

Do Authors of Online Electronic Materials for Teaching Mathematics use Their Potential to use Non-Stereotypical Cultural Settings?

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Abstract: The paper focuses on the cultural content of online electronic materials developed primarily by Czech in-service teachers of mathematics for smartboards. The author presents an analysis of these materials with a focus on the cultural settings of word problems they contain. The paper builds on a poster presented on ECEL 2015 conference and a paper presented on ECEL 2016 conference. The question the author asks is how innovative electronic materials are as far as their cultural, non-mathematical content is concerned. Are these materials a mere conversion of problems from traditional hardcopy textbooks or have its authors gone further, introducing new motives, images and realities? Do they use the potential of the online environment that allows easy updates (unlike hardcopy textbooks that are used without any change for years, even decades)? The author builds on her research in the area of non-mathematical content of mathematics textbooks (Moraová, 2013) and of problems posed by teacher trainees (Moraová, 2014). The here presented research combines qualitative and quantitative approaches. The author analyses one hundred and seventeen online activities from the website www.veskole.cz. Word problems are classified according to their cultural content and the most frequent images are described and commented upon. The findings of this study are of interest to in-service mathematics teachers planning to develop an online teaching unit, mathematics educators but also policy makers as not much attention is paid to the cultural contents of mathematics teaching materials.

Keywords: Textbooks, electronic online materials, word problems, non-mathematical content, subversiveness, realia, stereotypes, construction of social reality, culture reproduction

1. Introduction

Contemporary world is a fast changing world in all aspects of our lives. This puts pressure on school as an institution and teachers to adapt to the fast changes. One of the changes in today's society is the growing cultural heterogeneity of our society and classrooms. It is becoming more and more difficult to define what the cultural norm is, what ways of life should be seen as "correct", usual or desirable. Teachers often face the reality of culturally heterogeneous classrooms whose pupils' experience they know from their homes and families is very different from culture they are presented at school. And still, teachers are expected to be able to plan and teach such lessons that will be meaningful and useful for all the pupils in their classrooms. This is very difficult unless teachers have at hand teaching materials that reflect the changes in society, are more open and tolerant to otherness and actually speak openly of other cultural patterns and experience.

Fast developments in ICT are another major change the school and teachers face. Very often, innovation at schools is linked to the potential of modern technologies and electronic learning environments. If this is to be true with respect to cultural patterns and contexts, online and electronic materials would have to present more open and heterogeneous contexts than traditional hard copy materials. Uploading an electronic material on a website for teachers is a very easy process in comparison to publication of a textbook (it must be reviewed, approved by Ministry of Education and published and must make profit to the publisher as the world of textbooks as a world of business and making profit). Publishers of textbooks deliberately look for non-mathematical content that is timeless and prefer the authors to look for settings which are not likely to change within next ten years or longer (i.e. references to prices of commodities, references to technical devices, cars etc.). In contrast, theoretically speaking, authors of online materials do not have to worry as their materials can be easily changed and modified at any time and thus the realia presented in them may correspond to contemporary reality.

The issue of the potential of online materials in education has entered the spotlight of contemporary research in the area of (not only) mathematics education. E.g. Novotná (2014) focuses on the issue of how electronic teaching materials can be designed to support pupils' creativity and culture of problem solving.

2. Theoretical Background

The impact of mathematics textbooks and other learning materials on mathematics education must always be born in mind when discussing mathematics education and has raised a lot of attention of mathematics educators. A number of researchers in the field of mathematics education (more precisely in the area of mathematics textbook research) point out that mathematics textbooks have major impact on mathematics education and mathematics discourse (Mullis, Martin and Foy, 2008; Valverde, Bianchi, Wolfe, Schmidt and Houang, 2002). Textbooks are equally important resources for both groups – for pupils to learn mathematics and for teachers to plan and teach their mathematics lessons. Mathematics classroom instruction is, in many cases, generally organized around and delivered through the mathematical tasks and activities found in textbooks. Therefore, textbooks are probably among the most immediate determinants of educational practice (Amit and Fried, 2002; Chval, Heck, Weiss and Ziebarth, 2012; Li, Zhang and Ma, 2009; Silver, 2009; Törnroos, 2005).

Berger (2016) in her study on how pre-service teachers of mathematics interact with a mathematics textbook defines two pillars of mathematics classroom: the discourse of the mathematics textbook (the written discourse) and the ways in which students interact with this discourse (the enacted discourse). For the purpose of this study another pillar will be considered – the pillar of the author of the discourse that is later enacted in the classroom by pupils and teachers. More precisely the author focuses on the non-mathematical discourse of online electronic materials and the potential discourse it leads to in a classroom.

With reference to culture, Rezat and Straesser (2012) point out that what happens in a lesson of mathematics can never be sufficiently described by the traditional concept of the didactical triangle ‘teacher-pupil-mathematics’. There are a number of other factors that structure a mathematics lesson (artifacts, culture, community). Rezat and Straesser redefine the classical notion of the didactical triangle to the more complex and plastic model of a socio-didactical tetrahedron, which depicts the situation in a mathematics lesson much more accurately. Artefacts used within a lesson (i.e. textbooks and also problems posed by teachers) are one of the factors affecting the course of a mathematics lesson and mathematics education in general.

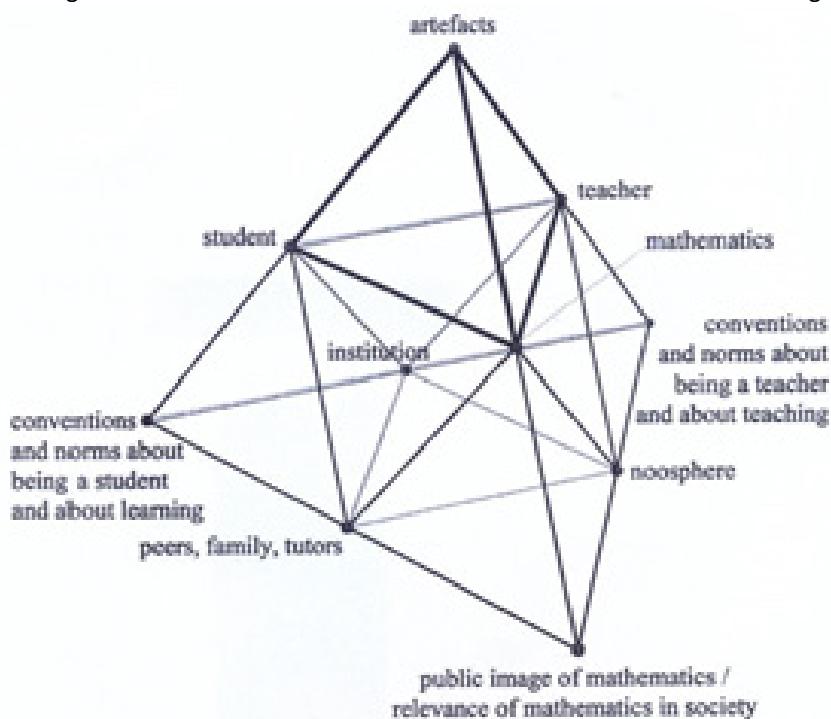


Figure 1: Sociodidactical tetrahedron according to Rezat and Straesser (2012)

At the same time recent years have witnessed rapid developments in the use of ICT at schools, and thus also in mathematics classrooms. New technological devices have fast become everyday part of pupils' lives and they should be handled in the classroom as such. Many researchers focus on efficiency and advantages of the use of ICT in mathematics classrooms, the potential of ICT and technological devices, the impact of the use of ICT on classroom practices, teaching methods, learner's activity and educational outcomes. Considerable attention in research has been paid to implementation of technological, e.g. (Hoyles and Lagrange, 2010) or (Kortenkamp and Ladel, 2013), who point out that teachers nowadays have to follow the developments in technological devices and adapt their teaching to these developments. Otherwise they are not able to keep pace with their pupils. Researchers also draw attention to the fact that their use in teaching is not always effective and may not support pupils' comprehension of the subject and its concepts (e.g., Jančářík and Novotná, 2011).

One of the areas where ICT has entered into mathematics lesson is the use of electronic multimedia materials developed for smartboards. Due to the possibility to publish these materials without any costs and lengthy reviewing processes by different education bodies, materials for smartboards are very often developed by in-service teachers. Their creation gives them the chance to adapt teaching materials to the particular conditions of their country, school, classroom or teaching style. That is why it is important to realize that any research in mathematics textbooks should nowadays also take into consideration other supplementary materials used in the classroom, including online electronic resources and multimedia materials for smartboards.

The above presented researches clearly imply that a lot of attention must be paid to what is presented in all learning materials (both hardcopy textbooks and electronic online materials). And, which is not the case so often, attention must not be only paid to what mathematics is presented and how it is presented, but also in what cultural context it is presented, what image of the world it gives to learners and society and what non-mathematical context is mathematics set in.

Sociologists, anthropologists and educators often draw attention to the fact that school is an institution responsible for reproduction of cultural patterns of a society and norms of everyday life. While functionalists, e.g. Durkheim or Parson (Prokop, 2005) see the process of enculturation as an important process that helps to maintain functioning of our society and believe that transmission of cultural values at schools is for benefit of all, theorists of culture reproduction and transmission as well as critical educators point out that this reproduction is for the benefit of some groups in the society while silencing and handicapping all other groups (Bourdieu, 1998, Apple, Au and Gandin, 2009, Giroux, 1983).

As Moraová (2015) points out, there is no doubt that what is going on at schools should be more than just mere transmission of knowledge from one generation to another. Apart from the content of the discipline taught (e.g. mathematics) children learn a lot about how society works. This is referred to as the hidden curriculum (Kentli, 2009). The process of enculturation or socialization happens in everyday interaction between teachers and pupils, among pupils but also in pupils' interaction with curricular documents and learning texts. These documents come into existence within the frame of specific discourse practices that shape them (Foucault, 2002), in a particular society with its everyday practices and image of what an educational text represents and the form and content it should have. These rules are often implicit and one may presume authors when writing a textbook do not realize how strongly they are influenced.

Critical educators are convinced that cultural transmission is not a static process and teachers' role in this process is not passive. In this perspective teachers are expected not only to mechanically transmit the official cultural values but to amend them, modify them, comment on them and work with them dynamically (Giroux, 1983). This subversive activity could be happening in situations when teachers stop using official printed textbook and become creators of their teaching materials. Non-mathematical, cultural content of word problems published in Czech hard copy textbooks of mathematics tends to be very conservative and stereotypical (Moraová, 2013). The newly published electronic learning materials created by in-service teachers should give their authors the space for presenting mathematics in a new way and in more up-to-date contexts. While printed textbooks often come out of their precursors, electronic materials created by in-service teachers may be based on classroom reality, on needs and interests of contemporary children, both as far as mathematical but also cultural content is concerned. And this is the case of the platform www.veskole.cz, a platform where in-service teachers upload materials for smartboards created by them. When creating interactive online materials, teachers can use their ideas, change the contexts and present mathematics in contexts comprehensible and natural for their pupils.

One of the objections that may arise is that the point of making a word problem in mathematics is to practice some mathematical concept or procedure, solving strategy or skill, not to inform learners about the world. It is natural that authors of mathematics textbooks and learning materials always put mathematics core and concepts first and adapt real life settings to their needs. The same happens in fiction. Literary theorists inform of the impossibility to depict "reality" and of every text being a mere *simulacrum* (Baudrillard, 1998). No text can ever be taken as a simple mirror of reality. However, the non-mathematical, cultural content of mathematical tasks and problems must never be ignored or seen as unimportant. A good setting of a word problem not only makes the problem more motivating and appealing and makes transition between contexts easier (and thus makes learning meaningful and allows pupils to use their everyday experience), but also every setting leaves imprints on pupils' mental schemas and their understanding of what norm and deviation are in a particular society because these categories are socially constructed. Textbooks and other learning texts including electronic materials make pupils define the norm and otherness (Blackman and Walkerdine, 2001). Moreover, as Havelková (2013) warns if schooling does not keep up with society, pupils regard education as irrelevant to their lives. Meany and Lange (2013) take a different perspective and warn that learners who have to transit from one cultural context to another (home context and school context) are more likely to fail to be able to use their everyday knowledge of mathematics from home at school when doing mathematics. Thus they face an additional obstacle.

Havelková (2013) suggests that introduction of modern technologies into classroom practices is one of the ways of making experiences from the outside world and from school closer to each other. But if this is to hold, modern technologies and online materials would have to be offering new contexts closer to everyday experience of learners. That is why the author of this paper has decided to make an inquiry into electronic materials produced by in-service teachers, posted in a website for Czech in-service teachers to see what cultural contexts are used in these materials and whether they tend to be more innovative and less stereotypical than contexts of Czech hard copy mathematics textbooks.

The research question the author asks in this paper is the following: Is the non-mathematical (cultural) content presented in word problems in online electronic mathematics materials more innovative than contexts presented in traditional hardcopy textbooks? Do the authors of online electronic materials make use of the potential the online environment with virtually no publishing costs to use more topical settings, or do they merely convert tasks and problems in traditional settings that can be come across in textbooks?

3. Materials and methods

The here presented research combines qualitative and quantitative designs. The author analyses about one hundred online activities that involve word problems. The analysed word problems are classified according to their cultural content and the most frequent images are described and commented upon.

All the activities were downloaded from and are available at the website www.veskole.cz, which provides about 35 000 teaching units for all school levels in all subjects and areas at this point. It allows its users to filter the content setting the subject (mathematics, elementary science, languages etc.), the age level (preschool, primary, lower secondary, upper secondary, other) and the planned use of the material (interactive exercise, materials for planning lessons). This limits the number of available activities and materials. Many of the materials allow the users to view them online and all of them can be downloaded for free. They are in .notebook format and work on computers with SmartNotebook software (which is very common in Czech schools). The user can also see the number of downloads of the material. The materials are ordered from those that are evaluated by mark 1* to those marked 3 (the worst evaluation). This evaluation is done by the users themselves and should give teachers some basic idea of the quality of the teaching material available. Considering the number of resources these marks may be very helpful to teachers to be able to predict the quality of a teaching material without having to download it. (see Fig. 2)

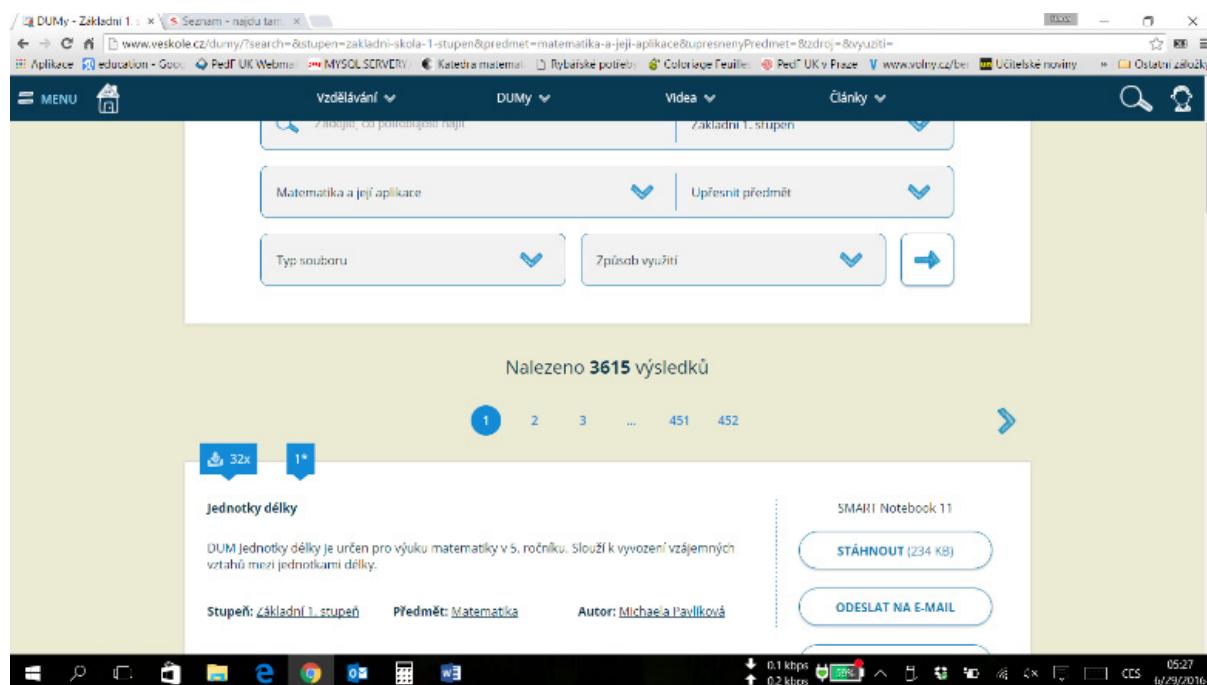


Figure 2: Print screen of the menu of www.veskole.cz

There is also a field in which the specific topic may be typewritten, e.g. word problems, fractions, area etc. to make the search more focused and the results fewer and closer to the desired mathematical content, concept, procedure to be taught, learned and practiced. For the purpose of this study the author used the key words "word problems" to limit the number of materials for analysis. These keywords show 195 results on primary school level. Primary school level was selected because the younger the children the more likely they are to read texts without critically assessing the content and thus are more likely to be affected and influenced by the contents.

Out of these 195 materials, the author downloaded 60 materials and conducted analysis of word problems that they include. She was looking for the setting of these stories and classified it to categories. These categories are introduced in the section below and commented upon. They are also compared to the findings from a study on the setting of word problems posed by teacher trainees (Moraová, 2014). The goal of this comparison is to show whether there are categories of settings or motives that are not typical for problems posed in pen and paper but are typical for online resources.

On average, each of the materials included 2.7 word problems. The total of problems analysed was 162 word. All materials, despite being found as the result of a search for "word problems" very often contained several interactive exercises that were not word problems and had no story and also parts with explanations of new concepts. These sections were usually followed by two to four word problems.

4. Results and discussion

The first thing that the analysis shows is that typical characters of multimedia materials are white, middle class people from nuclear families (with a father and a mother living together, as well as with grandmothers and grandfather available, very often in the countryside). There are no word problems that would present divorced families or minorities. This despite the fact that statistically every second marriage in the Czech Republic ends in a divorce, children live with only one parent, stepparents or live in shared custody. Everybody in word problems in online mathematics materials tends to be mediocre and white. In all the problems analysed there was not anybody from a different cultural background, there were no minorities presented. If names are used they are the common names for people of Czech nationality. Again, this does not correspond to the current state of Czech society and of schools. The number of children from different cultural background is increasing and each classroom can expect to have at least one child whose parents or one of whose parents is a foreigner.

The settings of word problems presented in the analysed materials were most likely to be food (52%), money and shopping (10%), school (7%), animals (6%), hobbies and free time activities (6%). The animal world is a context that was not used by teacher trainees at all in the study (Moraová, 2014), otherwise, the settings seem to be very similar. Within the categories it holds that women and girls cook, buy or distribute food. If men or boys are mentioned in the context of food, they consume it. Sweets are most often distributed or divided by mothers and grandmothers. "Feeding" is still the domain of women.

If women go shopping, it is for food or clothes, fabric and shoes. If men go shopping, they buy books, wood, wire netting, nails, i.e. a lot of things connected to "Do it yourself category". DIY category is a special type of category which has its roots in mathematics textbooks from the 1970s and 1980s when families used to spend weekends at weekend houses maintained by fathers' manual work – fathers were building, decorating, repairing roofs, building fences around the garden. Skilled workers could not work as free lancers at those times and thus it was impossible to hire them to do the manual work which was left to fathers. This is an example of a category that builds on cultural reality of the past and does not represent contemporary reality. Nowadays these activities are more likely to be done by hired craftsmen. Similar conclusions about proportion of DIY settings were in the analysis of problems posed by teacher trainees (Moraová, 2014). This seems to confirm that cultural stereotypes have very long life and are replicated again and again in the following generations regardless of their validity or relationship to reality. This may not be so surprising because in-service teachers, who create most analysed multimedia teaching materials, were brought on the same cultural contexts of mathematics word problems as teacher trainees involved in the study in (Moraová, 2014) and thus both pose similar problems.

Word problems in the category sports and hobbies are also male dominated. It seems that women are so busy cooking and sewing that they have no time for other hobbies.

What is a very surprising finding from the conducted and here reported study is that multimedia teaching materials do not use the setting of the world of technology at all and that use the setting of the world of finances in a very limited extent. Avoiding any reference to technological devices despite the fact that they build on the use of these devices is unexpected since they build on electronical devices and gadgets and it seems to be the natural environment. As stated in (Moraová, 2015), hardcopy textbook publishers prefer if the author avoids any references to actual prizes of things that can be bought in a shop. The life-span of a textbook in the Czech Republic is very long. It takes about two to five years for a collective of authors to write a textbook. Then it takes about one year to get the book approved by the Ministry of Education. The official approval of the Ministry of Education for a textbook is for six years and is likely to be prolonged by further six years. Textbooks for primary and lower secondary schools are purchased by the school and lent to pupils. Thus a school wants to be using the same textbook for as many years as possible for financial reasons. Also, according to interviews with publishers (Moraová, 2015) teachers tend to be very conservative and want to be using the same textbook for as many years as possible. This means an author, when writing a textbook, thinks in the horizon of at least 15 years. Any reference to costs of things and to modern technologies will make the textbook obsolete soon and thus tends to be excluded.

In online materials one would expect the authors not to be afraid of too fast aging of the textbook because of fast development in the area of electronic devices and changes in prices of products due to inflation. However, the authors of online materials analysed in this study not take the opportunity to make the word problems closer to real life and may be even more attractive for the young generation. They stay in the stereotypical settings of food, cooking, shopping, hobbies etc.

However, there were some differences to be observed between the non-mathematical contents of problems posed by teacher trainees in pen and paper and in the non-mathematical content of word problems presented online. Out of the 162 problems from online materials analysed in this study, the largest group has the setting of food, eating it, buying it or preparing it (52%, see Figure 3). In problems posed by teacher trainees this proportion was higher, 61% (see Figure 4).

A brand new setting of word problems in multimedia materials is the animal world. This is very likely to be connected to the facility of use of pictures in colour in contrast to the traditional pen and paper problems. Use of pictures in colour makes problems more attractive for learners. When posing a problem in pen and pencil, the authors are not likely to use any illustrations and the world of animals loses its charms.

Also, more attention is paid to the world of money and shopping in multimedia materials (10%) than in those posed by teacher trainees in pen and pencil (3%).

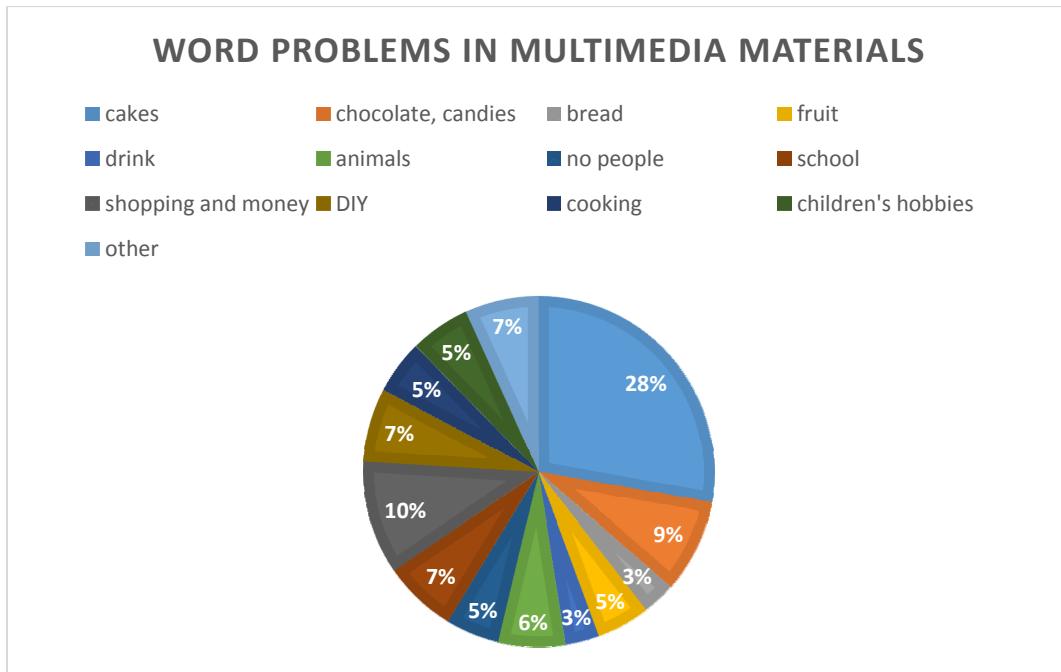


Figure 3: Proportion of word problems in different categories – problems from multimedia materials

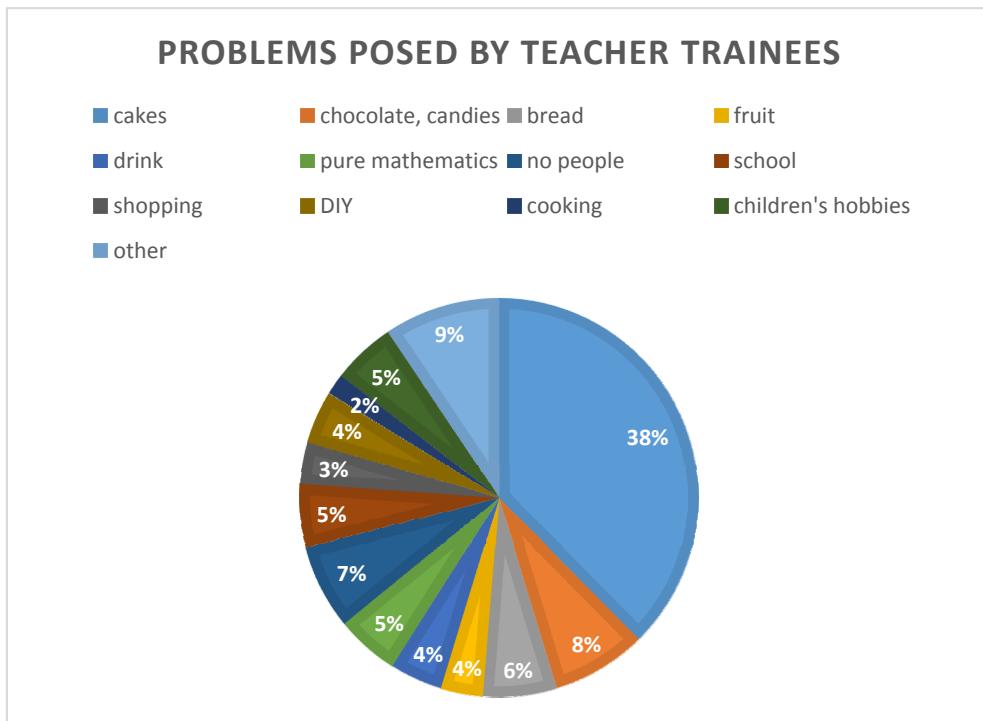


Figure 4: Proportion of word problems in different categories – problems posed by teacher trainees

5. Conclusions

The conducted study shows that despite critical educators' trust in subversiveness of in-service teachers' attitudes and approaches and their belief that teachers are not just automatons presenting materials and their cultural values but actively adapt them to current society and its lifestyle and cultural values, the world in-

service teachers create in word problems of their multimedia materials is very stereotypical, far from real life and defending old-fashioned middle-class values, traditions. In-service teachers whose materials were analysed in this study fail to respond to the world as it is now. Thus the answer to the research questions asked in this study is that in-service teachers fail to use the potential of the new medium (online multimedia materials). Although uploading materials is virtually for free and gives the authors the chance to be subversive and innovative as there are no reviewers whose approval would be needed, they tend to create problems similar to those they were brought up on. Instead of responding to the current state of society, the conditions of their classrooms and interests of contemporary young learners, they tend to replicate the same cultural patterns that they had come across as primary and secondary school students.

The selection of settings in online materials is very similar to the settings of problems posed by teacher trainees in pen and paper and also to the settings of word problems that are common in Czech textbooks of mathematics. This implies that more attention should be paid to the issue of non-mathematical and cultural aspects of mathematics education at the level of teacher training. Preservice and in-service teachers of mathematics need to grow aware of the fact that they are not only teaching mathematics, but also teaching culture and molding the new generation. Moreover, their insistence on the use of the most traditional images may make mathematics distant to those learners who come from different cultural backgrounds and have diametrically different experience with everyday life. And that contradicts the principle of equity and equal chances in education.

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