

## POSSIBILITIES OF DEVELOPMENT OF PUPILS' MATHEMATICAL LITERACY

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### Abstract

In this article, we deal with the development of mathematical literacy of pupils and students. The article responds to the current requirement to focus mathematics education on the practical use of knowledge in everyday life, i.e., on mathematical literacy.

The article is motivated by the results of a questionnaire survey conducted on a group of 159 students at the university teaching program in the Faculty of Education, Palacký University, Czech Republic, in 2021. It turns out that most future mathematics teachers are interested in developing mathematical literacy of their future pupils and students and are willing to continue their education in this field, for example, by participating in seminars on the development of mathematical literacy in children of all ages.

The aim of the article is to show ideas for a seminar for future mathematics teachers. We use mathematical examples to illustrate different approaches to the development of mathematical literacy and the joint development of mathematical and digital literacy.

**Keywords:** *Mathematical literacy, mathematics examples, questionnaire survey, prospective teachers.*

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### 1. Introduction

Mathematical literacy can be briefly characterized as the ability to apply mathematical knowledge, procedures and thinking in everyday life. The importance of mathematical literacy for society is also evidenced by the fact that, since the middle of the 20th century, comparative research has been carried out around the world to find out how pupils' knowledge and skills differ between countries and different education systems. The International Association for Evaluation of Educational Achievement (IEA) and the Organization for Economic Co-operation (OECD) have the longest tradition in conducting this research. The OECD is conducting perhaps the best-known mathematical literacy research project called the Program for International Student Assessment (PISA). This research examines the knowledge and skills of pupils needed for their effective application in modern society and emphasizes the importance of education as a preparation for real life in modern society, thus laying the foundations of mathematical literacy. Here we present the OECD definition of mathematical literacy: Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned, and reflective citizen (OECD, 2003). The second major international survey of pupils' knowledge and skills, which covers the areas of mathematics, is the TIMSS (Trends in Mathematics and Science Study) survey under the auspices of the IEA.

To find out the awareness of mathematical literacy and its importance among prospective teachers, a questionnaire of our own design was created, which was distributed online in the spring of 2021 among undergraduate students at the Department of Mathematics of the Faculty of Education, Palacký University in Olomouc, Czech Republic. The questionnaire was answered by 159 respondents. It contains items determining the general orientation of respondents in the field of mathematical literacy, also finds out their opinion on the availability of suitable resources for the development of mathematical literacy, their use in teaching and the like.

Respondents consider it important

- to develop mathematical literacy in pupils,
- to cultivate a positive attitude of pupils towards mathematics,
- to show the connection of mathematics with other subjects such as computer science, physics, natural and social sciences.

Students showed great interest in further education in the development of mathematical literacy of pupils and students.

## 2. Objectives

In teaching mathematics, emphasis should be placed on the applicability of mathematics and on building students' positive attitudes towards mathematics. For this reason, we are creating a Mathematical Literacy Seminar for students, prospective mathematics teachers, at our Faculty of Education.

## 3. Methodology

The methodology for the seminar on mathematical literacy for prospective mathematics teachers has the following steps:

1. A brief theoretical introduction to mathematical literacy.
2. Comparative research (PISA, TIMSS).
3. Examples of methodological materials for the development of mathematical literacy, their sources.
4. Discussion of students' ideas for the development of mathematical literacy.

The aim of the course is to give students stimuli to think about how mathematical literacy can be developed in children.

## 4. Discussion

How to develop digital literacy? We can give a lot of ideas and suggestions. However, every teacher must find his or her way to the pupils or students. It is necessary to teach mathematics with understanding and interestingly. It is a responsible job.

In this contribution we will present just a few ideas on where to look for inspiration. A suitable tool for developing mathematical literacy is to connect mathematics with other school subjects and providing examples from the practice of contemporary life.

Many different articles on mathematical literacy can be found on the Internet, such as the SCIENTIX internet platform, which gathers and promotes best practice in science teaching and learning in Europe and organizes science, technology, engineering, and mathematics teacher training and workshops. In the Czech Republic, the popular methodological portal [www.rvp.cz](http://www.rvp.cz) and others can be recommended.

Suitable examples for the development of mathematical literacy can be drawn from the above-mentioned international research TIMSS and PISA or from mathematical competitions such as the Mathematical Kangaroo. It is an international mathematics competition in more than 92 countries for primary school pupils and high school students. The competition is held once a year. The challenge consists of multi-option forms that are not standard issues with laptops and come from a variety of topics. In addition to basic computing skills, they require inspirational ideas, perseverance, creativity and imagination, logical thinking, and other problem-solving strategies. There are often small stories, interesting problems and surprising results that encourage discussion with friends and family.

### 4.1. Math Kangaroo problems

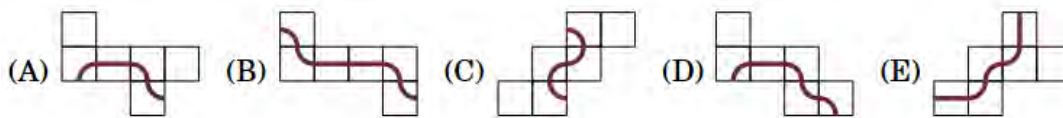
- Example from the category Kadet (age 14-15) for 3 points (easy level) from 2015: The cyclist rides at a speed of 5 meters per second. The circumference of each of the wheels of his bicycle is 125 centimeters. How many full revolutions will each lap make in 5 seconds?  
(A) 4 (B) 5 (C) 10 (D) 20 (E) 25
- Example from the category Benjamin (age 12-13) for 4 points (middle level) from 2017: In the picture you can see 5 coded locks and 5 keys to them. Identify the missing key code.

Figure 1. Five coded locks and five keys to them (and offered answers (A) to (E)).



- Example from the category Benjamin (age 12-13) for 5 points (difficult level) from 2019: Each of the following images represents a cube network. Only one of the cubes has after folding on its surface a closed line. Which one?

Figure 2. Cube networks (and offered answers (A) to (E)).



#### 4.2. PISA and TIMSS problems

Released issues PISA 2015 Mathematics items can be found at <https://www.oecd.org/pisa/test/>.

The released Trends in International Mathematics and Science Study (TIMSS) 2011 grade 4 mathematics assessment items can be found on [https://nces.ed.gov/timss/pdf/TIMSS2011\\_G4\\_Math.pdf](https://nces.ed.gov/timss/pdf/TIMSS2011_G4_Math.pdf). This is not a complete set of all TIMSS 2011 assessment items because some items are kept confidential so that they may be used in subsequent cycles of TIMSS to measure trends.

#### 4.3. Connecting mathematical and digital literacy

It is often very beneficial for mathematics to integrate digital technologies into teaching in all types of schools in a suitable way. Nowadays, for example, when even simple applications that allow complex symbolic calculations are available, schools still have a lot of time-consuming effort in mechanical calculations, so there is not much time left for an illustrative and interesting explanation of the new subject and especially for a constructivist approach to teaching mathematics. Digital technologies can be helpful in certain situations not only to facilitate calculations but also when illustrating the interpretation of a new topic or to verify algorithms.

#### 5. Conclusions

There is no clear guidance on how to develop mathematical literacy in teaching. The recommendation is to try to teach mathematics with understanding, responsibly and interestingly.

#### Acknowledgements

The research was supported by Palacký University in Olomouc, Czech Republic, Specific Research Support IGA\_PdF\_2022\_016 Developing mathematical literacy in leisure-based education and Specific Research Support IGA\_PdF\_2022\_002 Computer-Based Mathematics Teaching at Elementary School.

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