second most experienced activity (n = 82). The least activity used was role play, followed by dissection, but still more than half (53, respectively 58) students experienced and rated it. Life microscopy, conducting experiments, animal recognition, planning experiments and dissections were rated significantly better than other activities ($p < 0.05$). Human physiology, reasoning experiments, creating models, microscopy of dead objects, and role play were in the middle with no differences among them. Calculations and recognition of natural objects were rated significantly worse than other hands-on activities ($p < 0.05$), see Fig. 1. Calculations were rated better by boys ($d = 0.53$) whereas microscopy of both dead and live objects together with planning experiments and animal recognition were better rated by girls ($p < 0.5$; $d = 0.80$; $d = 0.70$; $d = 0.67$; $d = 0.54$), see Tab. 1. The differences in rating by girls and boys were all intermediate.

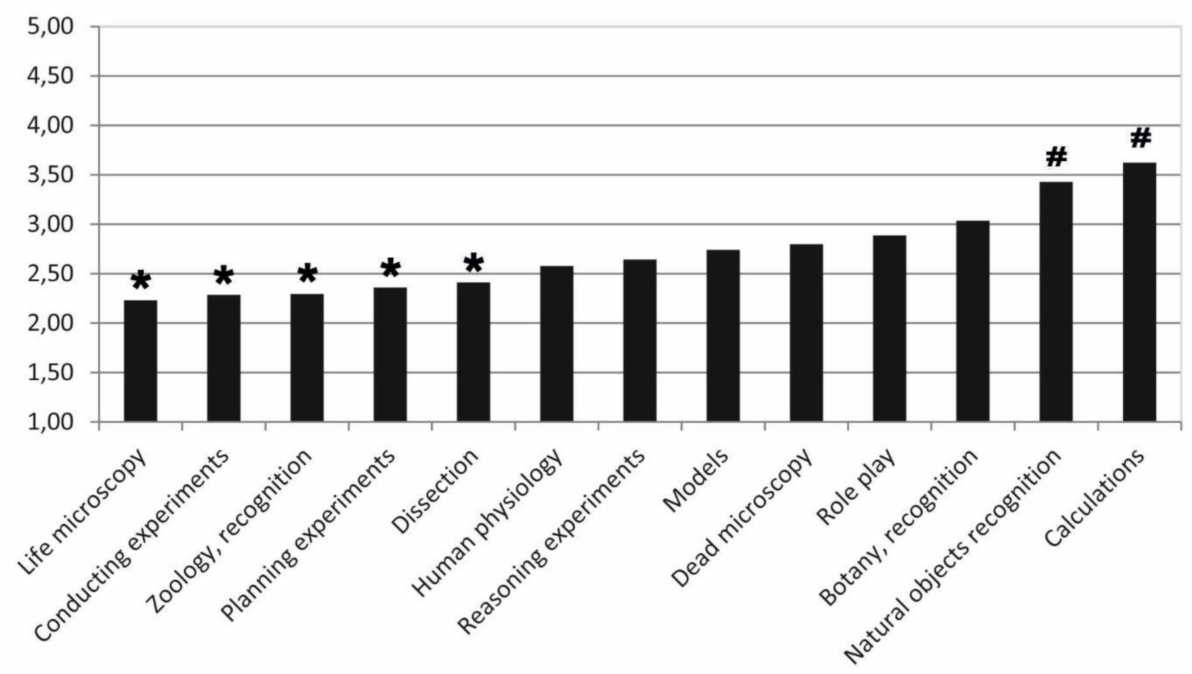

Fig. 1 Rating of different types of hands-on activities, source: author

1 is the best rating, 5 the worst. Activities with * were rated significantly better. Activities with # were rated significantly worse.

Tab. 1 Rating of different hands-on activities by gender, source: author

Activity	*No of students*	*Mean*	*SD*	*Mean girls*	*Mean boys*
Life microscopy	*87.00*	*2.23*	*1.06*	*1.95*	*2.67*
Conducting experiments	*70.00*	*2.29*	*1.08*	*2.14*	*2.53*
Zoology, recognition	*74.00*	*2.30*	*1.00*	*2.07*	*2.57*
Planning experiments	*69.00*	*2.36*	*1.15*	*2.12*	*2.84*
Dissection	*58.00*	*2.41*	*1.31*	*2.43*	*2.25*
Human physiology	*64.00*	*2.58*	*1.21*	*2.56*	*2.50*
Reasoning experiments	*70.00*	*2.64*	*1.02*	*2.60*	*2.63*
Models	*58.00*	*2.74*	*1.25*	*2.54*	*3.06*
Dead microscopy	*74.00*	*2.80*	*0.99*	*2.50*	*3.22*
Role play	*53.00*	*2.89*	*1.42*	*2.84*	*2.87*
Botany, recognition	*82.00*	*3.04*	*1.10*	*2.86*	*3.26*
Natural objects recognition	*77.00*	*3.43*	*1.11*	*3.44*	*3.35*
Calculations	*61.00*	*3.62*	*1.17*	*3.77*	*3.13*

The mean of two last marks from biology did not have influence on rating of the hands-on activities ($p > 0.05$).

DISCUSSION

The most experienced hands-on activity was life microscopy in concordance with Janštová (2015). Other best rated activities included those with animals (animal recognition and dissection) and the ones during which students could use their inventive skills (conducting and planning experiments). Again, this is in agreement with other studies (Chudá, 2007; Malcová & Janštová, 2018; Prokop et al., 2007). Surprisingly, hands-on activities connected to human biology were not among the best rated. This can be caused by doing actvities like step-up test and similar human physiology excercises together with non-popular calculations. Calculations were performed also as genetics practical course which probably caused genetics was not that positively rated although it is pupular among Czech pupils (Malcová & Janštová, 2018). Together with calculations, less regarded was also „natural objects recognition" which often means geology and recognition of minerals and rocks. Here, the unpopular topic (Malcová & Janštová, 2018; Prokop & Komorníková, 2007; Veselský & Hrubišková, 2009) probably caused bad rating of an activity which can be popular when it comes to animals. This brings us to a question which are the most effective activities and contents. A popular and well evaluated topic which is seen as very useful like human biology (Malcová & Janštová, 2018; Trumper, 2006) can be rated worse when unpopular calculations are involved. From the other point of view it would be interesting to investigate the best topics for practising calculations and using the popular ones is the first choice. It is an open question if to teach pupils what they prefer like Trumper (2006) suggests or use popular activities to teach unpopular topics and vice versa. We suggest e.g. that teaching unpopular geology using popular activities could improve the rating of geology. Moreover, the context of human (biology) might be a good topic for practising calculations.

Gender influenced rating of some hands-on activities with girls rating them better than boys with the exception of calcualation. Other studies show girls rate biology as whole better than boys (e.g. Prokop et al., 2007). Mark from biology did not have an influence at rating but there was nearly no variation among the students' marks.

Limitations of the study

There are other factors known to influence students' perception of the subject and attitude toward it which could influence our results. One of them is teacher himself/herself (Chetty, Friedman, & Rockoff, 2012; Prokop, Tuncer, & Chudá, 2007) who moreover often has favourite biology field (Bukáčková & Janštová, 2017). In our study, the hands-on activities were taught during one year by three different teachers who could emphasize diffent aspects of the activities. Also, we could not ensure the number of repeating particular hands-on activity was the same for all students and that all students experienced the same activities. For example making models could be both making a model of a cell or modeling the proces of mitosis. This was due to the fact that each teacher could teach the hands-on activities accordong to his/her normal schedule.

CONCLUSION

Our study showed that not only different topic and biology fields are rated differenty. This is true also for different types of hands-on activities. The significantly better rated were microscopy (which is also the most common one), animal recognition and dissection and planning and conducting experiments. Calculations and recognition of natural objects were significantly less attractive than other hands-on activities, but boys rated calculations better than girls. On the other hand girls gave better marks to microscopy, animal recognition and planning experiments. The popular topics are suggested for teaching unpopular activities like calculations. Popular activities can be practised while teaching unpopular topics.

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Inquiry vs. cookbooks in practical teaching biology viewed by teachers

Vanda Janštová, Lenka Pavlasová

Abstract

We focused on biology teachers' opinion on inquiry and cookbook practicals and analysed their ability to formulate a hypothesis. Teachers experienced inquiry based practicals where formulation of hypothesis was required, and cookbook practicals. We asked them by short questionnaire which activities were novel, beneficial, easy or difficult, most useful and then we examined if they were able to formulate correct hypothesis. Although the teachers did not perceive inquiry as unknown nor as difficult four out of ten were not able to formulate a hypothesis. When asked which the most beneficial activities were, teachers mentioned cookbook ones. We suggest including more inquiry in teacher training.

Key words

Biology, Inquiry-based teaching, Inquiry-oriented learning

INTRODUCTION

There are many studies pointing at the positive effect of practical activities on students' attitudes, knowledge and even motivation (Grant, Malloy, & Hollowell, 2013; Holstermann, Grube, & Bögeholz, 2010; Janštová, 2017; Uitto & Kärnä, 2014). Of course, these activities have to be well prepared and through to have the desired didactic effect (Abrahams & Reiss, 2012; van den Berg, 2013). One of recommended approaches which seem to be very useful in teaching science is students´ inquiry (Inquiry Based Science Education, IBSE). Of course, all the teaching procedures have to be mastered by the teachers first before they can be properly used to teaching students.

Laboratory work by cookbook develops the basic ability to handle laboratory equipment, instruments and products of nature, learns to work exactly according to the instructions and introduces pupils to basic research methods. Inquiry develops pupils´ autonomy, ability to search for information, increases motivation, competitiveness, supports a different view of the subject, other teacher and pupil communication, cooperation and it leads to a better understanding of relationships between concepts (Stuchlíková, 2010). The inquiry-based laboratory approach supports student learning of high-level investigative skills, but at the same time it requires background knowledge matching the same level (Suits, 2004). As laboratory practise guided according cookbooks we consider first two levels of inquiry

(Banchi & Bell, 2008): *confirmation* (teachers provide students with research question, method and protocol and the results are known in advance) and *structured* (teacher provides students with research question, method and protocol, but the results are not known). As inquiry laboratory activities we consider the rest two levels of inquiry: *guided* (teacher provides only research questions) and *open* (teacher doesn´t provide any information). Both types of practical laboratory tasks have a place in teaching biology. The problem is if only laboratory work according to the cookbook and not higher levels of inquiry are included.

The level of readiness of science teachers to teach inquiry is not very often examined. According to the questionnaire survey Czech teachers did not understand the concept of the inquiry well and they often misunderstood the term inquiry-based learning (Radvanová, Čížková, & Martinková, 2018). Roth, McGinn, & Bowen (1998) examined 8 teachers with master or bachelor-degree in science who attended teaching courses. They did not engage to higher degree in scientific representation practise than Grade 8 students. According to van der Berg (2013) teachers don´t use suggestion for effective laboratory teaching which leads to the fact that traditional and less successful approach is still prevalent.

In our previous study (Pavlasová, Janštová & Lindner, 2018) we analysed skills of pre-service biology teachers at the end of their studies to formulate hypothesis, goal and question and read and reason the results. Formulating a hypothesis was more difficult than formulating a goal and a question (in concordance with our teaching experience). But when a hypothesis was formulated, it was mostly answered correctly. Pre-service teachers were better at reading and reasoning the results.

In this study, we examine skills of in-service teachers through solving real laboratory tasks. We asked the following research questions: Which type of practical activity do teachers find easy, difficult, beneficial, new and usable? Are they able to formulate correct hypothesis?

METODOLOGY

Ten in-service science and mathematics secondary school teachers (all females), participants of five days long professional development course took part in this study. During the course, one day was devoted to practical biology and hands-on activities for practical courses both cookbook and inquiry. During the cookbook activities, teachers were required to follow the manual and make different models e.g. heart valve model (Hudson, 2014), chromosomes during mitosis model (Poethig & Waldron, 2003), model of lungs during breathing, genetic shift (Balgopal & Bondy, 2011), ontogenesis (Chowning, Griswold, Mathwig, & Massey, 2008) or inner surface of small intestine (Westrich & Berg, 2011). Two IBSE activities were focused on osmosis. The teachers were required to state a hypothesis, carry an experiment to test it and decide whether the hypothesis was true or not during following IBSE. In the first activity, the teachers could use potatoes chips, 1 M sucrose solution and different scales, ruler etc. Agar with NaOH and phenolphtalein together with vinegar (and more instruments like cooker on request) were used in the second IBSE activity (possible setting e.g. Nuffield Foundation). The activities were not limited by time. Manual skills were required both in making models and in inquiry hands-on activities as these included cutting and measuring.

All teachers filled a questionnaire with open-ended questions evaluating which activities and what about them was novel, beneficial, easy or difficult and most useful. They were also asked about what they plan to use during their lessons, if anything. The first part a) of the questionnaire was about all activities in general, the second part b) was focused on IBSE activities only. The answers were analysed by qualitative approach and were coded into categories by agreement of both researches, authors of the text. Individual teachers are marked T1 – T10. In part a) we identified following categories: cookbook (when the mentioned part of task were part of a cookbook activity, e.g statement The most difficult was to make heart valve model, T1), inquiry (when the mentioned part of task were part of an inquiry activity, I plan to use experiment as a whole, I mean osmosis, T8), both (when the mentioned parts of tasks were part of both cookbook and inquiry activities), nothing and other. Answers in part b) were used to gain additional information to inquiry labs. We analysed the frequencies of answers in categories and we illustrated our findings by examples of teacher quotes. The teachers´ hypotheses were evaluated from two points of view: i) formal structure, formulation including a possible effect of an independent variable on a dependent variable, and ii) the possibility of such hypothesis being tested.

RESULTS

All laboratory activities presented to teachers were found as novel and useful. Some teachers thought there were new and useful cookbook activities, some thought of inquiry and some of both. Cookbook activities were perceived as beneficial more often than inquiry labs, which weren´t named in any case. Further mentioned benefits were connection with Math, practicality of tasks and usage of cheap material. Half of the teachers stated the most difficult task was a part of cookbook activities, one teacher named an issue in inquiry task. All these difficulties were only technical. Again, five teachers found the easiest task as a part of cookbook activities. Two teachers suggested to provide printed manuals. The answers are summed up in Table 1.

Tab. 1 Frequency of answers in the first part a) of the questionnaire, source: authors

Which laboratory activity was…						
Categories	**Novel**	**Beneficial**	**Easiest**	**Most difficult**	**Useful**	**Further use**
Cookbook	3	4	5	5	3	3
Inquiry	3	0	0	1	2	1
Cookbook and inquiry together	4	2	0	0	5	0
Nothing	0	0	3	3	0	0
Other	0	4	2	1	0	6

The second part of the questionnaire b) focused only on inquiry activities. One teacher named a technical problem other nine found nothing difficult about them. Easiest were calculations (5 teachers). Only one teacher mentioned the “different“ inquiry approach in answer to the question what was most beneficial. Most of the teachers (6) plan to use both types of activities in their future teaching, one stated only inquiry task.

Six teachers formulated formally correct hypotheses which could be tested during inquiry-based osmosis task (4 put in relation diffusion speed and size, one diffusion speed and temperature, one hypotonic and hypertonic solutions and potatoes chip size). Three teachers did not formulate any hypothesis and one wrote only a note, not hypothesis. All correctly formulated hypotheses could be also tested.

There are three examples of answer combinations for individual teachers bellow. One of the teachers did not state a hypothesis, but found nothing difficult about inquiry, plans to use models in her future teaching and would like to get printed manual for the activities. Another teacher who did not state a hypothesis found formulating hypothesis difficult, plans to use osmosis and would also like to get printed manual for the activities. The teacher with badly formulated hypothesis found nothing new and nothing difficult about inquiry approach and plans to use models in her future teaching.

DISCUSSION

There is quite wide conformity of different authors at the obstacles to the introduction of IBSE. They mention first the incompetence of teachers providing instruction in science and technology subjects. Teachers are expected to pass on the "essence of the scientific method" and to awaken the interest and enthusiasm of the pupils. It is difficult if they do not have the proper knowledge (OECD, 2006). These conclusions are confirmed by Dostál (2013), who asks “Are teachers working in educational practice competent to carry out inquiry-based teaching?” in context of application of IBSE and by

Čížková and Čtrnáctová (2016), who mention insufficient teacher interest and lack of teacher readiness.

Only one teacher in our study found inquiry approach beneficial and none of them stated inquiry was new or that they had problems with it. This would suggest the teachers think they know how inquiry works and do not find it difficult, but still 4 out of 10 were not able to formulate a correct hypothesis. This finding is in concordance with Radvanová, Čížková, & Martinková (2018) who found teachers know the term inquiry but often misunderstood it. Formulating a hypothesis was difficult also for pre-service teachers (Pavlasová, Janštová & Lindner, 2018). The in-service teachers in this study would also prefer to have printed manuals on hand. Lack of manuals was often mentioned as a problem by in-service biology teachers in a survey by Janštová (2015). This all shows us teachers hear the term inquiry all around them but still may not be able to apply inquiry themselves and guide their students in the process.

This situation should be changed by routine using IBSE in both pre-service (Suits, 2004) and in-service (Čížková & Čtrnáctová, 2016) teachers' education and training. As Čížková and Čtrnáctová (2016) pointed out, the pre-service teachers are often under prepared and we lack a system of compulsory professional development of in-service teachers.

Of course, our study has some limitations. We examined only one small group of teachers (n=10) during voluntary professional development course. Our findings thus can be interpreted only with regard to this fact and cannot be generalized. We are aware of the fact that topic can influence the rating of the hands-on activity as shown by (Janštová & Míková, 2019). Modelling was neutrally rated by pupils (Janštová & Míková, 2019.). Different biological content was chosen deliberately not to tie the activity to one biological field which could influence the result as well as different biology disciplines are perceived differently bothy by pupils (Strgar, 2007) and teachers (Bukáčková & Janštová, 2017). In this case, the teachers were modelling both processes e.g. lungs during breathing, heart valves (Hudson, 2014), genetic shift (Balgopal & Bondy, 2011) or ontogenesis (Chowning, Griswold, Mathwig, & Massey, 2008) and structures e.g. inner surface of small intestine (Westrich & Berg, 2011). The inquiry practical courses included planning and conducting experiments, both evaluated as interesting by the pupils and calculations, evaluated as not interesting (Janštová & Míková, 2019). In this case we tried to use worse rated activity to “neutralize“ the possible influence of interesting inquiry activities.

CONCLUSION

IBSE has been shown to be an effective method of teaching science and biology (Rocard, 2007), teachers should master it to be able to use it while teaching their students. In this study, we found out that although teachers do not think inquiry is difficult or new to them they still might not be able to formulate a hypothesis which is one of the key steps in IBSE. We believe IBSE should be regularly used in pre-service teacher education and in-service teacher professional development. We hope this will lead to a needed improvement of teaching biology at schools.

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Ecological and carbon footprints and their role in the perception of climate change among pre-service science teachers

Lucia Kováčová, Ľubomír Held, Martin Pipíška

Abstract

Our research was focused on the perceptions of climate change among future science teachers. We also asked whether a knowledge of their own ecological and carbon footprints changed the students' attitudes towards climate change. To determine the study participants' impact on the environment and on greenhouse gas increases, a software that measures ecological and carbon footprints was used. The semantic differential method was used to determine how pre-service teachers understand the term "climate change" and the Climate Change Attitude Survey to measure students' attitudes towards environment with focus on climate change. The results indicate that pre-service teachers are not apathetic towards the climate change and calculating their ecological or carbon footprint allows them to determine some aspects of the influence of their own activities on the environment.

Key words

Environment, Emotion, Attitudes, Beliefs

INTRODUCTION

Climate change is one of the greatest challenges faced by humanity in the 21st century, and, according to the October 2018 report of the Intergovernmental Panel on Climate Change (2018), human activity has caused the global mean temperature to rise by 1ºC since the industrial revolution. If this trend continues at the same pace, the global temperature will rise by 1.5ºC from 2030 to 2050. Whitmarsh et al. found that personal transport and energy use in the home are together responsible for more than a third of global carbon emissions. Vandenbergh and Steinemann (2007) added that we should not focus only on the greenhouse gas emissions made by factories and other industry, but also those made by individuals. Everyone's carbon footprint is unique. For this reason, if people are familiarized with their own carbon footprint, they can alter their activities and behavior in order to reduce it. However, most laypeople are only indirectly aware, if at all, of how their energy use is connected to climate change (Smith, Kim & Son, 2017).

To form a constructive attitude towards this theme and foster environmentally responsible behavior, it can be useful to find out exactly how our actions influence the environment, as well as how our daily activities are connected to increases in greenhouse gas emissions.

THEORETICAL BACKGROUND

The relationship between a person and their environment can be defined in terms of ecological footprint (Öz-Aydin, 2016). In their book *Our ecological footprint: Reducing human impact on the Earth*, the sociologists Wackernagal and Rees (1996) determined the area required by one human or a population to ensure sustainability. In other words, ecological footprint is an indicator of long-term sustainable development; it quantifies how much regenerative biological capacity is consumed by human activity and can thus determine whether global human consumption has exceeded a given limit (McNichol et al., 2011, Kitzes a Wackernagel, 2009). A study by Keleş and Aydoğdu (2010) showed that the concept of ecological footprint can be used to educate future teachers of science and technical subjects about the environment, and that it has a positive influence on awareness, attitudes, and behavior. McNichol et al. (2011) attempted to quantify the environmental impact of one Australian university kindergarten by measuring the children's ecological footprint.

Carbon footprint is a subcategory of ecological footprint and is defined as the amount of greenhouse gases (e.g. CO_2) produced by human activity (Lin, 2015). According to Lynas and Kutluğ (2009, In Öz-Aydin, 2016), the concept of carbon footprint can be used to measure the influence of an individual on climate change. That is, a person can mitigate climate change by reducing their carbon footprint (Borgstede et al. 2013, Lin, 2015). Carbon footprint calculators, such as that introduced by the Climate Coalition (accessed on 27.01.2017), can be used to estimate greenhouse gas emissions associated with human activity. In Sweden, Endstrand (2015) determined how the use of a carbon footprint calculator influenced education about environmental themes and climate change. In that study, the calculator allowed students to understand the connection between climate change and human activity. Moreover, it enabled the students to quantify, analyze, and compare greenhouse gas emissions on an individual level, as well as across an entire country. Another contribution of this nature was published by Vojíř, Honskusová, Rusek and Kolář (2019) who proposed and evaluated a laboratory task focused on organic compounds reactions in the atmosphere or Kuncová and Rusek (2019) who in similar way focused on oxygen.

AIMS AND METHODS OF THE RESEARCH

The present study aimed to (1) identify the attitudes of future science teachers towards climate change and (2) determine whether these attitudes had changed after the students had calculated their own ecological and carbon footprints. The respondents comprised 47 first-year students of teaching science subjects. Research was conducted in December 2016 at Trnava University in Trnava, Slovakia and it used two main tools: the semantic differential and the Climate Change Attitudes Survey. Both tools were used in both the pre- and post-tests.

Two weeks after the administration of pre-test, the students' task was to use an online calculator to estimate their own ecological and carbon footprints. To calculate their ecological footprint, the students used the calculator at www.ekostopa.sk: an educational program that arose as part of the project "Improving Environmental Awareness in the Field of Nature and Countryside Conservation" (including NATURA 2000) (SZAP, 2018). The calculator estimates an individual's ecological footprint by pitching simple questions about everyday life. The respondents estimated their carbon footprint using a calculator found at www.zmenaklimatu.cz. The resulting carbon footprint shows the connection between greenhouse gas emissions and the home, transport, consumption, and waste production. Three days after the activity the post-test was distributed to students.

Using a semantic differential, we determined the connotative meaning of the term "climate change," based on the work of Seetaram (2012), who used the same method to determine the difference in use between the terms "global warming" and "climate change." In the present study, a semantic differential was created using 13 pairs of adjectives with opposite meaning, focused on the attitudes and emotions. For each of these pairs of adjectives, a 7-point scale was used to indicate which term better described how the students perceived the term "climate change."

The second research tool used was the Climate Change Attitude Survey (CCAS), which comprises 15 questions that determine the beliefs and intentions of respondents with regards to the environment, with an emphasis on climate change. We based our questionnaire design on the work of Christensen and Knezek (2015). The data were analyzed using a 5-point Likert scale. Each of the 15 fields contained a claim about the environment—mainly climate change. The respondents' task was to express to what degree they agreed with this claim (1, completely agree; 5, completely disagree).

In our research the following hypotheses were tested:

H_{01}: Calculation of carbon and ecological footprint has no effect on perception of the concept climate change among pre-service teachers.

H_{A1}: Calculation of carbon and ecological footprint has an effect on perception of the concept climate change among pre-service teachers.

H_{02}: Calculation of carbon and ecological footprint has no effect on pre-service teachers' attitudes towards climate change.

H_{A2}: Calculation of carbon and ecological footprint has effect on pre-service teachers' attitudes towards climate change.

RESULTS

We evaluated the data using Microsoft Excel (Office 365) and SPSS 23. Both pre- and post-test, we determined how reliable each of the research methods was using the Guttman split-half coefficient and the Cronbach α coefficient. Table 1 shows the results. Values higher than .50 and lower than .70 may be evaluated as acceptable if the translation of the research tool was used for the first time in the country (Kubiatko, 2016). This was the case of our research. Lower values of reliability in semantic differential may be caused by the small number of items (Tavakol, Dennick, 2011, Griethuijsen, et al., 2014).

Tab. 1 Reliability of the research tools

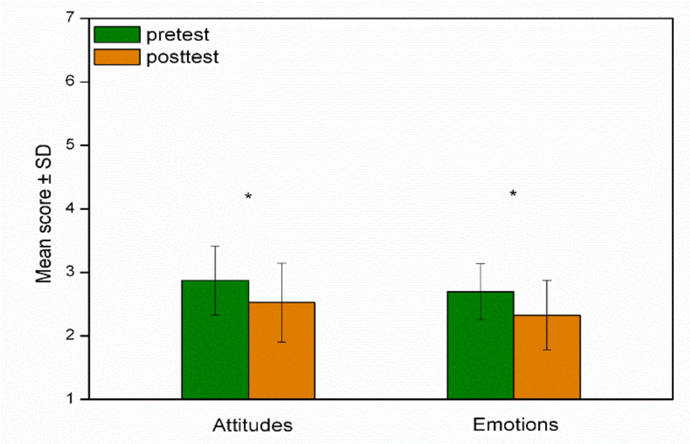
	Cronbach α coefficient		**Guttman Split-Half coefficient**
	Pretest	Posttest	
Semantic differential	0,625	0,556	0,691
CCAS	0,702	0,724	0,677

We confirmed that the data were normally distributed using the Shapiro–Wilk test ($p \geq .7$), and statistical significance was determined using the paired t-test.

Semantic differential

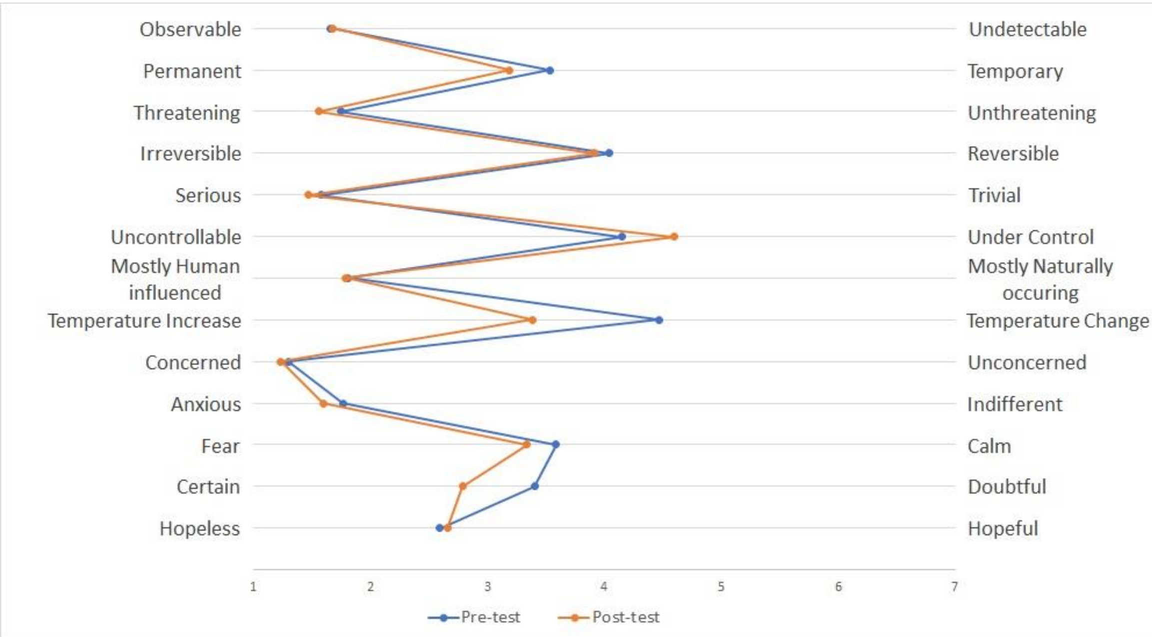
The overall average scores of the future teachers in the present study were $\bar{x}$ = 2.7 (SD = .60) in the pre-test and $\bar{x}$ = 2.4 (SD = .53) in the post-test. There was significant difference (p = .001, t = 3.31). We reject the null hypothesis (H_{01}) and accept the alternative hypothesis (H_{A1}). If the average score is between 3.5 and 4.5, the term is perceived in a neutral manner (Patočková, 2014). Our values indicate that, in both the pre- and post-tests, the respondents perceived the term climate change as having more serious and pessimistic connotations.

As described by Seetaram (2012), our research tool was divided into two dimensions: attitudes and emotions. Graph 1 shows the scores for the individual dimensions in the pre- and post-test.



Graph 1: Semantic differential. Average scores in the individual dimensions (*p < .05)

In the attitudes, the average score in the pre-test was $\bar{x}$ = 2.9 (SD = .54), while that in the post-test was $\bar{x}$ = 2.6 (.44), constituting a significant difference (*p* = .04, t = 2.1) and indicating that the respondents perceived the term "climate change" as a serious problem. In the emotional dimension, the pre-test average scores were $\bar{x}$ = 2.6 (SD = .62), while the post-test average was $\bar{x}$ = 2.3 (SD = .55), constituting a significant difference (*p* = .02, t = 2.4). These scores indicated that the respondents perceived the term "climate change" in pessimistic emotions, tending towards adjectives like "concerned" or "fear."

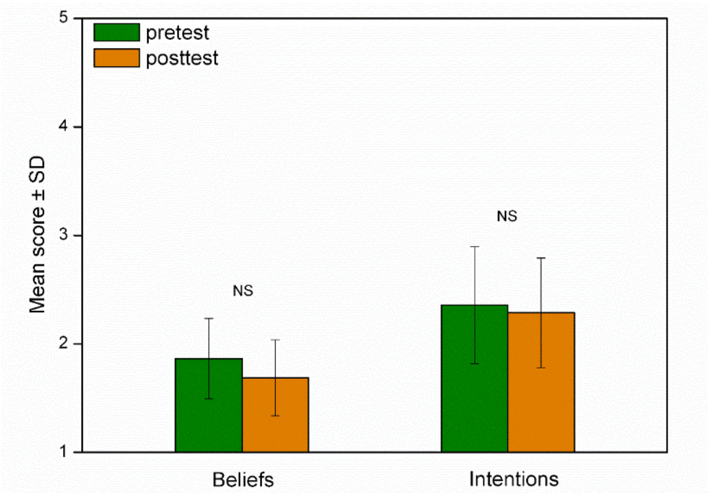


Graph 2: Semantic differential. Average scores of the individual fields.

Graph 2 shows the average scores in the individual fields. The field "certain - doubtful" was particularly interesting, because the average pre-test score was $\bar{x}$ = 3.4, while the average post-test score had fallen to $\bar{x}$ = 2.7, indicating that the students' doubts about climate change had been mitigated after they had calculated their eco- and carbon footprints. The respondents felt strongly that climate change affects us personally, as indicated by the scores close to 1 in both the pre-test and post-test.

Climate Change Attitude Survey

Overall, the average pre-test score of future teachers in the CCAS questionnaire was $\bar{x}$ = 2.0 (SD = .52), while the average post-test score was $\bar{x}$ = 1.9 (SD = .53) in the post-test. There was no significant difference (p = .71, t = .37), therefore we fail to reject the null hypothesis (H_{02}). It follows that the respondents had a generally positive attitude towards climate change, corroborating the study by Christensen and Knezek (2015), who also divided their research methods into two categories: beliefs and intentions (Graph 3).



Graph 3: CCAS. Average scores in the individual dimensions (NS – not significant)

We found no significant differences in beliefs (p = .16, t = 1,43) or intentions (p = .448, t = .77) between the pre- and post-tests. The *beliefs* dimension showed average scores of < 2 in both the pre-test ($\bar{x}$ = 1.8; SD = .37) and the post-test ($\bar{x}$ = 1.7; SD = .35), indicating a positive attitude and interest in the environmental problem. Similarly, the average scores in the *intentions* fields tended towards a positive evaluation, indicating that the respondents were inclined to attempt to mitigate their effect on climate change (pre-test: $\bar{x}$ = 2.4, SD = .54; post-test: $\bar{x}$ = 2.3, SD = .50).

The following fields showed the greatest levels of agreement, whereby the average scores tended towards 1: *I believe our climate is changing*, *Global climate change will impact future generations*. Conversely, the following fields showed the greatest levels of disagreement: *I think most of the concerns about environmental problems have been exaggerated*, *It is a waste of time to work to solve environmental problems*. The biggest differences between the average scores in pre- and post-test were in the fields: *I am concerned about global climate* change, *The actions of individuals can make a positive difference in global climate change*. Determining one’s own eco- and carbon footprint convinced the respondents that their own environmentally friendly actions can improve the environment and mitigate climate change.

DISCUSSION

In the present research, the respondents perceived climate change as a serious environmental problem that requires a concerted effort to solve. By calculating their own ecological and carbon footprints, the future teachers in the present study were further convinced of this position. Other studies have shown that calculation of a person's own ecological and carbon footprint has a positive effect on attitudes towards climate change (Endstrand, 2015, Keleş and Aydoğdu, 2010, Cordera et al., 2008).

According to Franzen a Vogl (2013), both knowledge level and political inclination influence an individual's opinions and attitudes towards environmental problems. This finding was confirmed in a study by Bradley et al. (1999), in which students with higher scores in a knowledge test showed more positive attitudes towards the environment.

The future teachers in the current research regarded climate change as an environmental problem that affects us personally and is influenced by human activity. Similar results were found in a study by Esa (2010), which focused on determining the environmental attitudes, knowledge, and skills of future teachers. The results showed that 69.3% of respondents completely agreed and 28.1% agreed that climate change is an environmental problem that is influenced by human activity. In contrast, a qualitative study by Pruneau (2011), which focused on the notions that children, adolescents, and adults have about climate change, demonstrated that the participants were unaware of the effects of global warming, even though they were familiar with the term. Many adolescents and adults claimed that climate change had no effect on their life. Tuncer et al. (2007) found similar results.

We agree with McNichol et al. (2011), who claimed that introducing the concept of ecological and carbon footprint in preschool education may show children the connection among the food they eat, the agricultural land that they use, and their environmental impact. As has been shown in many of the aforementioned studies, scientifically obtained information can contribute to pro-environmental behavior.

CONCLUSION

In the present work, the attitudes of future science teachers towards climate change were analyzed. To determine the connotative meaning of the term climate change, a semantic differential was used. Our results show that calculating their own ecological or carbon footprint significantly influenced how students perceived the term climate change, inclining the students towards more serious adjectives that illustrate the importance of this problem.

The attitude questionnaire CCAS showed no significant changes in the attitudes of future teachers, but the results indicate that students are not apathetic towards the environmental problem of climate change.

Based on the present study, we can conclude that calculating their ecological or carbon footprint allows students to determine some aspects of the influence of their own activities on the environment. This may prompt students to take specific steps towards reducing their own footprint.

The next phase of our research will focus on the influence of the calculation of the ecological and carbon footprint on the pupils' attitudes towards the climate change.

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V hlavní roli: kyslík

Starring: Oxygen

Lucie Kuncová, Martin Rusek

Abstract

This activity was designed to stress importance of oxygen for humans with a special focus on first aid. Two activities were tested. It starts with brainstorming about air, its importance, its composition etc. The teacher directs the discussion to oxygen. As the first activity, students encounter production of oxygen. They use an oxygen sensor to measure the production of oxygen by a plant under different conditions (dark, daylight, lamp). The second activity concerns human breathing. Students use the oxygen sensor to measure proportion of oxygen in the air in the lab, and later in the air they exhale.

Key words

Experiential Learning, Inquiry-oriented learning, Motivation, Health Education

ÚVOD

Experimentální složka výuky přírodovědných předmětů je jednou z nejčastěji zmiňovaných oblastí. Po vydání tzv. Rocardovy zprávy (Rocard, Csermely, Jorde, Lenzen, Walberg-Henriksson, & Hemmo, 2007) se do popředí díky aktivnímu zapojení žáka do učebního procesu dostává badatelsky orientované vyučování (BOV), které se jeví jako efektivnější varianta tradičních laboratorních prací (srov. van den Berg, 2013). Jednou ze základních charakteristik efektivní školní experimentální aktivity je její transparentnost (srov. Trna, 2013). Tento požadavek s sebou nese jistá omezení co do pomůckového vybavení i co do použitých látek. Dalším požadavkem je pak relevance[1] cílového učiva nebo poznatků.

S rostoucí popularitou BOV se samozřejmě objevují i aktivity, jejichž efektivita je diskutabilní. Podobně jako v případě projektového vyučování (srov. např.Rusek, 2017; Rusek & Becker, 2011) dostávají nálepku „badatelské aktivity“ činnosti, ve kterých zcela absentují základní principy badatelství, především pak důraz na rozvoj přírodovědného myšlení (např. Kuhn, 2002) prostřednictvím maximální autonomie žáků.

[1] Termínem relevance se zabývali autoři Stuckey, Hofstein, Mamlok-Naaman, and Eilks (2013), z jejichž textu vycházejí i autoři tohoto příspěvku.

Autoři tohoto příspěvku se v rámci dvou výše uvedených východisek a v duchu apelu na precizování stávajících namísto nahodilé tvorby nových badatelských úloh, či námětů na projekty (viz. Rusek & Vojíř, 2018), rozhodli pro výběr jednoduchého, již zpracovaného tématu. Jedná se o příspěvek k publikovaným textům zaměřeným na reakce v atmosféře (Vojíř, Honskusová, Rusek & Kolář, 2019) či ekologickou a uhlíkovou stopu (Kováčová, Held & Pipíška, 2019). S ohledem na potřebu relevance je možné najít paralelu s textem Tóthové, Matoušové, Šubové a Ruska (2019).

Náměty z pracovních listů v „Kuchařce" společnosti Vernier[2] byly přetvořeny do podoby badatelských aktivit. Žáci se tak zabývají kyslíkem po celou dobu jejich bádání, ovšem z různých pohledů. Nejprve z pohledu zastoupení kyslíku ve vzduchu a tvorby kyslíku, posléze z pohledu dýchání a poskytnutí první pomoci. Obě praktické aktivity jsou založeny na použití senzoru kyslíku připojitelného k počítači.

Aktivita lze v různých modifikacích použít jak se žáky základních škol, tak se žáky středních, popřípadě i vysokých škol.

ZAČLENĚNÍ AKTIVITY DO VÝUKY

Zvolené téma badatelsky orientované výuky zahrnuje mnoho tematických celků z Rámcového vzdělávacího programu pro základní vzdělávání (*Rámcový vzdělávací program pro základní vzdělávání*, 2017) i z Rámcového vzdělávacího programu pro gymnázia (2007). Aktivitu je možno využít v explanační fázi výuky chemie nebo biologie, zasahuje taktéž do průřezových témat Osobnostní a sociální výchova a Environmentální výchova.

Aktivita je vedena snahou pomoci žákům propojit vědomosti o kyslíku z více vzdělávacích oborů. Pomocí demonstrace a návodných otázek aktivita žáky vede k propojování nabytých vědomosti z více oborů. Díky tomu usnadní učitelům organizování učebních plánů do konkrétních tematických celků, dochází k posilování mezipředmětových vazeb a již zmíněnému posílení žáky vnímané relevance učiva (Lindner, 2014; Stuckey et al., 2013).

TEORETICKÁ VÝCHODISKA

Aktivity byly vedeny výše zmíněnými požadavky na transparentnost i na jednoduchost co do přístrojového vybavení i samotného provedení. Téma kyslík a první pomoc bylo vybráno jako

[2] Pracovní list pro první pokus je dostupný na: http://www.vernier.cz/stahnout/kucharka/kod/fotosynteza, pracovní list pro pokus s dýcháním je dostupný na: http://www.vernier.cz/stahnout/kucharka/kod/spotreba-kysliku-pri-dychani.

vhodné téma, které umožňuje i zapojení diskuse a má potenciál rozvíjení čtvrtého pilíře přírodovědné gramotnosti „Aktivní osvojení si a používání způsobů interakce přírodovědného poznání s ostatními segmenty lidského poznání či společnosti“ (Faltýn, Němčíková, & Zelendová, 2011). Pro komplexní rozvoj přírodovědné gramotnosti je velmi důležitá právě i praktická činnost žáků. Základem aktivity je samostatné bádání zaměřené na formulování a potvrzování předpokladů (hypotéz), důraz je kladen na význam poznatků v běžném životě.

CÍLE A METODOLOGIE

Cílem autorů bylo navrhnout, ověřit a zhodnotit badatelskou aktivitu založenou na experimentální činnosti (dále viz Rusek & Gabriel, 2013) s maximálním důrazem na zvýšení motivace žáků (Janštová & Rusek, 2015).

Návrh vycházel z výše uvedených teoretických východisek a vlastní zkušenosti autorů. Ověření probíhalo ve dvou krocích. Nejprve byla experimentální část ověřena samotnými autory, poté v kurzu Interaktivní výukové materiály se studenty druhého ročníku navazujícího magisterského studia[3] se specializací na výuku chemie na Pedagogické fakultě Univerzity Karlovy.

Zhodnocení aktivity probíhalo jednak prostřednictvím pozorování práce studentů na aktivitě, jednak s využitím nástroje IMI (Intrinsic Motivation Inventory) (Ryan & Deci, 2000). Respondenti odpovídali na sedmistupňové škále (1 – zcela nepravdivý, 7 – zcela pravdivý) na celkem 25 tvrzení. Ta se vztahují k pěti oblastem: *zájem* o aktivitu (7 tvrzení), *úsilí* vynaložené při řešení aktivity (5 tvrzení), *užitečnost* aktivitou získaných znalostí a dovedností (7 tvrzení), vnímaná *kompetence* při práci (6 tvrzení) a *tlak* vnímaný při zpracování úkolu (5 tvrzení). S ohledem na distribuci škály jsou hodnoty ordinální, tj. při jejich zpracování byly počítány mediány hodnot odpovědí v jednotlivých oblastí (Chytrý & Kroufek, 2017).

ORGANIZACE PROJEKTU

Časová náročnost aktivity je variabilní v závislosti na zvoleném pojetí i počtu úloh. V kompletním provedení zabere 3 vyučovací hodiny (3 x 45 minut). Toto uspořádání pojetí autoři považují za nejefektivnější. Projekt je řešený v menších skupinách po 3-5 žácích. K měření se v obou úlohách používá senzor koncentrace kyslíku např. Vernier O2-BTA, počet dostupných senzorů ovlivňuje počet skupin. V těchto skupinách žáci vymýšlejí správný postup úloh a odpovědi na otázky, které jsou jim

[3] Studenti studují obor vzdělávání v chemii v kombinaci s biologií a výchovou ke zdraví.

průběžně pokládány. Žáci si sami volí formu zpracování výstupů, spolupracují, rozdělují si úkoly v týmu (srov. Rusek, 2016).

Obě na sebe navazující aktivity (pokusy) jsou stejně koncipovány, žákům není předkládán celý pracovní list, ale získávají indicie (části pracovního listu) postupně. Tento postup je navržen s cílem podnítit žáky v uvažování nad problémem a k tvorbě předpokladů (hypotéz). Žáci na začátku dostanou pracovní list obsahující úvod do tématu a otázky před zahájením pokusu (viz Pracovní list). Učitel v roli moderátora začne s brainstormingem o vzduchu jako takovém. Diskuzi směruje k otázkám složení vzduchu, vzniku, funkci a významu kyslíku pro lidské tělo. Tato fáze je taktéž fází motivační. Žáci si zopakují teoretická východiska, která se jim budou hodit v dalším kroku. Následuje pasáž zaměřená na návrh vhodného postupu ověření hypotéz. V případě potřeby je k dispozici nápověda v podobě návrhu pomůcek, které budou při aktivitě využity. Následuje příprava a samotné řešení úlohy. V případě první úlohy (podmínky fotosyntézy) je nutné vždy počkat 10 minut, aby se produkce kyslíku za daných podmínek ustálila. Mezitím žáci odhadují výsledky pokusu a odpovídají společnými silami na další otázky (viz Pracovní list).

Po ukončení měření získají žáci poslední část pracovního listu úlohy, který žáky navede, jak zpracovat výsledky pokusu. Až na konci celé úlohy mají žáci vymyslet název úlohy. Tento krok je veden záměrem přimět žáky celou úlohu ještě jednou projít a shrnout myšlenkové postupy.

Po vypracování všech úloh následuje zhodnocení celé aktivity a zamyšlení se nad zásadami první pomocí – dýcháním z úst do úst. Cílem aktivity je učit žáky kritickému myšlení a podpora správného jednání při nutnosti poskytnutí první pomoci. Je zde kladen důraz na afektivní stránku žáků. Na závěr žáci vyplní připravený IMI dotazník.

HODNOCENÍ AKTIVITY

Jelikož byla aktivita ověřována pouze na studentech učitelství, týká se hodnocení pouze afektivní složky. Výsledky použitého nástroje IMI umožňují závěr, že jsou navržené aktivity vhodné pro realizaci. Čtyři respondenti, kteří aktivitu prováděli hodnotili její *zájem* o aktivitu hodnotou 7, tj. zcela souhlasí se sedmi tvrzeními vztaženými k zajímavosti úloh. Rovněž *užitečnost* aktivity a své *kompetence* hodnotili mediánem 7, resp. 6. Na pět otázek k vynaloženému *úsilí* respondenti odpověděli hodnotou 6, což lze interpretovat jako hodnocení výroků za „pravdivé“. Naopak hodnota mediánu odpovědí na otázky pocitu *tlaku* 1 umožňuje závěr, že respondenti považují výroky za nepravdivé a při řešení úkolů se necítili pod tlakem.

DISKUSE A ZÁVĚR

Téma dýchání se jeví jako vhodné pro řadu souvisejících podtémat. Nabízí řadu podtémat ať už z hlediska vzduchu a jeho složení, tak i z hlediska fyziologie. Míra podrobnosti pak určuje, nakolik se z oborového hlediska jedná o problematiku fyzikální, biologickou nebo chemickou.

Z pilotního šetření vyplývá, že navržené úlohy mají edukační potenciál a propojují nabyté znalosti žáků z různých předmětů (chemie, přírodopis/biologie, výchova ke zdraví) s reálným životem. Limitem ověřovací fáze je nízký počet respondentů a rovněž fakt, že se jednalo o studenty učitelství chemie a biologie, příp. výchovy ke zdraví. Žáci se učí aplikovat informace získané ve škole na běžné situace. Důležitým prvkem je inovovaný přístup k zadávání informací, což vede k aktivizaci žáků (Janštová & Rusek, 2015). Nastavení aktivity umožňuje otevřené bádání (Banchi & Bell, 2008), avšak nabízí dostatečné „lešení" (z angličtiny caffolding) pro případ, že žáci nejsou na otevřenost zvyklí a činnost vyžaduje vnější podporu. Zdrojem dat je měření senzory připojitelnými k počítači nebo tabletu či chytrému telefonu. To umožňuje další práci s naměřenými hodnotami, jejich analýzu a zpracování. Dochází tak k propojení přírodních věd s další disciplínou – ICT. Aktivita je doplněna problémovými otázkami, což vede žáky řešit úlohy na vyšší kognitivní úrovni. Samotné téma i celé pojetí aktivity rozvíjí badatelské schopnosti i přírodovědné myšlení (viz např. Kuhn, 2002).

Dalšími kroky autorů bude ověření aktivity se žáky základní školy. Ověření je zapotřebí provést s ohledem na funkčnost pracovních listů, optimalizace zadávání úlohy i s ohledem na vnitřní motivaci.

PRACOVNÍ LIST

1. Pokus: ______________________________________

Úvod do tématu

Fotosyntéza je složitý proces, který využívají rostliny k přeměně energie světelného záření na energii chemických vazeb. Dochází k přeměně jednoduchých látek (voda a oxid uhličitý) na látky složitější (sacharidy). Odpadním produktem fotosyntézy je kyslík. U rostlin probíhá také buněčné dýchání, při kterém se štěpí složitější látky (uvolňuje se energie chemických vazeb), dochází ke spotřebě kyslíku.

Otázky před zahájením pokusu

V jakém případě (denní světlo, lampa, tma) bude produkce kyslíku rostlinou nejvyšší? Odůvodněte své tvrzení. Navrhněte postup, jakým byste své tvrzení dokázali.

Ve kterých buněčných strukturách probíhá fotosyntéza?

O který děj se z energetického hlediska jedná? Spotřebovává se energie nebo naopak vytváří?

Pomůcky

čidlo koncentrace kyslíku Vernier O2-BTA, plastová nádobka, čerstvě utržené zelené listy rostlin, lampa, tmavá látka

---

Příprava

Pomocí USB kabelu připojte čidlo k počítači a spusťte program Logger Lite, v menu vyberte Experiment → Sběr dat, doba měření 1 800 sekund a potvrďte tlačítkem Hotovo.

Postup

1. Plastovou nádobku naplňte zelenými listy rostlin.

2. Utěsněte hrdlo plastové nádobky tělem čidla kyslíku.

3. Nádobku nechte volně stát na denním světle.

4. Spusťte měření zeleným tlačítkem.

5. Po deseti minutách měření umístěte nádobku pod lampu.

6. Po dalších deseti minutách měření zasněte lampu a zakryjte nádobku tmavou látkou tak, aby skrz ni žádné světlo k listům nepronikalo. Znovu deset minut vyčkejte.

Závěr

Vysvětlete jednotlivé části výsledného grafu, jaký vliv má působení světla na fotosyntézu?

Porovnejte vámi navržený postup s daným postupem.

Vytvořte název k této úloze.

2. Pokus:___________________________________

Úvod do tématu

Vzduch je složen přibližně ze 78 % z dusíku, 21 % kyslíku a malého množství dalších plynů, především argonu a oxidu uhličitého. Při dýchání se vzduch dostane do plic, kde část kyslíku přejde do krevního řečiště. Krví je dál přenášen po těle.

Otázky před zahájením pokusu

Nadechujeme-li se za účelem získání kyslíku, a vydechujeme-li oxid uhličitý, jak je možné, že funguje dýchání z úst do úst jako metoda resuscitace?

Jaké se mění složení plynu, který vydechujeme?

Kde ve třídě je nejvyšší koncentrace kyslíku, u země nebo u stropu? Proč tomu tak je?

Vysvětlete, proč atleti před závody jezdí trénovat do míst s vyšší nadmořskou výškou.

Navrhněte postup, jakým byste ověřili, že metoda resuscitace dýchání z úst do úst funguje.

Pomůcky

čidlo koncentrace kyslíku Vernier O2-BTA, mikrotenové sáčky (minimálně 2)

Příprava

Pomocí USB kabelu připojte čidlo k počítači a spusťte program Logger Lite.

Postup

1. Připravte si mikrotenový sáček a ověřte, že není děravý.

2. Spusťte měření zeleným tlačítkem.

3. Zapište si koncentraci kyslíku v místnosti.

4. Mikrotenový sáček „zmačkejte“, aby v něm nebyl žádný vzduch. Do sáčku vložte čidlo.

5. Připravte si otvor pro vdechování.

6. Hluboce se nadechněte, lehce vydechněte a zbytek vzduchu z plic vydechněte do sáčku. Sáček rukou uzavřete.

7. Několik desítek sekund vyčkejte na ustálení zobrazované hodnoty. Jakmile se číslo přestane výrazně měnit, vyjměte čidlo ze sáčku a znovu několik desítek sekund počkejte, než se měřená hodnota vrátí zpět na koncentraci v místnosti.

8. Připravte si druhý sáček a proveďte postup popsaný v bodech 4 a 5.

9. Nadechněte se vzduchu z prvního sáčku.

10. Vzduch vydechněte do druhého sáčku, sáček uzavřete a po několik desítkách sekund si zaznamenejte zobrazovanou hodnotu.

Závěr

Vysvětlete jednotlivé části grafu, popište, kterým aktivitám odpovídají.

Navrhněte postup, jakým byste zjistili maximální dobu, kterou vydrží člověk v uzavřené místnosti bez přístupu vzduchu.

Porovnejte vámi navržený postup s daným postupem.

Vytvořte název k této úloze.

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Finnish Student Teachers' Beliefs about Multidisciplinary Learning

Anssi Lindell, Kristóf Fenyvesi, Antti Lokka

Abstract

Multidisciplinary learning plays an important role in the Finnish National Core Curriculum. We develop a project-based, multidisciplinary learning model for teacher training as part of our Checkpoint Leonardo Network program. We applied the Theory of Planned Behaviour to identify student teachers' salient beliefs about multidisciplinary learning. Creative learning activities and the opportunity to study in different communities of learners turned out to be the most favourable, while differentiation the most negative components of the students' attitude towards multidisciplinary education.

Keywords

Attitudes, Beliefs, Educational reform, Curriculum, Project based learning

INTRODUCTION

The integrated approach to Science, Technology, Engineering and Mathematics education, or the "STEM", became one of the most successful global education policies of the recent decades. There is an increasing demand for STEM skills in the European Union (EU) labor market (Caprile, Palmén, Sanz & Dente, 2015). Finland is among those six countries in which the share of STEM professionals in total jobs openings by country is expected to be highest until 2025 (Caprile & al., 2015, p. 11). In order to get society and future generations prepared for these challenging demands by improving science education, Finland launched the STEM (LUMA) policy plan in 1996. Inquiry-based learning, which has several common characteristics both with project-based (PBE) and multidisciplinary educational settings, has been integrated throughout all curricular subjects including STEM since 2004 in Finland (Kearney, 2011, p. 22). Increasing students' motivation and engagement by modern pedagogical methods were among the main intentions behind reforming the Finnish National Core Curriculum as well in 2014 (FNCC, 2014). In this present FNCC, several collaborative practices have been suggested both regarding the students and the teachers to improve project-based and multidisciplinary education. These changes are fully in-line with recent policy development in the EU, which extends STEM to STE-A-M by linking the arts and humanities to it. Current European educational policies are advocating an increased focus on "interdisciplinary study programmes, and encourage the promotion, in tandem, of Science, Technology, Engineering, Art and Mathematics (STEAM) disciplines and of human and social sciences" (EU Committee on Culture and Education, 2018). Additionally, these changes are targeting a more inclusive educational practice, by highlighting the need to encourage the participation of women and other under-represented groups in STEAM subjects and the relevant professions.” (EU Committee on Culture and Education, 2018).

EU’s *Framework for Science Education for Responsible Citizenship* already in 2015 emphasized the complex transformative potentials (Morin 2002; Mishra, Koehler & Henriksen, 2011) of shifting from STEM to STEAM (cf. http://stemtosteam.org/) (Hazelkorn et al., 2015). FNCC positions multidisciplinary learning as one of the key pedagogical tools to develop “transversal competences” (see Figure 1.). Transversal competences enable to experience several phenomena from the perspective of various school subjects. According to FNCC, multidisciplinary learning is supposed to provide opportunity for every student to examine wholes and engage in exploratory work that is of interest to them. Based on this approach, FNCC prescribes that education providers must ensure that the schools include at least one multidisciplinary learning module every year (FNCC, 2014, p. 33). According to FNCC, initiating multidisciplinary learning projects is strengthening the students' participation and offering opportunities for involvement in the planning of the objectives, contents and working methods of the studies. It brings up issues that the students find meaningful and interesting, and creating opportunities for discussing and working on them. Multidisciplinary learning is providing additional opportunities for studying in different groups, as well as with students of various ages and with several different adults. It offers opportunities for combining what the students have learned outside the school with schoolwork. According to FNCC, multidisciplinary learning is giving space for intellectual curiosity, experiences and creativity and challenging the students to engage in many types of interaction and language use situations reinforcing the application of knowledge and skills in practice. Through multidisciplinary learning students can practice agency that is consistent with sustainable lifestyle and inspiring the students to act in a manner that contributes to the community and the society (FNCC, 2014, p. 34).

The importance of multidisciplinary learning is reflected also in FNCC’s concept of learning in general. FNCC describes learning as a primarily collaborative and interactive process, which sees the studens as active actors, who both intellectually and emotionally involved into understanding different viewpoints throughout their learning (FNCC, 2014, p. 17). According to these concepts, the multidisciplinary transformation of the learning process leads to the transformation of the students’ and the teachers’ role and enables “multiple creativities” coming into play. (Burnard, 2012, p. 223.) However, such transformation is a complex process, which can raise multiple challenges to on various levels in the process of implementing curriculum-based concepts in practice. The complex background, main tendencies and curricular tensions of the transition process from STEM to STE-A-M is well-shown in a comprehensive report created by the STEAM Committee for the British Education Research Association (BERA) (Colucci-Gray, Trowsdale, Cooke, Davies, Burnard, Gray, 2017)., 2017).

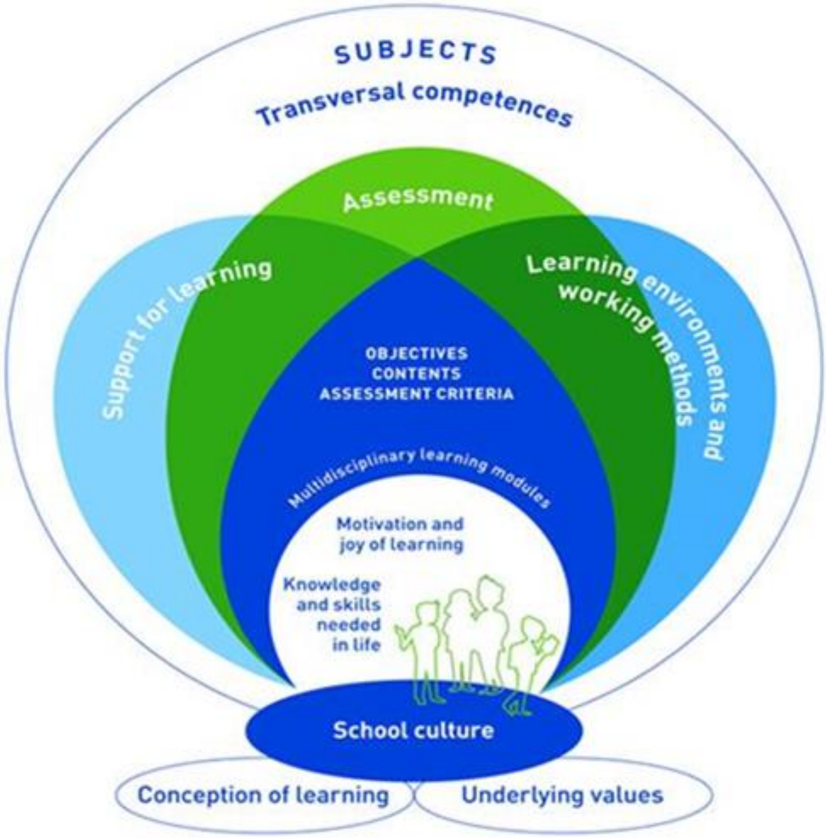

Figure 1: FNCC 2014 summarized in a diagram. Transversal competences are gained as a crosstalk between school subjects and multidisciplinary learning modules. (Finnish National Agency of Education)

Thijs and van den Akker (2009) define three curriculum levels: intended, attained and implemented. On the "intended level" policy makers develop curricula documents to define the learning objectives, which are important for the citizens of modern society. On the "attained level" educational research study pedagogy and search for methods by which students best achieve the goals written in the curricula. On the level of implementation, teachers make choice, which of the methods are attractive, useful and usable enough to be introduced in their classes. The gaps between the intended, attained and implemented curriculum levels can be bridged by appropriate design research (Thijs & van den Akker, 2009).

In University of Jyväskylä's teacher education program we have designed a STEAM project-based education module to support teachers in gaining experiences in the realization of multidisciplinary projects, as it is prescribed by the FNCC. In the module, student teachers collaborate with local schools and civic actors to design, test and assess STEAM inquiries. The module is part of a bigger project, called Checkpoint Leonardo Network (Finnish website: https://www.jyu.fi/science/fi/luma/

hankkeet/checkpoint-leonardo-network), which carries out research to study multidisciplinary teaching and learning.

Attitude is an important construct defining individual's intention towards a behaviour (Ajzen, 1985). It also plays important role in the establishment of key competences, as it is stated by the Council of the EU: "key competences are defined as a combination of knowledge, skills and attitudes" (The Council of the European Union, 2018). To study student teachers' attitudes towards multidisciplinary learning and instruction, we defined two research questions:

1. What are Finnish student teachers' salient beliefs towards their attitudes considering facilitation of multidisciplinary learning projects?
2. How much these salient beliefs influence on their attitude towards multidisciplinary instruction?

THEORY

Ajzen's theory of planned behaviour (Ajzen, 1985) has been useful to predict future behaviour of individuals. The theory has been applied in predicting human intentions and behaviour considering lifestyle (French & Cooke, 2012) and environmental choices (De Leeuw, Valois, Ajzen & Schmidt, 2015), for example. According to Ajzen, the intention for some activity depends on three distinct variables: attitude towards this activity (*AB*), subjective norms (*SN*) and perceived behavioural control (*BC*). The direct variables are obtained by calculating the averages for each of the indirect variables that affect them, which are defined as the product of the main salient beliefs and their effect:

$$AB = \frac{1}{n}\sum_{i=1}^{n} c_i\, g_i, \qquad SN = \frac{1}{l}\sum_{j=1}^{l} f_j\, m_j, \qquad BC = \frac{1}{q}\sum_{h=1}^{q} p_h l_h$$

where c_i is the salient belief in the consequences of behaviour and g_i estimates the importance of this consequence. Variable f_j is a belief in salient behavioural supporters and m_j is a motivation to obey this supporter. Variable p_h is a belief in salient obstacles and incentives for behaviour and l_h is estimate of its likelihood to occur. A belief is salient, if it affects directly to the intention towards a certain behaviour. A belief that multidisciplinary learning is closer to real life than learning in separate subjects is salient if it promotes or inhibits student's intention to multidisciplinary instruction, for example.

METHOD

To elicit the student teachers' salient beliefs on multidisciplinary learning, five experienced teacher educators first made a list of the beliefs they have detected during their teaching. Next a group of ten student teachers assessed these by seven level agree-disagree scale. In addition, they were asked to bring up new beliefs in open questions. We then asked three student teachers about their beliefs in a semi-structured interview. By the results of this pilot study, we ended up with four emerging beliefs on multidisciplinary learning: “Learning for real life”, “Differentiation”, “Joy of learning” and “Creativity” (Lindell, Kähkönen & Lokka, 2018). After testing this list with 14 Physics, Chemistry and Biology student teacher who explained their attitudes towards multidisciplinary learning in open questions, we included also “Work in different communities of learners” into the list.

The questionnaire was administered at the first meetings of our multidisciplinary CPLN project. The questionnaire defines multidisciplinary learning in line with the FNCC as “studying that is integrative and co-operative representing different approaches, and which promotes an understanding of the relationships and dependencies between issues.” Participating student teachers rated their beliefs on likelihood that multidisciplinary learning would promote the five outcomes by 7-point bipolar adjective scale ranging from -3 to 3, unlikely to likely and the importance of each outcome by a similar scale ranging from unnecessary to necessary (Francis et al., 2004). To triangulate the validity of the list of salient beliefs, we asked for the pros and cons of multidisciplinary learning also with the use of open questions prior the CPLN-project. A content analyses of 95 of these responses was conducted to monitor if beliefs outside our list will appear frequently. Two researchers independently coded the student teachers’ responses. Next, the researchers independently classified the codes into the 5 categories of the pilot study plus one “the others” category. Finally, we calculated Cohen’s kappa for the quantity by which the researchers classified the codes in the same categories and Spearman rank order correlation for agreement of the counts to the codes. Results showed that the researchers were in *substantial agreement* (McHugh, 2012) in the codes of categories: for pros $\kappa = .71$ (95% CI, .51 to .91), $p < .0005$ and cons $\kappa = .75$ (95% CI, .52 to .98), $p < .0005$. They also agreed on the cited advantages (rho = 0,95, $p < .001$) and disadvantages (0,94, $p < .001$) counts in the categories of adopting multidisciplinary education.

To define the student teachers’ attitudes towards the multidisciplinary education construct, each five of the perceived consequences (c_i) were multiplied by the evaluation of the importance of that consequence (g_i). The average of these were calculated for each student’s attitude towards the multidisciplinary learning. Spearman’s rhos were calculated to determine the components’ correlation with the resulting attitude.

RESULTS

The results of the content analysis of open questions are represented in Table 1. Ther most frequently mentioned category is *Creativity* (88 counts) while the least mentioned is *Collaboration*, with only 16 counts (all positive). The codes in the *Others*-category has the same number of counts, but the diverse codes could not be unified to make a new salient belief outside of the existing categories. The difference between positive and negative counts is negative only in the category of *Differentiation*.

Tab. 1 The numbers of the counts to different categories of attitude in 95 student teachers' answers to open questions of pros and cons of multidisciplinary learning.

Category	Examples of codes	Counts in the answers	
		Pros	**Cons**
Learning for real life	Everyday, Practical	54	2
Differentiation	Differentiation, different learners	13	38
Joy of learning	Joy, fun	38	4
Creativity	Creativity	64	24
Community	Environments, Collaboration	16	0
Others	Easier to remember, Less subjects, Disorder in the classroom, etc.	10	6

Student teachers in the sample (N = 184, 130 primary and 54 science student teachers) expressed a positive attitude toward the multidisciplinary education (M = 4.0, SD = 1.8, Theoretical range -9 - +9). The components of *Learning for real life* (M = 3.2, SD = 2.9), *Differentiation* (M = 2.2, SD = 2.9) and *Joy of learning* (M = 3.3, SD = 2.3) were moderate good, while *Creativity* (M = 5.3, SD = 3.2) and *Work in different communities* (M = 6.1, SD = 2.7) were good. Their medians of the components were 3, 2, 4, 6, 6 respectively. The distributions were not normal.

Comparing Tables 1 and 2 shows, that the attitude component of *Differentiation* has the least positive and most negative counts in the Table 1, as well as the least positive attitude component in the Table 2. On the other hand, the most positive component of *Community* in the Table 2 has second least positive counts in Table 1, but no negative counts there. The difference between positive and negative counts in Table 1 is the largest for *Learning for real life*, which is second smallest while comparing the student teachers' mean value in attitude components in the Table 2.

Tab. 2 Means, standard deviations and correlations between the components of attitude towards multidisciplinary learning.

Variable	N	M[a]	SD	1	2	3	4	5	6
1 Attitude	186	4.0	1.8	-	.64**	.66**	.59**	.67**	.66**
2 Real life	175	3.2	2.9		-	.25**	.26**	.31**	.24**
3 Differentiation	164	2.2	2.9			-	.35**	.26**	.35**
4 Joy of Learning	176	3.3	2.3				-	.25**	.27**
5 Creativity	180	5.3	3.2					-	.32
6 Community	180	6.1	2.7						-

** = p < .01 level

[a]Theoretical range = -9 - +9

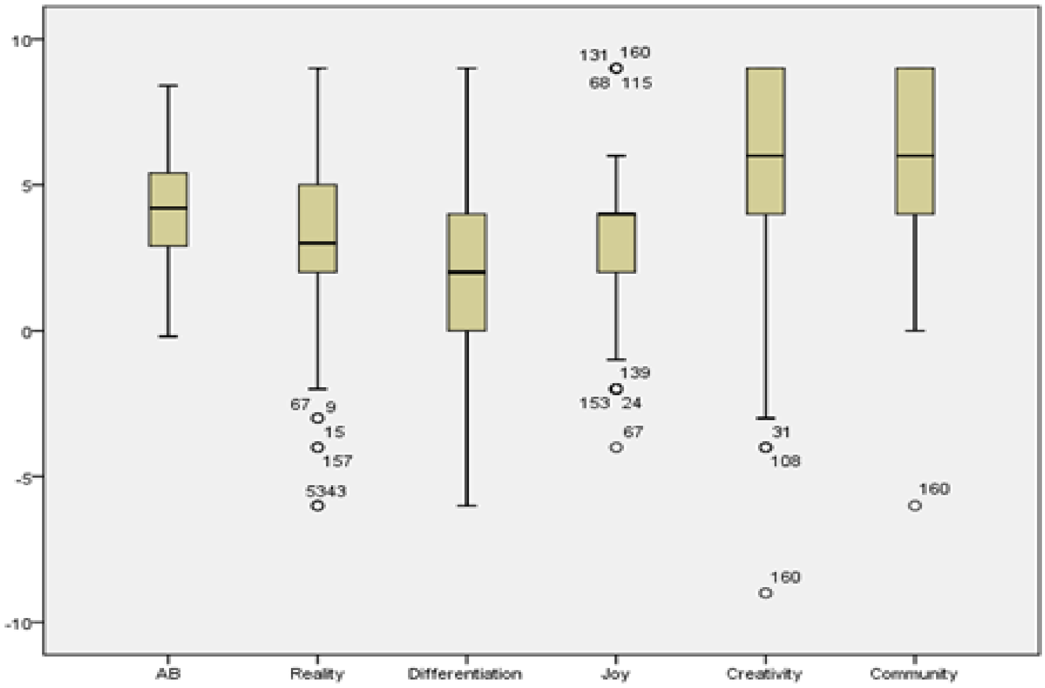

Figure 2: Boxplot of the distribution of components of attitude towards multidisciplinary education calculated from student teachers' responses.

CONCLUSIONS

FNCC has responded EU trends introducing multidisciplinary learning modules. To realize this indended curriculum in classes, we have been developing multidisciplinary CPLN learning module to teach student teachers to design, implement and assess multidisiplinary learning. In addition to that teachers are able to accomplish modern learning methodes, they also need to be willing to do so. For that reason, we have studied student teachers'salient beliefs influencing their attiudes towards multidisciplinary learning. Feeding student teachers' positive beliefs about multidisiplinary learning for real life, creativity and joy of learning are the first challenge in our next project.

Another challenge is to explain our student teachers, that learning objectives are not the same for everyone in PBE. This may dissipate the negative beliefs in the difficulty of differentiation in multidisciplinary learning.

Gaining creativity and capacity to work in diverse communities were the most positive components of attitude towrds multidisciplinary learning. Clearly, leaving the classroom is new but attractive method.

The modally determined salient beliefs and their influence on attitude towards multidisciplinary instruction and learning can be used in designing and assessment of multidisciplinary PBE, but also individual salient beliefs should be monitored to predict individual's subsequent attitudes, intentions, and behaviour.

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Proč zjišťovat, kde je obsažena sůl?

Why should we care, which Products contain Salt?

Martina Tóthová, Pavlína Matoušová, Šárka Šubová, Martin Rusek

Abstract

In this paper realization of a school project with salt being the main topic is described. While working on the project, the students found its multifaceted meaning. The main visible result of the project was published on the social network presenting information the students found. The findings stimulate a discussion to evaluate health effects of excessive salt intake in confrontation with the importance of NaCl for the human body. To assess the affective impact of the project, the IMI tool with 25 items divided in three subscales (enjoyment, value/utility, perceived choice) was used.to. The results suggest the students' slightly positive attitudes towards enjoyment and value of the project and neutral attitudes towards their perceived choice. This allows to consider the project successful.

Key words

Educational Technology, Learning Styles, Motivation, Project Based Learning, Science Education

ÚVOD

Popisovaný projekt je zaměřen na téma kuchyňské soli. V posledních letech stále roste její spotřeba (Morris, Na, & Johnson, 2008), což má dopad na lidské zdraví. Proto jsou ve světě realizovány různé intervenční programy (viz He & MacGregor, 2009). Otázkou zůstává informovanost veřejnosti, především co se obsahu soli v běžných potravinách týče. Po vypracování projektu by měli být žáci schopni si na tyto a další otázky odpovědět.

Z důvodu nízkého zájmu žáků o přírodní vědy prokázaného u nás (Čtrnáctová & Zajíček, 2010; Kubiatko, Švandová, Šibor, & Škoda, 2012), i v zahraničí (Awan, Sarwar, Naz, & Noreen, 2011; Potvin & Hasni, 2014) byl do výuky chemie na střední odborné škole nechemického zaměření zařazen projekt s cílem aktivizovat žáky (Janštová & Rusek, 2014). Žáci považují chemii spíše za nedůležitou (Veselský & Hanušková, 2009; Rusek, 2013), což značně ovlivňuje vzdělávací proces. Důraz na aktivizaci žáků je zde předpokladem nápravy současného stavu. Využití poznatků nabytých ve škole v reálném životě a vlastní práce žáků jsou motivací pro učení (Hanuš & Chytilová, 2009). Proto se projektová metoda, která tyto jevy slučuje (Průcha, Walterová, & Mareš, 2003), jeví jako ideální. Nadto je zvoleno téma, které se vyznačuje vysokým potenciálem tzv. „projektovosti“ (srov. Rusek & Vojíř, 2018).

POPIS PROJEKTU

Projekt byl realizován v prvním ročníku střední školy ekonomického zaměření (ekonomické lyceum). Vznikl zcela spontánně na základě diskuze na téma nebezpečí látek. Žáci vyjmenovávali, které nebezpečné látky znají. Jeden z žáků zmínil, že je sůl nebezpečná, což vyvolalo smích jeho spolužáků. Vyučující kladením doplňujících otázek pokračovala v udržování diskuze s žáky na toto téma, což dospělo až do znejistění žáků nad odpovědí na původní otázku. V tom se ukázal projektový potenciál tohoto poměrně častého námětu na projekt (viz Bubíková, 2010; Trčková, 2014). Vzniklá diskuse vedla žáky k návrhu celého projektu (srov. Rusek & Becker; 2011; Rusek, 2017). Projekt tak byl organizován převážně žáky a vyučujícím pouze korigován.

Vyučující podnítila žáky otázkou, jak by mohli posoudit, zda je jimi diskutovaný výrok pravdivý či ne. Žáci navrhovali různé možnosti (zeptat se odborníků, odborná literatura, internet, experimenty). V průběhu diskuze byli žáci směřováni na následující témata:

- využití soli, sůl v potravinářství – konzervační látka x chuť, sůl v lidském organismu,
- spotřeba soli (denní doporučená x reálná), sůl u nás ve škole, sůl v mém jídelníčku,

není sůl, jako sůl a obraz soli v médiích."

Poté byla žákům položena otázka, zda je toto téma všeobecně sledované. Žáci okamžitě začali odpovídat a vymýšlet, jak dát o takovém tématu veřejnosti najevo. V tuto chvíli přestala vyučující do rozběhnutého projektu zasahovat a dál byla pro žáky dostupná pouze jako rádce.

Role organizátora se ujal žák, který pokračoval v psaní nápadů na tabuli. Ostatní žáci navrhovali rozdělení do skupin. Ty byly zapsány na tabuli a k nim připsány jednotlivé úkoly (srov. Rusek & Becker, 2011).

Cílem projektu se stalo zjišťovat dopady kuchyňské soli na člověka a šíření informací týkajících se této problematiky. Během práce na projektu žáci objevují význam této chemické látky a uvědomují si každodenní blízkost chemických látek v reálném životě.

Na základě vytyčeného cíle se žáci rozdělili do skupin[4]:

- Organizace (žáci organizovali průběh a stav projektu),
- Propagace (žáci vytvářeli příspěvky na Instagram, připravovali prezentaci a letáčky)

[4] Použité názvy skupin jsou zcela autentické názvy, vymyšlené samotnými žáky.

- Výzkum (žáci prováděli experimenty: porovnání obsahu soli ve svém a v ideálním jídelníčku, funkce soli jako konzervační látky, zjišťování povědomí o dopadech soli u ostatních žáků školy),
- Informace/podklady (žáci hledali faktická data: působení soli na lidský organismus, hodnoty spotřeby soli u nás a ve světě, množství soli v různých potravinách),
- Podpora (žáci pomáhali skupinám, jež nestíhaly plnit své úkoly).

Pro dosažení svých cílů využili žáci Instagram. Založili „projektový účet", vyrobili letáčky, na kterých byly stručné informace a odkaz na instagramový účet. Pro zvýšení dopadu projektu žáci vytvořili PowerPointovou prezentaci pro ostatní žáky školy.

CÍLE

Cíle projektu

Hlavním cílem projektu z pohledu vyučujícího bylo odbourání strachu z chemie (chemofobie), převzetí zodpovědnosti žáků za vlastní jídelníček, zvýšení zájmu žáků o přírodní vědy a aktivizace žáků. Mezi dílčí cíle projektu patřilo: uvědomění si významu soli v běžném životě, zhodnocení pozitivních i negativních dopadů na zdraví člověka, osvojení výpočtu soli ze sodných iontů, vyhledávání ověřování informací nebo předávání informací vhodnou formou ostatním.

Cílem samotných žáků původně bylo pouze zveřejňovat zjištěné informace o soli. Později se cíl změnil na informování veřejnosti o spotřebě soli v jejich okolí, obsahu soli v potravinách a možnostech, jak množství soli v potravě omezit.

Hodnocení projektu

S ohledem na sebereflexi (viz Jezberová, 2011), byla při hodnocení projektu zohledněna kritéria, která si vymezili samotní žáci (časový harmonogram, rozvržení práce, kvalita práce). K sebehodnocení žáků byla využita tabulka upravena dle Salavcové a Anýže (2011). Vyučujícím pak byla hodnocena výsledná kvalita zpracování, zanesena do téže tabulky.

Projekt byl hodnocen také s využitím nástroje (IMI, Inventáře vnitřní motivace). Jedná se o nástroj vhodný pro posouzení subjektivních zkušeností žáků, jež se vztahují k cílové činnosti (Kekule & Žák, 2001; Ryan & Deci, 2000). Pro hodnocení postojů bylo využito troj-subškálové verze dotazníku, přičemž pouze subškála „Zájem a potěšení" měří vnitřní motivaci jako takovou (Kekule, Žák, Ješková et al., 2017). 28 žáků vyjadřovalo svůj názor na jednotlivá tvrzení prostřednictvím škály od 1 (zcela nepravdivý) po 7 (naprosto pravdivý výrok).

Naměřené výsledky vykazují průměrné a mírně nadprůměrné hodnoty. Střední hodnota subškály „Užitečnost a hodnota projektu" byla 5, čili mírně nad průměrem sedmistupňové škály. Stejný medián charakterizuje škálu „Zájem a potěšení“. Subškála „Vnímaná možnost volby“ vychází jako průměrná, se střední hodnotou 4. Zatímco mediány odpovědí žáků v subškálách „Užitečnost a hodnota projektu“ a „Zájem a potěšení“ jsou výsledky vcelku homogenní, a to průměrné nebo nadprůměrné (pouze jeden žák v obou subškálách uvedl hodnotu 1 či 2), u subškály „Vnímaná možnost volby“ se u jednotlivých žáků vyskytují značné odchylky. Z 28 žáků zvolilo 15 žáků hodnotilo daná tvrzení hodnotami uprostřed nabízené škály. Odpovědi zbytku žáků byly polarizované. Sedm žáků zvolilo hodnoty podprůměrné (1, 2), tj. považovalo možnost volby za nízkou. Naopak šest žáků hodnotilo vnímanou možnost volby velmi pozitivně. Takto odlišné hodnocení může pramenit z rozdělení žáků do pracovních skupin, přičemž někteří žáci si svou práci ve skupině zvolili, ostatní žáci byli do skupin přiřazeni svými spolužáky. To se mohlo odrážet v jejich vnímání možnosti volby. Další možnou interpretací je přirozený postoj k nabývání informací. Výsledky mohly být ovlivněny postojem žáků k projektové metodě jako takové. Výsledek také může být ovlivněn faktem, že práce žáků byla na konci projektu hodnocena školní známkou. S ohledem na dobu trvání projektu je to ovšem přirozený postup, který je v souladu s organizací studia. Na známce se však žáci velkou vahou podíleli (viz výše).

DISKUSE A ZÁVĚR

Jak vyplývá z předchozího textu, záměry učitele a žáků se mírně odlišovaly. Přes některé odchylky (jež se týkaly převážně výstupu projektu) se žáci dopracovali k většině záměrů i bez zadávání úkolů učitelem. Proto považujeme vytyčené cíle projektu za splněné, přičemž jich bylo dosaženo v duchu projektovosti projektu (Rusek & Becker, 2011). Žáci jej zpracovávali samostatně, byli jeho iniciátory. Cíl autorek projektu byl také zaujmout žáky pro přírodovědné téma tím, že je propojí s běžným životem. Z hodnot, které byly měřeny nástrojem IMI vychází položky průměrně až mírně nadprůměrně, přičemž vysoké odchylky vykazuje subškála „Vnímaná možnost volby“. Možné zlepšení spočívá v efektivnějším řízení činnosti žáků směrem k přesněji, na začátku projektu stanoveným cílům spolu s konkrétněji definovaným výstupem projektu.

Přínosem tohoto příspěvku je mimo popisu námětu na školní projekt rovněž ukázka přístupu, kdy vyučující disponující znalostí témat s projektovým potenciálem (viz Rusek & Vojíř, 2018) navodí podmínky pro zahájení projektu. Projekt tak přirozeně vyplyne, čímž je zachováno jedno ze zásadních kritérií, tj. jedná se o projekt žáka. Zdaleka ne vždy jsou vhodné časové i personální podmínky na realizaci projektu. Projekty vyžadují vhodný kolektiv žáků schopných samostatné skupinové práce, zároveň je vhodné, aby se nejednalo o třídu, ve které se vyskytují vážnější kázeňské problémy. Odchylky realizace projektu žáky od záměru vyučujícího jsou dokladem potřeby řízení projektu učitelem, zvláště jedná-li se o jedno z prvních setkání žáků s touto formou výuky. Její otevřenost se totiž zdá kontraproduktivní, a to i v případě, že žáci aktivně na zvoleném tématu pracují.

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Traditional lectures or project method based on the idea of Web 2.0?

Małgorzata Nodzyńska

Abstract

One of the most important parts of university education are lectures. Classically conducted they mean activity of an academic teacher and passivity of students. In order to increase students' activity during lectures the students were given a task to create a virtual book. To examine whether this form of activity contributes to the increase of students' knowledge, the knowledge of students during and after lectures was assessed. These studies show a significant increase in student knowledge. Also, the results reveal students' great satisfaction with this method of conducting lectures.

Key words

Learning Styles, Project based Learning, Web-Based Learning

INTRODUCTION

I listen and forget, I see and remember, I do and understand.
Confucius

A lecture (by definition) is an oral presentation intended to make aware of people about a particular topic. Lectures are still the most prestigious form of conducting classes at the university level. They have survived in academia as quick and cheap way of introducing large numbers of students to a particular field of study. There are outstanding lectures, which are listened to with bated breath, but in very many cases prestige does not go hand in hand with quality and with educational effectiveness. Critics point out that lecturing is mainly a one-way method of communication that does not involve significant audience participation but relies upon passive learning. The lecture belongs to the methods of giving, in which learning takes place through absorption. As shown by the pyramid of acquiring knowledge of Edgard Dale (1969), this is the least effective communication channel. Another problem is the decrease in concentration of students during the lecture. It is generally believed that adults are able to concentrate only for 25 to 45 minutes. Longer lectures are not effective. Also, if the lecture contains too many new topics, it will not be remembered as a whole. The situation is similar if the pace of the lecture is too fast - students will not remember "much" about it. During a one-hour lecture, an average lecturer speaks about 12,000 words, which corresponds to publications with more than 20 pages - it is about 20 times more information than the student is able to learn at a given time

(Nodzyńska, & Cieśla, 2015; Petty, 2009). Admittedly, it is not necessary to memorize the whole lecture by the student, however, remembering a large part of the lecture facilitates further learning.

THEORETICAL BACKGROUND

Studies on boredom appearing in students during traditional lectures have been studied recently by Sharp and co-workers (Sharp, Hemmings, Kay, Murphy, & Elliott, 2017). Their findings indicate that about half of all respondents experienced the most common precursors of academic boredom at least occasionally. Traditional lectures with excessive and incorrectly used PowerPoint turned out to be particularly boring. Their findings are considered valuable empirically and theoretically, leading to recommendations surrounding boredom mitigation, which challenge cultural traditions and pedagogical norms.

Also, research on changing teaching by speaking in teaching through practical action is described in the series of books Transforming Teaching and Learning. The book *No More Telling as Teaching: Less Lecture, More Engaged Learning (Not This but That)* Tovani and Moje (2017) discuss the teaching traps through lectures and what is the involvement of students during lectures. It was also proposed which practical changes can be applied in the classroom without changing the curriculum. Research conducted by DeJongh, Lemoine, Buckley, & Traynor (2008) determined how much time students spent preparing for traditional lecture versus team-based learning (TBL). Results of this project show students spend little time preparing for traditional lectures compared with other type of classes.

Therefore, change of the traditional lecture to involve the project-based method has been suggested (Janstova, & Rusek, 2015). Instead of applying transmission teaching, in which knowledge is passed from the teacher to the student, it was decided to introduce teaching using the theory of constructivism and make students responsible for their education (Johnson, 2015).

One of the methods to activate the students during teaching is to involve new teaching and learning approaches like those offered by involvement of ICT (ie. Web 2.0). This means that students not only use new technologies, but they are also active creators of content published on the Internet. Research on the use of Web 2.0 for teaching at the university level is described, inter alia, by Drahosova, & Balco, (2017) and Karvounidis, Chimos, Bersimis & Douligeris (2018). They do not, however, indicate how to convert traditional lectures into active learning involving students.

METHODOLOGY

In order to make students more active during lectures in the "Philosophy of natural sciences", the project method was introduced. The research was conducted in the academic year 2017/2018 among students of the second year of the master's degree in biology.

The hypothesis of the study was the independent construction of knowledge by students that will contribute to a significant increase in student knowledge.

The questionnaire for the Google Questionnaire was used as a research tool to check the initial and final knowledge of students.

Due to the small number of students in one year, it was not possible to conduct research using parallel group techniques. The purpose of this research was to test this method of lecturing and not compare it to other methods. A comparison of the effectiveness of different methods is planned.

CONTEXT, TASKS AND LEARNING ENVIRONMENTS DURING THE COURSE

The next elements of the modified lecture corresponded to the next steps in the project method. (see Fig. 1).

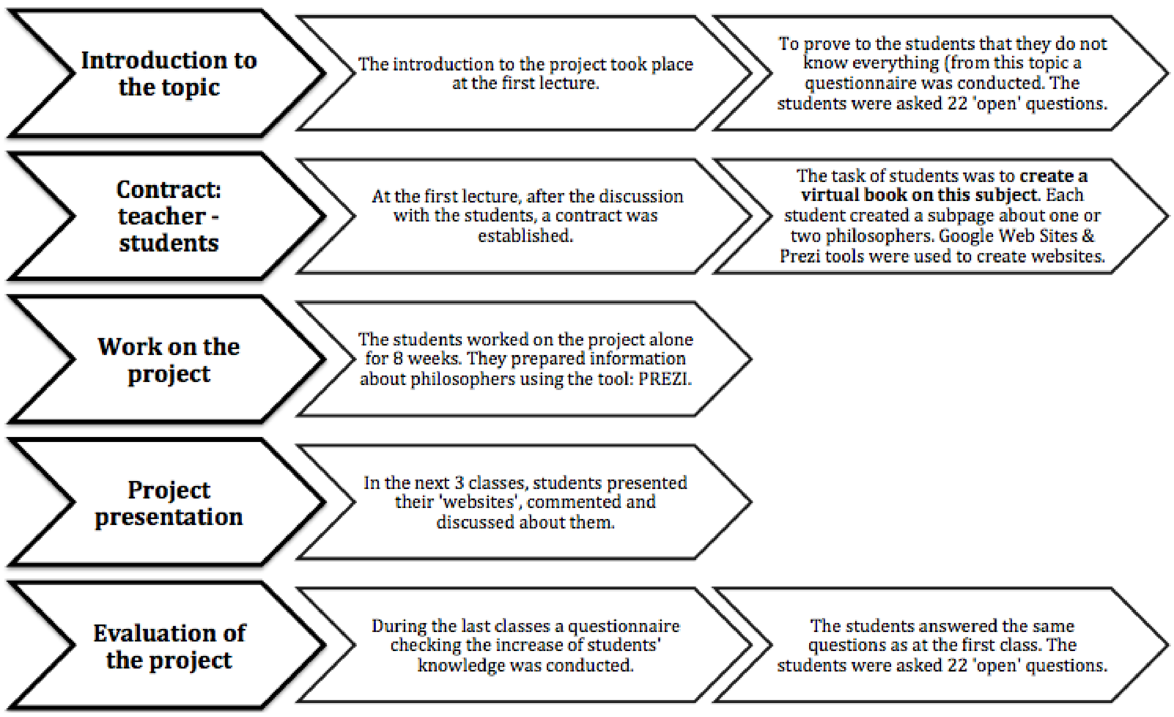


Fig. 1. Next steps in the project method and corresponding activities in the modified lecture.

Students used the Google Web Sites tool to create a virtual book in the form of a website. Individual pages of this book (devoted to the next philosophers) were created in Prezi (Bondarenko, 2018; Banerji, 2017), and then they were implemented into a website.

30 students participated in innovative lectures, however the article discusses the results of 23 students (some students taking part in the lectures did not complete the pre-test).

RESULTS

The knowledge of students was examined twice: before the project starts and after it's finished. Students' knowledge research was carried out using a questionnaire. It contained 22 open questions. Mainly they concerned Greek philosophers, but there were also questions about medieval philosophers, but also Hindu or African philosophy.

Initial student knowledge was very diverse (the lowest score was 12.5% and the highest was 89.6%). However, after the completion of the project, the level of students' knowledge was aligned (minimum 70.8% to a maximum of 97.9%). The percentage difference between the lowest result in the pre-test and the highest result in the pre-test was 77.1, the corresponding difference for the post-test was 27.1. (see fig. 2)

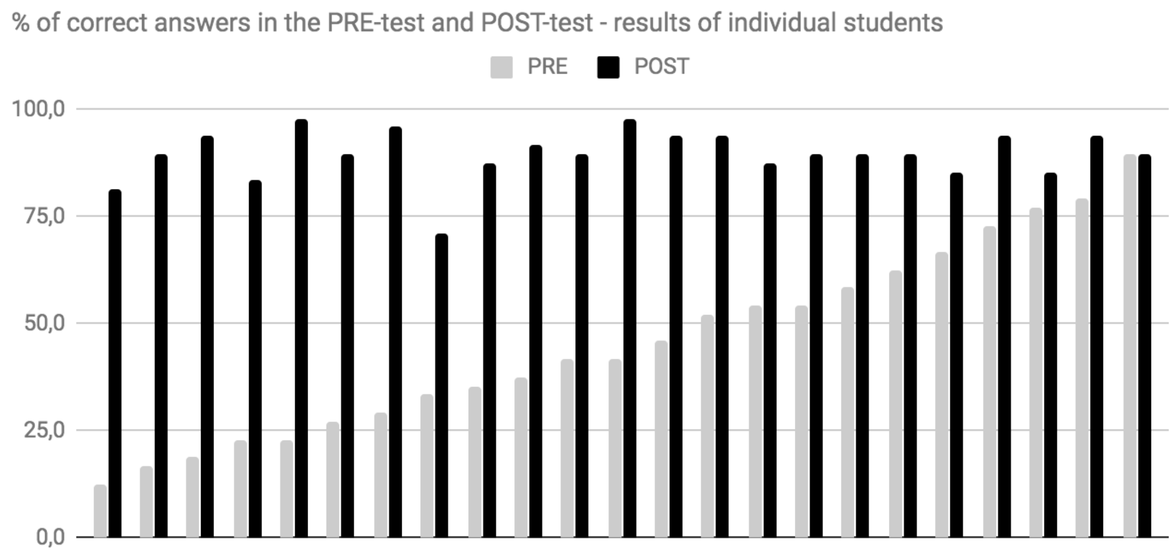


Fig. 2 Percent of correct answers in the PRE-test and POST-test - results of individual students

The increase in knowledge was highest among those students who initially knew little about philosophy. The increase in knowledge in individual percentage groups is shown in the chart below.

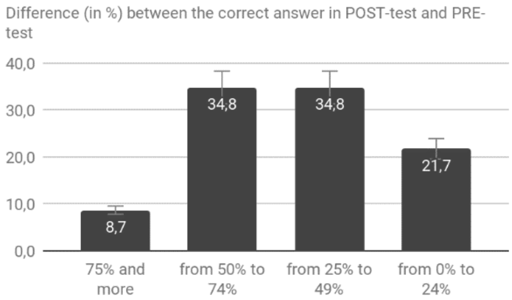


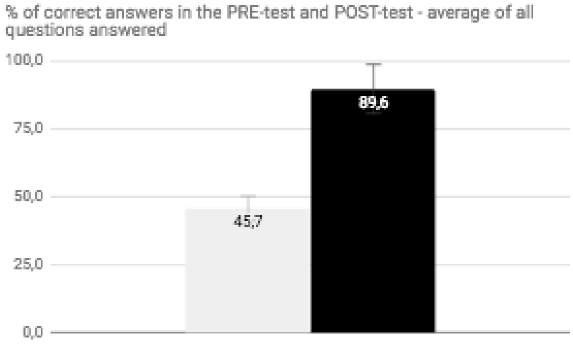
Fig. 3 Difference (in %) between the correct answer in POST-test and PRE-test.

For 8.7% of the surveyed students, the increase in knowledge was over 75%. For 34.8% of students, the increase in knowledge was within 50% - 74%, also for 34.8% of students the increase in knowledge was within 25% - 49%. It can be stated that in the majority of respondents (69.6%) their final knowledge increased (between 25% and 74%) with respect to the initial knowledge. For approximately 25% of respondents, the increase in knowledge was low and was within 0% - 24%. In this group there were also three students who achieved the highest results in the pre-test:

- from 77.1% to 85% - an increase of 8.3%;
- from 79.2% to 93.8% - an increase of 14.6%;
- from 89.6% to 89.6% - an increase of 0%.

It can be assumed that students who had a satisfactory knowledge before starting the course did not work as hard as their colleagues during the course. The result of this group of students may also result from the fact that before the course began they already knew most things and there were no new things to learn for them.

The average initial knowledge of students was not satisfactory (only 45.7%). However, at the end of the course, the average knowledge of students was as high as 89.6%. Therefore, it can be said that as a result of activities in the project, the knowledge of students almost doubled. Calculating the student's t-test shows that it is a statistically significant increase in knowledge ($t = 5.79$, $\rho < .00001$, $p < .05$).



Difference Scores Calculations

Mean: 22.59

$\mu = 0$

$S^2 = SS/df = 31549.15/(46-1) = 701.09$

$S^2_M = S^2/N = 701.09/46 = 15.24$

$S_M = \sqrt{S^2_M} = \sqrt{15.24} = 3.9$

T-value Calculation

$t = (M - \mu)/S_M = (22.59 - 0)/3.9 = 5.79$

Fig. 4. Percent of correct answers in the PRE-test and POST-test - average of all questions answered.

Discussion of the answers to individual questions

Seven questions concerned Greek philosophy. These were the questions about the "Arche" (is a Greek word with primary senses "beginning", "origin" or "source of action"). Before class, students were not able to define the term "Arche", nor were they able to determine what the philosophers indicated as "Arche" (the average percentage of correct answers ranged from 39.1% to 73.9%). After completing the course, the level of knowledge of students significantly increased - all respondents correctly answered four questions (question 2, 5, 6 and 7 compare figure 2). The lowest result (95.7%) was obtained for the third question.

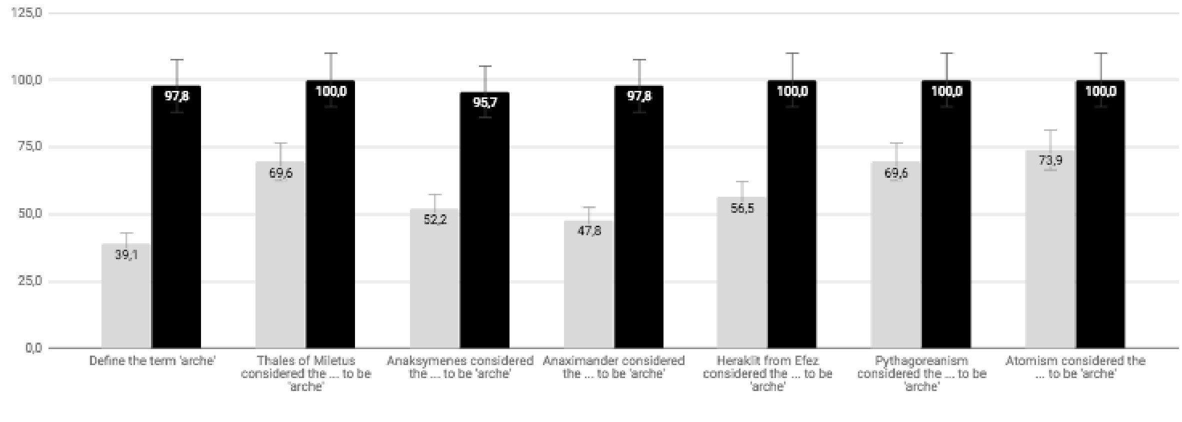


Fig. 5. Percent of correct answers in the PRE-test and POST-test regarding the term 'Arche'.

Another nine questions concerned basic associations: philosopher and connection with his theory. The students' task was to supplement the sentence describing the philosopher's views with his name.

Tab. 1. The table contains the content of the question, the percentage of correct responses from the pre-test and post-test as well as the expected response.

Questions	Pre	Post	Correct answer
About which philosophy we speak: He knew the phenomena of the magnet's influence on iron and electrification of amber, and he knew how to predict solar eclipses.	52.2%	95.7%	Thales of Miletus
He stated: panta rhei (everything flows), one can not twice enter the same river, its water, because they change, they are still flowing.	73.9%	100%	Heraclitus
Who explained the movement of atoms with their burden?	47.8%	60.9%	Democritus
... allowed for the existence of many different, contradictory truths, aiming at agnosticism, that is, the view negating the cognitive abilities of man in general.	13%	87%	Sophist
The Oracle in Delphi announced that he was the wisest man in the world, though .... believed that: he knows that he knows nothing.	73.9%	95.7%	Socrates
For ... matter is what exists eternally, but it does not rule about itself, that is, what is not a form in substance. He claimed that matter, just like ideas, does not exist alone, it is only an abstraction - a category, a concept used by philosophy and science. Truly, according to him, there are only specific bands of matter and form.	47.8%	95.7%	Aristotle
Through …., matter was understood as a factor of evil, and so remained in theological considerations.	4.3%	54.3%	Philo of Alexandria*
Whose views: matter is indestructible and eternal, everything consists of atoms and void (as in Democritus), atoms have a certain freedom of movement (declination).	21.7%	80.4%	Epicurus
Who was the creator of the concept of 4 elements?**	47.8%	95.7%	Empedocles

Philo of Alexandria used philosophical allegory to harmonize Jewish scripture, mainly the Torah, with Greek philosophy.*
*** In pre-test many people answer incorrectly: Aristotle.*

The next questions concerned Plato and his concept of matter construction.

Tab. 2. The table contains the content and questions and the percentage of correct answers in the PRE-test and POST-test.

Question	Plato, like the atomists, believed that the basic particles of matter differ in shapes, which corresponds to the four basic elements. These shapes are regular polyhedrons (Platonic solids). Match the names of regular polyhedrons to the corresponding elements.			
	First element	Second element	PRE-test	POST-test
	Fire	tetrahedron	56.2%	100%
	Earth	cube	52.2%	100%
	Air	octahedron	60.9%	100%
	Water	icosahedron	43.5%	100%

The next question concerned the definition of 'ether'. The term comes from the ancient Greek concept of the elements as the basic components of the material world. In Plato's philosophy, the particle of the fifth element - ether - had the shape of a regular dodecahedron constituted an element from which the heavens were created. This view was maintained until modern times. In medieval philosophy, the ether functioned under the Latin name 'quinta essentia' (quintessence, the fifth essence). The students had a very big problem with answering this question (the percentage of correct answers in the PRE-test was only 37.0% and in POST-test 54.3%). Many of them defined the ether as: *an organic chemical compound in which C-O-C bonds occur, where none of the carbon atoms is bonded to more than one oxygen atom*.

The last three questions concerned non-European philosophies:

A. How many elements did the Chinese philosophers mention?
B. Vaisheshika was an atomistic system of natural philosophy in the orthodox system of philosophy …
C. At the beginning, the whole world was infinitesimally few particles, being also the god Amma, Amma contained embryos of four basic elements: water, earth, air and iron. The breakup of this cosmic egg led to the creation of the universe. This event is the equivalent of the Big Bang in mythology … .

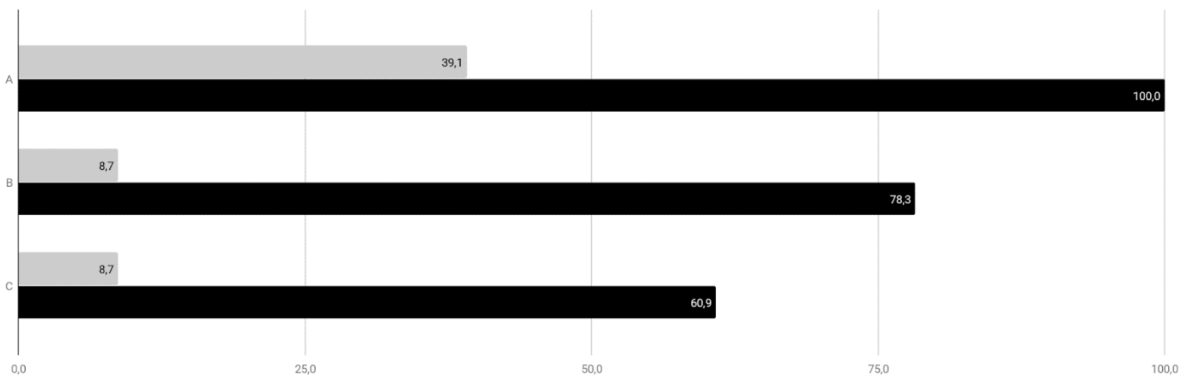


Fig. 6. Percent of correct answers in the PRE-test and POST-test regarding non-European philosophies.

CONCLUSIONS

Currently, lectures are an integral part of academic education, but their effectiveness should be considered. It is necessary to depart from traditional lectures, during which only the lecturer is active, and students are passive listeners. It seems that activating students is a necessity in the current situation. The proposal to exchange a traditional lecture for students' independent work using the project method proved to be effective. PRE-test and POST-test show a significant increase in knowledge (on average by 43.9%). This method was particularly effective for students whose initial knowledge was small (compare Figure 2). It can be said that the level of knowledge of students regarding the philosophy of natural sciences after the course carried out using the project method has been equalized. It is planned to continue the course this method in the following years.

ACKNOWLEDGEMENT

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Vývin koncepcie výučby organickej chémie v sekundárnom vzdelávaní

Development of teaching of organic chemistry in secondary education

Natália Priškinová, Ľubomír Held

Abstract

The aim of the contribution is to introduce changes in teaching of organic chemistry in the Central Europe over the past decades, as were monitored in selected textbooks. Using the analysis of current and older chemistry textbooks, we evaluate their content with an emphasis on the structure and the way the organic chemistry is communicated to the pupils at lower and upper secondary level (ISCED 2, ISCED 3). Our next objective focuses on comparing the development of concepts used in textbooks in the Central Europe with the concept applied inthe textbook representing Anglo-Saxon countries.

Key words

Chemistry, conceptual change in science, primary school, secondary school.

ÚVOD

Organická chémia má svoje stále miesto vo výučbe na základnej i strednej škole a jej dôležitosť je umocnená blízkosťou k človeku, ako aj významom pre spoločnosť. Výučba (nielen) organickej chémie počas uplynulých desaťročí prešla mnohými zmenami. Tieto zmeny badať aj na učebniciach, ktoré musia neustále držať tempo s rozvojom vedy na jednej strane a didaktiky na strane druhej. Učebnice sú základnými didaktickými prostriedkami pri realizácii výchovno-vzdelávacieho procesu, pričom ich vzdelávacia funkcia je len jednou z mnohých, ktoré plnia (Petlák, 2016). Nakoľko sú učebnice podľa Tureka (2014) najdôležitejšími nositeľmi učiva, aktuálne trendy vývinu koncepcií výučby sa v nich môžu dobre odzrkadľovať.

Problematika histórie výučby chémie bola a aj naďalej zostáva predmetom záujmu mnohých autorov. Napríklad Čtrnáctová, Banýr (1997) vo svojom článku poskytli historický prehľad výučby chémie na základných a stredných školách s uvedením charakteristických znakov učebníc pre dané obdobia. Hellberg, Bílek (2000) skúmali vývoj chemického vzdelávania v súvislosti s rozvojom chémie ako vedy. Held a kol. (1988) zisťovali smerovanie vývinu prírodovedného vzdelávania na základnej škole, pričom sa opierali o modelový pohľad na historicky existujúce projekty prírodovedného vzdelávania. Podobne historickým vývojom paradigiem prírodovedného vzdelávania sa vo svojich príspevkoch zaoberali aj Škoda, Doulík (2009, 2010).

Cieľom našej práce bolo na základe vybraných učebníc sledovať, ako sa v priebehu desaťročí zmenila koncepcia výučby organickej chémie v stredoeurópskom regióne. Pomocou analýzy súčasných a starších učebníc chémie sme sa pokúsili zhodnotiť ich obsah s dôrazom na štruktúráciu a spôsob sprístupňovania učiva organickej chémie. Z hľadiska metodológie sme realizovali nekvantitatívnu obsahovú analýzu (Gavora, 1997), aj keď v závere sme sa neubránili „pokušeniu" niektoré údaje kvantifikovať. Naším ďalším cieľom bola komparácia stredoeurópskych učebníc s výrazne odlišnou učebnicou z anglosaského sveta, ktorá síce nereprezentovala celý priestor, ale tým, že predstavovala odlišný prístup a kultúru, poskytla možnosť konfrontácie s „našimi" koncepciami.

ANALÝZA UČEBNÍC

Vzorku pre našu analýzu tvorili tie učebnice chémie, ktorých súčasťou bola organická chémia. Celkový počet zahŕňalo 40 učebníc od roku 1923 až 2018. Z hľadiska stupňa vzdelávania, 17 učebníc patrilo do kategórie ISCED 2 a 23 učebníc sme zaradili do kategórie ISCED 3. Čo sa týka regionálneho zaradenia, k dispozícii sme mali 13 historických československých učebníc, 10 českých, 4 slovenské, 11 maďarských, 1 nemeckú a 1 americkú učebnicu.

Nástroj pre analýzu

Nakoľko našou snahou bolo sledovať vývin koncepcie výučby organickej chémie, vychádzali sme z modelov prírodovedného vzdelávania, ktoré publikoval K. Holada. Modely boli pre nás dobrou pomôckou pri odhadovaní danej koncepcie. Za nástroj analýzy sme si zvolili Tabuľku 1, v ktorej vidíme, že každý z modelov má svoje špecifiká.

Tab.1 Modely prírodovedného vzdelávania, zdroj: Holada, 1985

prvky obsahu	**POZNATKY**			**ČINNOSTI**		
MODEL	empirické	teoretické	praktické	senzomotorické	intelektuálne	sociálne
fenomenologický	+	(+)	+			
štrukturálny	(+)	+				
polytechnický	+	(+)	+	+		
integrovaný	+	+	+			
orientovaný na osobnosť	+		+	+	+	
vytvárajúci prírodovedný obraz sveta	+	+	+	(+)	(+)	(+)
praxeologický	+	+	+	+	+	+

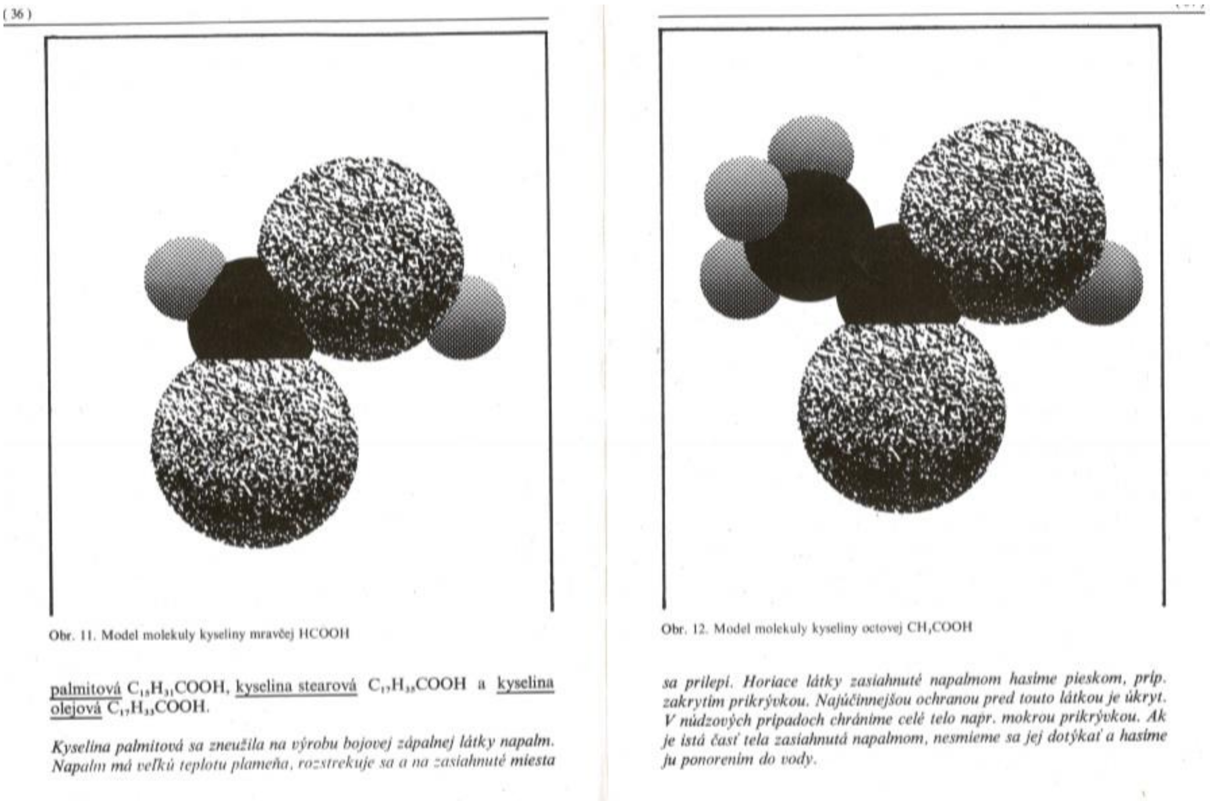
Poznatky a *činnosti* sú analytickými kategóriami, ktoré sú dôležité z hľadiska posúdenia základnej koncepcie, pričom symbolom „+“ je vyjadrený ich vzájomný pomer. V rámci poznatkov hovoríme o pomeroch medzi poznatkami empirickými, teoretickými a praktickými. V prípade činností sa vyjadrujú pomery medzi činnosťami senzomotorickými, intelektuálnymi a sociálnymi. V našej vzorke učebníc sme sa pokúsili odhadnúť proporcionálne zastúpenie poznatkov a činností v ich obsahu a zistiť ku ktorému modelu sa jednotlivé učebnice najviac prikláňajú. Vzhľadom na veľký rozsah učebníc a malý rozsah článku, sme zvolili redukovaný systém odkazovania na učebnice, aby zostal priestor pre dôležitejšie informácie.

Modely a učebnice

Typickou črtou *fenomenologického modelu* je, že popisuje látky a javy, prípadne zákonitosti empirickej povahy (Holada, 1985). Ak sa pozrieme na historické učebnice z obdobia Československa (1923, 1924, 1932, 1938, 1954), môžeme skonštatovať, že spĺňajú charakteristiku tohto modelu s prevahou poznatkov empirického charakteru. Mnoho vlastností a javov sa v nich vysvetľuje prostredníctvom experimentov a vlastnej skúsenosti. Praktické poznatky zahŕňajú najmä výroby známe z každodenného života (napr. výroba liehu, piva, papiera a i.).

V nemeckej učebnici *Umwelt Chemie* (1985) sa prevaha empirických poznatkov v časti organická chémia prejavila pri početných demonštračných a žiackych pokusoch, pri ktorých dochádza k rozvoju senzomotorických zručností žiakov: pozorujú (napr. farbu, vôňu, horľavosť, rozpustnosť, reaktivitu,...), narábajú s laboratórnym sklom a pomôckami. Praktické poznatky sa týkajú najmä využitia organických látok, prípadne ich výrob.

V *štrukturálnom modeli* sa nosnou kostrou učiva stávajú všeobecné poznatky, pojmy a princípy (Holada, 1985). Výraznú dominanciu teoretických poznatkov, v porovnaní s empirickými a praktickými, sme pozorovali v maďarskej učebnici pre gymnáziá *Kémia II. osztály* (1984), v ktorej jedinými grafickými elementmi boli štruktúrne vzorce a modely molekúl. Okrem štruktúr sa tu kládol dôraz na názvoslovie a väzby v organických zlúčeninách.


(36)

Obr. 11. Model molekuly kyseliny mravčej HCOOH

palmitová $C_{15}H_{31}COOH$, kyselina stearová $C_{17}H_{35}COOH$ a kyselina olejová $C_{17}H_{33}COOH$.

Kyselina palmitová sa zneužila na výrobu bojovej zápalnej látky napalm. Napalm má veľkú teplotu plameňa, rozstrekuje sa a na zasiahnuté miesta

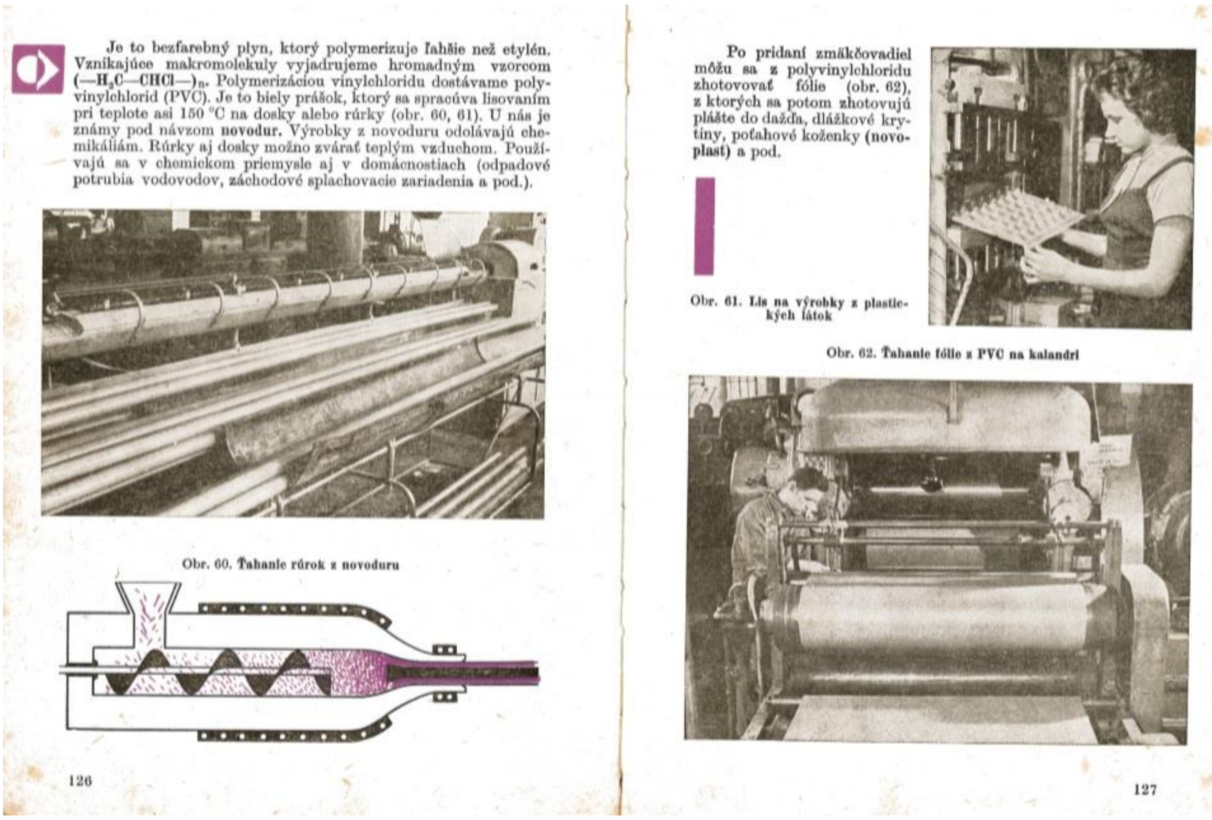
Obr. 12. Model molekuly kyseliny octovej CH_3COOH

sa prilepí. Horiace látky zasiahnuté napalmom hasíme pieskom, príp. zakrytím prikrývkou. Najúčinnejšou ochranou pred touto látkou je úkryt. V núdzových prípadoch chránime celé telo napr. mokrou prikrývkou. Ak je istá časť tela zasiahnutá napalmom, nesmieme sa jej dotýkať a hasíme ju ponorením do vody.

Obr. 1 Ukážka štrukturálnej učebnice, zdroj: Chémia 8, Šramko a kol., 1983

Podobne to bolo aj v prípade ďalších gymnaziálnych učebníc z rokov 1972, 1985 a 1998. Napriek tomu, že štrukturálny model nebol zreteľný vo všetkých učebniciach (1999, 2000, 2001, 2002, 2006), zaradili sme ich do tohto modelu z dôvodu, že obsahovali množstvo teoretických informácií, ktoré neboli podložené ani osobnou skúsenosťou, ani nevychádzali z každodennej praxe. Typickým predstaviteľom štrukturálneho modelu je aj učebnica *Chémia 8* (1983), ktorej predchodcom je pokusná učebnica z roku 1979 s výraznými štrukturálnymi prvkami.

Výnimočnosť *polytechnického modelu* spočíva v tom, že pozornosť upriamuje na praktické využitie organických látok, najmä čo sa týka priemyselnej výroby. Predstaviteľmi tohto modelu sú učebnice *Chémia 9* (1963) a *Organická chémia pre 2. a 3. ročník SVŠ* (1967), pre ktoré sú charakteristické schémy výrob, využitia či spracovania organických látok ako aj autentické fotografie priamo z výrobného procesu v závodoch. Obe učebnice vyčleňujú osobitý priestor pre prehľad, príklady a princípy dôležitých chemických reakcií, či dokonca schémy zariadení na úpravu surovín najčastejšie používaných v chemickej výrobe.



Je to bezfarebný plyn, ktorý polymerizuje ľahšie než etylén. Vznikajúce makromolekuly vyjadrujeme hromadným vzorcom $(-H_2C-CHCl-)_n$. Polymerizáciou vinylchloridu dostávame polyvinylchlorid (PVC). Je to biely prášok, ktorý sa spracúva lisovaním pri teplote asi 150 °C na dosky alebo rúrky (obr. 60, 61). U nás je známy pod názvom **novodur.** Výrobky z novoduru odolávajú chemikáliám. Rúrky aj dosky možno zvárať teplým vzduchom. Používajú sa v chemickom priemysle aj v domácnostiach (odpadové potrubia vodovodov, záchodové splachovacie zariadenia a pod.).

Obr. 60. Ťahanie rúrok z novoduru

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Po pridaní zmäkčovadiel môžu sa z polyvinylchloridu zhotovovať fólie (obr. 62), z ktorých sa potom zhotovujú plášte do dažďa, dlážkové krytiny, poťahové koženky (**novoplast**) a pod.

Obr. 61. Lis na výrobky z plastických látok

Obr. 62. Ťahanie fólie z PVC na kalandri

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Obr. 2 Ukážka polytechnickej učebnice, zdroj: Chémia 9, Pauková, Hájek, Otčenášek, 1963

Charakteristiku *integrovaného modelu* by mohla spĺňať učebnica programu FAST, ktorá sa usiluje o prepojenie viacerých vedných disciplín – fyziky, biológie, chémie či geológie. Učebnica vznikla na Havajskej univerzite v USA a v deväťdesiatych rokoch sa dostala do experimentálneho overovania na Slovensku. Spomedzi všetkých analyzovaných učebníc sa vymyká nielen integrovaným charakterom, ale aj redukciou teoretických poznatkov, umožnením skúmania javov, hľadaním súvislostí medzi nimi a riešením nastolených problémov. Rozvíjaním senzomotorických aj intelektuálnych činností javí učebnica výrazné črty *modelu orientovaného na osobnosť žiaka* s ťažiskom na empirických a praktických poznatkoch.

Model vytvárajúci prírodovedný obraz sveta má znaky viacerých vyššie uvedených modelov. Prezentuje chémiu ako vedný odbor, ktorý sa uplatňuje vo všetkých oblastiach ľudskej činnosti a má značný význam pre spoločenský pokrok (Holada, 1985). Presne takýto „chemický obraz sveta“ podáva napríklad maďarská učebnica *Kémia 10., 2015*, v ktorej sa vychádzajúc z bežného života poukazuje na chemické pozadie organických zlúčenín. Nájdeme tu napríklad kapitoly s názvom: *Čo poháňa auto?, Chémia našej výživy, Krása a čistota, Jedy a lieky*. Okrem empirických, teoretických a praktických poznatkov tu pozorujeme výrazný dôraz na činnostiach. Sociálne činnosti sa rozvíjajú tým, že žiaci diskutujú, argumentujú a pracujú v skupinách v rámci projektových úloh v jednotlivých kapitolách.

Ďalšími predstaviteľmi tohto modelu boli učebnice pre ZŠ: *Chemie 8* (2006), *Chemie 9* (2007), *Chemie 9* (2011), *Chémia 9* (2012), *Základy praktické chemie 2* (2015), *Základy chemie 2* (2017), *Chemie 9* (2018) a SŠ: *Kémia 10.* (2007, 2012). Nakoľko v tomto modeli je rozvoj činností len možnou alternatívou, umožňuje to zaradenie širšieho spektra učebníc. Učebnice v istom zmysle reflektujú danú dobu, preto v súčasných učebniciach výraznejšie pociťujeme vplyv IKT (práca s internetom, aplikáciami, 3D modelmi a i.).

VÝSLEDKY

Z celkového počtu učebníc sme 17 (~ 43 %) z nich zaradili do štrukturálneho modelu, 13 učebníc (~ 33 %) patrilo k modelu vytvárajúcemu prírodovedný obraz sveta, 6 učebníc (~ 15 %) reprezentovalo fenomenologický model, v 2 učebniciach (~ 4 %) sa premietol polytechnický model, jedna učebnica (~ 3 %) predstavovala model orientovaný na osobnosť a jedna učebnica (~ 3 %) spĺňala charakteristiku integrovaného modelu. *Praxeologický model*, v ktorom by boli v rovnakom pomere zastúpené všetky typy poznatkov a činností, sa v našej vzorke učebníc nenachádzal. Tento model K. Holada v roku 1985 označil za perspektívny a aj po tridsiatich rokoch sa ukazuje sľubným v prírodovednom vzdelávaní na celom svete. Vnímame, že postupne dochádza k presunu ťažiska od poznatkov k činnostiam senzomotorickým, intelektuálnym i sociálnym s tendenciou upriamenia pozornosti na žiaka.

Vychádzajúc z našej vzorky učebníc, model výučby organickej chémie, ktorý prevládal v historických česko-slovenských učebniciach, by sme mohli vnímať ako fenomenologický. Nakoľko v 50.-tych rokoch sa v Československu postupne zvyšovala snaha spájať prírodovedné vzdelávanie s technickou výchovou, učebnice zo 60.-tych rokov mohli byť poslednými, ktoré mali polytechnický charakter. Na tento model v 80.-tych až 90.-tych rokoch nadväzoval štrukturálny model, ktorý sme pozorovali v česko-slovenských a aj v maďarských učebniciach. Súčasnú koncepciu výučby organickej chémie na Slovensku, v Českej republike i v Maďarsku by sme mohli charakterizovať ako model vytvárajúci prírodovedný obraz sveta.

ZÁVER

Na základe analýzy učebníc konštatujeme, že koncepcia výučby organickej chémie sa v priebehu takmer storočia zmenila. Dôkazom toho je rôznorodosť modelov, ktoré sa nám v učebniciach podarilo identifikovať. Koncepcia americkej učebnice sa výrazne odlišovala od koncepcií uplatňovaných v učebniciach stredoeurópskeho priestoru.

Je potrebné si uvedomiť, že modely sú iba všeobecné kategórie a v praxi nemôžu existovať v čistej podobe. Z tohto dôvodu je kategorizovanie do konkrétnych modelov náročné a nie vždy úplne jednoznačné.

Takáto analýza učebníc prostredníctvom modelov môže byť výzvou k rekonštrukcii výučby organickej chémie, s cieľom vytvárať priestor, ktorý by žiakom umožnil efektívne učenie sa poznatkom a činnostiam zároveň.

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Contemplation of activating teaching methods in science education in undergraduate training of pedagogical students

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Abstract

This paper aims to introduce the effective reflection and evaluation of pupil's learning in order to absorb the subject matter. This contribution outlines the strategies helping teachers who want to influence pupils' learning and support them to keep the subject matter in their minds. The three-phase model E–R–R is discussed with the didactic cycle G–M–I–A–R–E. Certain contemplation emerged from demands and needs that pedagogical students experience during their training of the correct use of reflection, within the course Activating teaching methods and forms in science education.

Key words

reflection, evaluation, teaching methods, cooperative learning, teacher preparation

INTRODUCTION

For the past fifteen years the trend that points out the need for active learning and independent and critical thinking of pupils has received much attention. This tendency appears not only from the state´s requirements for education but also from the changing society. The trend is related to the changes of teaching styles, shift from the traditional teaching to finding new ways, methods and strategies leading to the effective passing the information on to pupils, the training of skills and to their motivation for lifelong learning. If we demand pupils graduating with the ability of solving problems, it means that pupils orient themselves in a flood of information, choose sources and evaluate the relevance of news and data, and then it is essential to support the process of their active learning, preferably since their babyhood (Kolková, 2006).

During the activating of pupils the terms that affect the activity, i. e. personal dispositions, motivation or surroundings, should be respected. The activation of pupils by the teacher creates the important conditions for pupils' individual work and for their creativity and subsequent activity is the matter of all activities of pupils. The effort of pupils' activity is therefore crucial for the pedagogical work of teachers. However, it should be taken into account that the induced activity is expressed in various activities. The activity has to be directed properly so it leads to creative works. Consequently, the activity has to be reflected and evaluated to strengthen pupils' learning. However, pure activity alone cannot provide effective learning; it also depends on pupils' effort to learn. Higher external activity can only be formal, educationally ineffective (cf. Petty, 1996; Silberman, Lawson, 1997; Pasch et al., 1998).

If we agree with the need of the activating of pupils during (not only) science lessons then it is necessary to introduce this trend already to future teachers, i. e. students of pedagogical disciplines. This should be presented both within their pedagogical-psychological courses and also in the field of didactics.

With respect to the above, this contribution aims to contemplate the possibilities of approaches to various methods and forms considering the use of their activating potential. On the basis of work with pedagogical students, future biology teachers, the paper proposes the use of didactic models for more effective group work of pupils. The final part this contribution emphasizes what teachers have to think of when activating their pupils to avoid activation just for activation and to give some sense to the pupils' group work with the help of appropriately chosen methods.

THEORETICAL BACKGROUND

Readiness of teachers to use the activating methods, whether traditional or non-traditional, is primarily based on the ability to approach pupils with adequate democracy. First of all, teachers need to get rid of habits of authoritative behaviour. They should know how to remove barriers in communication and primarily they should be endlessly patient (Kolář, Šikulová, 2007). It is advisable for teachers to be equipped with necessary professional competencies. These are the ones that enable teachers to lead the educational process *in the right way*.

Models supporting activation in teaching

The models outlined below can serve to realization of effective teaching, teaching learning sequences, that are focused on pupils‘ activity and that use alternative forms and activating methods.

The first presented model is the three-phase model of learning and thinking E–R–R (the acronym for words Evocation–Realization of meaning–Reflection). Nowadays it is quite widespread and known (not only) within Czech pedagogical community. The E–R–R model became the platform for the project RWCT (Reading and Writing to Critical Thinking). Its foundation lies in a constructivist pedagogical approach, which is based on the active approach of pupils and on individual implementation of new information into their interpretation of the world. **Evocation** is the first phase of the E–R–R model. Pupils recollect their knowledge about given topic, circumstances of its previous mention, their imagines about the theme or what more they would like to know about the issue. It reaches pupils' intrinsic motivation to learn, raises the interest in the subject and allows understanding the information in context, not only randomly. **Realization of meaning** of new information introduces the second phase of the E–R–R model. It means the type of learning when pupils work with various information sources, they search the answers to questions, confirm the accuracy of the information and original assumptions and they discover the new ones. As a result of mutual communication, they reconsider original **preconceptions**, build bridges between old and new. **Reflection** is the final part of the E–R–R model. It represents the feed-back and hindsight of the learning process. Pupils think out what they have learnt, consolidate the new information and knowledge and they evaluate and form results in their own words (cf. Hausenblas & Košťálová, 2006; Kolková 2012; Florea & Hurjui, 2015).

Each phase of the E–R–R model has its typical specific cognitive activities that develop positively pupils' learning. The model could be used almost everywhere where thinking is required, for any learning content, in any class (Hausenblas & Košťálová, 2006).

The above mentioned could pose a risk for starting teachers or teachers who usually do not work in this manner at their lessons. The basic ideas and principles of RWCT represent a comprehensive didactic system in which specific practical methods, techniques and strategies are built in an open but interconnected whole, in an effective learning system that can be used at school. In order for the teaching to be in line with the RWCT, it is essential for teachers to master the methods used, respectively the whole range of methods, and they apply them properly.

Therefore, the author of this paper recommends the student teachers and starting teachers to use rather the G – M – I – A – R – E didactic cycle (later in the text: GMIARE), acronym for Goal–Method–Instruction–Action–Reflection–Evaluation, which focuses on one method per time.

GMIARE didactic cycle

The didactic cycle GMIARE, in Czech CMIARE with regard to the first word Goal, was designed by Czech civic association called Projekt Odyssea (later in the text: Odyssea) as an effective tool for implementation of the cross-curricular subject of Moral, character and social education (later in the text: MSE) to routine schoolwork, see also Valenta (2006). It is introduced in this text why teachers can use the GMIARE cycle better when starting using the (non)traditional activating methods in their lessons. GMIARE is designed primarily for MSE but it could be considered even when we follow the learning process of pupils with use of activation; also when pupils works in a group in the classroom where it is desirable to have positive interactions between pupils to promote *cooperative learning*, see e.g. Kasíková (2004). The author of the article uses the model to teach pupils as well as future teachers how to work in the form of group learning, aiming at positive interactions among group members, in accordance with the principles of cooperative learning. Working in a group, based on cooperative principles, integrates the cross-curricular subject of MSE into the subject's teaching.

Let us focus on particular letters of the acronym GMIARE. The **goal** represents essential and irreplaceable category in pedagogical disciplines which also included the occupational didactics.

The **method** is always selected with respect to the defined goal; the same is applied within the E–U–R model. Odyssea works mainly with active didactic methods that lead pupils appropriately through the learning process. Following question could be asked by teachers looking for a suitable method: Does this method lead effectively to the set goal/goals?

The **instructions** bring to light the activity that will take place during the lesson and also the explanation of all the necessary information and rules for successful planned activity. Rules for activities have to be short, clear and comprehensive; we have to think consequentially of the sequence of rules.

The **activity** is the time of the action when pupils work using chosen method or methods. At this phase, the role of the teacher consists in observing how pupils work and what is happening in the classroom which enables to obtain as much material for reflection as possible. The teacher walks around individual groups and preferably writes down precisely his or her remarks on pupils' work (Srb et al., 2007).

Reflection and its irreplaceable meaning for learning of pupils are also described in the E–U–R model. The aim of reflection is to make easy, regulate and deepen the pupils' learning. Reflection always leads to the defined goals and it usually runs by asking open-ended questions to pupils (Srb et al., 2007). The purpose of reflection is to investigate with regard to the goal the consequences of behaviour (for example during work in the groups to promote cooperative learning) for work and pupils' learning. In the case the behaviour does not lead to successful activity it is advisable to avoid or prevent it next time (Kolková, 2012). Pointing towards reflection and its anchorage in school teaching is obvious mainly at authors working in the area of reflective learning associated with the experience (e.g. Moon, 2004). Despite the long-lasting belief in the academic community about the necessity of reflection (reflective element) in education, rich literary production is focused mostly on justification of the importance of reflection rather than on its empirical evidence (cf. Korthagen et al., 2011; Beauchamp, 2015 and others.). Publications aim primarily at teachers and they describe the way and results of real use of reflective practices in professional development of teachers (see Nofke & Brennan, 2005; Mena Marcos, Sánchez & Tillema, 2011).

Evaluation represents the final phase of the GMIARE didactic cycle. Only now we evaluate the extent to which defined objectives were achieved. During evaluation we use suitable tools for measurement of achievements of pupils' goals. Students may also have the option of conducting their own assessment or peer review. The evaluation may include summary experience such as quiz, task writing (Duran & Duran, 2004) or table or charts refilling.

For starting teachers, the GMIARE cycle is a guiding tool that helps to realize methods with activating potential step by step; it suggests to teachers without experience with group work to remember and think of the reflection and evaluation during planning and realization of activities at their lessons; it ensures that activation just for activation does not occur (Kolková, 2012).

SURVEY – METHODOLOGY AND RESULTS

In the summer semester 2017, within the course „Activating teaching methods and forms in science education", each of 15 students prepared, in line with G-M-I-A-R-E principles, the activity using an appropriate activating method, a method applied in group work to lead pupils to cooperative action. Then students present the method to their schoolmates, in the sense that he/she taught by this method a selected topic from biology his/her classmates - who "played" pupils and worked by given instructions; after action the practise included the final stages of G-M-I-A-R-E - reflection and evaluation. The activity was observed by teacher and classmates playing the pupils and deficiencies were noted for feedback.

In the light of the present, the following research question was asked: What deficiencies produce students when they prepare the lesson according to the G-M-I-A-R-E methodology?

The deficiencies that arose during the presentation of the upcoming activity are examined. After further discussion and reflection, the students, together with their teacher, defined the categories of deficiencies, see Table 1, column Categories of Problem, to be removed in subsequent written preparations submitted in the course of credit.

The course teacher evaluated 15 written preparations (one from each student), which were demonstrated by students during the course. Their analysis shows how much students eliminated original deficiencies and which inadequacies still remain and require more attention during next training as it is shown in Tab. 2.

Tab. 1 Results – Identified insufficiency

Category of Problem	Identified Insufficiency	Example
Missing goal/goals	Reflection or evaluation is not related to the set goals.	„How well have you worked?“ Non-specific question, the need to focus on the specific activities of the group as part of the cooperation.
Incomplete instruction	Lack of instructions for activity.	The pupils' (schoolmates') work is interrupted because of additional instructions and information.
Purposeless reflection	Irrelevant questions for the pupils with the only goal of having them speak.	„Would you ever play a similar game?“
Reflection with low cognitive activity	The teacher asks closed questions without higher cognitive demands.	Yes/no – questions. Closed (one word) questions. The teacher offers answers to his/her questions.
Incomplete evaluation	Evaluation does not cover all of the set goals.	The subject goal is evaluated; the social goal (group work) is not evaluated.

Tab. 2 Results – Persistent insufficiency, source JR

Category of Problem	Identified Insufficiency	Example or eliminated
Missing goal/goals	Reflection is led to a goal, which is not defined at the beginning.	„How well have you worked in the group?“ The goal targeted and defined in relation to working with the text.
Incomplete instruction	In the written text of preparations not detected.	Eliminated.
Purposeless reflection	Ambiguous / unclear questions – too stylistic.	„What was good?“
Reflection with low cognitive activity	Teacher asks closed questions without higher cognitive demands.	Yes/no – questions. Closed (one word) questions.
Incomplete evaluation	Evaluation does not cover the MSE set goal.	Eliminated, with the exception of two preparations.

DISCUSSION

The results of the presented investigation show that the greatest difficulties in the lessons conducted by the CMIARE methodology are recorded during the training of reflection and subsequently also in the evaluation. According to Kolková (2012) it can be stated that pupils do not take their own but the teachers‘ final concept which is definitely not the goal of reflection. Teachers often replace the reflection phase by their personal summary of the subject matter, which is not in line with the needs of reflection. In the ideal case, pupils should draw their own conclusion; during conducting the reflection and evaluation, teacher´s part consists in the role of a mentor and moderator who helps pupils to choose between essential and insignificant, to discern between true and false. As well as Korthagen et al. (2011); Beauchamp (2015), we are also concerned with the need for reflection (reflective element) in education to become evident and efficient and not just set into the theoretical frame when its importance and demands are justified. Therefore, the author of this paper uses in her didactic lessons the method of discussion with the aim to identify the insufficiencies leading to incorrect conducting of reflection and evaluation. As Moon (2004) presents, this supports pupils to carry their experience from activities through their everyday life. Within the frame of this paper, pedagogical students may use this experience through their future professional life. In the final, we come to the same findings as Duran & Duran (2004) after completing the course, students-teachers are equipped with new skills and are encouraged to introduce even less common methods into biology teaching, making the class a thrilling and dynamic place to learn.

CONCLUSION

In the course Activating teaching methods and forms in science education, students prepared activities as a part of their training for proper reflection and evaluation. The aim of this task was to prepare the activity to respect and follow the CMIARE didactic cycle. Subsequently categories of deficiencies that occurred during training and that were not in agreement with the principles of reflection and evaluation as it is described above were identified. Following categories are involved: missing goal/goals, incomplete instruction, purposeless reflection, reflection with low cognitive activity, incomplete evaluation. Ensuing analysis of submitted preparations show categories of deficiencies that still remains (missing goal/goals, purposeless reflection, reflection with low cognitive activity) and that were eliminated (incomplete instruction, incomplete evaluation).

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How Much Do We Know about the Way Students Solve Problem-tasks

Martin Rusek, Kateřina Koreneková, Martina Tóthová

Abstract

This contribution aims at the actual meaning of results gained from student testing via problem tasks. According to Koreneková (2018), positive responses do not necessarily mean that students managed to solve the problem tasks and reached the expected outcomes defined in the national curriculum. Concurrent think-aloud method was used to identify strategies students (N = 16) used to solve problem tasks. The results were worse than in the pilot testing of the same tasks. Many false-positive results were identified which puts the original test results into question.

Key words

Problem-solving skills, chemistry problem tasks, problem-solving strategies, chemistry education

INTRODUCTION

Problem solving is an integral part of science and therefore needs to be emphasised in science education. Also scientific literacy in its various definitions (Faltýn a kol.. 2011; OECD, 2016) contains the use of scientific methods as one of its components. The stress on problem solving in (science) education is obvious. Its relevance is further advanced by PISA (Problems of International Student Assessment) tests which gained worldwide popularity after 2000 (see OECD, 2018).

Problem tasks became a part of the Czech national curriculum when original objectives (Expected Outcomes) were concretized by indicators and by at least three problem tasks to every theme within each education field (see Vojíř a kol.. 2017). The indicator (problem) tasks for chemistry were piloted by Vojíř (2017). The same tasks were later verified by Koreneková (2018), who along with the tasks applied the retrospective think-aloud method (Van Den Haak a kol.. 2003) to find out about the course of students' problem solving. The results showed significantly lower success-rate compared to Vojíř's (2017) results, despite the very same tasks were used.

This adds to the criticism of PISA tests which are by some considered more intelligence and reading tests than tests of literacies (Štech, 2015). Another argument for revisiting the contemporary testing practice is the possibility to understand the reasons of the students' failure, i.e. a look into the problem-solving strategies they use (cp. Koreneková, 2018). The strategies are an unsubstitutable component, yet they seem to emerge themselves without any official systematic support from curriculum policy makers. Students' possible failure in tests based on problem-tasks then does not merely indicate students' knowledge and field-related skills. Reading skills (literacy), misunderstanding (misconception) but also the level of their problem-solving skills are also in play. Interpretations of such tests, however, often omit the latter aspect. From this reason, authors of this paper decided to look more into the results received from problem-tasks.

THEORETICAL BACKGROUND

As shown below, problem-solving is a phenomenon many researchers deal with. According to the research by Chang a kol.. (2010), problem-solving belongs among one of the most often researched-on topics in science education research. This also applies for chemistry education (Teo a kol.. 2014, p. 475).

There are several criteria how to sort problem-solving skills. In this paper, the authors use the categorization into: *supporting strategies, limiting strategies* and for the sake of its difference *reading strategies*. The group of *supporting strategies* contains: analogy, deduction of unknown out of known (Vacínová & Langová, 2005), problem breaking into pieces (Ogilvie, 2009; Polya, 1973), logical reasoning (Posamentier & Krulik, 2009), self-reflection (Dewey, 1987), connection to reality (Posamentier & Krulik, 2009). The group of *limiting strategies* contains: memorial breaking of the answer (Chupáč, 2008), „I simply think so" (Skalková, 2007). The group of *reading strategies* defined by Najvarová (2008) contains: reading aloud, repeated reading and multiple reading. Students' *problems with problem solving* were in the literature identified as *problems with the task* itself: misunderstanding the task, problem with understanding the task, task adjustment and checking task understanding Dewey (1987). Chupáč (2008) completes the list with *problem with knowledge*: unknown-subject matter (Students state the subject-matter is unknown to them and therefore fail solving it.) or *ignorance* (Students lack the knowledge to solve the problem.)

To get information about cognitive processes (Van Someren a kol.. 1994) the *think-aloud* method is being used. The method consists in a subject explaining their steps in an interview. There are two main types of the think-aloud approach: *concurrent* think-aloud when a problem-solving subject describes their steps directly when taking them and *retrospective* think-aloud which is performed after the task is solved. Both of the approaches have their pros and cons. Critics of the concurrent think-aloud argue it may affect the results (Chi, 1994). Also subjects do not mention everything regarding the problem when talking whilst solving it (Cooke & Cuddihy, 2005). This approach was noted to cause discomfort to the subject (Nielsen, 1994). On the other hand, this method is only as time-consuming as the problem-solving and allows researchers to track the entire process.

The *retrospective* think-aloud takes more time as the problem-solving process is revisited. Tai a kol.. (2006) argue that the subjects forget their steps and do not provide so all the information.

The following research questions were guiding the research: *Which strategies do students use when solving chemistry problem-tasks?* and *Which problems do students face when solving the problem-tasks?*

METHODS

Research design

To answer the research questions, the following model was developed (Fig. 1). In order to form tests for student selection and for subsequent qualitative research, tasks from Czech educational standards for chemistry (Holec & Rusek, 2016) were evaluated by a panel consisting of chemistry educators, Ph.D. students in the field of chemistry education and chemistry teacher students (N = 8). The panel members evaluated the tasks according to their perceived difficulty. Optimal-difficulty tasks (Vojíř et al., 2017) with comparable difficulty score assigned by the expert panel were divided into two tests by three tasks.

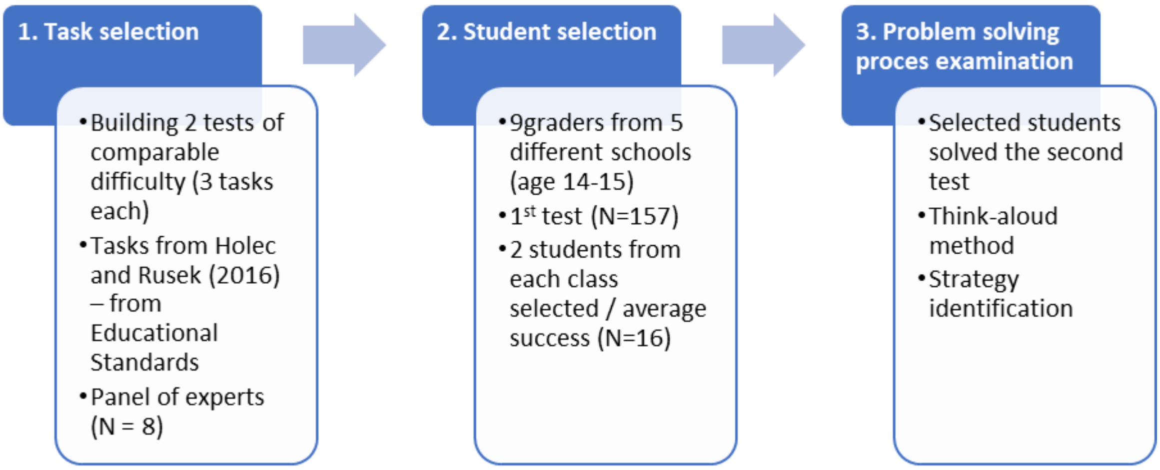

Figure 1 The research design

Participants

To answer the research questions, the following model was developed (Fig. 1). In order to form tests for student selection and for subsequent qualitative research, tasks from Czech educational standards for chemistry (Holec & Rusek, 2016) were evaluated by a panel consisting of chemistry educators, Ph.D. students in the field of chemistry education and chemistry teacher students (N = 8). The panel members evaluated the tasks according to their perceived difficulty. Optimal-difficulty tasks (Vojíř et al., 2017) with comparable difficulty score assigned by the expert panel were divided into two tests by three tasks.

Five different lower-secondary schools (8 classes) from Prague with history of cooperation with the authors' department were selected. Altogether 157 nine graders (age 14-15) were submitted to the first round of testing in late spring 2017. Based on the first test results, successful, average and unsuccessful solvers were detected. Two average task solvers from each class were then chosen based on the results. Altogether, 16 students (10 girls and 6 boys) were selected for the second round which was conducted by the end of the school year 2016/2017, i.e. in the end of their school attendance. The problem-solving interviews took from 6 to 28 minutes.

Strategies identification

The selected students were visited in their schools. They were explained the method and the purpose of the study and were individually given the second test. The concurrent think-aloud method was used and the process audio-recorded. The recordings were later transcribed and coded according to the previously known strategies from the literature (see above). Some more codes were created for newly found strategies (e.g. working with the task text, use of the periodic table, decision based on the difficulty of the task, result prediction according to the task stucture). The codes were then matched with the test score. By analysing both sources, students' problem-solving strategies were mapped.

RESULTS AND DISCUSSION

First, the results were compared with the results from the tasks first piloting (Vojíř, 2017). The results were considerably worse. There are two possible explanations to this. First, the tests themselves do not reflect on the students' actual skills as they are assessed only based on the result. Given the fact that to be considered successful, students needed not only to choose the correct answer, but also a correct explanation (cp. Adadan & Savasci, 2012; Potočnik & Devetak, 2018). So called "false-positive" results were then ruled out. The second explanation follows concerns e.g. by Chi (1994) – concurrent think-aloud method affected the result.

One of the main findings is that on average the success in task solving is not a reflection of knowledge or skill. Often applied "guessing strategy" was noticed. From the supporting strategies, the students used mostly: problem breaking down, logical reasoning, working with the task (periodic table, data in tables, graphs) result. As far as reading strategies are concerned, the students applied reading loud and repeated reading strategies. From the limiting strategies, "I simply think so" strategy was used along with tipping/guessing and result prediction based on the task structure – a strategy not mentioned in the literature focused on these problems.

When the reasons of unsuccessful problem-solving were looked for, task misunderstanding, task adjustment, and checking the task understanding emerged from the research results. Looking back at the tasks which are designed to test the learning objectives and considering that average students were selected, it seems the learning objectives were not met. The results could be different if the tests consisted of traditional tasks and not learning tasks (Vojíř et al., 2017), however considering the fact these tasks were designed to serve as indicators, their use for the purpose of this study is legitimate. Moreover, testing just fragmentary pieces of knowledge out of context violates the main idea of scientific literacy (OECD, 2016).

The results open another important, yet so far undiscovered research area. There is a lack of knowledge about the students' acquisition of strategies or skills. This belongs to one of the limitations of this study. In the following studies, students need to be questioned also about the style the teachers work with developing their problem-solving strategies. Triangulation of this information gained from students, by questioning teachers and by analyzing the students' problem-solving process would offer a much deeper look into the problem. Based on this knowledge, it would be possible to offer interventions leading to strengthening of these skills.

Another improvement of the methodology of this study is seen in the use of retrospective think-aloud method supported by an eye-tracking record to ensure students have some guidance when describing their problem-solving progress (see Mason a kol.. 2013; Pienta, 2017).

The whole research would certainly benefit from repetition with two-tier task versions. This would enable researchers compare the effect of problem-solving affected by concurrent talking with retrospective eye-tracker enhanced talking and describing the processes.

CONCLUSION

This research represents a second step of putting problem-tasks into practice. After piloting them, reasons for the students' failure were investigated. This opens a whole different field which has not been given enough attention in the Czech Republic. Academic society lacks information about the students' problem-solving progress which makes test results (including PISA) less predicative.

In this research, supporting as well as limiting strategies students use when solving problems were identified. During the course of the research, several other approaches were discovered. Together they would shed more light on this area providing all stakeholders with valuable information about the process of skills-testing technique. Also, it remains uncertain if school is the main factor which equips students with appropriate set of problem-solving strategies and knowledge which makes them successful in international comparison based on problem-tasks.

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Using project-based education to develop pre-service biology teachers' knowledge of the cooling effect of vegetation.

Renata Ryplová, Jan Pokorný

Abstract

Vegetation has a significant cooling effect on local climate and contributes to the retention of water in the landscape. Surprisingly, this significant environmental topic is completely omitted from the Czech science curriculum. To introduce this topic into the curriculum it is necessary to first educate the future science teachers. Our paper presents results of a pilot study that introduced pre-service teachers to the cooling effect of vegetation via a hands-on project and assessed the improvement of their understanding of the key concepts using a pre and post-test.

Key words

Environment, Initial Teacher Education, Project based Learning, Science Education

INTRODUCTION

Why is it important to teach about the cooling effect of vegetation?

Everybody knows that during the heat of the summer it is much more pleasant to spend a hot day in the forest rather than in the city. The cooling effect of vegetation (Fig.1) is widely known, but it is taken for granted and not well understood. People mostly do not care about the reasons why the climate is cooler in the forest. This is one of the consequences of human indifference and ignorance of the roles plants have in their environment; this indifference has been referred to as "plant blindness" (Wandersee & Schussler, 1999).

Considering the recent changes in the global climate, it is very important to understand the physiological role of vegetation in cooling climate at local scales. Global temperature has been steadily increasing, the continents have become significantly dryer, and the experts warn of an impending global water crisis (IPCC, 2014, 2018). One of the possible ways to mitigate this dire situation is proposed by the…"new water paradigm", (Kravčík et al.,2007). It calls for better landscape management to retain water in the landscape and recover the cooling function of ecosystems. Although the positive role of vegetation in cooling of local climate and in increasing water availability in the landscape has been demonstrated in numerous studies (for the review see Ellison et al., 2017), general public pays less attention to this topic. Deforestation and incompetent management of the landscape, caused by ignorance of the role of plant physiology in dissipation of solar energy and in the hydrologic cycle, contribute to the warming of climate at local scale, and lead to a decrease in the availability of water in the landscape (Ellison et al., 2017, Huryna & Pokorny, 2016).

Therefore it is necessary to raise awareness of the general public about the physiological „cooling“ function of the vegetation and to teach the subject, at an appropriate level, in elementary schools. According to the curricular documents of the Czech Ministry of Education, this topic falls into the category of environmental education. To educate future science teachers, a project-based lesson on the cooling effect of vegetation was developed and implemented into the education of pre-service biology teachers at Department of Biology, University of South Bohemia in Ceske Budejovice. A pilot study was carried out to answer the following research question: Can an expert-developed project-based lesson improve students’ knowledge of the cooling effect of vegetation?

The “air-conditioning” effect of evapotranspiration

Transpiration is a necessity by which a plant maintains its internal temperature within it’s optimal thermal limits. Using elementary physics, it can be shown that at the level of a landscape, evapotranspiration is the most efficient air conditioning system developed by nature. In addition to optimizing temperature, plants use evapotranspiration to control the water balance in their root zone. Water is able to redistribute much of the solar heat energy received by the Earth through the water cycle, thanks to its high latent heat of evaporation and condensation. Water has a unique feature. It exists in three aggregate states in our living environment: solid, liquid and vapour. Phase transition from liquid into vapour is associated with changes of volume (18 ml of liquid forms 22,400 ml of vapour) and consumption or release of energy (0.68 kWh kg^{-1}, 2.45 MJ kg^{-1} at 20 °C). The consumption of heat through evaporation in places that are currently hot and the release of heat through condensation in places that are currently cold (e.g. via formation of fog or dew equalizes temperature differences in time (between day and night) and in space (between different spaces).

Let us imagine a tree with a crown 5m in diameter covering an area of approximately 20 m^2. On a single sunny day, the crown will receive in the excess of 150 kWh of solar energy. What happens with this energy? About 1 % is used for photosynthesis, 10 - 15 % is reflected back into space, 5 – 10 % is released into the atmosphere as sensible heat and the same percentage is transferred as ground heat flux into soil. The largest percentage enters the process of transpiration, whereby water vapour is released from the tree. If a tree has a sufficient water supply, it can evaporate more than 100 litres of water a day and use approximately 70 kWh (250 MJ) of solar energy in the process. This energy is hidden in water vapour as latent heat and is released again during the process of condensation to liquid water.

The tree transpired around 100 litres of water, thus cooling its environment by approximately 70 kWh. The tree transpired water only during the daylight hours when it's stomata were open, and much of the evaporation happened during peak solar radiation, thus during a ten-hour period the tree cooled its environment with a 7 kWh power output. The energy of 70 kWh did not appear as sensible heat, it stayed in form of water vapour, and was released in cool places or during a night. Such a tree has a cooling capacity comparable with several technological air-conditioning and heating system used in households, hotels, offices. Transpiring tree has a double air-conditioning effect: it cools when water evaporates and water vapour passes energy to cool places where latent heat is released when water vapour condensates back to water liquid (Pokorny, 2019).

From thermodynamic point of view, trees reduce gradients of energy between the sun and outer space, they degrade incoming solar radiation through life processes (Schneider & Sagan, 2005).

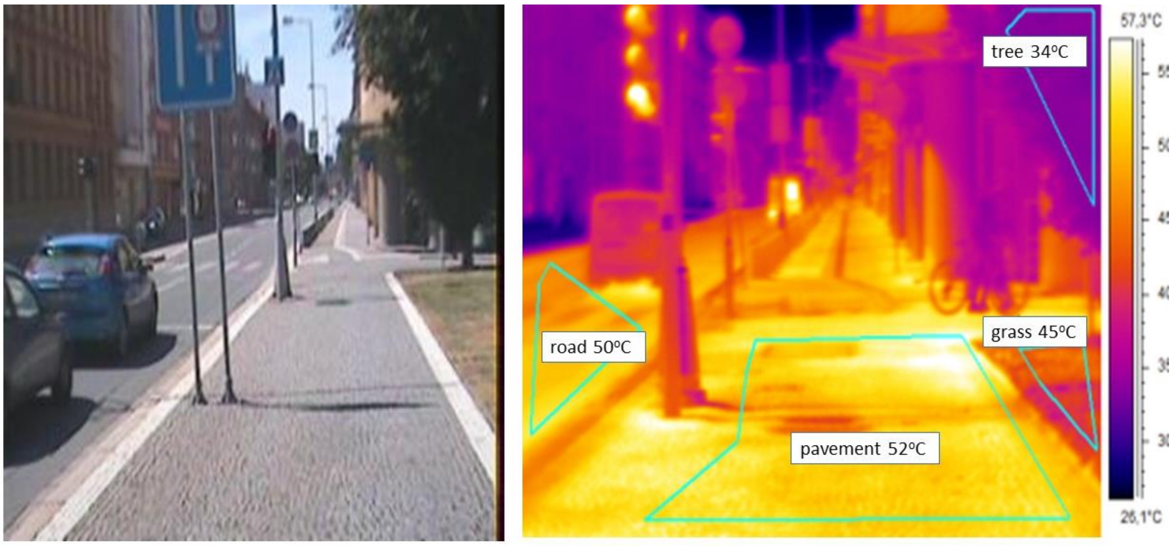

Fig.1. Street without trees on a summer day. Surface temperature of pavement 52°C, a tree on a side 34°C. (Pokorny et al., 2018)

METHODOLOGY

Project- based education on the topic of the cooling effect of vegetation

To educate future biology teachers, we developed a project-based lesson named "Using vegetation cover to cool down the main square in our town", focusing on the topic „solar energy – vegetation – water in the landscape." The lesson was implemented into the education of fourth grade pre-service biology teachers at the Faculty of Education, University of South Bohemia. The lesson was based on hands-on field experiments, using a thermo-camera, a solar radiation meter, and an IR thermometer. For the purposes of the lessons scientific measuring methods were adopted and simplified. An impact of this teaching method on students' knowledge was investigated by the didactic survey described below.

Design of the project-based learning:

1. **Theoretical introduction** - **Transpiration and solar energy distribution in the landscape.** One hour lesson was delivered in the classroom on the distribution of transpiration and solar energy in the landscape, motivated via the following inquiry question: "Why is the shadow under the tree cooler than the shadow under the umbrella? "
2. **Outdoor hands-on part - three groups working on different inquiry based tasks during a sunny day**:

Group A: How much solar energy reaches the surface of the grass under a tree compared to open treeless space? What is the surface temperature of the grass in the open and under the tree? The pre-service teachers we asked to consider the cooling power of the tree given a transpiration rate of 20 litres per hour.

Group B: Is there any difference between the surface temperature of the lawn with tall uncut grass and cut grass? The pre-service teachers were asked to make observations using the thermocamera (or IR thermometer) and to explain any differences.

Group C: Using the IR thermometer, find the coolest surface in the courtyard of the faculty building, including the lawn, the pavement, the tree and the building. Explain the differences among the various surface temperatures

3. Presentation of the results and discussion among the groups.

4. A proposal for the vegetation cover of the main square. All groups work together on the proposal, based on their experience from the hands-on field exercises (A-C).

The pre-service teachers were given the following directions: Imagine, that the average amount of solar energy reaching the surface of the main square in our town (Ceske Budejovice, 1hectare area) is 900 W/$m^{2.}$ Create a proposal of a new vegetation cover (how many trees, how many m^2 of uncut lawn) to cool the square by the average of 200 kW/ hour. Draw the trees and lawns into the map of the square (source - Google maps).

(Consider transpiration rate of a tree as 20 l / hour, transpiration rate of 1 m^2 uncut lawn as 0, 3 l/ hour)

Design of the didactic survey

To investigate the impact of this project-based lesson on the students' knowledge of the cooling effect of vegetation a pre – test/ post- test experimental design was used. The respondents underwent a pre–test a day before and a post–test a day after the project. The students' understanding of the cooling effect of vegetation was assessed using the short questionnaire consisting of 5 questions:

1) Tropical rain forests and deserts occur on the Earth at approximately the same altitudes. How is it possible, that there are big differences between the day and night temperature in the desert, while there are nearly no differences in the tropical rain forests? Explain: *(2 points)*
2) If we cut down the forest, the local climate: a) will warm up, because…b) will cool down, because… *(correct answer (a) with correct explanation 2 points, correct answer with wrong or no explanation 1 point, false answer (b) 0 point*
3) Is it possible that some deserts have recently enlarged due to the wrong human management?

   a) Yes, because…. b) No, because…. *(Correct answer (a) with correct explanation 2 points, correct answer with wrong or no explanation 1 point, false answer (b) 0 point)*
4) Which physiological process in plant utilizes the biggest amount of solar energy reaching the plant surface? *(transpiration 1 point)*
5) The morning dew condensing on a leaves a) warms up, or b) cools down the plant? *(a=1 point)*

In a total 13 pre-service teachers in the first year of their master studies took part in this survey (1 male, 12 females). The results of the tests were statistically evaluated by using STATISTICA 12 PC package (StatSoft Inc.) and the differences between the pre and post-test were compared by using Student t-test.

RESULTS AND DISCUSSION

Pre-test results

According to the results of the pre-test, the level of the pre-service teachers' knowledge of the cooling effect of vegetation was very low before the lesson (Fig.2). In a pre-test the students achieved quite a low mean score of 2.61 ± 1.55 Std. Dev. (out of 8 possible points). The most difficult question was question number 4, which asked the pre-service teachers to name the physiological process that consumes the largest amount of solar energy. None of the respondents gave the correct answer; all pre-service teachers considered photosynthesis instead of transpiration as the correct answer. The respondents either did not fully understand the process of transpiration or they did not have a correct conception about the solar energy distribution across the landscape. They understood photosynthesis to be the main solar energy-consuming process in the plant. The overestimation of the role of photosynthesis and underestimation of the role of transpiration follows also from the incorrect answers on the questions Nr.1 and 2. In question Nr.1 the respondents explained the differences between the diurnal course of temperatures in a desert and a tropical rain forest by the differences in photosynthesis, consuming significantly more solar energy in a tropical rain forest and therefore decreasing the day temperatures. Similarly, on the question Nr. 2 they mostly answered that if we cut down the forest, the local climate warms up, because the lowered photosynthesis in the cut forest causes more solar energy to be radiated as a heat. Thereby we can assume that the respondents did not understand the thermoregulatory function of evapotranspiration in the local climate and did not consider transpiration as the process that transfers solar energy and prevents the plant from overheating. Further problems were found in interdisciplinary relations: The respondents did not understand the heat transfer via evaporation of water (questions Nr.5, Nr.1 and Nr.2). These results correspond to the results of previous studies aimed on the basic or high school students' knowledge of water regime of the plant (Ryplova & Bezpalcova, 2016) or plant role in environment (Ryplova, 2017), which also revealed low level of understanding of the cooling function of the vegetation via evapotranspiration. To our knowledge, no studies on the pre-service teachers' knowledge of the cooling effect of vegetation exist in the recent international literature, but according to the personal experience of the authors the knowledge of the cooling effect of vegetation is also low in other countries (this remains to be shown by future research). Several previous studies point to transpiration as a difficult subject in science education (Vitharana, 2015; Wang, 2004).

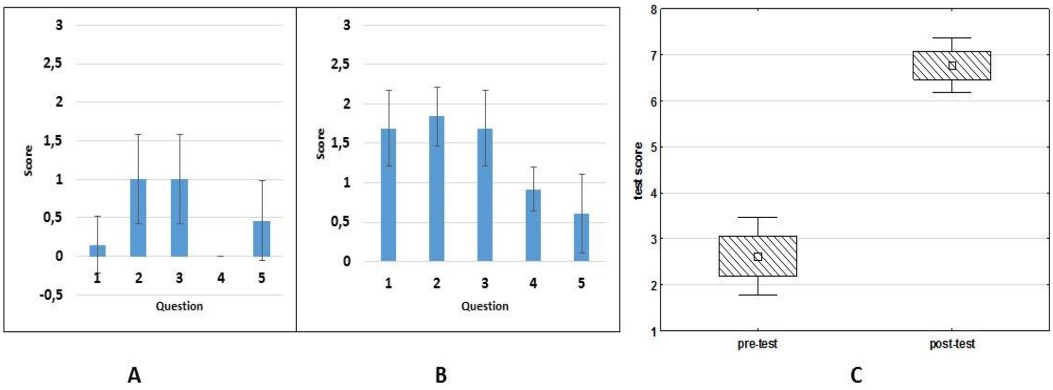

Fig.2. The detail results of pre – test (A) and post-test (B). The values represent mean score ± std. dev. C - comparison of the general results of pre- and post –test (small squares represent mean values, boxes mean value± std. dev., line segments mean value± 1,96*std. dev. t = -7,8767, p=4,15*10^{-8}, N =13.

An impact of project-based learning on the knowledge of the cooling effect of vegetation

The project-based lesson with elements of inquiry improved significantly the level of pre-service teacher' knowledge of the cooling function of vegetation. The differences between the pre and post – test (the general score) were statistically significant according to the Student t-test (t = -7,8767, p=4,15*10^{-8}).

Drought and global warming are serious problems of recent times and thus the pre-service teachers were fully interested in taking part in this project. The project-based learning was advantageous for this interdisciplinary topic. According to the Bilek and Machkova, (2014), project-oriented instruction is a method of motivating students to actively problem-solve and search for meaningful "products"/solutions. One such „product" was a possible plan of cooling the square in their own city by using vegetation. Positive impact of interdisciplinary projects in the pre-ervice teachers' preparation was also found by previous studies (Lindner, 2013, Machkova et al., 2015). According to the results of this pilot study, we can assume, that project-based education seems to be suitable for the topic of cooling function in the pre – service teachers' preparation. These results are to be corroborated by future research, because of the low number of respondents taking part in this pilot-study survey.

CONCLUSIONS

The project-based lesson improved the pre-service teachers'knowledge of the cooling function of vegetation. Education on this topic should be focused on the following critical points, based on the results of our pre-test: a) evapotranspiration b) solar energy distribution in the landscape (especially over estimated role of photosynthesis, underestimated role of transpiration) c) interdisciplinary relations - the use of laws of physics (heat conversion, evaporation, condensation) as drivers for biology (transpiration).

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Change in the perception of animal dimensions as one of the results of the project-based education

Romana Schubertová, Tatiana Kviatková, Radovan Malina

Abstract

There are some objective reasons which cause misconceptions in perception of the birds´ wingspan dimensions. They are usually underestimated for all species, more in the case of predators than in the case of smaller songbirds. This paper is mapping the effectiveness of project, implemented into 5th grade biology education of secondary school, with potential to change the perception of birds´ dimensions. The survey was attended by 160 pupils, 93 of them were involved in the realization of designed project, rest of them made control sample. The project consisted of making paper models of different bird species in their real dimensions. Data about perception of dimensions of 6 common bird species were collected right before and then 3 months after realization of project. Quantitative analysis indicated statistically significant differences in the perception of the dimensions of the individual species. Even after the realization of the project, the pupils underestimated the dimensions of the wing spans, but their estimates were more accurate than in the case of pupils who did not implement the project.

Key words

Project-based Learning, Models in Science, Misconceptions, Science Education, Birds

INTRODUCTION

There is a critique of researches in the field of didactics, caused by a little relation to the school reality (Reeves, 2006). One of the solutions is to use the Design-based research (DBR) as approach, which combines the design of learning processes, methods or innovations (collectively named as artifact) and the research of teaching in the proposed environment (Barab & Squire, 2004). Creating of this artifact requires an iterative process and hence its repeated used to optimize product (Juuti & Lavonen, 2006). In such a process, for example, educational materials were created in the field of chemistry didactics (Schubertová, 2014). It is important to work with real teachers who provide target feedback. Surveys studying misconceptions do not usually use this approach, they are often formal, and their conclusions are difficult to use in the creation of educational materials.

In the case of misconceptions about birds, their classification, relationships with humans, physiology, or living conditions were studied so far (Cardac, 2009). Prokop and Rodák (2009) investigated the impact of various stimuli (visual and acoustical) on the ability of pupils to identify species. Randler and Bogner (2002) focused on impact of hands-on, learner-centered environment on knowledge about species. Learner-centered and teacher-centered approaches didn´t differ in their effectiveness if there was a larger number of learned species. Reduction of them caused significantly better results in the group of learner-centered pupils. So far, the marginal area of the study of misconceptions in natural sciences is the perception of the biological objects´ dimensions - such studies dominate in didactics of physics because of astronomy and large interplanetary distances (Miller & Brewer, 2010) and in chemistry education due to the very small size of particles (Cokelez, 2012). As a part of the presented research, we focused on the perception of bird dimensions in Schubertová, Kviatková and Malina (2018), in which we stated that pupils underestimated the real dimensions of birds (which is also interesting stimulus to further exploration of the birds by pupils).

GOALS OF RESEARCH AND METHODS

Research conducted through the approach DBR had two fundamental goals:

- to bring new insights into the theory of biological education in the area of the perception of animal dimensions;
- to reveal the possibilities of influencing ideas by testing the design of project activity.

The process of testing the activity was also focused on the optimization of educational materials. Research has been divided into the following stages:

- testing pupils´ original ideas about the size of the wingspan of different bird species;
- the creation of educational materials with the potential to correct the misconceptions of pupils;
- testing the effectiveness of using the educational materials in the context of change of dimensions´ perception;
- adaptations of educational materials according to the requirements of practice.

The first two points were discussed in Schubertová, Kviatková and Malina (2018). This paper analyses changing of ideas after realization of activity and discloses editing of educational materials. In the context of testing the effectiveness of educational materials, the hypothesis was established: pupils who have been educated on birds by modeling them in their real dimensions will make minor mistakes in estimating their wingspans.

Participants

A total of 160 pupils were involved in testing the effectiveness of the proposed activity and in exploring the ideas about wingspan of different bird species. 93 pupils formed an experimental sample, which, after the initial collection of data about original perception, was involved in the creation of bird models. 76 pupils made a control sample, which was educated by common practice and available education materials (common textbooks). Pupils came from different types of five schools in total.

Data collection and analysis process

We used a table with the names of each species to collect the data before the teaching of topic (pretest), while the pupils had wooden or paper rulers with length of 1 meter (to help to imagine scale). Six well-known species were selected, including small, medium and large species and also predators and owls:

- Common Buzzard *(Buteo buteo)*, Northern Goshawk *(Accipiter gentilis)*, Tawny Owl *(Strix aluco)*, Eurasian Jay *(Garrulus glandarius)*, Great Spotted Woodpecker *(Dendrocopos major)*, Great Tit *(Parus major)*.

We examined "the mistakes" of pupils and expressed them as difference from real average value of the wingspan, which can acquire both positive and negative values. The difference in perception of the wingspan was then re-labeled (to make the results more comparable between the species) by formula:

(value of pupil – real value) × 100 / real value

This gave us an insight into the percentage difference between pupils´ view and real wingspan in the case of each species.

Data about perception of dimensions were collected again with a delay of 3 months after realization of project activity in the posstest (activity is described in more detail in Schubertová, Kviatková & Malina, 2018). Wilcoxon´s nonparametric test was used to determine the difference between groups, values were calculated using the software PASW Statistic 18 (SPSS inc. 2009). Jackknife resampling technique was used.

RESULTS

There was no statistically significant difference in the control and experimental groups ($p = 0.35$) in the case of pretest. In the case of posttest, the pupils in experimental group made an average absolute mistake -8.56 cm, in the control group pupils made an average absolute mistake -11.98 cm. We observed a statistically significant difference (p = 0.009) among pupils´ outcomes from experimental and control group. Table 1 shows not only the absolute, but also relative mistakes of the pupils in the perceived dimensions after the realization (or not realization of the project). Significant differences were identified in the case of larger bird species (*Strix aluco, Buteo buteo* – p = 0.001). A statistically significant difference was not observed in the case of *Parus major* and *Accipiter gentilis*. However, interesting average of pupils´ perception shows that control group made in this case of *Parus major* positive deviation from the real value.

Table 1 Main characteristics of predictions of experimental (RP) and nonexperimental (NP) groups in the case of 6 bird species.

bird species	real average value of wingspan (cm)	average mistake (cm)		average relative mistake (%)		variance		p - value
		NP	RP	NP	RP	NP	RP	
Dendrocopos major	36	+10,41	-0,6	+28,92	-1,67	244,5	125	0,008
Buteo buteo	120,5	-45,21	-23,17	-37,6	-19,23	117,01	101,24	0,001
Garrulus glandarius	55	-15,03	-11,57	-27,32	-21,05	163,64	118,18	0,007
Accipiter gentilis	110	-25,48	-14,81	-23,16	-13,46	131,81	105,45	0,07
Strix aluco	99	-31,05	-3,99	-31,36	-4,04	142,43	112,13	0,001
Parus major	24	+3,56	-3,71	+14,83	-15,48	270,9	116,63	0,19

Within 3 months (from pretest to posttest), the ideas of pupils in control group, changed in a positive way too. The graph (Figure 1) shows comparison of the average value of the pupils´ original ideas (in pretest) and the average values in posttest. The average pupils´ estimate was closer to the real value of the wingspan in the experimental group in all of the cases, except of *Parus major*.

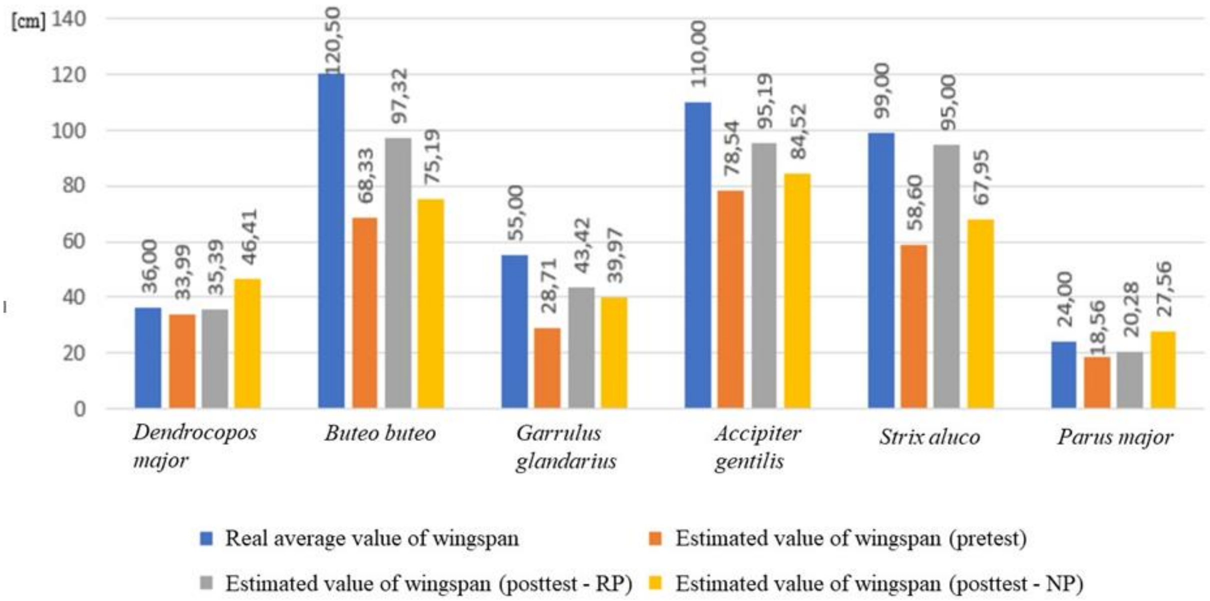

Figure 2 Comparison – average value of pupils´ ideas in experimental (RP), nonexperimental (NP) group and real average values of wingspan.

Experimental and control group also differed in the data distribution of posstest. It is obvious that a larger number of pupils estimated the dimensions more precisly in the case of control group (Figure 2) – there is a lower variation range in all of the species. The most striking difference is, hovewer, in the case of *Parus major*.

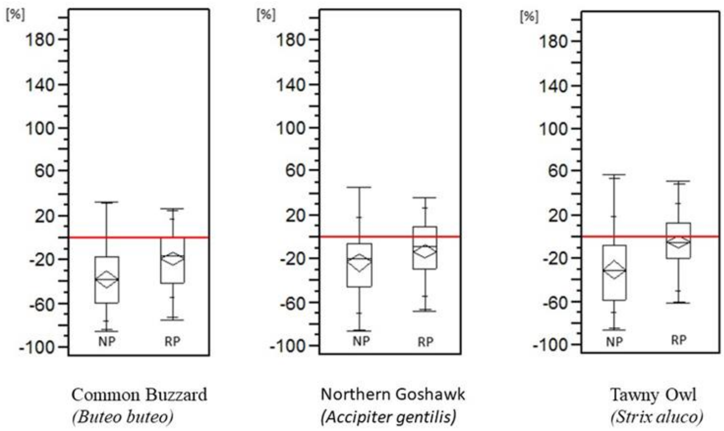

Figure 3 Distribution of data inside of experimental (RP) and control (NP) group in the case of posttest – predators

In the case of predators, the difference between the upper and lower quartile is not as distinct as in the case of *Parus major, Dendrocopos major* and *Garrulus glandarius* (Figure 2 and 3).

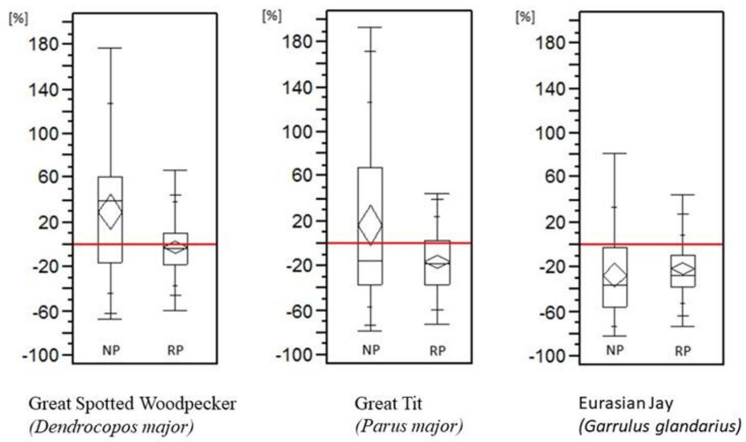

Figure 4 Distribution of data inside of experimental (RP) and control (NP) group in the case of posttest – smaller passerines

One of the research results is also the optimization of the proposed educational procedures. Teachers have suggested changes in the terminology used in materials for pupils and the need for graphic editing. The resulting materials include the introduction of the problem (through comix interview), a space for making predictions about wingspan, and making notes of real dimensions. To produce bird models, the pupil is provided with a picture of their silhouette and a bird species card with various information (Figure 4).

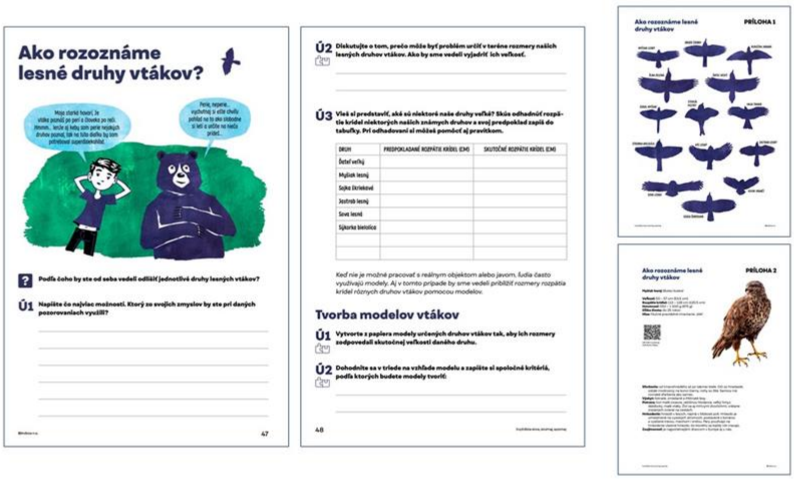

Figure 5 Materials for pupils, enhanced realization of project – making models of birds in their real dimensions, made in iterative process (Schubertová, Škodová, Chrenková & Balážovič, 2018).

CONCLUSIONS

The aim of education in natural sciences is to help transform misconceptions of pupils about natural phenomena and objects. One of the misconceptions, which we can often observe also in an adulthood, is the underestimation of birds´ wingspan. There is a possibility of positive change in pupils´ ideas, by making a models of different bird species in their real dimensions. We confirmed our hypothesis, as quantitative analysis indicated statistically significant differences in the perception of the dimensions of the individual species. Pupils after realization of project estimated dimensions of birds more accurate than pupils which didn't make paper models of birds. The direct experience of pupils with dimensions of birds can affect ideas in long-term way. At the same time, it is an interesting initiative point for pupils to investigate also another birds´ characteristics.

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Digestion in human body in Science education – results of a questionnaire

David Šarboch, Milada Teplá

Abstract

In 2017, a questionnaire dedicated to secondary school chemistry and biology teachers was created and realized via Google docs platform. This questionnaire investigated the state of teaching of digestion in human body at secondary schools. Firstly, according to the answers, this topic is interdisciplinary and should be taught mainly during biological and chemical lessons. Secondly, there is a need to promote the illustrative nature of the topic. And last but not least, the relation between scientific knowledge and everyday life should be supported.

Key words

Chemistry, biology, science education, secondary school

INTRODUCTION

This contribution is dedicated to a pedagogical research that was realized in 2017. The survey examined the level of teaching of "digestion in human body" topic and was based on a quantitative research method – a questionnaire. The research goals were, firstly, to find out the teaching disposition of the topic at secondary schools, secondly, to define what materials are used during the educational process connected with the topic, thirdly, how the topic is perceived by teachers themselves and last but not least try to ascertain and define factors that should be promoted by teachers during children's exposition to the topic. Except of the data discussed below, another outcome of the research is an interactive animation that is accessible on www.studiumbiochemie.cz web page.

The first chapter of this contribution discusses the inclusion of the topic in the national curricular document – RVP G (Framework education programme for Secondary General Education, 2007). The next part concerns the theoretical bases connected with the chosen topic and the modern trends of the science education. The final chapter is devoted to the results of the questionnaire itself.

INCLUSION OF THE DIGESTION IN HUMAN BODY TOPIC IN THE CZECH NATIONAL CURRICULAR DOCUMENT

The concrete form of the national Czech curriculum is represented by the Frameworks education programmes. These documents specify the concrete objectives, form, and basic curricular content of education, as well as general conditions for their implementation. Within the Framework education programmes, there are two educational areas concerning the topic of digestion: *Man and nature* and *Man and health*. In the *Man and nature* educational area, the following outcomes are particularized in Chemistry, specifically in Biochemistry: *"The pupil shall explain the structure and function of compounds necessary for important chemical processes taking place in organisms, the pupil shall characterise basic metabolic processes and their significance."* (Framework education programme for Secondary General Education, 2007). In Biology section this outcome is determined: *"The pupil shall utilise his/her knowledge of organ systems to understand the relationships between processes taking place in the human body."* The educational area *Man and health* mentions in the part named *Healthy lifestyle and self care for health* that *"The pupil shall strive for positive changes in his/her life connected with his/her health and the health of others."* (Framework education programme for Secondary General Education, 2007)

The topic of digestion in human body reflects all the expected outcomes mentioned above. That was also one the reasons to choose this topic.

INTERDISCIPLINARY RELATIONS

Interdisciplinarity, interdisciplinary relations, integration, complex presentation of the curriculum. All these terms often appear in papers coming out in the Czech Republic in the last twenty years (Škoda & Doulík, 2009, s. 24-44, Hejnová, 2011, s. 77-90, Janík & Stuchlíková, 2010, s. 5-32). The worldwide trends in science education point out on the usefulness of a partial integration of some subjects or at least interdisciplinary connections of some specific topics. According to Janík & Stuchlíková (2010, s. 5-32) that can contribute to the raising of the attractivity of the science disciplines that is a crucial step because of the pupil's fading interest in the science education. Interdisciplinarity (or interdisciplinary approach) is characterised as a specific way of teaching linking the knowledge and the methods of a several science disciplines (Průchová et al., 2003). In the Czech Republic, there is an attempt to implement interdisciplinarity within the cross-curricular subjects in RVP G. These units shall connect related disciplines and summarize the curriculum that should be presented to pupils in a complex way and not via separate subjects.

Advantages and disadvantages of the interdisciplinary relations

There are a lot of authors that assess positively the implementation of the interdisciplinarity into the learning process. Casey Jones (Jones, 2009) sums up in his paper named Interdisciplinary Approach – Advantages, Disadvantages and the Future Benefits of Interdisciplinary Studies the fundamental advantages and disadvantages of the interdisciplinary relations (*Tab. 1*). His vision of the interdisciplinarity in practice uses a "team teaching" approach when teachers of the different subjects not only cooperate while forming a new curriculum but also teach a specific topic together. According to Jones, team teaching is one of the best methods of the interdisciplinarity application into the learning process.

Tab. 1 – Advantages and disadvantages of the interdisciplinary relations according to Jones (2009)

ADVANTAGES
Promote the understanding of the relations within the disciplines.
Make pupils think about the problem from other perspective.
Emphasize the pupil's lifelong learning thus promote his/her personal development.
Cultivate the pupil's ability of a context considering and face the real world problems.
DISADVANTAGES
The cross-curricular subjects are difficult to specify and draw up.
Schools often implement the modern approach of the interdisciplinary relations even if they are not prepared enough for that. The quantity is strengthened to the detriment of quality.

VISUALIZATION AND ANIMATION

The fact that man receives the majority of the information from the world outside by eye-sight is evident. According to the experimentally obtained data, we gain about 80 % of information by the sense of sight. Another research claims that man is able to retain 70 % of the total amount of knowledge obtained by oral presentation after three hours, by three days you remember only 10 %. Using visual presentation, a man remembers 75 % after three hours and 20 % after three days. By combination of these two types of presentation (visual and oral), after three hours a man retrieves 85 % of information and 66 % after three days on average (Bradbury, 2001). This fact forms one of the basis of the modern teaching process, represented by a teacher who is no more a bottomless well of knowledge, but shall be a tutor transferring the learning content in the most various forms possible in order to enable pupils to find their own best way to understand the curriculum.

Visualization

One of the curriculum exposition examples mentioned above is visualization, which represents an ideal tool allowing students to choose the best mean of learning the abstract parts of the schoolwork (Nodzynska, 2012, s. 519). Three visualization forms can be applied while using this kind of exposition (Schönborn & Anderson 2005): 2D and 3D static models, 2D and 3D dynamic models, 2D and 3D multimedia models.

2D static models represent basic and in these days widely used visualization tool, that comprises for instance of an educational text, a picture of a chemical apparatus or a p-V graph of an isothermal process. Ball-and-stick molecule models are an example of a 3D static model.

Dynamic models make part of the second category, which is represented by simple 2D and 3D animations without any interactive components, for example the animation of a covalent bond creation.

The most complex and required visualization tools are multimedia models. These models put diverse audio-visual elements together to create an outcome that is presented afterwards (Schönborn & Anderson 2005). The visualization tools mentioned above are texts, pictures, sound, videos and animations.

Animation

Animation can be classified as a dynamic visualization tool (Ainsworth & van Labeke, 2004, s. 241-255). Pospíšil & Michal (2001) delimit the term of animation as *„the simulation of a fluent movement obtained by composing of individual frames or drawn pictures*. By combination of this definition and the fact that a human eye has always been attracted by movement (Hamlin, 2000), an ideal educational mean is received. Nowadays, an approach claiming that using animation leads to more effective learning process, is generally accepted. This opinion is promoted by the majority of researches, according to Bétrancourt & Tversky (2000, s. 311-329).

STRUCTURE OF THE QUESTIONNAIRE

At the beginning of the questionnaire, the instructions and the introductory information about the research goals, were presented. The first part was dedicated to the teacher specialization and the whole learning process of this topic (in which subject the teacher would present this topic and where he/she really does, how many hours he /she sacrifices to teach the topic and what tools the teachers use while presenting digestion in human body). The second part pursued the teachers´ subjective opinions about the attractiveness of the topic for themselves as well as for pupils. Another questions tried to find the answers for the present state of using the textbooks and their didactic quality. In the final part of the questionnaire, teachers were asked to choose the important factors that should be emphasized while presenting the topic of digestion in human body.

RESULTS OF THE QUESTIONNAIRE

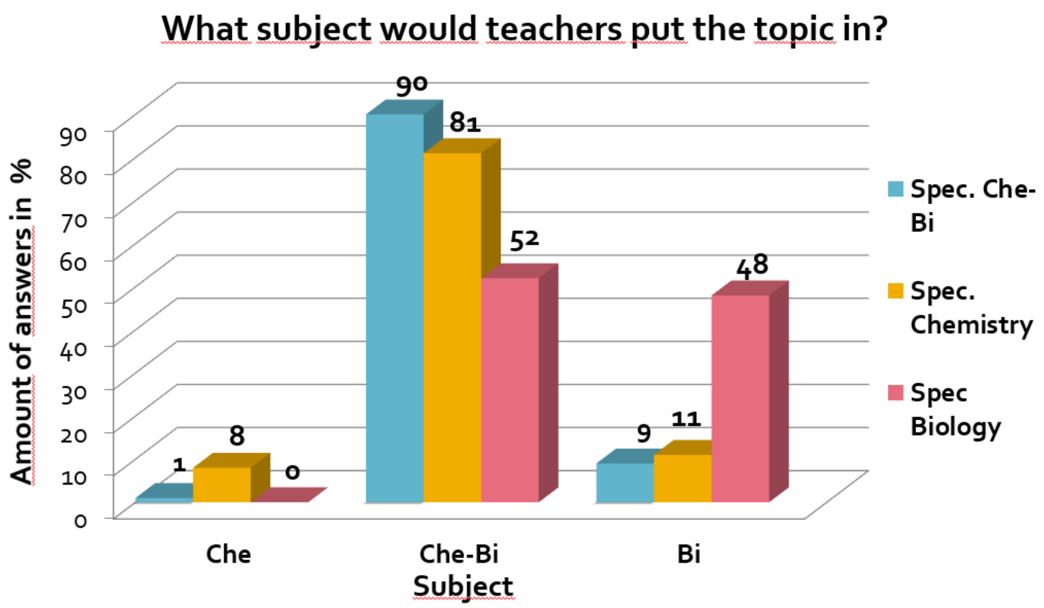
The questionnaire was distributed via electronic way to 421 respondents (chemistry and biology secondary school teachers) all over the Czech Republic. The rate of return was 35 % and the form was filled in by 146 teachers. Also 11 printed questionnaires were distributed and in this case the rate of return was 100 %. In total, 432 questionnaires were distributed and the final rate of return made 36 %.

Teachers specialization

The most frequent respondents' specialization was a combination of chemistry and biology (46 %), followed by only the chemistry or chemistry and other subject (but not biology, mostly mathematics and physics) specialization (40 %). The third category was represented by biology and biology and other subject (but not chemistry) teachers (14 %). The majority of respondents comprised of chemistry teachers.

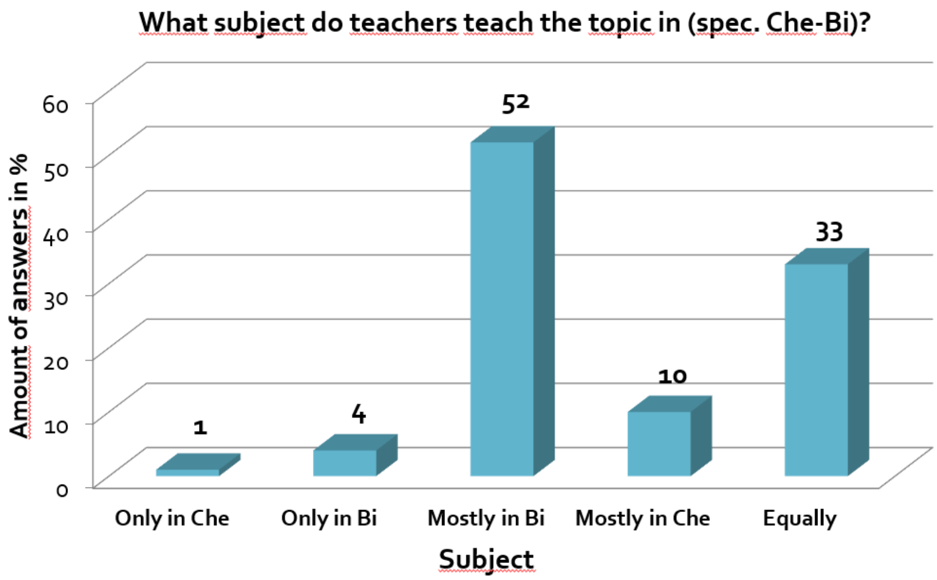
Topic inclusion

The first question exposed to respondents was: In which subject would you teach this topic? The results are summarized in Graph 1. Apparently, the major part of the chemistry-biology teachers (90 %) would put the topic into both subjects. A similar opinion is evident concerning the chemistry and chemistry and other subject teachers (81 %), while the biology teachers (with specialization: biology and biology and other subject) would present this topic equally in both subjects (52 %) or only in biology (48 %). Another remarkable fact is that 11 % of chemistry teachers (without those with specialization chemistry-biology) would present the topic in biology merely, meanwhile no biology teachers (without those with specialization chemistry-biology) would put the topic only in chemistry.



Graph 1 – Subjective inclusion of the topic into subject discussed above (chemistry, biology) selected by teachers with specialization in chemistry-biology, chemistry-other subject and biology-other subject.

The next question led to the real state of teaching the digestion topic in both subjects. In Graph 2, the chemistry-biology teachers´ answers are arranged. Comparing with Graph 1, where 90 % of chemistry-biology teachers would put the topic in both subjects, there is a correspondence with Graph 2, where exactly 95 % of chemistry-biology teachers really present the topic in chemistry and biology. The equal situation of teaching the topic in chemistry and biology is apparent in 33 % cases. Nevertheless, more than 50 % of teachers present the topic mainly in biology. 10 % of respondents teach the digestion in human body mainly in chemistry, 4 % only in biology and 1 % only in chemistry. The principal outcome from these answers is that in present days the topic is classified as a biological one. This fact is emphasized by a comparison of the total amount of teachers presenting the topic mainly and only in biology (56 %) and those teaching the topic mainly and only in chemistry (11 %).



Graph 2 – Representation of the real state of the digestion in human body teaching by chemistry-biology teachers.

Time span relating to the topic

Chemistry teachers (chemistry and chemistry and other subject including biology), sacrifice 4.1 hours on average to the topic. On the other hand, biology teachers (biology and biology and other subject including chemistry) dedicate 3.5 hours to digestion in human body on average.

Teaching aids

The question concerning the teaching aids was answered as follows. In biology lessons, teachers use mainly powerpoint presentations (89 %), then videos (52 %), blackboard and chalk (47 %), textbooks (47 %), 3D models (45 %), work sheets (42 %) and wall paintings (39 %). Experiments and animations are utilized much less (experiments – 25 %, animations – 23 %). In chemistry, the most applied teaching aids are also powerpoint presentations (79 %), followed by blackboard and chalk (57 %), work sheets (39 %), experiments (33 %), textbooks (31 %), videos (29 %) and animations (25 %). Wall paintings are used only by 7 % of teachers; just 4 % work with 3D models.

Processing of the topic in chemistry and biology textbooks

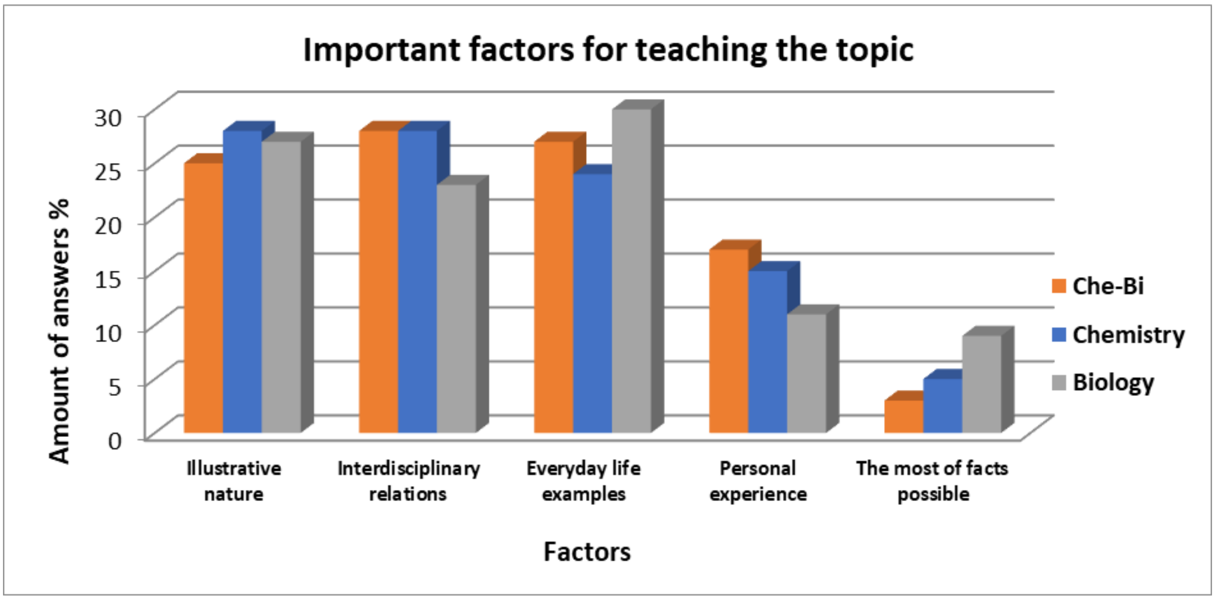
The textbooks were evaluated by teachers on the five-mark scale (1 very well-processed, 2 well-processed, 3 neutral opinion, 4 insufficiently processed, 5 very insufficiently processed).

In general, biology textbooks are evaluated as well-processed. The most frequent mark among biology teachers (only biology and biology and other subject excluding chemistry) was 2 (65 %). Then a sharp decrease is apparent and roughly the same amount of teachers assess the processing by 3 (20 %) and 4 (15 %). A similar trend can be seen regarding the chemistry-biology teachers answers. They mostly evaluate biology textbooks by 2 (41 %) and then mark 3 (35 %). Only 11 % of teachers consider biology textbooks to be very well-processed, 13 % ticked mark 4.

Chemistry teachers (with only one specialization or with other subject excluded biology) mostly evaluated chemistry textbooks by 3 (25 %), followed by 4 (16 %) and then mark 2 (12 %), 5 (4 %) and 1 (2 %). Chemistry and biology teachers assessed equally thus their most frequent mark was 3 (28 %). However, the second most common mark was 2 (12 %), then 5 (8 %), 1 (5 %) and finally 4 (1 %).

Important factors while teaching digestion in human body

The last question of the questionnaire investigated the factors that, according to the teachers, are important for teaching the discussed topic (Graph 3). All the factors mentioned in Graph 3 were already included in the questionnaire. Teachers did not add any other suggestions even if there was a possibility (free box signed „Other:“). These three factors are the most crucial while teaching the digestion in human body: interdisciplinary relations support, illustrative nature and everyday life examples.



Graph 3 – Important factors for teaching the topic of digestion in human body

Summarizing of the questionnaire results

The outcomes of the survey can be summed up as follows:

1) The topic of digestion in human body is perceived as interdisciplinary by the respondents. According to their answers it should be taught in both subjects (chemistry and biology) equally even if it is presented mainly in biology in present days.
2) Chemistry teachers dedicate about 4 hours to this topic during the learning process, meanwhile biology teachers need 3.5 hours on average.
3) The teaching aids most frequently utilized are powerpoint presentations. Also, blackboard and chalk, work sheets, videos (mainly in biology), textbooks (again mainly in biology) are commonly used in both subjects. Experiments are implemented mostly in chemistry, however during biology lessons teachers use wall paintings and 3D models. Animations are applied by a fourth of chemistry and biology teachers.
4) The topic of digestion is considered as attractive for pupils and very attractive for teachers.
5) The most commonly used biology textbooks are Biologie pro gymnázia (Jelínek & Zicháček), then Biologie člověka (Novotný). Concerning chemistry textbooks, the most frequently utilized is Chemie pro čtyřletá gymnázia (Mareček & Honza). A lot of teachers also work with other materials.
6) Basic factors that shall be strengthened while teaching the topic of digestion are illustrative nature, support of interdisciplinary relations and everyday life examples.

CONCLUSION AND DISCUSSION

The questionnaire survey whose data were discussed in this paper showed the interdisciplinary character of the topic of digestion in human body. Despite this fact, the topic is taught mainly in biology that is most likely related to the processing quality of the topic in chemistry and biology textbooks. Digestion in human body seems to be attractive for pupils as well as for teachers. Thus, a higher attention shall be devoted in order to improve the teaching of the topic. To attend this goal, these three factors should be emphasized: illustrative nature, support of interdisciplinary relations and everyday life examples. One of the possibilities how to promote the teaching of digestion in human body is the creation of interactive learning animations, where both the chemical and biological content of the topic would be mentioned.

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Nitrace aromatických sloučenin v badatelsky orientovaném vyučování

Aromatic compounds nitration in IBSE

Karel Vojíř, Linda Honskusová, Martin Rusek, Karel Kolář

Abstract

The aim of this paper is to present IBSE activity based on a simplified process of phenol reaction with nitrous gases on TLC. The activity was tested during Environmental Seminar with 14 pre-service biology teachers. The activity proved to be feasible. All four student groups successfully solved the task and they were able to interpret the results correctly. The IMI tool was used to gain feedback. Students seem not to feel pressure during their activities. In all other subscales (interest/enjoyment, effort/usefulness, perceived competence, value/usefulness) the students scored medians.

Key words

Inquiry Based Teaching, Science Education, Chemistry, Environment

ÚVOD

V životním prostředí jsou v současné době již běžně přítomny nitroaromatické sloučeniny. Od 70. let 20. století jich bylo identifikováno přes sto různých typů. Je zřejmé, že jsou přítomny ve všech složkách životního prostředí (Barek, Cvačka, Moreira & Zima, 1996). Převážná část nitroaromátů se vyskytuje v ovzduší (Stiborová, 2002), do kterého pronikají důsledkem antropogenní činnosti, mezi kterou se řadí například vysokoteplotní procesy jako je spalování fosilních paliv, zpracování kovů, tepelná likvidace odpadů a automobilová doprava. V důsledku těchto procesů se ovšem do ovzduší dostávají rovněž oxidy dusíku a aromatické uhlovodíky či jejich deriváty. Mezi nimi dochází k chemickým reakcím. Značná část nitroaromatických sloučenin tak vzniká přímo v atmosféře. Z té mohou být vdechovány do plic, ukládají se atmosférickou depozicí do půdy a lze je nalézt i v dešťové vodě a říčních sedimentech (Nielsen, Feilberg & Binderup, 1999; Stiborová, 2002).

Aromatické nitrosloučeniny jsou z pohledu ochrany životního prostředí i lidského zdraví značně rizikové, neboť vykazují mutagenní a karcinogenní aktivitu. Mezi podezřelé karcinogeny lze zařadit např. o-anisol, nitrofen, 1-nitropyren aj. (Stiborová, 2002; Takamura-Enya, Suzuki, & Hisamatsu, 2006). Nádorové procesy lze pozorovat zejména v játrech, plicích, prsních žlázách a v močovém měchýři (Anderson et al., 1997; Arlt, 2005).

Mezi toxikologicky nejvýznamnější nitroaromáty kromě nitropyrenů, nitroanisolu, nitrofluorenu, nitrochrysenu, nitrobenzanthronu a nitrofluoranthenů patří i nitrobenzen. Ačkoli se v ovzduší, ze kterého se přes půdu dostává do podzemních vod, nachází ve velmi malém množství, při opakované expozici způsobuje methemoglobinemii. Během experimentů na zvířatech byl zjištěn vývoj nádorových onemocnění štítné žlázy, ledvin a jater (*Toxicological profile for nitrobenzene*, 1990).

Chemické změny v atmosféře není možné přímo pozorovat. Ve výuce, pokud jsou vůbec zařazeny, se tak často stávají teoretickým konceptem, který je pro studenty zabývající se environmentálními faktory zcela abstraktní. Jedná se jen o pouhá tvrzení předkládaná učitelem. Tento problém je možné překlenout pomocí badatelsky orientovaného vyučování, které umožňuje hlubší porozumění problematice v širších souvislostech a zvyšuje žáky vnímanou relevantnost učiva (Stuckey, Hofstein, Mamlok-Naaman & Eilks, 2013). Navržená aktivita je tak v souladu s prací Kováčové, Helda a Pipíšky (2019).

Badatelsky orientované vyučování ve výuce ekoorganické chemie

Ekoorganická chemie propojuje klasické poznatky organické chemie s ekologickými faktory. Vstupuje tak jako významný informační zdroj do environmentální výchovy, tj. *„komplex často značně se různících přístupů reagujících na problémy v hledání koexistence mezi lidskou společností a přírodou“* (Činčera, 2006, p. 4). V dnešní době lze v otázce enviromentální výchovy pozorovat ustupující trend od převážně znalostně orientovaných programů k postupům, kdy je volen kritický přístup vedoucí k hlubšímu porozumění (Palmer, 2003).

Vzhledem ke snaze o holistický přístup ve vzdělávání se nabízí mezipředmětové propojení ekologie a organické chemie v kontextu reálných situací. Ve smyslu vymezení BOV některých prací (Janík, 2004; Maňák, 1994; Pasch, 1998) integrující badatelské aktivity mohou rozvíjet žáky a studenty, aby byli schopni mj.:

- využít znalosti ze základních chemických disciplín pro porozumění výskytu, osudu a účinkům chemikálií v prostředí,
- navrhovat a realizovat chemické experimenty pro poznání environmentálních procesů,
- analyzovat získaná data, interpretovat a diskutovat laboratorní experimenty,
- prezentovat výsledky vlastní práce, diskutovat a komunikovat environmentální problémy,
- rozumět environmentálním aspektům lidské činnosti a hodnotit environmentální vlivy technologií,
- identifikovat, analyzovat a navrhovat řešení pro široké spektrum environmentálních problémů.

CHARAKTERISTIKA BADATELSKÉ AKTIVITY

Navržená badatelská aktivita vychází z experimentů navržených Kolářem a kol. (1998, 2001). V rámci těchto experimentů byla zpracována modelová simulace vzniku nitroaromatických sloučenin. Reakce jsou prováděny v plynné fázi. K identifikaci vznikajících produktů je využívána tenkovrstvá chromatografie. Díky jednoduchému instrumentálnímu uspořádání, nízkým spotřebám chemických látek a relativně nízké toxicitě v simulačních procesech vznikajících produktů se tyto experimenty ukazují jako vhodné pro využití v badatelsky orientovaném vyučování.

Aktivita je navržena jako skupinová práce s časovou náročností přibližně 90 minut. Průběh aktivity a činnost studentů je řízena materiálem v písemné formě[5], ve kterém jsou studentům předloženy základní faktické informace. V iniciační fázi badatelské aktivity je využíváno motivačního potenciálu aktuálního tématu, které propojuje vzdělávací aktivitu s mimoškolním prostředím. S informacemi o znečištění životního prostředí, ovzduší nevyjímaje, a souvislost polutantů s řadou onemocnění se studenti setkávají v řadě mediálních prostředků. V rámci aktivity studenti pracují s reálnými výzkumnými informacemi o znečištění ovzduší a účincích nitrovaných aromatických sloučenin na lidské zdraví[6] a propojují tyto informace s poznatky získanými badatelskou činností o vzniku těchto sloučenin z prekurzorů. Tyto informace hodnotí a dávají do kontextu se závěry z vlastní badatelské činnosti zachycující průběh reakcí na modelovém příkladu. Aktivita tak zprostředkovává procesy vedoucí ke vzniku pro zdraví nebezpečných látek, které se do atmosféry dostávají nejen přímým lidským působením, ale významnou měrou vznikají jako produkty sekundárních reakcí.

Aktivita studentů je směřována pomocí řídících otázek strukturujících průběh aktivity, sledující model 5E – Engage, Explore, Explain, Elaborate, Evaluate (Bybee, Taylor, Gardner, Van Scotter, Powell, Westbrook & Landes, 2006). V češtině je tento model označovaný jako 5Z – Zapojení, Zkoumání, Zpracování, Zobecnění, Zhodnocení (Čtrnácová, Teplá & Čtrnáctová, 2015):

1. plánování postupu bádání na základě předložených informací o modelových chemických reakcích a využívaných metodách, vyjádření očekávání (tj. zapojení a zkoumání),

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[5] Materiál obsahoval následující kapitoly a podkapitoly: A) Simulace vzniku nitrofenolů v atmosféře: Jak lze postupovat při uspořádání experimentu. Jaký je princip probíhajících reakcí. Co je to chromatografie (popis metody, tenkovrstvá chromatografie). Jak vyhodnotit chromatogram látek vzniklých nitrací fenolu. B) Experiment - opravdu k reakcím dochází?: Nitrace fenolu + Vliv doby působení oxidů dusíku na fenol (Jak budeme postupovat? Navrhněte v bodech postup. Co očekáváme? Provedení experimentu - co jsme zjistili? Co vyplývá z výsledků provedeného experimentu?).

[6] Studentům byl předložen text Stiborové. (2002): Škodlivé aromatické nitrosloučeniny. Lze zabránit jejich působení na člověka? *Vesmír*, 81, 683-685.

2. provedení experimentů a zaznamenání výsledků (tj. zpracování),
3. interpretace výsledků a jejich propojení s informacemi v odborných textech zabývajících se vlivem nitroaromatických sloučenin na životní prostředí a lidské zdraví (tj. zobecnění a zhodnocení).

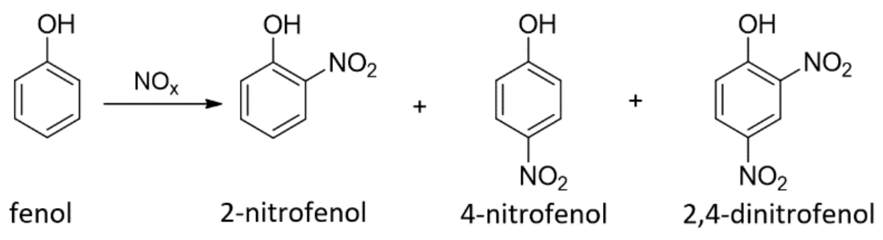
Součástí navržené badatelské aktivity je interpreatce závěrů z badatelské činnosti a jejich zobecnění v kontextu organickochemických procesů a environmentálních aspektů. Studenti tyto závěry písemně zpracovávají na základě vlastních výsledků a dostupné literatury.

Zatímco typicky se vzdělávací obsah v souvislosti s atmosférou omezuje na složení vzduchu a důvody a dopady přítomnosti kyselinotvorných oxidů, představená aktivita přináší rozšíření o další látky významně ovlivňující životní prostředí i lidské zdraví. Předpokládaným výstupem je přiblížení nitračních reakcí na modelovém příkladu reakcí fenolu s nitrózními plyny. Zároveň se aktivita zaměřuje na usouvztažnění teoretických poznatků s praktickou činností demonstrující princip vzniku nitroaromatických látek z prekurzorů dostávajících se do atmosféry antropogenním působením. Celá aktivita tak cílí na porozumění problematice týkající se významných ekologických a zdravotních rizikových faktorů, jakými jsou například strukturně blízké nitroanizoly či nitrované vícejaderné aromatické sloučeniny (např. Svobodová, Dračínská, Martínková, Hudeček, Hodek, Frei & Stiborová, 2008; Takamura-Enya, Suzuki & Hisamatsu, 2006).

Vzhledem k šíři problematiky, na kterou se navržená badatelská aktivita zaměřuje, je možné ji využít i jako námět pro projektově orientované vyučování. Nabízí se širší propojení s biologickými a medicínskými tématy v oblasti působení nitroaromátů na organismy a člověka i sociálními vědami v rámci problematiky antropogenního působení. Nasnadě je i kontext mediální výchovy. V maximální šíři by bylo možné např. realizovat projekt orientovaný na výše zmíněné důvody a dopady přítomnosti vybraných plynů v atmosféře.

Realizace experimentální části

Navržená aktivita využívá snadno probíhajících reakcí mezi fenolem a plynnými oxidy dusíku. V rámci těchto reakcí vzniká řada nitrofenolů, u nichž je zřejmá strukturní blízkost s identifikovanými karcinogeny (Stiborová, 2002), kterým je například 2-nitroanisol.



Obrázek 1 Nitrace fenolu

Možný postup provedení experimentální části lze rámcově shrnout do níže uvedených bodů. Dílčí kroky se ovšem mohou odlišovat s ohledem na sestavení postupu studenty.

1. Pro jednodušší manipulaci se jako vhodné ukazuje nanesení fenolu na tenkou vrstvu sorbentu (silikagel), která zároveň poslouží i k výslednému vyhodnocení – tenkovrstvé chromatografii. Nanesením roztoku fenolu v toluenu (0,1 g fenolu a 5 cm^3 toluenu) se připraví vzorky na 2 deskách. Jeden bude použit k reakci, druhý slouží jako referenční.
2. Ve vhodné nádobě (např. větší skleněná vana či kádinka) se připraví nitrózní plyny (např. 5 g dusitanu sodného a 3 cm^3 koncentrované kyseliny chlorovodíkové). S ohledem na bezpečnost je nezbytné tuto část experimentu provádět v digestoři.
3. Do nádoby s nitrózními plyny se zhruba na 5 sekund[7] vloží jeden připravený vzorek fenolu na tenké vrstvě.
4. Vzniklé produkty reakce se oddělí pomocí tenkovrstvé chromatografie ve vzestupném uspořádání. Vhodnou mobilní fází je toluen. Pro porovnatelnost se stejný postup provede i u referenčního (nenitrovaného) vzorku fenolu.
5. Světle zbarvené nitrofenoly se detekují okouřením amoniakem za vzniku nitrofenolátů výrazně žluté barvy. Nezreagovaný fenol je možné dokázat stejnými reakcemi, tedy zopakováním okouření nitrózními plyny a následně parami amoniaku.

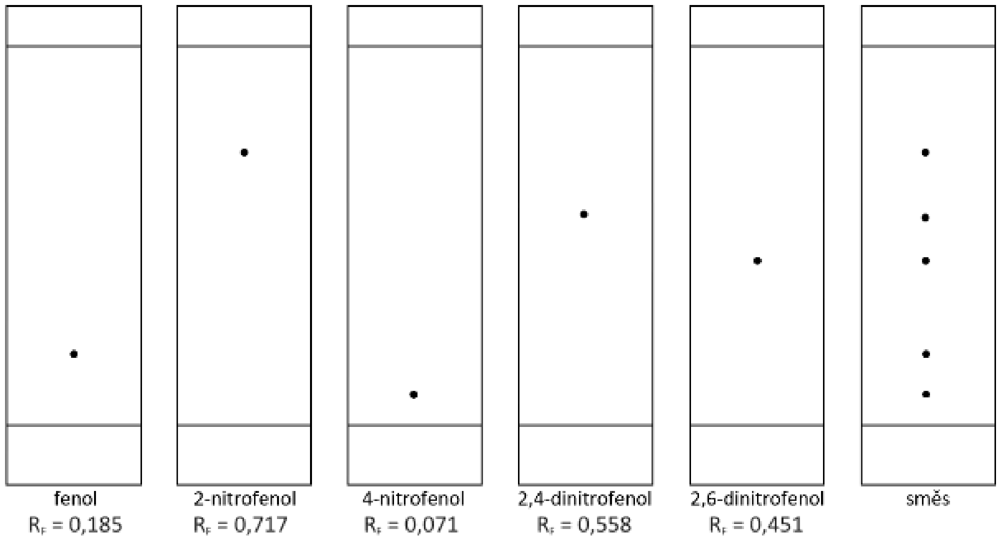
Vyhodnocení

Pro chromatografickou identifikaci se obvykle využívá komparace se standardy, které ovšem nejsou ve školním prostředí dostupné. K vyhodnocování v rámci badatelské aktivity je proto možné využít komparace se zjištěním rozložení produktů během dříve provedených chromatografických procedur v obdobném uspořádání. Ačkoli se vhledem k podmínkám provedení budou zjištěné retardační faktory mírně odlišovat, základní rozložení separovaných produktů zůstává shodné a je možné provést zobecnění. Výsledky pro popsané uspořádání experimentu jsou znázorněny na obrázku 2.

Výše popsaná experimentální část badatelské aktivity se zaměřuje výhradně na demonstrování nitračních reakcí. Uvedený laboratorní postup je ovšem v rámci badatelské výuky vhodný i pro zkoumání dalších výzkumných otázek. Možným příkladem je sledování závislosti zastoupení

[7] Nitrační reakce probíhají prakticky okamžitě. S narůstajícím časem nad mono nitrovanými produkty reakce převažují více nitrované fenoly. Z didaktických důvodů je při vyhodnocování vhodné získání širšího spektra produktů. Opakováním experimentu bylo zjištěno, že takového výsledku je možné dosáhnout při reakčním čase 5 s. Přesná reakční doba ovšem není v kvalitativním vyhodnocení pro potřeby badatelské aktivity určující.

jednotlivých produktů s ohledem na reakční čas. Zatímco mononitro deriváty vznikají již do 1 vteřiny a je možné detekovat i nezreagovaný fenol, s narůstající dobou převáží pouze dinitro produkty a v reakci podléhá nitraci prakticky veškerý fenol.



Obrázek 2 Identifikace produktů s využitím tenkovrstvé chromatografie

Upozornění o bezpečnosti

Vzhledem k tomu, že studenti pracují s látkami jako je fenol a *n*-nitrované fenoly, je proto v laboratoři třeba zamezit vdechování prachu a par, používat ochranné rukavice/ochranný oděv/ochranné brýle/obličejový štít. Pokud dojde k jejich požití, je nutné okamžitě volat toxikologické informační středisko či lékaře. Pokud dojde ke styku s kůží (nebo s vlasy) veškeré kontaminované části oděvu okamžitě svlékněte a kůži opláchněte vodou/osprchujte. V případě zasažení očí je nutné několik minut opatrně vyplachovat vodou a vyjmout kontaktní čočky.

PILOTNÍ OVĚŘENÍ AKTIVITY

Navržená badatelská aktivita byla pilotně ověřena v rámci výuky předmětu *Seminář z environmentální výchovy* na Pedagogické fakultě Univerzity Karlovy. Ani jeden z účastnících se studentů nestudoval jako druhý učitelský obor chemii. Ověření, kterého se zúčastnilo 14 studentů (12 žen, 2 muži) proběhlo během letního semestru akademické roku 2017/2018. Při realizaci byli studenti rozděleni do 4 skupin.

K získání podrobnější zpětné vazby v oblasti motivační orientace studentů byl využit nástroj *Intrinsic Motivation Inventory* (IMI, dotazník vnitřní motivace) (Kekule & Žák, 2001; Ryan & Deci, 2000). Jedná se o vícerozměrný nástroj k hodnocení subjektivní zkušenosti účastníků v souvislosti s laboratorní činností. Dotazník byl využit v řadě výzkumů, které potvrdily jeho funkčnost a validitu v zaměření na různé výukové metody (Šmejkal, Skoršepa, Stratilová Urválková & Teplý, 2016; Whitehead & Corbin, 1991). Pro výzkumné účely pilotáže byl použit dotazník o 30 položkách sestávající ze subškál zájem/potěšení, úsilí/důležitost, tlak/tenze, vnímaná kompetence a hodnota/užitečnost. V souladu s původním návrhem dotazníku hodnotili studenti jednotlivé položky na sedmibodové Likertově škále (1 – zcela nepravdivý výrok, 7 – naprosto pravdivý výrok). Dotazník byl vyplňován po dokončení aktivity. Hodnocení probíhalo anonymně.

Výsledky pilotního ověření

Provedení a zhodnocení laboratorní úlohy

Navržená aktivita se ukázala jako plně funkční a dobře proveditelná i pro výuku studentů, kteří nestudují chemii (učitelství chemie). Všechny čtyři skupiny dokázaly sestavit odpovídající postup a provést experiment (viz obrázek 3). V otevřeném písemném vyjádření v závěru aktivity všichni studenti dokázali správně interpretovat badatelsky zjištěné výsledky a uvést je do kontextu jevů probíhajících v atmosféře. Výsledky experimentální části se tedy zdají být studentům dobře srozumitelné. Transparentnost výsledků s ohledem na informace o nitroaromátech uváděných v literatuře ukazuje, že experimentální část může sloužit jako vhodný ilustrující model. Experimentální část je díky jednoduchému provedení a spolehlivosti reakcí realizovatelná i bez zkušeností s prováděním laboratorních činností chemického zaměření. Na základě výše uvedených zjištěních je možné považovat badatelskou aktivitu za vhodnou k realizaci i na středních školách.

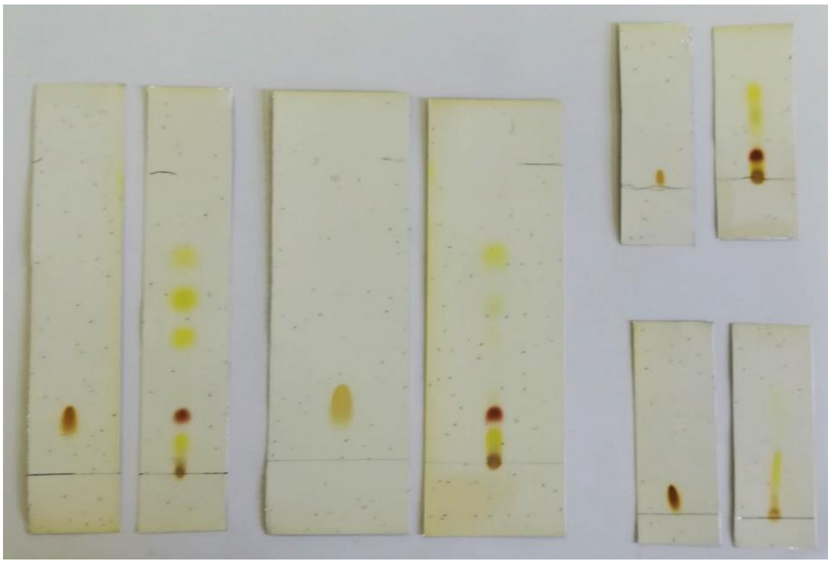
Afektivní dopad navržené aktivity

Reliabilita u hodnotícího dotazníku IMI byla posouzena pomocí koeficientu Cronbachova alfa (viz tabulku 1). U všech subškál lze považovat hodnoty za přijatelné (viz Tavakol & Dennick, 2011).

Tabulka 1 Výsledky hodnocení IMI

Subškála	α	μ	σ
Zájem/potěšení	0,95	4,39	1,34
Úsilí/důležitost	0,87	3,87	1,52
Tlak/tenze	0,89	3,04	1,64
Vnímaná kompetence	0,85	3,77	1,53
Hodnota/užitečnost	0,89	4,49	1,39

S výjimkou dvou subškál studenti aktivitu hodnotili průměrně na středu sedmistupňové škály (viz tabulku 1), výroky tedy označují jako do jisté míry pravdivé. V žádném ze sledovaných aspektů ovšem nehodnotí aktivitu negativně. V hodnocení studentů se může promítat jejich studijní zaměření, ve kterém je chemicky orientovaná aktivita nadstavbovým rozšířením jejich studijního diskurzu, jakož i obecný postoj k chemii jako takové (Kubiatko, 2016; Rusek, 2011; Salta & Tzougraki, 2004). Tvrzení v oblastech *zájmu* a *potěšení* (vlastní subjektivní měřítko vnitřní motivace), respektive *úsilí* a *důležitosti* v průměru studenti hodnotí jako do jisté míry pravdivé. S ohledem na motivační potenciál aktivity se jako pozitivní ukazuje nesouhlas studentů s tvrzeními, že je činnost vůbec nezaujala ($\mu_{rev} = 5,42$) a připadala jim nudná ($\mu_{rev} = 4,64$). Motivační potenciál úlohy potvrzuje, že studenti spíše nesouhlasí s tvrzením, že se v činnosti nesnažili uspět ($\mu_{rev} = 4,71$). Tyto vlastnosti úlohy se ukazují jako u pro další edukační využití i vzhledem k dlouhodobé neoblíbenosti přírodních věd a chemie, obzvláště u žáků na středních školách (Kubiatko, 2016; Rusek, 2011).



Obrázek 3 Výsledné chromatogramy studentského řešení experimentální části

V hodnocení na škále tlak/tenze studenti s tvrzeními spíše nesouhlasí. To dokumentuje hodnocení u konkrétních výroků, jakým je například nesouhlas s tvrzením, že se u této činnosti cítili pod tlakem ($\mu = 2,79$). Výroky na škále vnímané vlastní kompetentnosti studenti v průměru hodnotí, jako do jisté míry pravdivé Studenti neměli předchozí zkušenosti s podobnou činností a prací v chemické laboratoři. To je patrné i z hodnocení vlastního výkonu v činnosti ($\mu = 4,42$).

Jako do jisté míry pravdivé hodnotili studenti i výroky vztažené k *hodnotě/užitečnosti aktivity*. V tomto hodnocení se nejspíše odráží i to, že se jednalo o rozšiřující aktivitu nastavenou na reálný problém lidské činnosti. Studenti spíše souhlasí s tvrzením, že činnost by pro ně mohla mít hodnotu ($\mu = 4,93$) a může jim pomoci v porozumění předložené problematice ($\mu = 4,86$). Tyto faktory mají významný vliv na interiorizaci poznatků a samoregulaci učení (srov. Deci, Eghrari, Patrick & Leone, 1994).

ZÁVĚR

Nitrační procesy probíhající v atmosféře je možné simulovat v jednoduchém laboratorním provedení. Díky tomu je i ve školním prostředí možné názorně ilustrovat reakce látek pocházejících z antropogenního působení a dávat tak problematiku znečištění životního prostředí do širších souvislostí. Všem skupinám se podařilo samostatně sestavit postup experimentu a následně ho provést. Studenti dokázali správně interpretovat výsledky. Navržená aktivita badatelsky orientovaného vyučování se tedy ukazuje jako dobře realizovatelná a poskytuje dostatečně transparentní výsledky, které jsou srozumitelné i studentům nechemického zaměření, u kterých rozšiřuje porozumění environmentální problematice. Ověření pomocí IMI ukazuje, že se studenti v rámci řešení spíše necítí pod tlakem.

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High School Student's Ideas about Ideal Chemistry Lesson

Irena Chlebounová, Petr Šmejkal

Abstract

This qualitative research is based on an analysis of an one hour interview with 14 students of the year 12. Students were interviewed about what would help to increase the effectivity of their learning. Analysis showed that it is the teacher's well-prepared presentation complemented by interactive interpretation. It is also the understanding of students how chemical knowledge can be used in everyday life. The other effectivity increasing tools are: appropriate teaching methods, illustrative examples, demonstrations and motivational assignments, information materials for self-study, student's practising of schoolwork, active outputs, and research projects.

Key words

Chemistry, Motivation, Student Interest, Teaching Methods in Science

INTRODUCTION

In this rapidly changing world, it is necessary to have educated community that uses evidence-based critical thinking to solve problems (Lachish-Zalait et al., 2018). Such skills must be regularly practised through different tasks especially in subjects like mathematics, chemistry, and physics. There are activities leading to reinforcing students' independence and motivation to learn as *learning by doing*, *learning by teaching* each other, the theatrical performance, and projects (Kobylańska, 2016). There are also guidelines through teaching strategies that help children to develop such skills as thinking, asking, creativity, and aiming (Fisher, 1995).

If there are motivated students who find classroom activities meaningful and worthwhile, they take them seriously (Wentzel, Brophy, 2014). Enthusiastic and motivated teachers can raise the students' interest. It could be done by chemistry experiments (Yunus, Ali, 2013), acceptable methods of instruction (Festus, Ekpete, 2012) or just by effective communication between teacher and student (Mareš, Křivohlavý, 1995; Mešková, 2012; Šeďová, Švaříček, Šalamounová, 2012; Kopřiva, Nováčková, Nevolová, Kopřivová, 2016). There are written books about the development of key competencies as of an indispensable tool for the labor market (Hansen Čechová 2009, Belz, Siegrist 2001).

The aim of this qualitative research was to discuss with students what they see in chemistry subject as helping to increase their interest and competences and how do they imagine *the ideal* lesson of chemistry in classroom (not the laboratory one).

METHODOLOGY

This qualitative research is one part of more complex view on student's competency and motivation. It was done according to the grounded theory (Strauss, Corbin, 1990), which is typical by three types of coding - an open coding, the axial coding and the selective coding. The grounded theory consists of three steps. In the first step (**open coding**) a code is given to each statement. Afterwards, statements are divided into categories by their similarities. Names of categories are created. The second step is called **axial coding**. In this step relations between the categories are found. This is shown on so called **paradigmatic model**. The sampling at this part of research is relational and variational. In the third step (**selective coding**) one main category is chosen and marked as central. Other categories are given into relationship within the so-called **central category** and a **story line** is created.

Research Sample

The respondents were students of one 8-year Prague grammar school. All 14 students were from the 7th grade (18 years and older). Next 6 students from this class were missing because they did not attend school that day.

This class is described by teachers (through interview led with them by authors) as very communicative and openminded in opinions. All teachers claim that these students are full of humour and good mood, have good connections with each other but they are mostly not too much oriented to deep knowledge. One of them wants to study chemistry in the future and other three choosed to graduate in chemistry.

The teacher who led the interview with students has been teaching these students chemistry for 3 years and they have been used to discussions with her as well as reflective questionaries which had been done with them by her in previous years.

The Structure of the Interview

The one hour lasting semi-structured interview was led in classroom during a whole-school project week. There was informal and friendly atmosphere during the interview and all participants sat in a circle together with the teacher. The teacher had prepared some questions, but during interview she slightly changed them as she wanted to react on student's ideas.

Therefore, seven questions were discussed:

1. How would you imagine the ideal lesson of chemistry in which you would learn a lot, but you would not get "destroyed" by the requirements of the teacher?
2. Would it be helpful to give you a more concise presentation during lessons and more comprehensive information for home repetition?

3. Would you appreciate if there were chemical information written by your teacher in Moodle (the school educational website)? Do you know how to get there?
4. How often would it be meaningful to prepare your active outcome for your schoolmates (a presentation in front of class, for example)?
5. What would you think is a reasonable range of homework? And how often?
6. What would you like to do more during your chemistry lessons? Do you miss something?
7. What would you like to do less during lessons you participate in?

Everyone had a chance to say his/her opinion to every question. Students were taking turn in speaking. The interview was recorded with the permission of all, transcribed, the involved students and the transcript was open coded. Students signed the informed consent.

RESULTS AND DISCUSSION

Open coding

Students considered the current lessons as well guided and structured.

> *111 – "The lessons with presentations are well guided.*

> *831 – "I am satisfied with the course of the lesson and also with the structure of it."*

They also appreciated presentations done by the teacher and given to students before test as studying material.

> *2141 – "I appreciate that the presentations are perfectly prepared…"*

As a way how to make the teacher's explanation more effective students highlighted a combination of presentation, teacher's writing on the blackboard and given material as worksheets or presentations with extra information for revising at home. Some students were arguing that there is a lot of work for home also in other subjects and they do not have enough time to do it especially in the 7th grade (year 12) and in the 5th grade (year 10).

> *6143 – "The compulsory homeworks, which are given from one lesson to the next, are pure evil. My schedule is often so full, that I have no time to do all the tasks in the evening. And doing them through the night is, in my opinion, a nonsense."*

> *541 – "I am strictly against homeworks in this grade. The amount of homework is worst in grades 5 and 7."*

Students had also different opinions on the meaningfulness of their active outcome for others (question 4). Some students spoke about their shyness to explain something in front of the class, some of them were against the rule of being active. They wanted to make it voluntary instead of compulsory.

Axial coding

As it is shown in Figure 1, if the teacher is active and student's role is just to write notes and to listen, students' attention is quickly decreasing, and they forget almost everything very quickly. Many students are learning just to pass an exam on test.

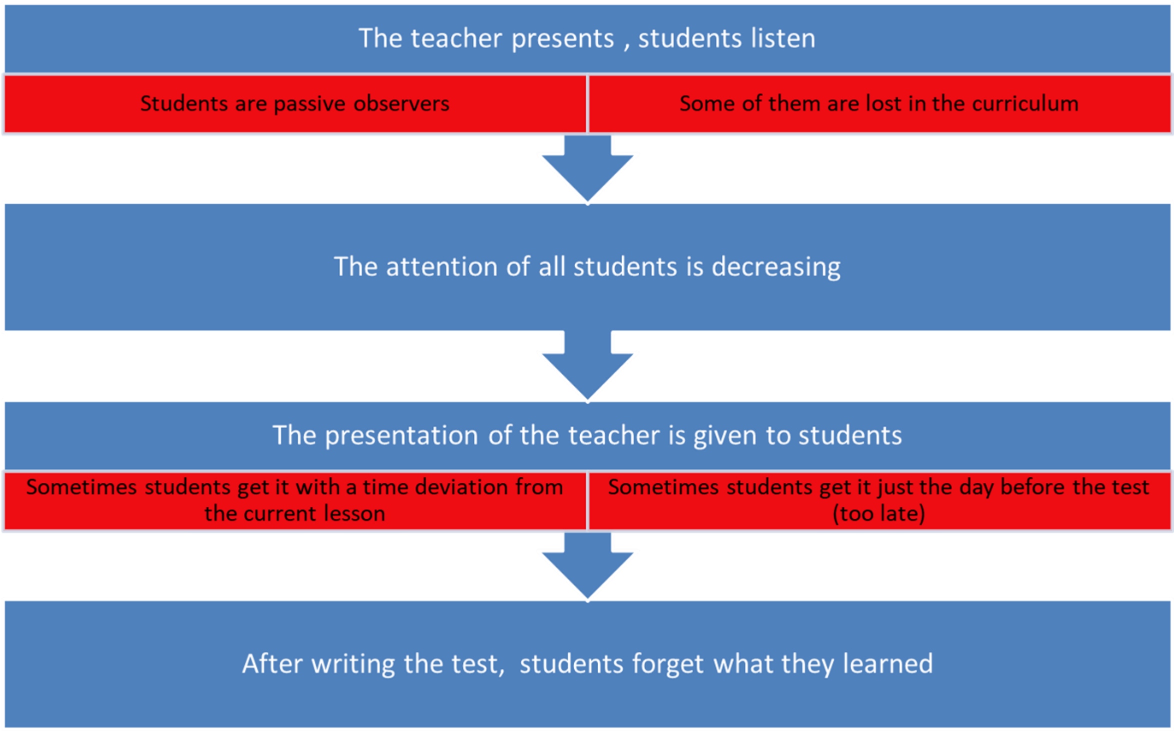

Fig. 1 Paradigmatic Model No. 1

Figure 2 shows a different situation. The teacher prepared an interactive presentation and students are invited to cooperate with her/him through questions and various activities. As a result, many students have strengthen their knowledge through their active learning.

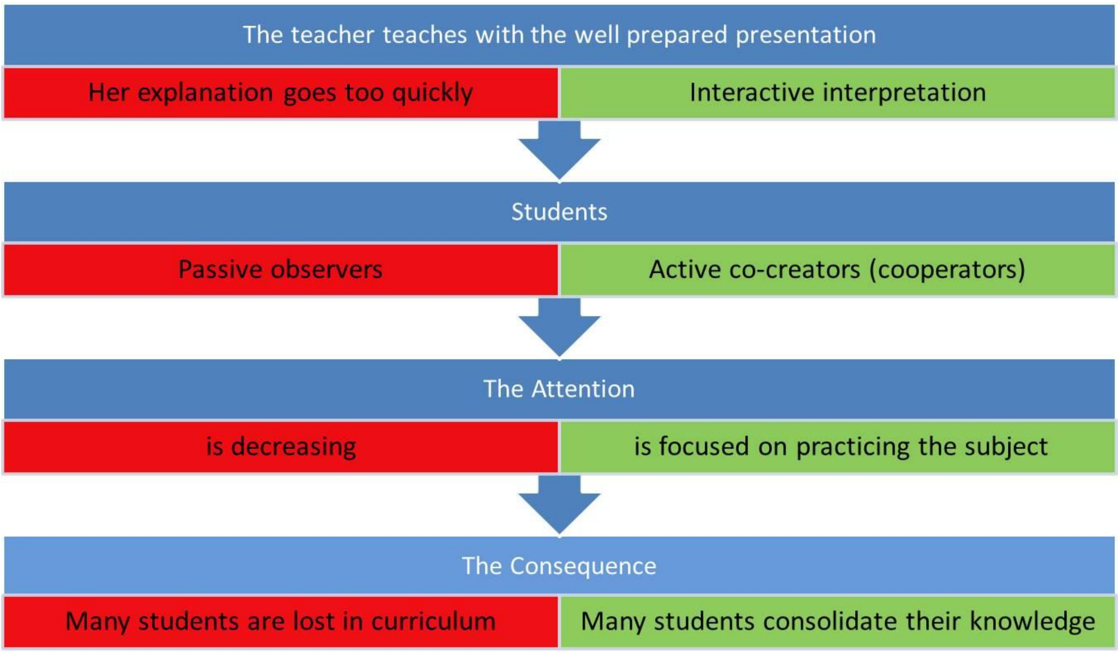

Fig. 2 Paradigmatic Model No. 2

In the situation described in Figure 3, some students prepared their own explanation for others while the others were just passive participants in the teaching process. It often occurs that some students are motivated to do extra work while others are not. As a consequence, there is a huge difference in the level of knowledge among students from the same class. This leads to difficulties for teacher in further lessons.

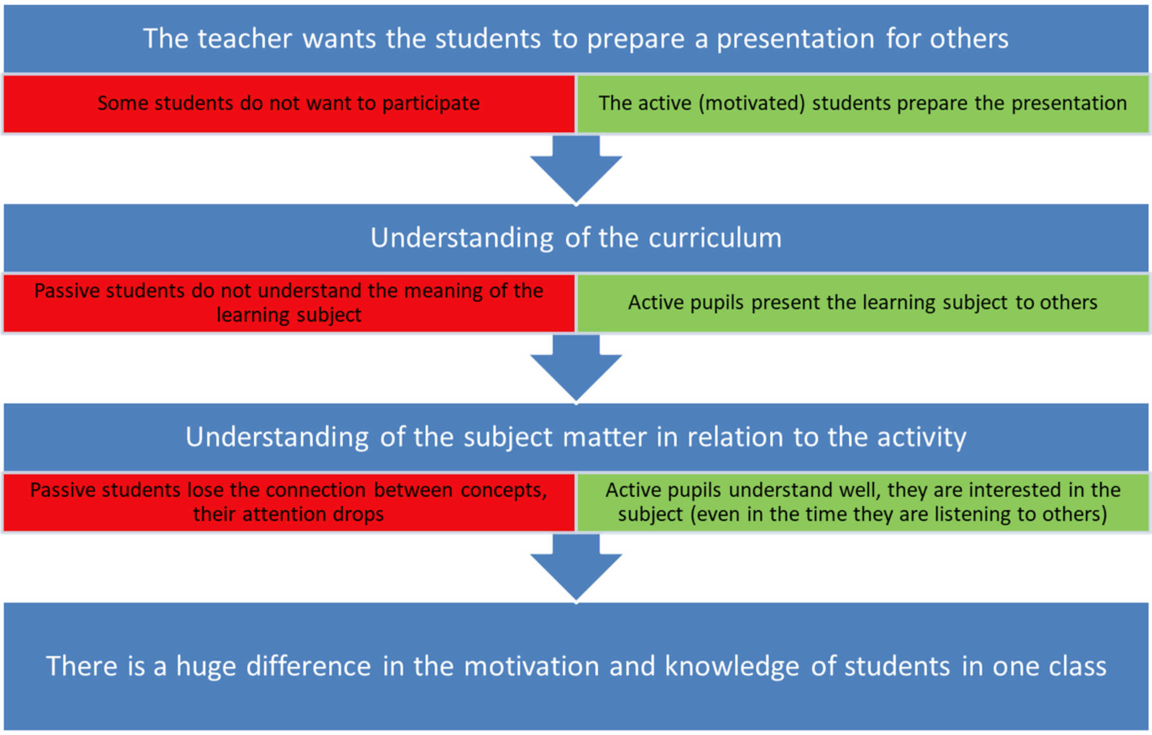

Fig. 3 Paradigmatic Model No. 3

Selective coding

As it is seen in Figure 4, the chosen central category which connects all other categories is called *an ideal lesson of chemistry.* It is connected to 10 other categories. Each of them consists of some concepts.

Fig. 4 The Central Category – An ideal lesson of chemistry – and its connection to other subcategories

List of categories (and their subcategories) found:

1. ***Active students' outcomes*** - Facultative projects (every 3 months); Presentation, paper, poster, reader's diary; News from the research of the learning topic at the end of every chapter; Discussion in the class; Students own topics based on interest (mainly at seminar, deeper understanding).

2. ***To engage students into research*** - Voluntary work of the year (thesis); Measurement and evaluation of it.

3. ***To practice calculations, problem tasks and nomenclature at the blackboard*** - Less tasks in one lesson; To solve problem tasks on the blackboard in the group instead of alone; To use Kahoot for practising; Not getting marks for practising.

4. ***Motivational tasks*** – Voluntarily; Worksheet at the end of each chapter; Once in 3 months; Range 1 page A5 or 2 examples for counting; To know about it a week ahead; Do not overload the students; to receive a good mark for finishing the tasks.
5. ***To motivate students*** - By showing video; To motivate by interesting examples within the topic; To evaluate the activity of the pupils in the class with + and – marks; To motivate by Illustrative examples; By dangerous experiments full of surprise; By Kahoot.
6. ***Demonstration examples*** - Illustrative and dangerous experiments full of surprise.
7. ***To change teaching styles and methods*** – IBSE (Inquiry Based Science Education); Activation methods; Films; Lectures; Explanation of the teacher with the blackboard; Presentations done by the teacher.
8. ***Well prepared presentations by a teacher*** - To stay longer at 1 slide; Brief and understandable presentations; Concise presentations; Timing slides; To wait until most students understand the meaning.
9. ***Information materials for revising at home*** – Worksheets; Informations from Journals, Books; Graphically processed solutions of problem tasks; Presentations prepared for students in Moodle.
10. ***Practical use of chemistry in everyday life*** – To explain the reason why something is important to know; What are we talking about (connection to life).

In agreement with Matúš, Šulcová, Teplá (2017) the results suggest (point 3) that there is a link between poor students' ability to use mathematical principles and difficulties in chemistry. According to interview many of the students also face problems even when they are asked to speak in front of the class. According to the mentioned authors students also appreciated study support in the form of worksheets (point 4 and 9) simplifying the explanation of the chemistry teacher and practicing of educational tasks.

Results of this research support the conclusions of Chroustová and Šmídová (2016) or Kobylańská (2016) about importance of the active work of students (point 1, 5, 7) for seeking information and putting them into the context of their knowledge.

As well as in the research done by Fabryová and Janštová (2017), motivated students from 7th grade asked for lessons full of practical learning (point 6, 10), clear instructions, presentation performed by a teacher (point 8) and engaging them into some kind of research (point 2) as a voluntary work.

CONCLUSION

According to the ideas of interviewed students, the ideal chemistry lesson is well prepared by the teacher (the goal, the appropriate motivation, structure, changing the methods during lesson, the interactivity and homeworks). It should be connected with everyday experience. When the students are able to see meaningfulness of the topics and participate in classes by active outcomes, engaging in research and cooperating in groups, it is positively reflected.

ACKNOWLEDGEMENT

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Using a mental map to plan an educational project with science orientation

Małgorzata Nodzyńska, Anna Baprowska, Paweł Cieśla, Martin Bílek

Abstract

The article presents research on the use of mental maps for planning activities in the project oriented education. Mostly used for planning long-term Work Breakdown Structure activities and Gantt charts are too complicated for primary school students. Therefore, it was decided to find a tool already familiar to students and adapt it to a new role. The research was carried out on 118 students aged 10 to 14 years. For primary school students, this method of planning work is quite difficult. Few of them coped with this task, therefore, in order to be able to use this tool to plan work in a project, you should devote more time to learn how to create memory maps beforehand.

Key words

Project based Learning, Mental Models, Lower Secondary Education

INTRODUCTION

Work management can be difficult for many reasons: time, effort, people etc. If the students plan their work poorly, the project may fail or the effects will not be as expected. One of the biggest reasons projects don't work out is because of the lack of planning (Bilek, Machkova & Chroustova, 2015). When a project doesn't have a well-orchestrated plan, or has a plan that is too demanding in scale for the time frame, things will go wrong: either causing the project to be worse than what it could have been, or not getting finishing at all. On this basis, it can be concluded that planning activities is one of the most important stages of work using the project method. During the planning of activities, it is necessary to specify what actions will be taken, determine their order and also those responsible for individual tasks. It is also necessary to work out a list of problems that may arise during the implementation of goals and to come up with solutions to these problems (Donnelly & Fitzmaurice, 2005, pp. 87-98). It is a very difficult task for students in primary school because it requires long-term planning. Most often, in the planning of many long-term activities in the project, the Work Breakdown Structure and the Gantt chart are used (Grześ, 2014, pp. 196-197), especially long-term projects, like the one that students planned. It was decided to examine whether the use of a mental map would allow students to better and more effectively plan activities in the project based learning.

The mind map can be used for time planning (Buzan & Griffiths, 2016, p. 7). The mind map allows us to identify the basic activities that must be done in the project to achieve the goal (Marian, 2008, p. 100). And then allows you to break down these basic activities into further, smaller components. By completing the mind map with more levels, we constantly ask ourselves the same question "What needs to be done to achieve the goal?" We also need to estimate how long it will take to complete it and what resources we will need for each basic activity.

The mind map, as a tool familiar to elementary school students and simple to use – should effectively replace the Work Breakdown Structure and the Gantt chart.

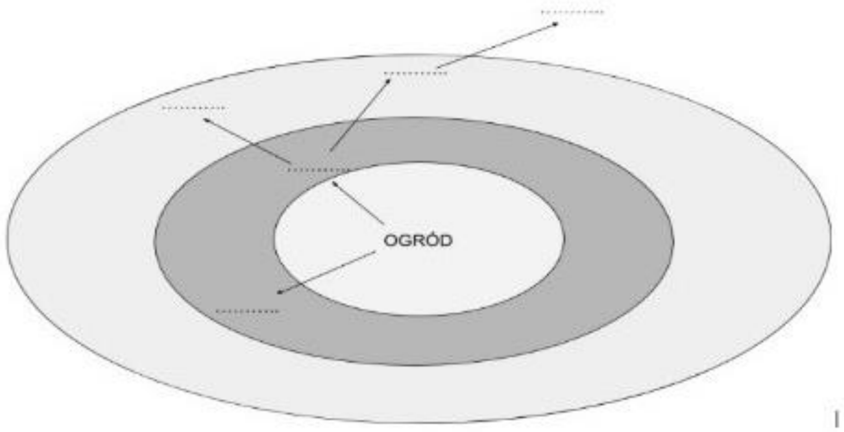
RESEARCH DESIGN

It was decided to check how students use the memory map as a tool for planning work in the project. For this purpose, an instruction for pupils was prepared containing information about what the project should concern and how to construct a map while planning tasks in the project. These were qualitative studies, based on the analysis of students' work. In the study 120 students aged 10-15 participated. Groups were randomly selected.

The research used the following board. The pupils' task was to supplement it according to the instructions (Fig.1).

Instructions for the student

You were asked to create a school garden. Plan work on this project using a mental map. In the middle of the map, you have an end goal written, i.e. a garden. Think about what actions you must first do to cope with this task. Enter these tasks in the first circle. Next, think about what is necessary to perform these (tasks you enter) - enter the task subtasks in the next circle.You can add as many arrows (to the tasks) as you need, you can also add more circles, which symbolize the detail of individual actions.Complete the scheme below, keeping in mind that in the circles closest to the center you should enter the actions you will take first. Both the details of the plan (the number of districts and the number of tasks, arrows) and the substantive correctness will be assessed.



Name ....

a number of levels ... a number of branches ... a number of terms ... consistency ...

Fig. 1. **Instructions for the student, source: Nodzyńska,Baprowska**

Maps of thoughts drawn by the students were very diverse. Colourful, but not detailed (Fig. 2), Colourful, including pictures and accurate (Fig. 3). Each branch, various activities was marked with a different colour (Fig. 4). Detailed, but the color for the student was irrelevant (Fig.4). There were also a lot of maps, the king was not properly made, not detailed and not thought out.

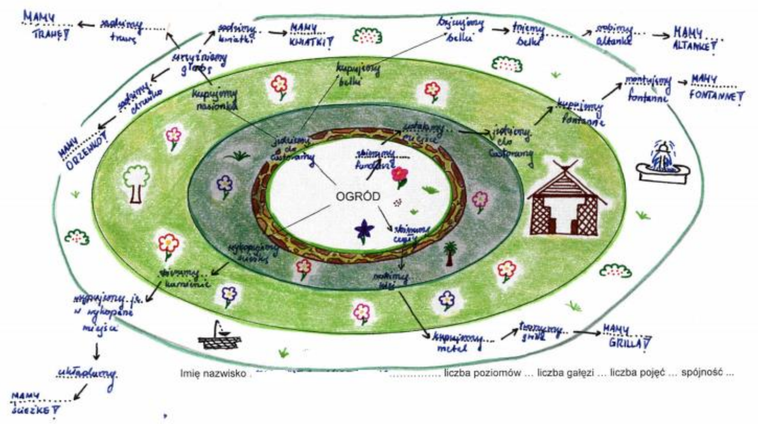


Fig. 2. Example of students work

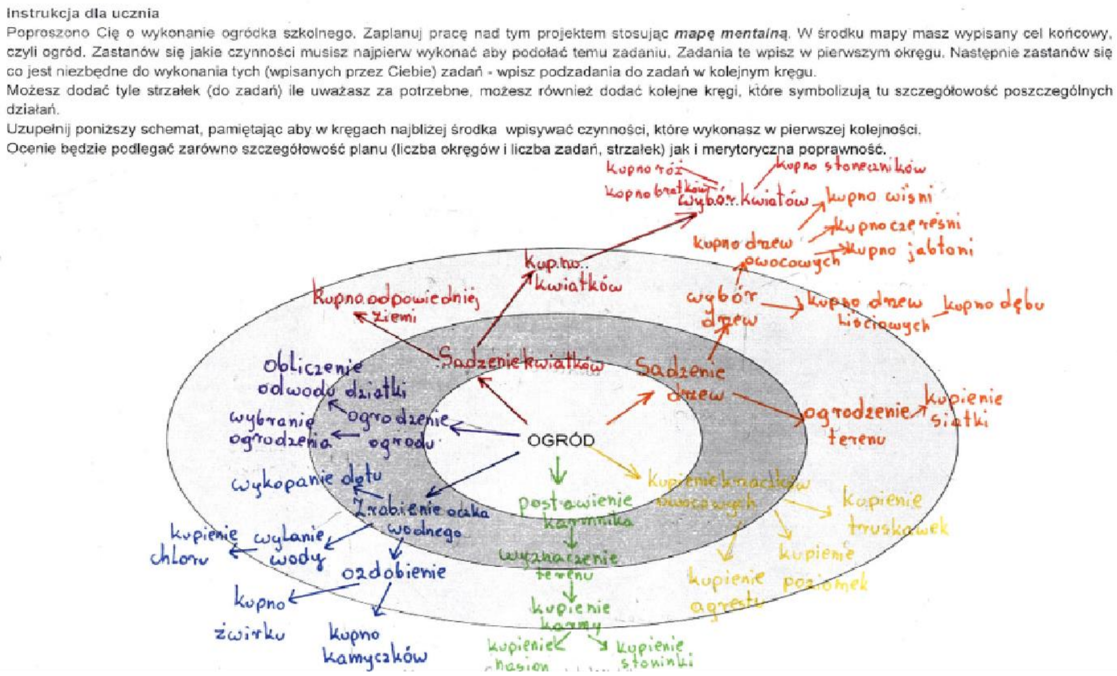


Fig. 3. Example of students work

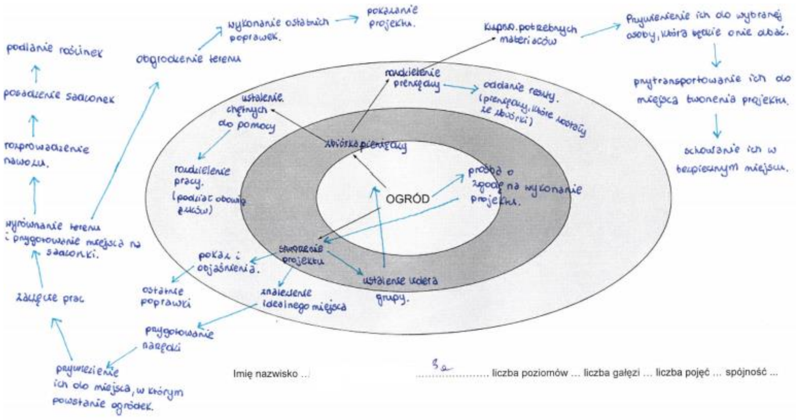


Fig. 4. Example of students work

Analyzing the maps, we paid attention to:

1. number of levels,
2. the total number of concepts,
3. number of branches emerging from the first concept (GARDEN),
4. correctness / consistency of the proposed activities.

The initial map had three levels, two branches and a place (in the form of dots) on 5 dates.

On average, the maps had slightly over 3 levels (average score: 3.3-3.5), there were no major differences between students maps of particular grades. The average number of branches was the lowest (average score: 2.3) in the fifth class. While the average number of branches on the maps grade 7 students and 3G was significantly higher (average score: 4.4, 4.3). Similarly, the results were obtained in the case of the average number of concepts. On average, fifth grade students' maps contained 8.9 concepts. The highest score was achieved by students from class 7 and 3G (their maps contained on average 20.3 and 18.8 terms).

Tab. 1. Results – expansion of the memory map - average number of levels, branches, concepts

	NUMBER OF LEVELS	NUMBER OF BRANCHES	NUMBER OF CONCEPTS	ACORRECTNES CONSISTENCY
AVERAGE SCORE (CLASS 5)	3.3	2.3	8.9	0.1
AVERAGE SCORE (CLASS 7)	3.3	4.4	20.3	0.5
AVERAGE SCORE (CLASS 8)	3.4	3.6	12.0	0.4
AVERAGE SCORE (CLASS 3G)	3.5	4.3	18.8	0.6

If we do not analyze the average results, we notice that the average results of class 8 and 3G are understated by lazy students. In class 8 there were people who did not fill even the levels marked on the starting map - (the minimum number of map levels = 2). Some students in the 3G class did not even complete the first level of the map. On the other hand, in class 8 and 3G, a lot of students drew maps that had up to five levels. One student drew a map containing as many as 9 levels.

Tab. 2. Results - minimum, maximum and average of map levels

	MINIMUM NUMBER OF LEVELS	MAXIMUM NUMBER OF LEVELS	AVERAGE NUMBER OF LEVELS
CLASS 5	3	4	3.3
CLASS 7	3	4	3.3
CLASS 8	2	5	3.4
CLASS 3G	0	9	3.5

If we analyze the number of branches emerging from the central concept we can notice a clear difference between the fifth-grade students and other students. The maximum number of branches on the fifth-grade students' maps was twice as small.

Tab. 3 Results – minimum, maximum and average of map branches

	MINIMUM NUMBER OF BRANCHES	MAXIMUM NUMBER OF BRANCHES	AVERAGE NUMBER OF BRANCHES
CLASS 5	1	4	2.3
CLASS 7	2	9	4.4
CLASS 8	2	9	3.6
CLASS 3G	0	10	4.3

Also, the number of concepts on the fifth-grade students' maps was definitely smaller.

Tab. 4 Results – minimum, maximum and average numbers of concepts

	MINIMUM NUMBER OF CONCEPTS	MAXIMUM NUMBER OF CONCEPTS	AVERAGE NUMBER OF CONCEPTS
CLASS 5	5	16	8.9
CLASS 7	5	43	20.3
CLASS 8	5	30	12.0
CLASS 3G	0	35	18.8

CONCLUSION

It seems that the use of conceptual maps has worked well in planning work and can be applied to project methods. Even fifth-grade students (aged 10) have done their job correctly. Working with the concept map did not cause them any trouble. Older students fully used this tool. The teacher using the memory map as a tool for work planning can very quickly determine whether the student understands what the project is and change the plan or discuss with the student how to improve the plan. Such a graphic form of the plan should also be more understandable for students.

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Incorporation of Project Based Learning in Educational Chemistry Studies at Faculty of Natural Sciences and Mathematics in Maribor, Slovenia

Hanija Bujas

Abstract

Project based learning is becoming more popular, and therefore implemented, in European universities. Chemical Education master studies at Faculty of Natural Sciences and Mathematics in Maribor are focused on developing students' soft skills as well as knowledge in order to prepare them for work in elementary and high schools. Our subjects are, for this reason, based on projects. This paper introduces the projects that are being done in Educational Chemistry master studies at the FNM, what is the purpose behind them and what do students gain by participating in them. Students found that the used teaching methods fit under the term project based learning. Those methods were proved useful in terms of developing students' teaching skills and knowledge.

Key words

Chemistry, Project-based Learning, Science Education, pre-gradual chemistry teachers' education.

INTRODUCTION

This article explains Educational Chemistry studies on Faculty of Natural Sciences and Mathematics at University of Maribor (FNM). It explains the aim of the project work being done as part of the studies and how it helps future chemistry teachers. FNM is divided in different departments: Department of Mathematics and Computer Science, Department of Physics, Department of Technical Education and Department of Biology. Each of the aforementioned has educational studies based on the department's expertise (Department of Biology is an exception, for it includes Educational Chemistry as well as Educational Biology). Students combine 2 educational studies in a study program called The Subject Teacher, in which they are educated and trained to be elementary and high school teachers.

The measurement of quality teaching methods is the satisfaction of students, the knowledge and skills they gain and can use for the future. This is not the most reliable measurement, however it is also something that should be assessed and evaluated. For this reason, following questions were raised:

1. Are students familiar with the methods used in our studies?
2. What do students think that is the aim of individual subject?
3. Would students say that the project work on our studies is useful?

4. How do students grade knowledge and experience gained through project work?

As a student, I had my answers to the questions, but wanted to assess the opinion of my colleagues. In this article the outcomes of a conducted research will be presented.

THEORY

What is Project-based Learning

PBL is an approach to learning that is based on students pursuing knowledge through complex set of questions and research under the teachers supervision. It is „a key strategy for creating independent thinkers and learners“ (Bell, 2010).

According to Grant (2002), there are different models of PBL, which have distinguishing characteristics. However, there are common features in their implementations, which are following:

- introduction of the activity;
- aim, guiding question or driving question;
- a process or a research;
- resources (articles, books, ...);
- guidance and platforms which help learners assess the students' progress;
- collaboration and cooperation (e. g. peer reviews, teams, groups, ...);
- reflection (closure, debriefing).

Subjects and projects in Educational Chemistry studies at FNM

At Educational Chemistry master studies, we have 4 didactical subjects: Experiments 1, Experiments 2, Chemistry didactics 1 and Chemistry didactics 2. First two are based on performing and researching on different experiments that could be useful for students as future teachers.

At Experiments 1 students of Educational Chemistry conduct different experiments, through which they teach first year bachelor biology students about specific group of elements (e. g. alkali metals, halogen), while being in traditional classroom instead of laboratory. At Experiments 2 students have to: a) find an article with an innovative experiment and conduct it in the lab and b) mentor other students in conducting an experiment.

Both Chemistry didactics 1 and 2 are based on practicing lecture delivery in front of colleagues, learning about goal-setting and working on a project. The difference between the two is that one is held on the first year of masters, the other on the second and one is aimed at elementary school, while the other at high school. The project topic is chosen by the students and approved and mentored by the professor. Examples of some finalised projects are:

- quality testing of beeswax and creating food/hygiene products from beeswax,
- comparing quality of store and homemade hair gel products,
- is baking soda from pharmacy of better quality than the one from the store,
- food pH value and its effect on body pH value, ... (B. Dojer, personal communication, 2018)

The aim of project work in Chemistry didactics is motivating students through research on and about everyday problems they are interested in, learning how to define a project, learning about the teacher's and student's role in a project and most important learning how to include a project work in science subjects in schools.

MATERIALS AND METHODS

A research was done by creation of the survey through google forms. It consists 4 sections: general information, information on Experiments 1, information on Experiments 2 and information on Chemistry didactics. The survey was disseminated to current students of 2nd masters year of Educational Chemistry and students who finalised studies in the past 3 years. Since the number of students on this study is significantly low, so was the response to the survey – 15 respondents. The statistics of the respondents were following:

- 11 female respondents and 3 male;
- 50% respondents are, alongside Educational Chemistry, studying Educational Mathematics, and other 50% Educational Biology;
- 7 respondents started masters studies in the year 2017, 3 in 2016, 4 in 2015, and 1 in 2014;
- 12 out of 14 respondents are familiar with project-based learning

The results of the survey were meant to be simple and straightforward. For that reason, the analysis was done in Microsoft excel.

RESULTS AND DISCUSSION

Students as individuals have different opinion on purpose of each subject. My hypothesis was that students believe that each subject has a goal to increase our experience more than actual knowledge, which we got with our bachelor degree. As seen in Figures 1, 2 and 3, the students have different perceptions on what is the aim of individual subjects.

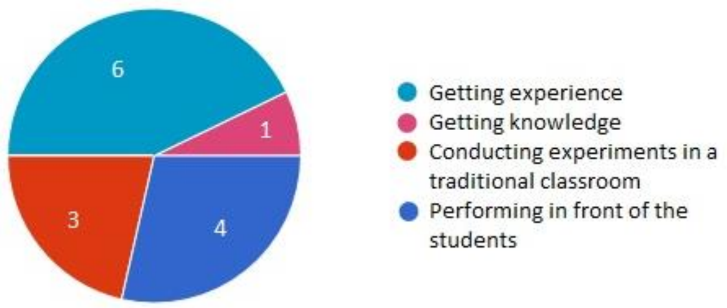

Fig. 1 Aim of the Experiments 1 according to students

Fig.2: Aim of the Experiments 2 according to students

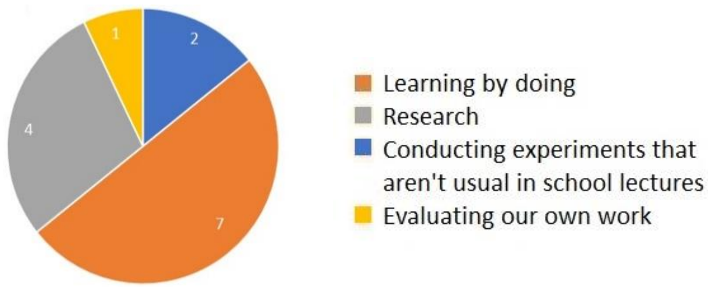

Fig.3: Aim of the Chemistry didactics according to students

As seen from the results, students believe that all three subjects are aiming on getting experience and learning through practical work, which confirms the hypothesis made.

So now that we confirmed that students‘ opinion are aligned with the aim of subjects, the question is if the aim is fulfilled. Students graded subject Experiments 1 and 2 with high grades when it comes to both knowledge and experience (Figures 4 and 5). If we compare the results, we can see that according to students in these 2 subjects they gained more knowledge than experience. When it comes to Chemistry didactics the results are the other way around – gained experience has higher grade than the gained knowledge. In case of each subject we can confirm that project work turned out as good teaching method for students‘ experience and knowledge.

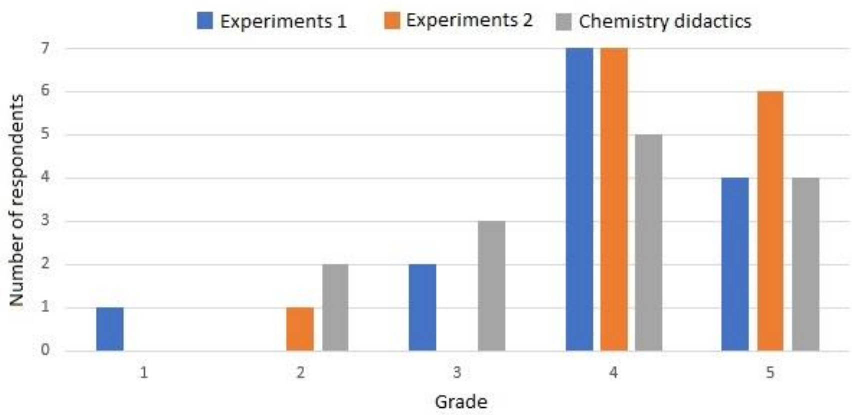

Fig.4: Students' grading of knowledge gained in individual subject

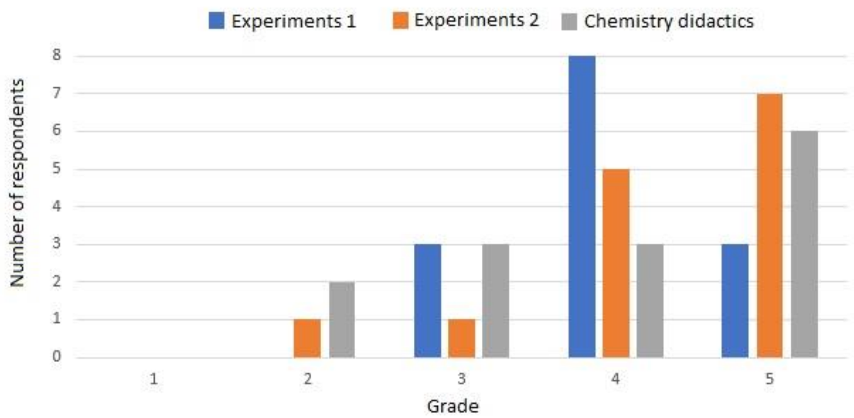

Fig.5: Students' grading of experience gained in individual subject

All the respondents are students who either graduated from college and are working or students who are still studying, but delivering lectures in schools. For this reason, it seemed fair to ask how did individual project work prove useful for their profession. From Figure 6 it is seen that project work at Experiments 1 proved as the most useful for the future profession as a teacher, while on the other hand Chemistry didactics work proved as the least useful. The reasons behind these results as students' stated are:

- teaching plan allows little freedom to include project based learning in schools,
- experiments are more often used in schools than projects,
- it's beneficial to have project work in college, so it is easier for us as teachers to implement it in our work.

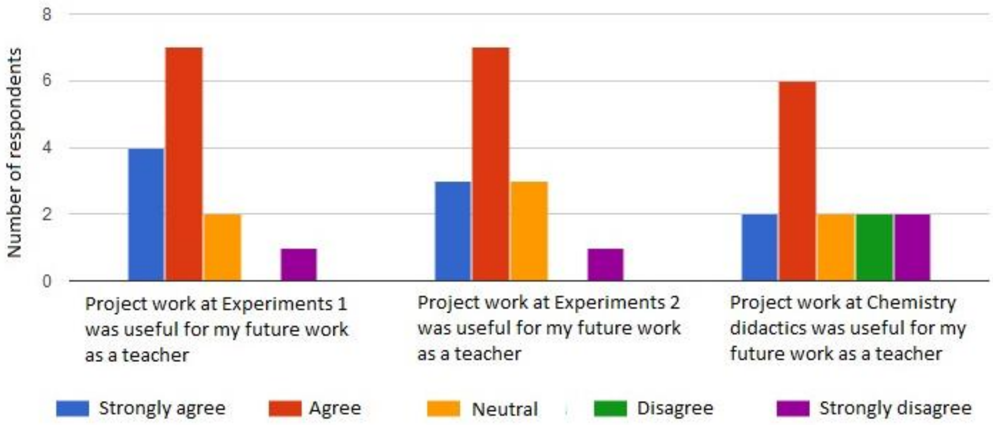

Fig.6: Students' opinion on usefulness of an individual project for their future profession

CONCLUSION

Using PBL as a learning method on Educational Chemistry studies at FNM proved beneficial for students. Three different approaches to project-based learning were presented and majority of respondents believe that all of them proved useful for their future professions, for they have gained both knowledge and experience through them. By using a different approach, such as PBL, professors can not only increase the knowledge of a student, but also give them space to develop their soft skills and experience needed for their future profession (in this case chemistry teacher).

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Teaching skills for Inquiry Based Science Education

Kateřina Čiháková

Abstract

Science teachers in the Czech Republic are not self-confident in using Inquiry based science education (IBSE), it appeared in less than 5 % of science lessons evaluated by the Czech School Inspectorate in 2016/17. We present a set of teaching IBSE skills designed for our professional development program. We provide first examination of the skills of teachers at the starting point of their education for becoming IBSE mentors. There was strong positive correlation between teaching outdoors, promoting pupils' activity and pupils' assessment and no correlation with IBSE skills.

Key words

Inquiry-based education, Teacher Professional Development, Mentoring in Teacher Education

INTRODUCTION

Biology teachers in the Czech Republic are generally not self-confident in using Inquiry Based Science Education (IBSE). IBSE appeared in less than 5 % of science lessons evaluated by the Czech School Inspectorate in the survey focused on scientific literacy in 2016/17. Only 6.8 % of high school teachers use IBSE methods regularly (Radvanová, 2018). The respondents state various constraints that prevent them from using IBSE more frequently, which correspond with previous studies both from the Czech Republic (Petr & Papáček, 2015; Petr, 2014) and abroad (Katz, Sadler & Craig, 2005), such as the amount of time needed, fear of losing control over the learning process, lack of knowledge and skills needed for IBSE at both the students and the teachers level (Kirschner, Sweller & Clark, 2006; Pavlasová et al., 2018) and concerns about the appropriate assessment of the learning process (Rokos & Závodská, 2016). Czech teachers often misunderstand the principles of IBSE not identifying "asking own questions" or "conducting self-designed research" as the key aspect (Petr & Papáček, 2015). Here we aim to examine teaching skills needed for IBSE in order to help teachers to identify the particular skill they personally need to improve their practice.

Based on our experience with a professional development program (later PDP) for future IBSE teacher mentors we suggest that the teaching skills needed for IBSE cannot be separated from the general skills in promoting cooperative learning, critical thinking and assessing information. Further we include the skill in preparing outdoor learning to both enable study of natural phenomena and enforce motivation of pupils as described by various authors in the Czech education context (Daniš, 2018, Činčera & Holec, 2016).

In this contribution we present the relationships between the self-reported frequencies of providing learning opportunities for pupils (viewed as part of teacher skills), teacher background and their goals in professional development.

We compiled a competency profile for IBSE Teachers using the ISSA Framework (ISSA 2010) and sets of teaching skills used in observation forms of the Fibonacci project (Borda Carulla et al., 2012) and indicators from questionnaires of Czech School Inspectorate (ČŠI, 2015). We use them to construct a self-reflection tool for teachers entering PDP Mentoring in IBSE (in Czech Oborový mentoring). We chose a set out of 7 focus areas from ISSA Framework that we consider the most important for IBSE: Planning and Assessment, Learning Environment and Teaching Strategies.

We asked following questions: 1. Is there any difference between self-reported teaching practice of elementary school teachers and lower secondary science teachers? 2. Are there any correlations between particular variables (frequencies) of self-reported teaching practice? 3. Is there any relationship between the goals set by individual teachers and their teaching practice or teacher background?

Our hypotheses: 1.Teachers from the elementary schools provide more opportunities for pupils to raise their own questions, design an experiment or observation and use active-learning strategies more frequently compared to lower secondary teachers. 2. Teachers who teach outdoors, use natural objects and living organisms and active-learning strategies frequently will also encourage pupils to ask questions and involve pupils in planning investigations (use IBSE methods generally) more frequently. 3. The individual goals will correlate with the length of previous teaching practice, the novice teachers will choose goals from Planning and Learning Environment focus areas while more experienced teachers will choose goals in Teaching Strategies and Assessment focus areas.

METHODS

The Professional Development program started with the course where the inquiry cycle was introduced and teachers participated in identifying investigable questions and making predictions. A month later the participants filled the questionnaire as a part of the session with their mentor. The participants were then asked to choose 1 to 4 individual goals for their further professional development. The respondents differed in age, length of teaching practice, education (primary teachers vs. science teachers), the age group of their pupils and the status of the school where they teach (private/public).

There are only quantitative indicators derived from the Competency Profile chosen for the entry questionnaire regarding the frequency of teaching activities. Teacher were asked to score frequency of providing learning opportunities for their pupils in the following respect: Hands On (pupils have first-hand experience with natural objects and living organisms), Outdoors (teaching in outdoor setting), Questions (pupils formulate investigable questions that we pursue), Design (pupils design their own investigations), Investigations (pupils record their investigations and draw conclusions), Activity (Activity is on pupils' rather than teacher's side) and Assessment (pupils assess their work, work of their peers or work of the teacher).

We analysed the entry questionnaires derived from Competency Profile for IBSE Teachers filled by 22 participants during the session with experienced PD provider (IBSE mentor) and the data regarding teacher and school parameters and teachers' goals from mentoring contracts (from 14 participants). All the Teaching practice variables (Outdoors, Questions, Design, Investigations, Assessment) were scored according their frequency as follows: 1 – never, 2 – exceptionally (less than twice per semester), 3 – more than twice per semester, 4 monthly with the exception of "Using natural objects for hands-on activities" which was scored 4 – "in every lesson" and 3 "once in a month". The variable Activity was scored as 1 (less than 10 %), 2 (10 – 25 %), 3 (25 – 50 %), 4 (more than 50 %).

We used Pearson correlation for analysis of self-reported frequencies in teaching practice. We used Principal Components Analysis on the correlation matrix of scored responses to extract main directions of shared variation among the teaching practice variables. We used scores of individual teachers on the two main axes to express their position in the multivariate space of these variables. The PCA was calculated using the package `Vegan`, version 2.4-0 (Oksanen J. et al., 2016). To visualize correlation of the teacher's background and school parameters and PCA axes, teacher's background and school parameter variables were passively projected into the ordination space using the function *envfit* from the package *vegan*.

RESULTS

We found that there is a group of participants in our PDP that reported that they never provide the opportunity for pupils' own questions, designing the investigations and pupils' self- and peer-assessment. The most frequent activity taking place on a monthly basis were pupils' self- and peer-assessment and teaching outdoors (Fig. 1). The monthly frequency of using natural objects and living organisms for hands-on activities was reported by three participants only.

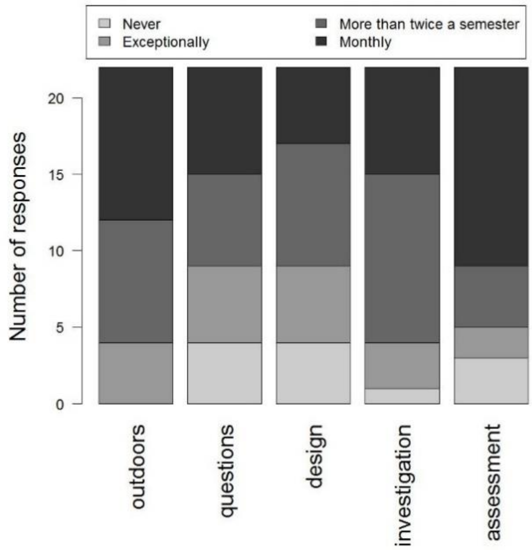

Fig. 1. Number of responses from the entry questionnaire regarding teaching practice

The first axis of Principal Components Analysis explained 35.2 % of variability and separated "teaching topics according the textbook order" from high scores of "pupils' activity, frequency of pupils' self- and peer-assessment and teaching outdoors". We interpret the first axis as teacher's flexibility in planning (Fig. 2, Tab. 1).

The second axis explained 21.2 % of variability and it captures difference between frequency of IBSE (pupils raising their own questions, designing experiments and recording their investigations) and hands-on activities with natural objects and living organisms, we interpret it as IBSE axis.

Projection of the parameters of school and teacher as passive variables to the PCA plot showed private schools having higher scores in pupils' activity, frequency of pupils' self- and peer-assessment and teaching outdoors. Younger teachers tended to use IBSE methods more frequently. Secondary science teachers were more likely to follow the textbook order of the topics instead of planning learning outdoors and promoting opportunities for active learning (Tab. 2).

Tab. 1 Correlation matrix of teaching practice variables

	hands.on	outdoors	textbook.order	questions	design	investigation	activity	assessment
hands.on	1	0.035	0.354	-0.111	-0.034	0.011	0.087	0.285
outdoors	0.035	1	-0.43	**0.423**	-0.048	0.035	**0.597**	**0.539**
textbook.order	0.354	**-0.430**	1	**-0.402**	-0.25	0.057	**-0.402**	-0.318
questions	-0.111	0.423	-0.402	1	**0.479**	0.291	0.276	0.359
design	-0.034	-0.048	-0.250	**0.479**	1	0.153	-0.147	-0.089
investigation	0.011	0.035	0.057	0.291	0.153	1	-0.239	0.082
activity	0.087	0.597	-0.402	0.276	-0.147	-0.239	1	**0.698**
assessment	0.285	0.539	-0.318	0.359	-0.089	0.082	0.698	1

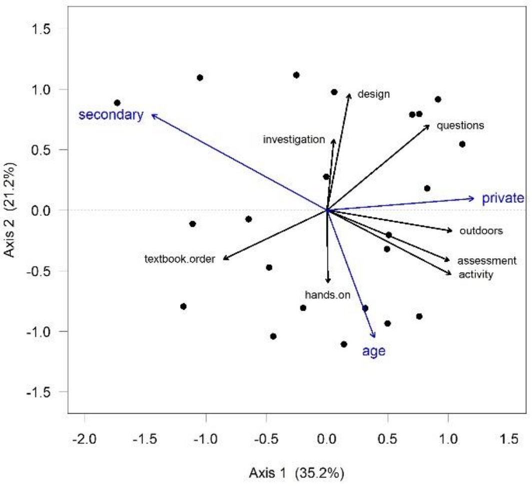

Fig. 2: PCA: Teaching practice variables and passively projected teacher and school parameters.

Tab. 2 Correlation matrix of teacher and school background parameters and PCA scores on main axis

	Flexibility Score	IBSE Score
age	0.155	-0.420
practice	-0.037	-0.091
education	-0.288	0.128
private	0.484	0.039
secondary	-0.578	0.315

DISCUSSION

We found no correlation between teaching outdoors and practicing IBSE (frequency of pupils raising their own questions, designing experiments and recording their investigations) and between IBSE and hands-on activities with natural objects and living organisms. We conclude that teaching in outdoor setting *per se* (which is more frequent in the lessons of elementary than lower secondary teachers) does not promote IBSE, because elementary teachers were not probably educated in IBSE during their university study (Radvanová et al., 2018).

We explain the lack of relationship between using natural objects and IBSE methods by the fact that the natural objects are often used for demonstration purposes only and the pupils do not have the opportunity to investigate it in detail. This finding is in line with other studies mainly from United States, suggesting that hands-on activities per se do not imply quality IBSE (Furtak et al., 2012).

Teachers who stated that they follow the textbook order during the school year instead of creating the year plan of their own had lower scores in teaching outdoors, pupils' activity and frequency of pupils' self- and peer-assessment. High scores in this axis were present at teachers from private schools. This fact exposes the urgent need for new textbooks enhancing outdoor learning, pupils' own investigation and self-assessment that should be developed according to innovated curriculum that will be more focused on IBSE. Until then the current PDPs have to enhance the teachers' skills in planning IBSE and making use of outdoor environment for learning.

There was no significant relationship between the individual teacher's goal and IBSE score and flexibility score in PCA. Half of the teachers chose "Encouraging pupils to raise investigable questions" as their individual goal. This is probably due to the fact that they filled the questionnaire one month after the introductory session where the inquiry cycle was presented with the emphasis on the questions and hypothesis step. The participants have hence had the personal experience with formulating investigable questions and are motivated to promote this skill among their pupils. However, we would expect that this goal will be chosen by majority of participants, and the fact that teachers set various different goals confirms the role of mentoring in teacher professional development.

Other frequently set goals include "Promoting pupils' self- and peer-assessment", "Planning and assessing education outcomes", "Enhancing time spent by pupils' active learning" and "Promoting critical thinking and work with information". These goals are not dependent either on the length of teaching practice or teachers' education (science teacher/primary).

Teachers have set their goals for "questions" or "assessment" even if they self-reported that they perform these frequently in their teaching practice. They probably feel the urge to improve the quality of the process rather than frequency, but the entry questionnaire together with Competency Profile enabled them to formulate their goals. The PDP Mentoring IBSE enables the participating teachers to follow their own goals, refine and redefine them during the collaboration of participant and his mentor. It may turn out that the goals set in the beginning phase don´t apply to the reality of teaching practice. Eg. no teacher has set the goal regarding the experiment design and only one decided to promote the pupils' own records of investigations and drawing conclusions. Using a subset of indicators during the observation of inquiry lessons (one of the 3 forms for specific inquiry step: a) questions and hypotheses, b) designing and performing investigations, c) analysis and conclusions) the teacher identifies his weaknesses and may change of refine his particular goal.

CONCLUSION

The self-reflection tool and the Entry Questionnaire are designed to help PD provider to tailor the current PDP to the needs of their participants. We found no correlation between using natural objects (reported as rather non frequent in the current teaching practice) and IBSE methods. Therefore, we plan to focus on the teachers' skills in providing natural objects and living organisms in the learning environment together with strengthening the skills to plan and carry out pupils´ investigation both with these natural objects and in the outdoor setting. The mentors will encourage the participating teachers to collect the evidence of their improvement in “Encouraging pupils to raise investigable questions” which was set as their primary goal and to build upon the experience and continue to further steps of inquiry cycle. During the PDP the participating teachers will become internal mentors in their school and will use the self-reflection tool, questionnaire and forms to introduce IBSE to their colleagues. We plan to improve and refine the self-reflection tool and observation forms to be used in pre-service teacher training.

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Using WebQuest as a kind of project method in chemistry lessons

Wioleta Kopek-Putała, Małgorzata Nodzyńska

Abstract

The article describes the correlation between the project method and its on-line version called WebQuest (WQ). The possibilities of using WQ were also described, as well as an analysis of the advantages and disadvantages of WQ. The article presents the results of the WQ evaluation research entitled "pH indicators". The aim of the research was to get to know students' opinions about working with WQ. As a research tool, a questionnaire on student attitudes was used, which contained 10 questions. Students concluded, among other opinions that this way of working is interesting for them (69.3%) they have learned a lot from it (73.1%) and would like to learn using it more often (71.4%).

Key words

Web-Based Learning, Project based Learning, Technology in Education and Training, Teaching and Learning, Multimedia and Hypermedia Learning

INTRODUCTION

Currently, another reform of the education system has been introduced in Poland. In this reform, among others:

- a 3-year junior high school was terminated (Ministry of National Education, 2016 a),
- the number of classes in primary school was changed from 6 to 8 (Ministry of National Education, 2016 b, c),
- the obligation to implement an educational project by students has been dropped (previously the grade from the project was entered into the student's certificate),
- chemistry course was blocked from 3 years in junior high school to 2 years in primary school (leaving unchanged the number of hours of chemistry classes).

As a result, teachers gave up using the project method in school education. The main reason was the lack of time required to implement project method for both students and teachers. Another reason was the fact that every time the teacher worked on the project method, he had to devote a lot of time to it. However, once prepared WQ can be used by the teacher multiple times – which saves his work time. Also, the work of students with WQ runs faster than in a traditional project. Therefore, it was decided to replace the project method with WebQuest.

WebQuest is a collection of mini-projects in which a large percentage of the input and material is supplied by the Internet (British Council BBC, 2004). As Mikina and Zając (2006, cited by: Czura, 2018, p. 127) wrote "WebQuest goals are largely identical with the main assumptions of the project method ...". WebQuest is an online teaching strategy used at various levels of education, which describes Zheng, Stucky, McAlack, Menchaca, Stoddart (2005, pp. 41-49) including middle school (Lipscomb, 2003). WQ is also used on various courses, and so the use of WQ in maths classes has been described, among others, by Göktepe (2014) and Halat (2008 a, b), in English lessons Zhang Z, Zhang Y, Jia (2011) and Saekhow, Kittisunthonphisarn (2015) in history lessons Lipscomb (2003), also the use of WQ in natural science was described, for example: Donovan (2005) and Çığrık, Ergül (2010).

The structure of WebQuests

WebQuest should consist of 6 main parts (subpages) and the WebQuest structure corresponds to the next steps in the project method:

- Introduction - general, motivating description of the project,
- Task - a description of the product to be created,
- Process - description of steps to be taken to solve tasks,
- Resources - a list of links to resources available on the network, needed to solve tasks,
- Evaluation - scoring and method of performance evaluation,
- Conclusion - a summary of the project (Educational Broadcasting Corporation, 2004).

In addition, there is often a subpage containing information about this WebQuest, tips for other teachers who would like to use such a project in the future.

In the WebQuest (Nodzyńska, Kopek-Putała, 2018) on the 'Introduction' page, in addition to the elements described above, there was also a pre-test containing 13 questions. An identical post-test was placed on the 'Evaluation' page. On this page there was also a link to the task that the students were supposed to complete. The final product / task in this WQ was the Concept Map. Below are examples of concept maps developed by students (Fig. 1a,b,c.).

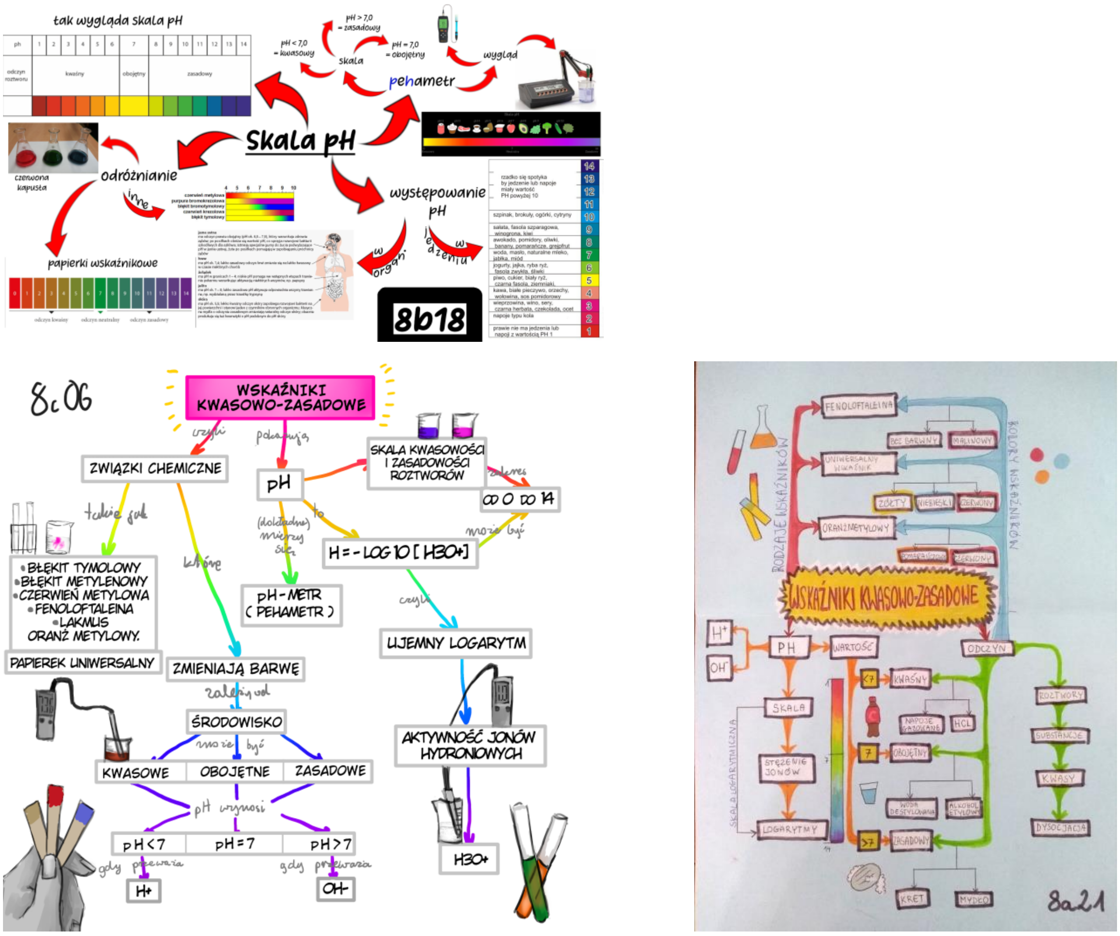

Fig. 1a b c. Examples of maps of concepts developed by students

WQ only slightly limits pupils' creativity - compared to the traditional method of projects but in the same way as in the project method, the student creates the product by himself.

Work using the project method is very useful for students. It helps them learn how to actively approach learning, as well as develop their independence, entrepreneurship and creativity. Students feel like researchers and explorers. Taking into this point of view, it was decided to examine the effectiveness of the variation of the project method - WebQuest.

PURPOSE

In this study, WebQuest was modified so it can be used in teaching chemistry. The subject of this WQ-based lesson was indicators and pH of solutions. It was prepared in such a way that it would not require any preliminary knowledge from students. In the WQ the level of difficulty of individual elements increased with the progress of the exercise. In addition, it can be used by anyone - who has access to the internet. One of the goals of the authors who created WebQuest was to check whether it is possible to use the WQ to carry out a mini educational project in a 2-hour lesson.

METHODOLOGY

Research questions: Is work with the use of WQ is interesting [8] for students? Does working with WQ increase student knowledge and how big is this increase? Is it possible to evaluate the final WQ product? Can you limit the duration of WQ to 2 units of lessons?

Area of research: The prepared WebQuest was disseminated on a large scale to teachers gathered in groups available on Facebook *('Chemistry teachers', 'Science teachers', 'I teacher - we create quality in education'*). The teachers then shared this WebQuest with their students. As could be expected only a few teachers (potentially motivated) gave WQ to their students. Also, not all of their students did this homework. This is in line with Rogers' theory. Despite the wide availability of WQ, the number of people who used it to their full extent was small.

Research tool: Several research tools were used in the research: knowledge tests (pre- and post-tests), surveys assessing students attitudes and document analysis (concept maps). Prior to joining WebQuest, the students completed the pre-test regarding their initial knowledge. And after completing work with WQ, the knowledge gain was tested using post-test. In addition, students were asked to provide feedback on such a way of learning by completing the evaluation questionnaire. The conclusion of working with WebQuest was to draw a Mind Map.

In this article - only a part of the results of research on the WebQuest evaluation by students is described. The questionnaire on student attitudes survey described in this article contains 10 questions: 6 closed with a 5-point Likert scale, 1 open short answer, 2 open long answers, 1 closed YES / NO.

The credibility of the research tool was verified using the Cronbach's alpha reliability coefficient. The Cronbach's alpha coefficient for the questionnaire is within 0.5-0.7, which can be considered as a limit

[8] Interests and their role in human development can be analyzed based on different theoretical approaches. The research uses an approach in which interests are relatively stable over time, but are influenced by the environment. They influence behavior through motivating, reflect the individual's identity (Gurycka, 1978, Matczak, 1991). This approach was used because in Poland the use of ICT in education is not new.

value (Bendermacher, 2010, Cortina, 1993; TenBerge & Zegers, 1978 cited by: Kubiatko, 2016). This value is accepted, among others, in the case of pilot studies (as in the discussed studies).

FINDINGS

The maps of concepts created by the students were very diverse and correctly showed the correlations between the newly acquired concepts (see. Fig. 1.). The description of correctness of the concept maps and their contents, the way of performing etc. will be discussed in another article.

The results of students' answers to 7 questions were placed below. In the analysis of answers, the answers to open questions requiring a long answer were omitted. The two questions omitted in the analysis: Write what was the most interesting? Write what was the least interesting?

The analysis also omits the question that concerned information about the independence of student work with WebQuest. The question was omitted due to its unreliability, tested with the Cronbach's alpha reliability coefficient. The result seems to be in line with the realities of the Polish school. Family or tutors help with homework to pupils (eg Frątczak, 2009, Smucerowicz, 2017), but not necessarily children and assistants admit it.

The number of pupils (and percent) who chose a given answer in six Likert-scale questions is shown in Table 1.

An open short question concerned the students' work time with WQ and it was*: Write how much time did you work with WQ.* In answering this question, students gave different values from 20 minutes to 6 hours. On average, work with WebQuest took students 1h 50 minutes.

One closed question was: *Would you like to learn using WQ more often? YES / NO.* 36 respondents (representing 71.4%) would like to learn more often using WQ, while 16 students (28.6%) would not like to learn using this method.

Tab. 1. Students' answers to questions with the Likert scale, source Kopek-Putała, Nodzyńska

Question	Answers - number of pupils, percentage (5-grade Likert scale)						
Prepared WebQest was:	boring	2 3.8%	3 5.8%	11 21.2%	23 48.1%	11 21.2%	very interesting
WebQest's tasks were:	incomprehensible	1 1.9%	5 9.6%	26 50.0%	18 34.6%	2 3.8%	very easy
I learned from this WQ:	nothing	0 0.0%	3 5.8%	11 21.2%	24 46.2%	14 26.9%	very much
Solving the tasks I worked:	carelessly	0 0.0%	1 1.9%	7 13.5%	23 44.2%	21 40.4%	very diligently
Generally, this method of learning is estimated at:	1*	2 3.8%	4 7.7%	10 19.2%	18 34.6%	18 34.6%	5

* *in Poland, the '1' rating is the lowest with a school grade*

DISCUSSION AND CONCLUSIONS

The results described below concern only student feedback. However, the subjective belief of the student about whether a given method of learning is interesting, effective, whether he worked well and whether, according to him, he learned new things - is very important because it directly influences the motivation of students to learn. On the basis of opinions obtained from students, it can be stated that work in WQ was interesting for them (69.3%) and they gained a lot of new information (73.1%). The students worked carefully (84.6%). WQ difficulty level would be chosen accordingly. The vast majority of students (69.2%) evaluate it well or very well. 71.4% of respondents would like to work more often using WQ. The average work time of students with WebQuest was 1h 50 min. Further research describing the correlations between the subjective feelings of students and the real results of pre- and post-test would be described in subsequent articles.

It can therefore be concluded that the hypothesis has been confirmed and work with the use of WQ is interesting for students, in pupils opinions causes the increase theirs of knowledge, there is the possibility of evaluating the final product and the duration of WQ is in 2 units of lessons.

When it comes to the opinions of the studied students about working with WQ, our results are identical to the results obtained by Baarnard-Ashton, van der Linde, Rothberg & Mcinerney (2018, pp. 3-11). In their research, students wrote that WebQuest was “just right”. The majority of the students felt that the WebQuest made the learning process more interesting but were more ambivalent regarding their enjoyment of the WebQuest, possibly due to technical issues and experiencing it as being time consuming. Overall the WebQuest was a successful modality for orientating the students to the online tools and resources of the University.

It can therefore be concluded that the obtained results are consistent with the results of other researchers. Thus, in a Polish school, working with WebQuest can replace the work of the project method.

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Používání učebnic chemie na základních školách v České republice: tvorba a pilotní ověření dotazníku

The Use of Chemistry Textbooks at Basic Schools in the Czech Republic: A Questionnaire preparation and piloting

Karel Vojíř, Martin Rusek

Abstract

The goal of this paper is to introduce the starting point, construction, piloting a questionnaire and preliminary results of the pilot study focused on the use of chemistry textbooks at basic schools. The tool is constructed in order to find out which textbooks are being lend to students, which textbooks are used by teachers to prepare for lessons and which parts of the textbooks are used in education. Altogether 37 respondents took part in the pilot study. Based on their responses, the most frequently used are textbooks by the Fortuna publishing house. Teachers did not show either satisfaction or dissatisfaction with the contemporary used books. This can explain the statement that more textbooks are being used by one teacher. Based on piloting, the constructed tool can be considered reliable and usable for research.

Keywords

Textbook, chemistry, lower-secondary education

ÚVOD

Vzhledem k tradici, rozsáhlému využívání a rozšíření jsou učebnice označovány za hlavní didaktickou pomůcku (např. Valverde, Bianchi, Wolfe, Schmidt & Houang, 2002). Žákům na základních školách je v ČR učebnice povinně bezplatně poskytnuta. S ohledem na jejich dostupnost lze tedy předpokládat, že se jedná taktéž o nejrozšířenější didaktický prostředek výuky. Učebnice zároveň představuje i nejkonkrétnější vyjádření kurikula, se kterým učitelé pracují a které tak přímo zasahuje do učební činnosti žáků. Díky variabilitě dostupných pomůcek, stejně jako rozdílům v jejich používání, dochází k diferenciaci učebních příležitostí. Předkládaný příspěvek se zaměřuje na první krok ve výzkumu používání učebnic chemie pro základní školy, který je součástí širšího výzkumného záměru jejich analýzy.

TEORETICKÁ VÝCHODISKA

S ohledem na srozumitelnost problematiky je ve využívání učebnic zapotřebí odlišovat využívání učebnice žáky, tj. učitelem vybranou metodu výuky, a využívání učebnice učitelem. Z pohledu práce žáka s učebnicí uvádí Sikorová (2007, s. 5), že ve vyspělých zemích pracují žáci s učebnicí 60 % vyučovací doby. Také většina jejich domácí přípravy spočívá v práci s textem. Žáci si osvojují z učebnic vědomosti i dovednosti, učebnice ovlivňují jejich postoje a hodnotové systémy (Sikorová, 2007). Přesunutí instrukcí z učitele na učebnici není vnímáno jako znak nízké způsobilosti učitele, který by se tím zříkal své role. Laws & Horsley (1992) uvádějí, že dobří učitelé využívají učebnice, pokud jsou kvalitní. To samozřejmě předpokládá, aby byl učitel dostatečně ztotožněn s pojetím, jakým autoři prezentují vzdělávací obsah. V tomto ohledu jsou zásadní závěry Janíka a kol. (2007): učitelé využili učebnici ve výuce fyziky v polovině zkoumaných vyučovacích hodin. Průměrná doba využití ve vyučovací hodině tvořila ale pouze 3,06 min.

Z pohledu výuky je podstatný především v učebnici uvedený vzdělávací obsah a zvolené metody jeho prezentace žákům. Prostřednictvím schvalovacích doložek MŠMT certifikuje kvalitu obsahu učebnice, tj. mimo jiné i formu prezentace učiva. V literatuře se pro tuto funkci používá označení podpůrné kurikulum (Walterová, 1994). V praxi to často znamená, že jsou učebnice používány jako (primární) zdroj organizace vzdělávacího obsahu a vyjádření úrovně dosažených výstupů, tj. realizovaného kurikula (Chiappetta & Fillman, 2007). Ve srovnání s Rámcovým vzdělávacím programem učebnice představují implicitní modely výuky a pomocí zahrnutých strukturních prvků vyjadřují i explicitní vzorce pro navození učební činnosti (Sikorová, 2007). Učebnice tak slouží učitelům i při přípravě výuky (Honing, 1991, In Mikk, 2000). Výzkumy provedené v Austrálii a USA ukazují, že zcela zásadní roli hraje učebnice v přípravě výuky zejména u začínajících učitelů (Horsley, 2009, Loewenberg-Ball & Cohen, 1996). Učebnice jsou totiž pro některé učitele užitečnou pomůckou v porozumění konceptům a přípravě na otázky žáků (srov. Horsley, 2010, s. 50), což platí jak pro začínající učitele, tak např. pro učitele vyučující obor, který nestudovali[9]. To klade zvýšené nároky na kvalitu učebnic, neboť pokud používají učitelé shodné metody jako v učebnici, dochází k posilování jejich vlivu, a tedy i případným problémům žáků s porozuměním (Bergqvist & Rundgren, 2017). Zároveň z těchto důvodů může docházet k rozdílům realizovaného kurikula na školách, tj. učiva prezentovaného žákům. Realizovaná kurikula se mohou lišit v závislosti na tom, kterou učebnici jejich učitel ve výuce využívá. To vytváří prostor pro diferenciaci, která zasluhuje další výzkumnou pozornost. Vliv učebnice zároveň samozřejmě závisí také na jejich využívání.

[9] Např. problematika výuky přírodovědných oborů na středních odborných školách nepřírodovědného zaměření viz Rusek, M., Havlová, M. & Pumpr, V. (2010). K přírodovědnému vzdělávání na SOŠ. *Biologie-chemie-zeměpis,* 1, 19-26.

Učebnicím chemie bylo v České republice doposud věnováno pouze malé množství publikovaných výzkumů. Autoři Klečka (2011) a Šmídl (2013) se věnovali analýze středoškolských učebnic. Učebnicím chemie pro základní školy byla prozatím věnována systematická pozornost pouze v oblasti obtížnosti textu (Rusek, Stárková, Metelková & Beneš, 2016, Rusek & Vojíř, 2019). Samotnému využívání učebnic chemie pro základní školy prozatím v českém prostředí pozornost věnována nebyla. S ohledem na možný dopad tohoto didaktického prostředku výuky je ovšem zásadní se tímto tématem zabývat.

CÍLE PRÁCE

Pro zjištění současného stavu jakožto kontextu dalšího výzkumu je cílem zmapovat, které učebnice jsou v současné době k výuce chemie na základních školách v ČR využívány. Významným faktorem je i způsob jejich využívání a jejich vnímání učiteli. Z tohoto důvodu se autoři předkládaného textu rozhodli zjistit:

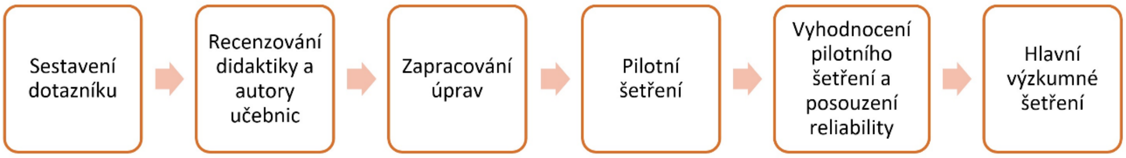
- Které učebnice chemie zapůjčují základních školy svým žákům?
- Které učebnice chemie využívají učitelé k přípravě výuky?
- Které strukturní komponenty učebnic učitelé využívají nejčastěji?
- Za jak významné pro kvalitní výuku považují učitelé jednotlivé strukturní komponenty učebnic chemie a k jakým účelům tyto komponenty využívají?

Cílem autorů tohoto textu je představit konstrukci a pilotní ověření výzkumného nástroje sestrojeného za účelem získání odpovědí na tyto otázky. Vhled do četnosti a způsobu využívání učebnic chemie a v nich obsažených prvků je významným podkladem pro budoucí autory učebnic i dalších didaktických materiálů. Zároveň poskytují informace o faktorech ovlivňujících chemické vzdělávání českých žáků.

Pole učebnic je v ČR významně ovlivněno plnou liberalizací, díky které je vydávání učebnic (s výjimkou přidělování schvalovací doložky) nezávislé na státu a závisí pouze na jednotlivých nakladatelstvích. Výběr konkrétních učebnic a jejich využívání je pak plně v rukou konkrétních škol, respektive učitelů, kteří mohou ve výuce využívat i učebnice bez schvalovací doložky MŠMT. Zároveň tak k zastoupení a využívání učebnic chemie na základních školách nejsou dostupné prakticky žádné informace. Tento výchozí stav výzkumné problematiky je vysoce specifický. Z tohoto důvodu bylo zapotřebí zkonstruovat vlastní výzkumný nástroj umožňující zodpovězení výše uvedených otázek.

METODOLOGIE KONSTRUKCE A OVĚŘENÍ DOTAZNÍKU

Využívání jednotlivých prvků v používaných učebnicích chemie je zkoumáno z pohledu četnosti užívání, učiteli vnímané významnosti pro kvalitní výuku chemie a účelu využívání. Postup činností je shrnut v obrázku 1.



Obr. 1: Postup dotazníkového výzkumného šetření

Konstrukce dotazníku

Dotazník byl vzhledem k možnostem distribuce zpracován v elektronické podobě, k čemuž byl využit nástroj Formuláře Google. S ohledem na cíle výzkumu byly do dotazníku zařazeny otázky vztahující se k charakteristice respondentů, učebnicím, které jsou zapůjčovány žákům a využívány k přípravě výuky, způsobu výběru učebnic, spokojenosti s učebnicí a jejich vnímanému významu, četnosti a způsobu využívání jednotlivých prvků v učebnicích a učiteli vnímanému významu těchto prvků. Jelikož jsou vlastní učebnice součástí širšího didaktického textového komplexu (viz Průcha, 1998) byly zařazeny i otázky vztahující se k využívání dalších prvků vybavenosti učebnicových projektů. V dotazníku byly využity především uzavřené otázky, v případě výběru používaných učebnic a jejich používání doplněné o možnost zadání jiné odpovědi. Do položek určených k hodnocení četnosti využívání, vnímané významnosti a účelu využívání strukturních prvků učebnic bylo zařazeno 15 individuálně hodnocených prvků. Pro následnou porovnatelnost byla ve výzkumném nástroji využita terminologie strukturních prvků učebnic dle Průchy (1998). Mezi hodnocené strukturní komponenty byly zařazeny: výkladový text prostý; výkladový text zpřehledněný (přehledová schémata, tabulky,…); shrnutí učiva; doplňující texty (dokumentační materiál, citace z pramenů, statistické tabulky,…); poznámky a vysvětlivky; slovníčky pojmů, cizích slov,… (s vysvětlením); nauková ilustrace (schematické kresby, modely,…); fotografie; mapy, kartogramy, plánky, grafy, diagramy; otázky a úkoly; instrukce k úkolům komplexnější povahy (návody k pokusům, laboratorním pracím, pozorováním,…); náměty pro mimoškolní činnosti s využitím učiva (aplikace); explicitní vyjádření cílů učení pro žáky; prostředky nebo instrukce k sebehodnocení pro žáky; odkazy na jiné zdroje informací.

K hodnocení četnosti užívání a vnímané významnosti strukturních komponentů, prvků vybavenosti i učebnice jako celku byly využity pětistupňové Likertovy škály (Likert, 1932). Pro zajištění spojitosti dat k následnému vyhodnocení byly slovně popsány pouze krajní hodnoty škály (Chytrý & Kroufek, 2017). Způsob využívání jednotlivých prvků v učebnicích, respektive pracovních sešitů k učebnicím byl zjišťován uzavřenou otázkou s možnostmi: příprava výuky, realizace výuky, domácí příprava žáků a rozšiřující aktivity určené jednotlivým žákům. Součástí dotazníku je i prostor volné vyjádření respondentů k tématu.

Validizace nástroje

Po sestavení výzkumného nástroje byla provedena obsahová validizace nástroje (Kerlinger, 1972). K tomuto účelu byl osloven odborný panel osmi didaktiků chemie. Těm byl dotazník předložen k oponování. Zastoupeni byli autoři sedmi různých řad učebnic chemie pro základní školy, zároveň se oponování účastnil vždy alespoň jeden z autorů všech učebnic chemie pro základní školy, které aktuálně disponují platnou schvalovací doložkou MŠMT. Navrhované úpravy byly s recenzenty konzultovány a následně zapracovány do upravené verze dotazníku.

Pilotáž nástroje

Po zapracování úprav byl v průběhu ledna až dubna 2018 nástroj pilotován na dostupném vzorku 37 učitelů chemie na základních školách. Pro četnost vzorku k pilotáži byla zvolena hranice 10 % minimálního vzorku. Pro výpočet minimálního vzorku potřebného k získání statisticky významných výsledků zobecnitelných pro celou skupinu učitelů chemie na základních školách v České republice byl využit systém Raosoft[10]. Tento vzorek na hladině významnosti $\alpha = 0{,}05$ při počtu 2719 základních škol s 2. stupněm[11] a při započítání rezervního předpokladu 1,5 vyučujícího na školu odpovídá minimálnímu počtu 352 respondentů.

Pro zvýšení validity nástroje byli respondenti v rámci pilotáže dotazováni rovněž k obsahu, struktuře a srozumitelnosti vlastního dotazníku. Tuto zpětnou vazbu poskytovali po vyplnění dotazníku formou volného vyjádřeni.

Reliabilita dotazníku

Na základě dat získaných pilotním šetřením byla zkoumána reliabilita dotazníku. K posouzení vnitřní konzistence byl použit koeficient Cronbachova alfa (Cronbach, 1951). Vzhledem k povaze škálových otázek v dotazníku byly samostatně posuzovány dvě subškály. Cronbachova alfa subškály *vnímaného významu* se rovnala 0,879, Cronbachova alfa subškály *četnosti využívání* se rovnala 0,942. Obě zjištěné hodnoty jsou přijatelné (Tavakol & Dennick, 2011) a vytvořený nástroj tak lze považovat za vhodný k využití při výzkumném šetření.

[10] Raosoft: Minimal size calculator, http://www.raosoft.com/samplesize.html
[11] údaj ze školního roku 2016/2017, zdroj: MŠMT. Statistická ročenka školství - výkonové ukazatele.

Úpravy dotazníku na základě pilotáže

Z výsledků pilotáže dotazníku vyplynula potřeba mírných úprav dotazníku pro jeho další využití v hlavním šetření. Úpravy vycházely zejména z podnětů pilotujících respondentů v jejich hodnocení dotazníku. Zapracovány byly rovněž četně dopisované další možnosti u výběrových otázek. Na základě nejčastějších odpovědí byl upraven výčet připravených možností k výběru u položky dotazující se na učebně vzdělávací obory. Byly doplněny výčty učebnic ve výběrových otázkách pro usnadnění vyplňování i následném vyhodnocování. V otázce vztahující se k využívání metodické příručky k učebnici chemie byly sloučeny možnosti *ne, nemám k dispozici* a *ne, k učebnici není dostupná*. Z odpovědí nebylo jisté, že byli respondenti schopni tyto možnosti řádně rozlišit, což doplňující vyjádření potvrzovala. V případě, že ji sami nemají k dispozici, řada respondentů nevěděla, zda byla k učebnici vydána. Byly vyloučeny otázky vztahující se k interaktivním materiálům v elektronické podobě (e-učebnici) k učebnici chemie. Respondenti opět zřejmě nebyli schopni řádně rozlišit vztah elektronických materiálů vydaných ke konkrétní učebnici chemie. Byla doplněna otázka na význam pracovního sešitu pro kvalitu výuky. K otázce na preferovanou učebnici k pořízení pro žáky byla doplněna možnost *nevím*. I po doplnění dalších možností u otázek s výběrem odpovědi byly zachovány možnosti *jiné*, které umožňují uvedení další odpovědi, aby nebyla omezena možnost přesného a pravdivého vyjádření respondenta.

VÝSLEDKY PILOTNÍHO ŠETŘENÍ

Charakteristika výzkumného vzorku

Ve výzkumném vzorku bylo zahrnuto 30 žen a 7 mužů, z nichž většina učí pouze na základní škole (N = 32). Další 4 vyučující učí kromě základní školy i na gymnáziu a 1 vyučující učí současně na základní a vysoké škole. Všichni respondenti dosáhli vysokoškolského vzdělání. Většina vystudovala vysokoškolský obor se zaměřením na učitelství chemie (N = 30). Ve výzkumném vzorku byli zastoupeni začínající i zkušení učitelé. Největší podíl představovali zkušení učitelé s více než desetiletou praxí. Kromě chemie vyučují ve vzorku zařazení řadu různých dalších vzdělávacích oborů, nejčastěji přírodopis a matematiku

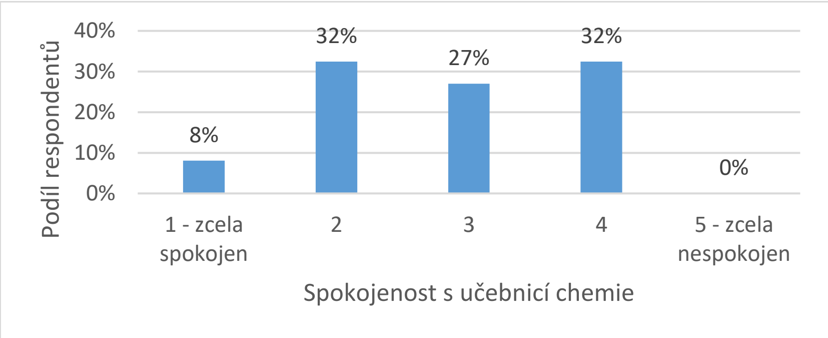
Používané učebnice chemie

V tabulce 1 jsou uvedeny učebnice nejčastěji zapůjčované žákům. Do výčtu jsou zařazeny i kombinace v případě, že škola disponuje více učebnicemi a žáci používají obě. Nejčastěji jsou žákům poskytovány učebnice nakladatelství Fortuna Základy chemie, a to ve více než 40 % případů.

Tab. 1: Učebnice chemie půjčované žákům[12]

Učebnice	Počet respondentů
Fortuna (ZCH)	10
Fortuna (PCH)	6
Fraus	6
Nová škola	6
Prodos	2
Scientia	1
Fortuna (ZCH) a Fortuna (PCH)	3
Fortuna (ZCH) a Fraus	2
Fraus a Nová škola	1

Dotazovaní učitelé s učebnicemi využívanými na jejich školách nejsou v průměru ani spokojení ani nespokojení (graf 1). Ačkoli nikdo z respondentů není se v současnosti využívanou učebnicí zcela nespokojen, je patrné, že současné učebnice nenaplňují očekávání většiny učitelů.

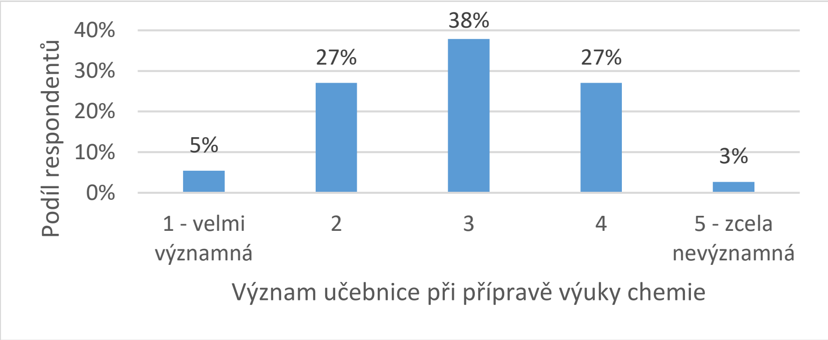


Graf 1: Hodnocení spokojenosti s učebnicí chemie používanou ve škole

Spokojenost s používanou učebnicí je zapotřebí hodnotit i prostřednictvím způsobu výběru učebnice. Většina dotazovaných učitelů chemie (59 %) se aktivně nepodílela na výběru využívané učebnice. V případě, že se tento trend projeví i v hlavním šetření, to může znamenat silný vliv na způsob využívání učebnice (srov. Sikorová, 2007). Nejčastěji učitelé uvádějí, že využívají učebnice, které již byly dostupné ve škole. Učitel, který aktuálně na dané škole vyučuje chemii tak nebyl procesu výběru učebnice přítomen.

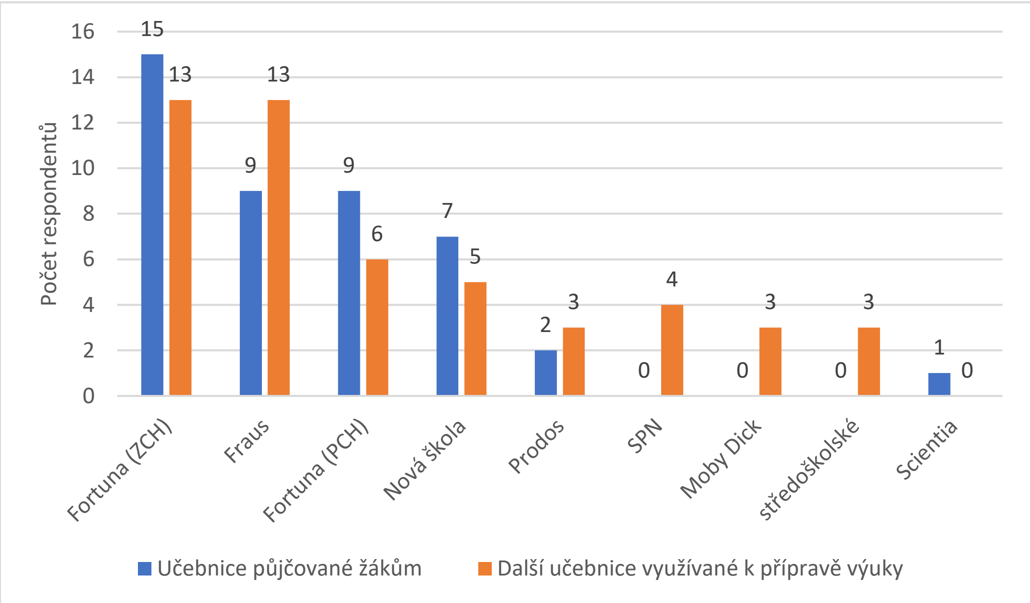
Pro téměř třetinu dotazovaných učitelů chemie je učebnice významná při přípravě (graf 2). Necelých 38 % dotazovaných učitelů nepovažuje učebnici chemie za ani významnou, ani nevýznamnou při přípravě výuky.

[12] Jednotlivé řadu učebnic jsou označeny názvem nakladatelství. Dvě řady nakladatelství Fortuna jsou rozlišeny zkratkou: ZCH – Základy chemie, PCH – Základy praktické chemie.



Graf 2: Vnímaný význam učebnice chemie při přípravě výuky

Většina respondentů (68 %) využívá k přípravě výuky více různých učebnic chemie. Ukazuje se, že učitelé nepovažují jednotlivé učebnice za plnohodnotné a při přípravě výuky kombinují více různých řad učebnic. Mezi učebnicemi používanými k přípravě výuky převažují učebnice nakladatelství Fortuna a Fraus. Tyto učebnice se zdají být nejčetnějšími jak mezi učebnicemi, které jsou využívány i s žáky, tak jako doplňující knihy k přípravě výuky (graf 3). Překvapivé je zjištění, že tři z respondentů používají k přípravě výuky chemie na základní škole učebnice určené pro vyšší stupeň vzdělávání.

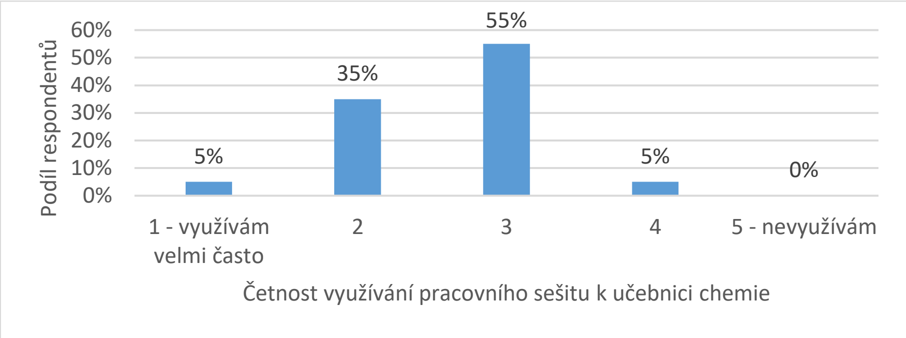


Graf 3: Učebnice chemie půjčované žákům a využívané k přípravě výuky

Metodickou příručku k učebnici chemie využívá pouze 22 % dotazovaných učitelů. Z učitelů, kteří ji nepoužívají větší část jako důvod uvádí, že jí nemá k dispozici, či není dostupná. U řad učebnic, ke kterým byla vydána, se tak zřejmě projevuje ekonomický faktor. Nikdo z učitelů, kteří metodickou příručku využívají k přípravě výuky, ji nevyužívá často ani velmi často a v průměru ji nepovažují ani za významnou, ani za nevýznamnou.

Oproti tomu 54 % respondentů uvedlo, že pracovní sešit k učebnici chemie využívá, přičemž 22 % respondentů ho využívá často nebo velmi často, tj. prakticky v každé hodině či přípravě na ni (graf

4). Pracovní sešit na rozdíl od učebnice nemusí školy ze zákona svým žákům poskytovat. Jelikož se jedná o pomůcku, kterou nelze poskytovat vícero žákům po sobě, nastávají komplikace při jejich obstarávání. To se projevilo u 22 % učitelů, kteří pracovní sešit nevyužívají, jelikož ho nemají k dispozici. Všichni učitelé, kteří pracovní sešit využívají, ho používají při realizaci výuky. Dalšími četnými způsoby je využití pracovního sešitu jako zdroje rozšiřujících aktivit pro konkrétní žáky (27 % učitelů) a v domácí přípravě žáků (24 % učitelů).



Graf 4: Hodnocení četnosti využívání pracovního sešitu k učebnici chemie (pouze učitelé využívající pracovní sešit, N = 20)

V hodnocení významu označují učitelé jednotlivé strukturní komponenty v učebnicích chemie spíše za významné. V hodnocení na škále 1 – velmi významný až 5 – zcela nevýznamný jsou strukturní komponenty hodnoceny průměrnou hodnotou 2,3. Jak je z výsledků patrné, učebnice je z pohledu učitelů pro kvalitu výuky chemie významným didaktických prostředkem výuky.

Mezi nejvýznamnější strukturní komponenty řadí učitelé:

- výkladový text zpřehledněný (přehledová schémata, tabulky, …) – 1,62;
- nauková ilustrace (schematické kresby, modely, …) – 1,62;
- shrnutí učiva – 1,86 a
- instrukce k úkolům komplexnější povahy (návody k pokusům, laboratorním pracím, …) – 1,89.

Jako méně významné, nikoli však nevýznamné, hodnotí učitelé:

- prostředky nebo instrukce k sebehodnocení pro žáky – 2,6;
- doplňující texty (dokumentační materiál, citace z pramenů, statistické tabulky, …) – 2,71;
- explicitní vyjádření cílů učení pro žáky – 2,81 a
- odkazy na jiné zdroje informací – 3,03.

Pro komplexní pohled učitelů chemie na učebnice je důležité sledovat i četnost využívání jednotlivých strukturních prvků. Tento aspekt je významný pro další tvorbu na poli učebnic chemie, neboť pouze aktivně využívané komponenty mohou ovlivňovat průběh vzdělávání i jeho výsledky. Mezi hodnocenými strukturními komponenty není žádný, který by nikdy nebyl využíván. V četnosti využívání jednotlivých strukturních prvků jsou ale významné rozdíly. Učitelé uvádějí, že častěji využívají:

- nauková ilustrace (schematické kresby, modely, …) – 2,38;
- výkladový text zpřehledněný (přehledová schémata, tabulky,…) – 2,5;
- Otázky a úkoly – 2,92 a
- Fotografie – 2,92.

Naopak méně často učitelé využívají:

- prostředky nebo instrukce k sebehodnocení pro žáky – 3,78;
- odkazy na jiné zdroje informací – 3,9;
- náměty pro mimoškolní činnosti s využitím učiva (aplikace) – 3,97 a
- explicitní vyjádření cílů učení pro žáky – 4,07.

Četnost využívání jednotlivých prvků je mimo potřeb učitelů a jejich představy o kvalitní učebnici ovlivněna i jejich spokojeností s konkrétní učebnicí. Tato problematika si proto žádá další zkoumání.

Jednotlivé strukturní komponenty plní v učebnici, respektive výuce, rozličné funkce. Zároveň se liší způsoby jejich využívání jednotlivými učiteli. K přípravě výuky využívá nejvíce zúčastněných učitelů (49 %) výkladový text prostý. Významnou roli v přípravě výuky sehrávají rovněž instrukce k úkolům komplexnější povahy, jakými jsou návody k pokusům a laboratorním pracím. Jejich využívání uvedlo 41 % dotazovaných učitelů chemie.

Nejvíce jsou respondenty jednotlivé strukturní komponenty učebnic využívány k realizaci výuky. Ústřední roli v tomto způsobu využití učebnice sehrávají naukové ilustrace, zpřehledněný výkladový text, jakým jsou přehledová schémata, tabulky apod. a otázky a úkoly. Jejich využívání uvedlo od 84 do 73 % učitelů chemie. Využívání otázek a úkolů v realizaci výuky je zároveň posíleno i využíváním pracovního sešitu. Používání otázek a úkolů z učebnice nebo pracovního sešitu při realizaci výuky chemie uvedlo 81 % učitelů.

Pro rozšiřující aktivity určené jednotlivým žákům, tj. prvky individualizace vzdělávání, využívá nejvíce respondentů doplňující texty (dokumentační materiál, citace z pramenů, statistické tabulky,…) – 35 % učitelů, otázky a úkoly a slovníčky pojmů, cizích slov,… (s vysvětlením) – obojí 30 %. Žádný z učitelů neuvedl využívání shrnutí učiva jako rozšiřující aktivity. To je naopak jedním z nejvíce učiteli využívaných prvků k domácí přípravě žáků. K tomuto účelu ho využívá 41 % respondentů. Největší skupina učitelů (43 %) uvádí, že využívá k domácí přípravě žáků otázky a úkoly, 27 % využívá k tomuto účelu také prostředky nebo instrukce k sebehodnocení pro žáky.

DISKUSE A ZÁVĚR

Nově sestavený nástroj určený pro zmapování doposud opomíjené oblasti na poli učebnic chemie pro základní školy lze na základě ověření validity a provedeného testu reliability považovat za vhodný k použití ve výzkumném šetření.

Výsledky pilotního šetření ukazují, že nejčastěji využívanými jsou učebnice chemie nakladatelství Fortuna. Zajímavým zjištěním je, že většina dotazovaných učitelů používá k přípravě výuky více než jednu učebnici. V tomto konkrétním případě by výsledky mohly poukazovat na učiteli vnímanou nižší kvalitu učebnic, jak tomu bylo v případě fyziky (Janík, Najvarová, Najvar & Píšová, 2007). V 16 % případů je více než jedna učebnice poskytována i žákům. Učitelé tím zřejmě kompenzují vnímané nedostatky jednotlivých knih.

Téměř polovina učitelů uvedla, že má vybranou jinou učebnici, kterou by chtěla pro své žáky pořídit. Dominantní postavení v tomto ohledu zastává řada učebnic nakladatelství Nová škola. Tyto jsou ze všech nabízených nejnovější, čímž lze interpretovat zájem některých respondentů o výměnu stávajících učebnic právě těmito.

Předností tohoto textu je zaměření na opominutou oblast výzkumu v didaktice chemie. S využitím dotazníku budou v dalším kroku získána výzkumná data umožňující generalizaci. Výsledná zjištění přispějí nejen odborné komunitě, ale také mohou posloužit začínajícím učitelům, jak naznačují výsledky Horsley (2009) nebo Loewenberg-Ball & Cohen (1996). Limitem výsledků získaných pilotáží je především nízký počet respondentů pilotního šetření včetně způsobu jejich výběru. Jedná se tak o pouze orientační výsledky, jejichž smysl leží v ověření srozumitelnosti a funkčnosti nástroje a v rovině směřování dalších výzkumů. Obsahová validizace proběhla pouze s pomocí didaktiků chemie. Zapojení odborníků z dalších disciplín by mohlo dále zvýšit kvalitu výzkumného nástroje. Odpovědi respondentů na jednotlivé položky, jejich komentáře k nástroji i hodnoty testu reliability však umožňují považovat výzkumný nástroj za spolehlivý.

Zkonstruovaný výzkumný nástroj mohou autoři poskytnout pro výzkumné záměry v dalších vzdělávacích oborech.

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