p-ISSN: 2184-044X e-ISSN: 2184-1489 ISBN: 978-989-53614-3-4 © 2022
https://doi.org/10.36315/2022v1end055

DEVELOPING MATHEMATICAL PRE-LITERACY AND ROBOTIC TOYS FROM THE PERSPECTIVE OF SCHOOL PRACTICE

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Abstract

We encounter mathematics and mathematical concepts in our everyday lives. The foundation for later mathematical skills lies in the good development of pre-mathematical ideas in a child's preschool years. In this paper we will discuss partial results of the study entitled "Mathematics and Reading Preschool Literacy (MRPL1)", in which 119 teachers from 72 kindergartens from different parts of the Czech Republic participated. The focus will be mainly on the use of modern robotic tools based on the trend of incorporating digital technologies into preschool education. Targeted work with these tools can significantly contribute to the development of children's spatial orientation, their numerical skills, logical reasoning and algorithmizing. In the application part we will focus specifically on the possibilities of educational use of the robotic toy Bee Bot.
The research has revealed that the need to develop children's mathematical literacy in kindergartens is still neglected by teachers. While teachers do acknowledge its importance, they themselves do not know how to develop children's mathematical pre-literacy. In their own practice, they prefer the children to play spontaneously and fill in pre-printed worksheets. It is encouraging that the teachers have shown interest in the new ideas. Activities related to Bee Bot interested them. Overall, however, they lack sufficient methodological support. Based on the findings, educational activities with Bee Bot have been included as part of the undergraduate education of kindergarten teachers at the Faculty of Education of Palacký University in Olomouc.

Keywords: *Mathematics, pre-literacy, teaching, robot, toys.*

1. Introduction

The definition of the concept of mathematical literacy is not uniform in specialised literature. A number of authors use the definition of mathematical literacy provided by the International Research Committee of OECD. "Mathematical literacy is the ability of an individual to know and understand the role mathematics plays in the world, make well-founded judgements and tap mathematics so that it fulfils that individual's needs as a creative, interested and thinking citizen." (PISA 2003). It can be said that mathematical literacy is manifested when the child/pupil uses his/her knowledge and abilities to solve various types of problems that may have a supra-field context. It is the use of mathematical competencies in a range of situations, from everyday simple situations to unusual and difficult ones. We perceive mathematical pre-literacy as mathematical literacy developed at the child's preschool age (Uhlířová & Cibáková, 2019)

Robotic toys are becoming a contemporary phenomenon. The idea behind these toys is that the child can "program" himself/herself how the toy will behave. Robotic toys provide a new type of educational environment that has a strong motivational framework. They encourage discovery through trial and error, allowing immediate feedback and active work with errors. With systematically guided activities, they have significant potential for developing children's cognitive abilities. The most famous toys of this type suitable for preschool age include Bee Bot, Blue Bot, Code–a-pillar, Code & Go Robot Mouse, Botley Robot, Ozobot. Bee Bot (BB) is a programmable robotic toy in the shape of a bee. BB moves on a square mat in 4 directions: right, left, forward and backward. Up to 40 commands can be "programmed".

In our paper we will focus on the reflection of the current educational environment of the kindergarten. We will try and answer the following research questions:

RQ1 Do kindergarten teachers have robotic toys at their disposal?

RQ2 Do teachers have enough methodological materials for developing mathematical pre-literacy through robotic toys?

2. Mathematics and reading literacy in preschool education (MRLPE1 research)

The Mathematics and Reading Preschool Literacy 1 (MRPLE1) study was focused on the examination of the education environment of kindergartens in the context of developing the mathematical and reading pre-literacy in children, and on the reflection of the teaching of kindergarten teachers with a focus on the development of the aforesaid literacies. (Uhlířová & Laitochová, 2020) In the text of this paper we will focus only on the issue of developing mathematical pre-literacy through robotic toys in the context of the formulated research questions.

2.1. Research instrument

The method of non-standardised questionnaire survey in combination with an interview was chosen for the research. The questionnaire consisted of 28 items. Attention was paid to 4 areas: Personal prerequisites for the development of the pre-literacy in question (A), Material conditions for the development of the pre-literacy in question (B), Obstacles to the development of the pre-literacy in question (C), Education needs for the development of the pre-literacy in question (D). The data obtained were transferred to MS Excel and processed. Basic descriptive statistics were used.

2.2. Characteristics of the research sample

The MRPLE1 research involved 119 teachers from 72 kindergartens from different parts of the Czech Republic. Kindergartens from cities as well as small villages were represented. The questionnaire survey was anonymous and took place in September and October 2019. Beginning as well as experienced teachers participated in the questionnaire survey. The average length of teaching practice in the group of respondents was 7.8 years.

3. Results

As part of the description of the educational environment, we were interested in whether teachers had suitable material conditions for developing mathematical pre-literacy in the kindergarten environment. Questions Q10 to Q15 dealt with material conditions. Overall, it can be stated that teachers are satisfied with their material conditions and that didactic aids are continuously provided to kindergartens. (Uhlířová, Laitochová, 2020). Based on personal interviews with teachers, the problem is not a lack of didactic aids. Rather, teachers do not know how to use the tools effectively to develop mathematical pre-literacy. They lack specific methodological suggestions. At the same time, there is such a wide range of educational materials on the market that it is very difficult to navigate. Questions Q13 to Q15 dealt exclusively with robotic toys.

Q13. Do you have robotic toys in your kindergarten? If you do, please specify which ones.

Q14. Do you use robotic toys to develop mathematical pre-literacy? If you do, please specify how.

Q15. Would you welcome methodological support on how to work with robotic toys?

Only 8 (i.e. 6.7 %) teachers reported having robotic toys in their kindergarten. In all cases it was Bee Bot (BB). 18 respondents reported having interactive whiteboards or children's tablets. However, these are not included in the category of robotic toys. Some of the responses to question 14 are as follows: *counting, route finding, reasoning, orientation in space.* All the respondents who have a BB in their kindergarten said they would be interested in methodological support on how to work with robotic toys (Q15). We were pleased that a total of 81 respondents (i.e. 68.07 %) had answered question 15 in the affirmative. The responses suggest that teachers are interested in new possibilities. The low availability of robotic toys may be due to a lack of teacher awareness of new tools. Based on the information gathered, we created a set of methodological suggestions for developing mathematical pre-literacy through activities with BB. The suggestions were tested in the practice of the kindergarten in the form of a pedagogical experiment. The experiment lasted 5 days and involved 11 children aged 4-7 years. Figure 1 shows the implementation of the experiment, specifically the Maze activity.

Figure 1. Performing the Maze activity.

The children were very interested in all the activities tested. It was possible to observe a gradual improvement in the children's personal performances. Some of the children preferred to work individually on their own, while others turned to the teacher for help and sought the right solution with the support of the teacher's authority. Overall, it can be concluded that the performance of all the children improved significantly over the course of the experiment. The children liked the bee and demanded repetition of the activities. The researchers registered the need for age appropriateness of the tasks. For the youngest respondent (boy, 4 years old), some of the activities were beyond his abilities. On the part of the researchers, the difficulty of the tasks was reduced so that the disappointment of failure did not outweigh the motivational emphasis of working with the robotic toy. It is important that the teacher prioritises an individual approach to children and respects their learning needs and interests.

4. Conclusions

The issue of robotic toys in the context of developing mathematical pre-literacy is still fresh. We are convinced that it makes sense to include activities with robotic toys in preschool education. However, teachers lack sufficient methodological support in practice. Based on this conviction, the issue of robotic toys and mathematical pre-literacy has been included in the curriculum of undergraduate education of kindergarten teachers at Palacký University Olomouc.

Acknowledgements

The research was supported by Specific Research Support IGA_PdF_2022_016 Developing mathematical literacy in leisure-based education and IGA_PdF_2022_009 Teaching activities using Platonic solids for the development of math thinking.

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