



HAL
open science

Using Concept Cartoons in future primary school teacher training: the case of problem posing and open approach

Libuše Samková

► **To cite this version:**

Libuše Samková. Using Concept Cartoons in future primary school teacher training: the case of problem posing and open approach. Eleventh Congress of the European Society for Research in Mathematics Education, Utrecht University, Feb 2019, Utrecht, Netherlands. hal-02422680

HAL Id: hal-02422680

<https://hal.science/hal-02422680>

Submitted on 22 Dec 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Using Concept Cartoons in future primary school teacher training: the case of problem posing and open approach

Libuše Samková¹

¹University of South Bohemia in České Budějovice, Czech Republic; lsamkova@pf.jcu.cz

The contribution focuses on an educational tool called Concept Cartoons from the perspective of problem posing activities of future primary school teachers within the framework of the open approach to mathematics. It introduces Concept Cartoons, the open approach to mathematics, and a small qualitative empirical study conducted with future primary school teachers. The aim of the presented study is to observe how open might be problems posed by future primary school teachers in the Concept Cartoon form. The results of the study confirm that Concept Cartoons can be successfully employed in problem posing activities and that they have a potential from the perspective of the open approach to mathematics.

Keywords: Concept Cartoons; elementary school teachers; mathematics education; open approach to mathematics; preservice teacher education.

Introduction

The study presented here reports about an educational tool called Concept Cartoons, and about the way how the tool can be employed in future primary school teacher training. In particular, it will focus on the possibility to use Concept Cartoons during problem posing activities and observe the posed Concept Cartoons from the perspective of the open approach to mathematics. The study follows up the contributions of me and my colleagues from previous CERME and ERME conferences, as it discusses mathematics problems of a given structure and their employment in future teacher training (Tichá & Hošpesová, 2015), problem posing of future teachers (Tichá & Hošpesová, 2010), and future teachers facing or composing potential pupils' misconceptions in the Concept Cartoon form (Samková & Hošpesová, 2015; Samková, 2017; Hošpesová & Tichá, 2017). The issues of teachers posing problems and teachers facing potential pupils' misconceptions are the topics that have been broadly discussed at CERME and ERME conferences in TWGs related to teacher professional development, e.g. by Malaspina, Mallart and Font (2015), Milinković (2017), Kuntze and Friesen (2017). The topic of Concept Cartoons is close to the concept of polyvalent math tasks presented at CERME by Hellmig (2010).

In the following text, I will introduce the idea of Concept Cartoons and my experience with them, and the open approach to mathematics. Then I will describe an empirical qualitative study addressing the following research question: *“How open are problems posed by future primary school teachers in the Concept Cartoon form?”*

Theoretical background

Concept Cartoons

An educational tool called Concept Cartoons appeared in Great Britain more than 20 years ago (Keogh & Naylor, 1993), in order to support discussion and involvement of primary school pupils during science lessons. Later the tool also expanded to other school subjects and school levels.

Concept Cartoon is a picture showing a situation familiar to pupils from school or everyday reality, and several children discussing the situation in a bubble-dialog. Each bubble presents an alternative viewpoint on the pictured situation. The alternatives might be correct as well as incorrect; the correctness also might be unclear or conditioned by circumstances not mentioned in the picture. Sometimes the picture includes a blank bubble with just a question mark, to indicate that there might be other alternatives not presented in the picture yet. For a sample see Fig. 1.

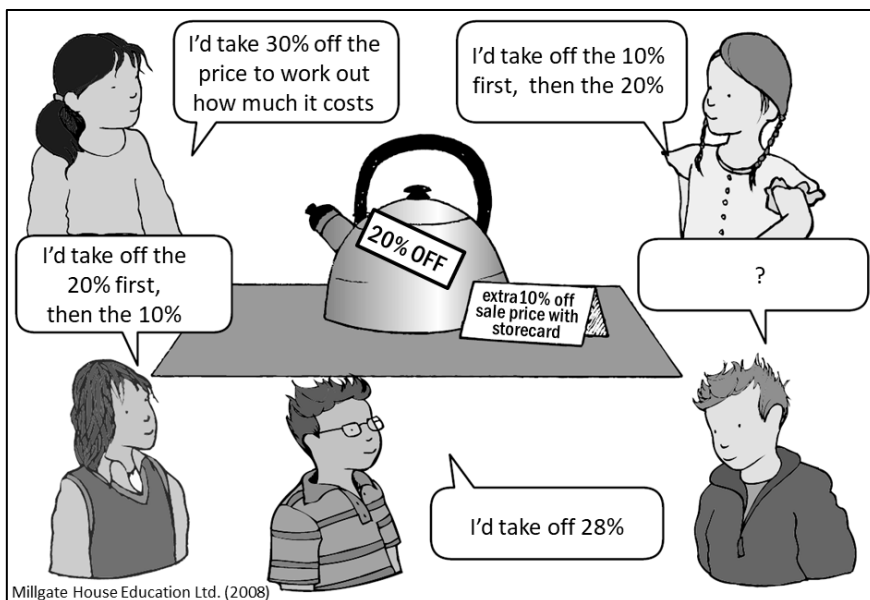


Figure 1: An original Concept Cartoon with three correct bubbles, one incorrect bubble, and a blank bubble; taken from (Dabell, Keogh, & Naylor, 2008: 4.11)

When working with Concept Cartoons in the classroom, pupils are asked to decide which children in the picture are right and which are wrong, and justify the decision. In that setting, it turned up that the lack of agreement amongst the pictured children encourages the pupils to join the discourse and defend their opinions (Naylor, Keogh, & Downing, 2007).

Besides the original classroom use, we started to consider each Concept Cartoon as an educational model of a contingent situation (Samková & Hošpesová, 2015), and more widely as a representation of practice oriented on diagnostic purposes (Samková, 2018b). In that sense, Concept Cartoons do not cover all aspects of school practice but might be regarded as a result of a decomposition of practice according to Grossman et al. (2009). Following this line, I created my own set of Concept Cartoons and accompanied them by a list of indicative questions focusing more deeply on conceptions and misconceptions probably hidden behind individual bubbles (Samková, 2018b). We included these Concept Cartoons as a diagnostic tool in future primary school teacher training, and conducted several studies: on aspects of pedagogical content knowledge (Samková & Hošpesová, 2015; Samková, 2018b), reasoning on selected topics (Samková & Tichá, 2017), or comparison between information on mathematics content knowledge that can be obtained through Concept Cartoons and through word problems in standard written tests (Samková, 2018a). In this paper, I will focus on Concept Cartoons within the framework of open approach to mathematics.

Open approach to mathematics

Open approach to mathematics is a method of mathematics teaching that employs problems called open. These problems have multiple levels of grasping (i.e. their starting situation is open), multiple correct ways of solving (i.e. their process is open), multiple correct answers (i.e. their end products are open) and/or multiple ways to transform the problem into a new one (i.e. ways to develop are open) (Nohda, 2000; Pehkonen, 1997). Such problems allow us to perceive mathematics in all its diversity. For samples see Table 1. Also Concept Cartoons themselves may be considered as open problems, since they present various alternatives (of grasping, solving, solutions) in their bubbles.

There are 4 beds of seedlings in a forest nursery, each of them having 5 rows with 240 seedlings. How many seedlings are there?	starting situation is open (it is not clear whether 240 is the amount for each of the rows, or altogether for all 5 rows); process is open (for the first case above: we may count the number of rows in all beds and multiply it by 240, or count the number of seedlings in one bed and multiply it by 4);
90-minute tickets in Prague cost 32 crowns; 24-hour tickets cost 110 crowns. How much will Ivan pay for the tickets on a weekend trip?	starting situation is open (we do not know how much or how often will Ivan travel around the city, how long the trip will last: less than 24 hours? more than 48 hours? how much more? ...); end products are open (there are 13 different solutions, from minimal pay of 0 crowns, to maximal pay of 330 crowns).

Table 1: Samples of open problems (left), with their open-approach characteristics (right)

Open problems that have multiple solutions of different levels of difficulty while every pupil is probably able to find a solution appropriate with his/her actual knowledge are called polyvalent (Hellmig, 2010). The Concept Cartoon from Fig. 1 might be considered as polyvalent, since it has three different correct bubbles, and each of the them requires a different level of knowledge to justify its correctness: the easiest is the bottom left bubble where the discounts are in the same order as in reality in the shop; the top right bubble deserves an additional knowledge that changing order of discounts does not change the final price; the bottom middle bubble is the most difficult, it is the only one with some other calculations behind. The incorrect bubble (top left) deserves another type of knowledge – that a combination of discounts cannot be solved by their addition.

Design of the study

Participants

Participants of the research were 29 future primary school teachers – full time students of the 5-year teacher training program at our university. They had already finished all mathematics content courses of the program, and in the time of the study they were attending the course on didactics of mathematics. During the mathematics content courses the participants had several times worked with Concept Cartoons, discussing them in the classroom or responding in written form to various sets of questions related to them, i.e. they got familiar with the format of Concept Cartoons.

Course of the study

In the data collection stage, the participants were asked to create their own Concept Cartoon that could be assigned to primary school pupils during a mathematics lesson. They worked on the task individually, in the form of a compulsory written homework where they introduced the Concept Cartoon, and gave a short explanation of the task and the bubbles.

During data analysis I searched for answers to the research question “How open are problems posed by future primary school teachers in the Concept Cartoon form?”. I processed collected data qualitatively, using open coding and constant comparison (Miles & Huberman, 1994). During open coding I focused on the composition of the Concept Cartoon, on its mathematical correctness, and on displays of openness in relation to Nohda’s definition of open problems (2000). For better arrangement, some of the codes were denoted by plus or minus sign to distinguish between positive and negative aspects (correct or incorrect format, open or non-open parameters of the task, etc).

The following code categories appeared as relevant for my study:

- A. the format of the Concept Cartoon (this category included codes *proper format, improper format, no bubbles, no alternatives, each bubble solves a slightly different task, independent bubbles, conditional bubbles*, etc.);
- B. grasping of the task in the picture and its levels (codes *unique, multiple, unclear, too open to be comprehensible, various parameters, diverse interpretations of the assignment*, etc.);
- C. ways of solving the task in the picture (codes *unique, multiple, diverse procedures offered in bubbles*, etc.);
- D. number of solutions and their interpretations (codes *unique solution, multiple solutions, unique interpretation, multiple interpretations of unique solution*, etc.);
- E. difficulty and smartness of the posing process (codes *detailed preparation needed, smart pre-calculations made*, etc.).

Subsequently, I analysed the codes and categories in order to divide the participants into groups according to the level of openness provided in their Concept Cartoons. Since each Concept Cartoon that is properly formatted might be considered as an open task, the participants who were not able to pose their Concept Cartoon in a proper format were assigned to the lowest level group named LL. The other participants were assigned to groups named L#, where # stands for a number from 1 to 4 denoting in how many code categories of B to E did the individual participant cause positive codes.

Findings

Improper vs proper format of the Concept Cartoon (category A)

Three of the participants composed their Concept Cartoon in an improper format; they form the LL group. These participants offered either a picture without bubbles or a picture with bubbles that discussed diverse situations not much related to the picture.

Thirteen of the participants composed the Concept Cartoon in a proper format but with no other openness: they prepared a task with a unique solution, grasped it unambiguously, and did not considered multiple correct ways of solving (see Fig. 2a). These participants form the L0 group.

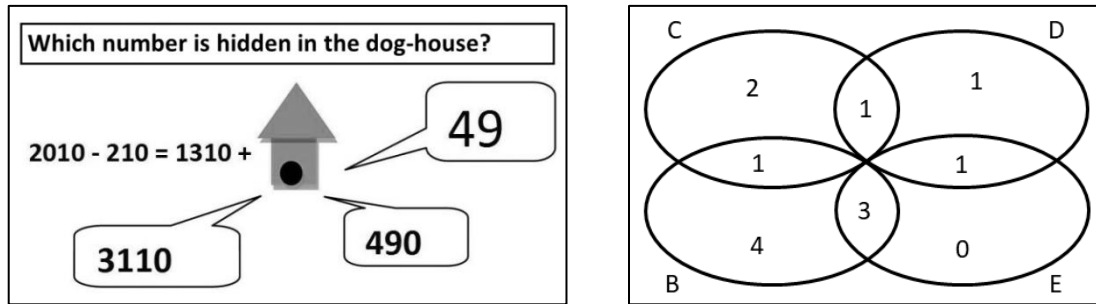


Figure 2: The Concept Cartoon posed by Beata, translated from Czech (left); numbers of participants displaying particular open aspects in their Concept Cartoon (right)

Openness of the Concept Cartoon with proper format (categories B to E)

The other participants composed a properly formatted Concept Cartoon that can be considered as open: seven of them caused positive codes in one of the categories B to E (they form the L1 group), six of them caused positive codes in two of the categories B to E (they form the L2 group). The distribution of the participants among the code categories with positive codes is shown in Fig. 2b, a detailed description of particular open aspects is given in the following text.

Multiple levels of grasping the task in the picture (category B)

Eight of the participants presented in their bubbles various ways how the pictured task might be grasped. For instance, Francis prepared a task about clocks (Fig. 3), and contrasted various possible ways of grasping the term "most hours". Her Concept Cartoon provokes many questions: "What does it mean most hours?", "Shall we take the biggest number in the notation, or the latest hour?", "Is 10 in the morning the same as 10 in the evening?". Annie prepared a task about 30 candies in a bag, and contrasted relative and absolute meanings of numbers (see Fig. 10 in Samková & Tichá, 2017). Morris prepared a practically based task about part-time job offers, and contrasted three different ways to make money (weekly wage, monthly wage, and daily task wage; see Fig. 8 in Samková & Tichá, 2016).

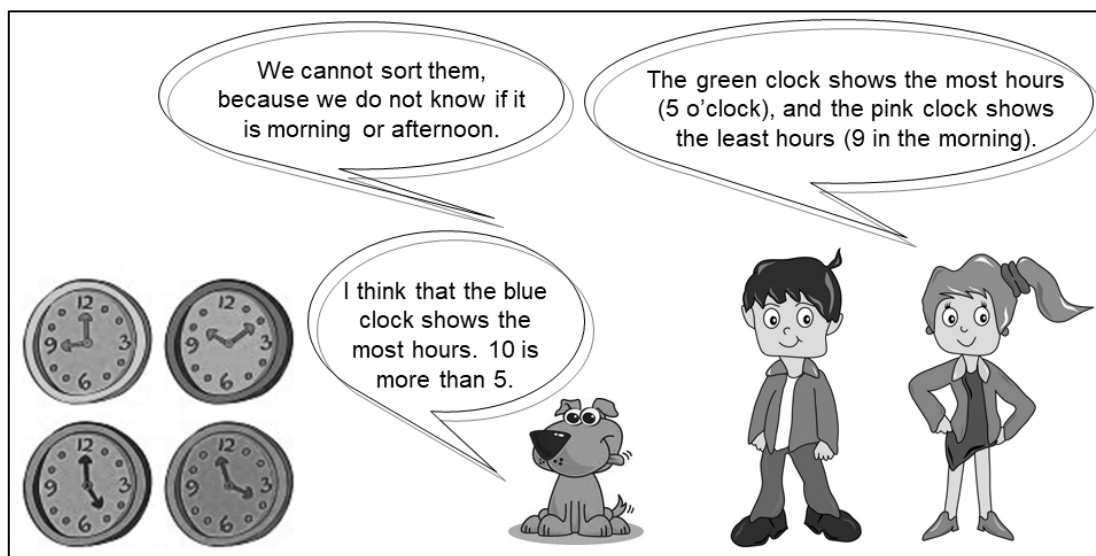


Figure 3: The Concept Cartoon posed by Francis, translated from Czech

Multiple correct ways of solving the task (category C)

Four of the participants posed tasks that allow multiple correct ways of solving; e.g. Viola offered in her bubbles two diverse ways of solving a task about Easter eggs (see Fig. 4).

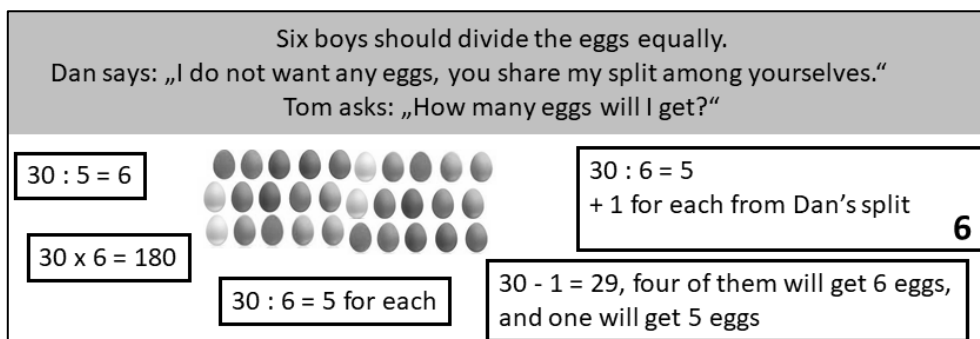


Figure 4: The Concept Cartoon posed by Viola, translated from Czech, graphically adjusted

Multiple correct answers to the task (category D)

Only two of the participants posed tasks with multiple solutions. Tammy prepared a wordless Concept Cartoon based on a geometric task with two different solutions (see Fig. 7 in Samková & Tichá, 2016), Diana prepared a task with eight different solutions (see Fig. 6 in Samková & Tichá, 2016). In each of these Concept Cartoons, the particular solutions of the task are of the same difficulty, based on a common idea, i.e. these Concept Cartoons cannot be considered as polyvalent.

One of the participants (Helen) posed a task with a unique solution but interpreted the solution in multiple ways. In her bubbles she described various properties of the solution.

Difficulty and smartness of the posing process (category E)

Four of the participants presented Concept Cartoons that required detailed preparation of the content of bubbles and smart pre-calculations; all of them belong to L2 group. For instance, Morris in his Concept Cartoon about part-time jobs prepared five bubbles based on diverse wage conceptions but the diverse calculations hidden behind particular bubbles lead to numbers that are almost the same. Since the aim of his task is to compare the jobs and find the most suitable one, such an arrangement makes the task open for wide discussions. Ruth in her task about who is the fastest runner assigned that Rex ran 10 rounds in 3 min 20 sec, Punt'a ran 7 rounds in 2 min 27 sec, and Max ran 5 rounds in 1 min 50 sec. One of the misconceptions in her Concept Cartoon originated in an erroneous conversion of the times into decimal notation (e.g. 3 min 20 sec converted to 3.20 min). She prepared the numbers in the assignment so smartly that with that erroneous conversion the order of the runners differs from the order in the correct solution.

Conclusions

The presented study hopefully enriched the puzzle on "How can we meaningfully employ Concept Cartoons in future teacher education" by another piece of knowledge, by studying the tool during problem posing activities within the framework of the open approach to mathematics and by looking for answers to the research question "How open are problems posed by future primary school teachers in the Concept Cartoon form?".

The results confirmed that Concept Cartoons can be successfully employed during problem posing activities, and that they have a potential also from the perspective of the open approach to mathematics. Although for the participated future primary school teachers it was the very first opportunity to create their own Concept Cartoons, almost all of them were able to compose a properly formatted Concept Cartoon, and almost half of them were able to compose a Concept Cartoon that positively displayed openness in one or two of the following aspects: multiple levels of grasping the pictured task, multiple correct ways of solving the task, multiple number of solutions and their interpretations. Some of the participants also proved their ability to thoroughly think about the task they pose, and presented Concept Cartoons that required detailed preparation and smart pre-calculations.

The described results of problem posing activities of future primary school teachers also illustrate how Concept Cartoons may help to elaborate a wide range of pedagogical content knowledge: authors of the Concept Cartoons had to pose an appropriate mathematical problem, present at least one of its correct solutions and several possible pupil misconceptions, and combine them into one complex bubble-dialog task.

Such results are in accordance with the recent research showing the importance of implementation of mathematical problem posing activities into future teacher education (Singer, Ellerton, & Cai, 2015).

References

- Dabell, J., Keogh, B., & Naylor, S. (2008). *Concept Cartoons in Mathematics Education (CD-ROM)*. Sandbach, Great Britain: Millgate House Education.
- Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, *111*(9), 2055–2100.
- Hellmig, L. (2010). Effective 'blended' professional development for teachers of mathematics: design and evaluation of the „UPOLA“-program. In V. Durand-Guerrier, S. Soury-Lavergne, & F. Arzarello (Eds.) *Proceedings of CERME 6* (1694–1703). Lyon, France: INRP.
- Hošpesová, A., & Tichá, M. (2017). Concept Cartoons created by prospective primary school teachers. In S. Zehetmeier, B. Rösken-Winter, D. Potari, & M. Ribeiro (Eds.) *Proceedings of ETC 3* (319–320). Berlin, Germany: Humboldt-Universität zu Berlin.
- Keogh, B., & Naylor, S. (1993). Learning in science: Another way in. *Primary Science Review*, *26*, 22–23.
- Kuntze, S., & Friesen, M. (2017). Assessing pre-service teachers' competence of analyzing learning support situations through a multi-format test instrument comprising of video, comic, and text vignettes. In S. Zehetmeier, B. Rösken-Winter, D. Potari, & M. Ribeiro (Eds.) *Proceedings of ETC 3* (36–45). Berlin, Germany: Humboldt-Universität zu Berlin.
- Malaspina, U., Mallart, A., & Font, V. (2015). Development of teachers' mathematical and didactic competencies by means of problem posing. In K. Krainer & N. Vondrová (Eds.) *Proceedings of CERME 9* (2861–2866). Prague, Czech Republic: Charles University, Faculty of Education.

- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: A sourcebook of new methods*. London, Great Britain: SAGE.
- Milinković, J. (2017). Faults in preservice teachers problem posing: What do they tell us? In S. Zehetmeier, B. Rösken-Winter, D. Potari, & M. Ribeiro (Eds.) *Proceedings of ETC 3* (238–247). Berlin, Germany: Humboldt-Universität zu Berlin.
- Naylor, S., Keogh, B., & Downing, B. (2007). Argumentation and primary science. *Research in Science Education*, 37, 17–39.
- Nohda, N. (2000). Teaching by open-approach method in Japanese mathematics classroom. In T. Nakahara & M. Koyama (Eds.) *Proceedings of PME 24 (Vol. 1)* (39–53). Hiroshima, Japan: Hiroshima University.
- Pehkonen, E. (Ed.) (1997). *Use of open-ended problems in mathematics classroom*. Helsinki, Finland: University of Helsinki.
- Samková, L. (2017). Using Concept Cartoons to investigate future teachers' knowledge: New findings and results. In S. Zehetmeier, B. Rösken-Winter, D. Potari, & M. Ribeiro (Eds.) *Proceedings of ETC 3* (207–216). Berlin, Germany: Humboldt-Universität zu Berlin.
- Samková, L. (2018a). Assessing future teachers' knowledge on fractions: Written tests vs Concept Cartoons. *ERIES Journal*, 11(3), 45-52.
- Samková, L. (2018b). Concept Cartoons as a representation of practice. In O. Buchbinder & S. Kuntze (Eds.) *Mathematics Teachers Engaging with Representations of Practice. ICME-13 Monographs*. Cham, Switzerland: Springer International Publishing AG.
- Samková, L., & Hošpesová, A. (2015). Using Concept Cartoons to investigate future teachers' knowledge. In K. Krainer & N. Vondrová (Eds.) *Proceedings of CERME 9* (3241–3247). Prague, Czech Republic: Charles University, Faculty of Education.
- Samková, L., & Tichá, M. (2016). On the way to develop open approach to mathematics in future primary school teachers. *ERIES Journal*, 9(2), 37–44.
- Samková, L., & Tichá, M. (2017). On the way to observe how future primary school teachers reason about fractions. *ERIES Journal*, 10(4), 93–100.
- Singer, F. M, Ellerton, N. F., & Cai, J. (Eds.) (2015). *Mathematical problem posing: From research to effective practice*. New York, NY: Springer.
- Tichá, M., & Hošpesová, A. (2010). Problem posing and development of pedagogical content knowledge in pre-service teacher training. In V. Durand-Guerrier, S. Soury-Lavergne, & F. Arzarello (Eds.) *Proceedings of CERME 6* (1941–1950). Lyon, France: INRP.
- Tichá, M., & Hošpesová, A. (2015). Word problems of a given structure in the perspective of teacher training. In K. Krainer & N. Vondrová (Eds.) *Proceedings of CERME 9* (2916–2922). Prague, Czech Republic: Charles University, Faculty of Education.