HISTORY OF MATHEMATICS AS A FACTOR FOR INCREASING MOTIVATION IN THE MATHEMATICS CLASSROOM

Bojan Lazić and Sanja M. Maričić
University of Novi Sad, Faculty ofEducation, Sombor,Serbia;
University of Kragujevac, Faculty of Education,Užice, Serbia;

In this paper the authors consider the role of history of mathematics and some historical dataas a factor for encouraging interest and motivation of students to study mathematics. History of mathematics has a lot of questions, examples, and problems which can be adapted to cater for contemporary teaching and to become a direct support for content that needs to be processed, determined and deepened. Well-presented historical examples can have great importance in supporting mathematical and didactical meaning. The starting point in this paper is that "old" tasks preserved on the earliest memorials of mathematics, the anecdotes of great mathematicians and the ways of solving tasks can serve as a special kind of motivation for students' learning of mathematics because they introduce a special spirit and motive for solving such tasks and problems.

Keywords: History of mathematics, motivation, mathematics education, tasks.

In theoretical and empirical studies dealing with learning and teaching, more and more attention is paid to the development of learning through an educational process. Starting from the choice of content, its methodical transformation and optimal methods for their processing are increasingly being studied.

One of the main goals of the educational process is the development of students' opinions, so the greatest importance is attached to an understanding and thoughtful activation of students. The exceptional importance of basic education, especially mathematics, requires a large number of innovations in teaching that represent "original and specific changes that contribute to the rationalization, modernization, and efficiency of the teaching process" (Milijević, 2003, p. 11).

In 1962, a symposium dedicated to the initial teaching of mathematics was held in Budapest, organized by UNESCO, in accordance with the previous knowledge of psychology and didactics of mathematics (Piaget, Skemp, Galperin,

lazicbsaa@yahoo.com

Leontyev, Polya, Bruner, Dienes, Varga etc.), and attended by the most eminent scientists in this field.

It was then that the idea of mathematical education not just being possible for children, but also having a deep meaning and importance was established. Regardless of the abstract system of concepts in mathematics, it can be introduced already in the initial stages of teaching if, in accordance with the mental development of children, it starts from the game, the manipulation of things, that is, from the specific activities of the students, according to their interest.

Accordingly, basic mathematics education must be planned and taught so that, regardless of interest, the acquired knowledge and skills are permanently retained together with the achieved level of cognitive abilities. Modern mathematics should be an agent of communication and an "instrument" that is used in everyday life, to represent the connection between the child's experience of the world and mathematical structures, as well as to develop systematic and creative work. Thereby, the teaching of mathematics should be experienced as a process, or as a creative activity in which students actively participate.

The researchers of mathematical education (Poenkare, 1908; Polya, 1954; Freudenthal, 1980; Kooper, 1996) constantly point to the role and importance of intuitive, spontaneously acquired knowledge that includes elements of the history of mathematics in teaching as one of the necessary conditions for increasing motivation and interest of students in processing abstract mathematical content at all levels.

Cvetković asserts that "interest in mathematics and nurturing motivation to deal with it, can be developed by using data from the history of mathematics" (1980, p. 217). The same attitude is held by Dejić, who says that elements of mathematics contribute to "awakening" interest in mathematics (1997, p. 251).

The history of mathematics abounds with questions, examples, and problems that can be adapted to contemporary teaching and become direct support for content that needs to be processed, exercised, and deepened. Well-presented historical examples and tasks can be of great importance both in mathematical and methodical terms. Nevertheless, in order to allow higher quality materials to be better mastered, these tasks should encourage students to think, increase their interest and motivate them (Zlokas, p. 2017).

The first connection between mathematics education and the history of mathematics is about the history of mathematics education, especially modes and justifications. The researchers argue that reasons for the history of mathematics being so interesting can be divided into three themes. The first one sees the history of mathematics as encouraging multicultural approaches, giving students historical role-models, connecting the study of mathematics with human emotions

and motivations (e.g., Swetz, 1995; Avital, 1995; Brown, 1993). The second one includes claims that the history of mathematics adds variety to teaching, decreases students' fear of mathematics, and so on. And the third theme claims that it is different when we speak about the influence that history has on teachers and a completely different one when we speak about influence on students.

There are two basic strategies for introducing the history of mathematics into the curriculum. Some researchers have given the name Strategy of addition to one of them, which is a passive strategy, and includes biographies of mathematicians. The second one, called Strategy of accommodation, includes using a historical development in one's explanation of a technique or organizing subject matter according to a historical scheme (Fried, 2001).

Also, researchers point to historical approaches to mathematics education, and argue that teachers can say that they need extra time for teaching history, and the thing is that teachers do not need extra time for it. They just should give students a historical problem, directly related to the topic they are teaching, or they can replace an ordinary classroom problem with one referring to the same material but having a historical context. A big issue of this story is relevance. Some researchers claim that the historical approach can work, in this view, since for every topic in the curriculum one can find a relevant historical problem, idea, or figure. But the downside of this continual measuring of relevance is that it turns the author of a historical approach in mathematics into a kind of editor of history, accepting what is relevant and throwing out what is not. "Mathematics teachers are committed to teaching modern mathematics and modern mathematical techniques naturally makes their relationship to the history of mathematics quite different from that of a historian of mathematics" (Fried, 2001, p. 398)

In the last part of the text, the author gives two directions toward resolving this difficulty: radical separation and radical accommodation. The first one represents the history of mathematics as a completely separate track compared to an ordinary course of instruction, and the second one is based on changing the study of mathematics into the study of mathematics text (Fried, 2001)

Some other research deals with involving the history of mathematics in mathematics education and a connection between history and pedagogy of mathematics. It also presents some meetings and related proceedings. One of them is European Summer University on the History and Epistemology in Mathematics Education, which is also one of the major activities in the HPM domain. They want to provide a school for working on a historical, epistemological, and cultural approach to mathematics and its teaching, with emphasis on actual implementation; they give an opportunity to mathematics teachers, educators, and researchers to share their teaching ideas and classroom experience related to a historical perspective in teaching; and motivate further collaboration along these lines

among teachers of mathematics (Clarck, Cjeldsen, Schorcht, Tzanakis and Wang, 2016)

As something that can be interesting both for teachers and for students, is that we can use the history of mathematics to improve our methods and lesson plans. In that way, we can motivate students for their own research, so they can be introduced with more historical information that can be interesting for them, and which can be used in other subjects as well.

Some authors claim that integrating the history of mathematics with teaching and learning mathematics may force history to "serve" education, so it can be something like "Whig"- "…the present is the measure of the past. Hence, what one considers significant in history is precisely what leads to something deemed significant today" (Fried, 2001, p. 395).

A view in the history of mathematics shows that mathematics terms do not arise in abstract constructions for 'torturing' children, but for people's need to solve their own life problems and to master nature. In the past, people dealt with mathematics because there was a justified need for it, and that has led to the development of interest in this science, so it is clear that students will deal with mathematics if there is an interest in it. The first written facts, used as a basis on which we can surely speak of the level of development of mathematics, comes from the ancient civilizations of Babylon, Egypt, China, about 2,000 years BC. Thus, the first mathematics tasks were discovered on the slabs of the ancient Babylonians, on the papyrus of the ancient Egyptians and on the corners of the wood written by the ancient Chinese.

Students will be motivated by the fact that some tasks are very old, and we are still solving them today. Tasks like that "awake" more interest in solving. In the same way, students can be introduced with some of the tasks that are written in one of the oldest written mathematical findings (papyrus). One of the oldest findings of mathematical literacy is Moscow papyrus. It was written "during the reign of Pharaoh Senusret III or Amenemhet III, in the middle of the 19th century BC, and was discovered by the viceroy of the Russian Egyptology of the Golenishte (1892 or 1893) in Theba" (Živanović, 2012). The papyrus has 25 tasks with solutions. Some of them, which can be given to the children in lower grades of primary school and can be prepared for them are:

- *The number and its half give 9 when added. Find that number.*
- *Which even number added to its half and number 4 gives 10?* (Živanović, 2012, p. 129)

Ahmes papyrus too, which is dates back to 1650 BC, has ancient tasks which have been used even today. One of them is:

- *Size and its fourth totalled 15 units.*

The peculiarity of solving this task is that in solving it the ancient mathematician for the first time used the method of the false assumption.

The following task is from Ahmes calculation too.

In each one of seven houses live seven cats, every cat catches seven mice, every mouse eats seven barley ears, and every barley ear gives seven measures of barley. What numbers make this line and what is their sum? (According to Živanović, 2012).

This kind of a task brings into the mathematics classroom a special spirit and motive for solving it. To the pupils, the history and tasks that some ancient civilizations were solving, create a special mystery and they are eager to solve it. That inspires additional interest in studying mathematics.

Motivation and awaking new interest in mathematics can be achieved by tasks and anecdotes about great mathematicians. Pupils are especially interested in anecdotes about great mathematician Karl Friedrich Gauss whose teacher instructed his class to determine the sum of the first hundred natural numbers:

$1 + 2 + 3 + 4 + 5 + \ldots + 96 + 97 + 98 + 99 + 100.$

The teacher expected the pupils to be engaged in solving the task and to remain calm for a long time. But, he was quickly surprised, when, after just a few moments, little Gauss gave the correct answer. So, by observing a series of given numbers, Gauss realized that the sums of pairs of natural numbers from different ends of the sequence are always of the same value:

$1 + 100 = 101,$
$2 + 99 = 101,$
$3 + 98 = 101,$ etc. (Maričić, Špijunović, Cotič and Felda, 2017, p. 173).

Gauss came to the original idea for solving the task. Teacher today should use an example like this one to encourage students to be creative and express originality in the process of solving the tasks, and to be flexible in doing it, which can contribute to the development of divergent and creative thinking.

Motivation of awaking new interest in mathematics can be achieved by "interesting tasks", which contribute to the development of the ability to conclude, to think logically, to study conditions, causes, and consequences. One of these tasks is the task about a wolf, goat, and cabbage from the 8thcentury.

The man must carry across the river a wolf, a goat, and cabbage. In the boat, beside the man there can only be a wolf, or a goat, or cabbage. But, if he left the wolf with the goat, the wolf would eat the goat; if he left the goat with cabbage, the goat would eat cabbage, and in presence of man "no one will eat anyone". The man managed to carry across would wolf, would goat, and cabbage. How did he do that?

There are many tasks from the history of mathematics which can be used in teaching mathematics with the aim of awaking interest of students in mathematics, and their motivation to research and study mathematical content. The main goal of introducing this content and the similar one is to increase participation of students in the classroom. Students who show interest in the content of study have a more expressive motive for achievement and through personal autonomy create an environment that suits his possibilities and interests, which is again a prerequisite for success.

REFERENCES

Avital, S. (1995). History of mathematics can help improve instruction and learning. In F. Swetz, J. Fauvel, O. Bekken, B. Johansson & V. Katz (Eds.), *Learn from the Masters* (pp. 3-12). Washington DC: The Mathematical Association of America.

Brown, S. I. (1993). Towards a pedagogy of confusion. In White, A. (Ed.), *Essays in Humanistic Mathematics* (pp. 107-122). Washington, D.C.: Mathematical Association of America.

Cvetković, Ž. (1980). Izazivanja interesovanja učenika u nastavi matematike. *Zbornik Instituta za pedagoška istraživanja*, *13*, 217-221.

Clarck, K., Cjeldsen, H., T., Schorcht, S., Tzanakis, C., & Wang, X. (2016). *History of mathematics in mathematics education*. Recent developments. Montpellier: IREM

Fried, M. (2001). Can mathematics education and history of mathematics coexist? *Science & Education*, *10*, 391-408.

Dejić, M. (1997). Matematičke sposobnosti i njihovo razvijanje, *Zbornik 3*. Vršac: Viša škola za obrazovanje vaspitača.

Freudenthal, H. (1986). *Didactical phenomenology of mathematical structures*, Mathematics Education Library.

Maričić, S., Špijunović, K., Cotič, M., & Felda., D. (2017). *Matematičko mišljenje u početnoj nastavi matematike.* Koper: University of Primorska Press.

Kooper, A. (1996). The historical development of mathematics – its integration into the teaching of the subject in the upper grades by means of independent readings by students (in Hebrew). *Aleh 18*, 27-31.

Milijević, S. (2003). *Interaktivna nastava matematike*. Banja Luka: Društvo pedagoga Republike Srpske.

Polya, G. (1954). *Mathematics and plausible reasoning*. New Jersey: Princeton University Press.

Poincare, H. (1908). *The future of mathematics*. Paris: Revue generale des Sciences pureset appliquées, No. 23.

Swetz, F. J. (1995). Using problems from the history of mathematics in classroom instruction. In F. Swetz, J. Fauvel, O. Bekken, B. Johansson & V. Katz (Eds.), *Learn from the Masters* (pp. 25-38). Washington DC: The Mathematical Association of America.

Zlokas, M. (2017). *Istorija matematike kao izvor školskih pimera i zadataka.* Master rad, Beograd: Univerzitet u Beogradu.
Živanović, M. (2012). Nastava matematike u drevnom Egiptu. *Sinteze*, *1*, 123-135.

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд
371.3::51(091)(082)(0.034.2)

TRAINING Conference “History of Mathematics in Mathematics Education” (2018 ; Jagodina)

Proceedings of the Training Conference History of Mathematics in Mathematics Education, Jagodina, October 26-30, 2018. [Elektronski izvor] / [editors] Snežana Lawrence, Aleksandra Mihajlović, Olivera Đokić. - Jagodina : University of Kragujevac, Faculty of Education ; Belgrade : University, Teacher Education Faculty, 2019 (Jagodina : University of Kragujevac, Faculty of Education). - 1 elektronski optički disk (CD-ROM) ; 12 cm
Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 50. - Bibliografija uz svaki rad.

ISBN 978-86-7604-176-3 (UKFE)

а) Математика - Историја - Настава - Зборници
COBISS.SR-ID 274359308