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Tasks and tools in elementary mathematics

Edited by Jarmila Novotná and Hana Moraová

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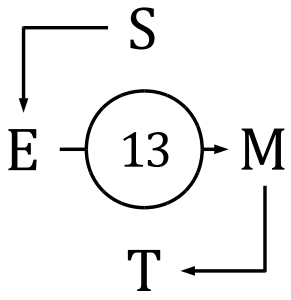

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PRIMARY SCHOOL TEACHERS' ATTITUDES TO THEATRE ACTIVITIES IN MATHEMATICS EDUCATION

Jarmila Novotná, Antonín Jančařík, Kateřina Jančaříková ☜

Abstract

Theatre activities in mathematics education (i.e. pre-prepared situations and improvisations) have the potential to act as an important tool for development of pupils' comprehension, their motivation and for diminishing their fear that mathematics is too abstract. In the paper, results of a survey among primary school teachers focusing on their experience with and attitudes to such activities are presented. The use of these activities in mathematics teaching is discussed by the authors as one of the possibilities that can help teachers make mathematics lessons more enjoyable both for pupils and teachers.

Keywords: Mathematics education, theatre activities, improvisation

> *A teacher in school should develop his/her students' know-how, their ability to reason as well as encourage their creative thinking.* (G. Polya, 1966)

1. Introduction

In general, teaching regardless of the subject taught is primarily communication. Based on the traditional way of teaching mathematics, the widespread belief about teaching mathematics is that it represents transmission of rules and definitions (Hošpesová et al., 2011). But contemporary perception of teaching mathematics is much broader; it covers not only pure mathematical issues but also information processing, problem solving, development of strategic thinking and sharing the gained knowledge and skills etc.

There are various useful and rewarding teaching strategies that support the new trends in teaching mathematics. Educators pay attention to research of narrative pedagogy, use of storytelling and collective reading in teaching, e.g. (Jančaříková, 2012). But, as Gerfosky states "it is still considered an unusual idea to teach mathematics via the arts; and where the arts have been accepted into mathematics instruction, it is far more likely that they will be visual and sculptural media used for representing mathematical objects and relationships. … Of these three areas of the performing arts [music, dance and drama], drama might again seem the hardest 'sell', since it is particularly difficult to represent mathematical entities directly in a dramatic medium. Drama depends on character, dialogue, human interactions and emotions, and the abstract nature of mathematics has sometimes been seen to preclude these." (2011, p. 329).

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Despite this some attention has been paid to the use of theatre activities in mathematics education in mathematics education research. E.g. Gerofsky (2011, p. 329) claims that "the whole group improvisation drama in an 'as if' setting engages students through immersive emotional and contextual modes of understanding". Using theatre in teaching mathematics involves acting, which is qualitatively similar to children's spontaneous role-playing. Pallascio and Lajoie (2001) study role-playing as an efficient tool for making students active in a given situation. The objective of theatre activities, similarly to role-playing, when used in teaching contexts is to lead student-actors and other student-spectators to learn something from the given situation. When dramatizing a mathematical concept, pupils use facial expressions, role-playing, improvisation etc. They work in groups and improve their understanding of mathematics through writing scripts and playing the theatre.

2. Theatre activities in teaching

In the paper, the following two types of activities are considered as theatre activities (TA):

P Pre-prepared situations suitable for improving learners' ability to solve mathematical problems

Implementation of this type of activities usually does not demand any special planning from the teacher. It suffices to prepare or adopt a script of a TA which most often stems from the material of the solved problem. If the problem arouses pupils' interest, their activity may then be made use of and the play further developed. For example pupils may produce set pieces or costumes. This can result in production of theatre plays of supreme quality.

I Improvisation

From the point of view of mathematics lessons, improvisation activities are far more difficult as they put higher demands on cooperation and pupils' effort. On the other hand these activities give the teacher much more feedback on the pupils' knowledge and at the same time are a convenient tool for communication among the pupils and between the pupils and the teacher. If improvisation is to be successful, the teacher must not only know the mathematical context he/she wants to focus on but also theatre and improvisation techniques (see McKnight & Scruggs, 2008).

One must bear in mind that improvisation, although being a free activity, has its own strict rules. These rules give external form to the improvisation. However, if improvisation is to be successful it also requires some internal rules. For example it is important to pay attention to the real life struggles and preoccupations of the particular group of learners in the group. An awareness of their own struggles in life can be woven into the drama, adding subtexts and levels of meaning to the drama. (Heathcote & Herbert, 1985).

3. Our project

The research presented in this paper is part of a larger project focusing on how to train teachers for use of TA in teaching. The main objective of the project is to implement TA in teacher training in order to show teachers the potential these activities bear and the advantages of this approach but also to allow them to gain experience prerequisite to their active role in situations of TA. All this should contribute to development of their use of TA in their teaching of mathematics. The main question of the project is: How to develop pre- and in-service teachers' competencies necessary for using TA in their teaching? The aim is to arouse teachers' interest in these activities and motivate them to use them.

This paper focuses on the following partial questions of the project:

- What experience with the use of TA in mathematics education do primary teachers have?
- What are their attitudes to TA?
- What knowledge and skills do they need to get in their teacher training if they are to implement TA successfully? What should there be in the syllabus of a course that would help them use TA successfully in their teaching practice?

To find out mathematics teachers' attitudes to and experience with TA in teaching mathematics, an online questionnaire survey was prepared. This questionnaire is briefly described and the key findings from the survey summarised in 3.1 (3.1.1. to 3.1.4). Part 3.2 presents basic types of TA and includes examples of TA suitable for various teaching situations. These activities form the core of a newly designed pre-service teacher training course whose aim is inclusion of TA into mathematics education.

3.1. Questionnaire survey

The questionnaire was answered by 31 teachers, out of which 20 were primary school teachers (teaching pupils younger than 11). With respect to the focus of the conference, this paper focuses only on the answers of the 20 primary school teachers.

The questionnaire consisted of 11 items divided into groups of items with the same focus. Below is a brief characteristics of each of the groups of items, the form of the items and the findings.

3.1.1. Respondents' hands-on experience with use of TA in teaching

This part consisted of three yes/no questions. In question 1 respondents answered whether they had come across TA in mathematics lessons at primary or secondary school, in question 2 whether they had come across TA during their undergraduate studies. In question 3 they were asked whether they had ever considered use of TA in their own teaching. This group of questions was

rounded up by an open ended question, in which the respondents were asked to specify the context in which they had come across TA.

The results are summarised in the following table:

Question	Yes	No
1	2	18
2	16	4
3	18	2

What we find very interesting is the misbalance between inclusion of TA at primary and secondary schools and in teacher training. On the other hand the agreement between questions 2 and 3 signals how important role their experience from TA in teacher training is as it seems to motivate students to think about how they could use it in their teaching practice.

When answering the open ended question about context, the respondents gave the following sources of information or experience: textbooks (7), modelling situations in problems (8), experience with use of TA in other subjects (1), recommendation in curricular documents (1), their own interest (1); 2 respondents did not answer this question.

3.1.2. Evaluation of video recordings of TA in lessons

In this part of the questionnaire the respondents watched two video recordings and expressed their opinions on their meaningfulness and potential in mathematics education. The first sample was a dramatization of solution of simple linear equations (for more details see Example 2 below) in which the individual steps were represented by pupils. The other was a description of properties of Euler's constant e in the form of rap. In case of the first recording the respondents appreciated its illustrativeness (15), importance for understanding of solving procedure even by pupils who find symbolic mathematical records incomprehensible (6), pupils' activity and creativity (3). In case of the second video recording, most respondents thought it did not really help, it was just a different form of transmitting facts (6), pupils are not involved actively (2), it is good just for memorizing (1) etc.; if it were regarded as suitable, then for individual study (1) or as an additional activity to other activities (1). The respondents in both cases mentioned the relationship to experiential learning (3, 2).

3.1.3. Influence of inclusion of TA on teaching

This group consisted of four questions in which the respondents were asked to indicate the amount of agreement or disagreement (from strongly disagree to strongly agree) on a five-point scale. The items were: Use of TA may contribute to deepening knowledge, Use of TA may contribute to increase in motivation

and interest in the subject, Use of TA in lessons may improve communication in the class, Use of TA in mathematics lesson is meaningful. The results are presented in Fig. 1.

In all four items the respondents appreciated the positive impact of TA on improvement of learning.

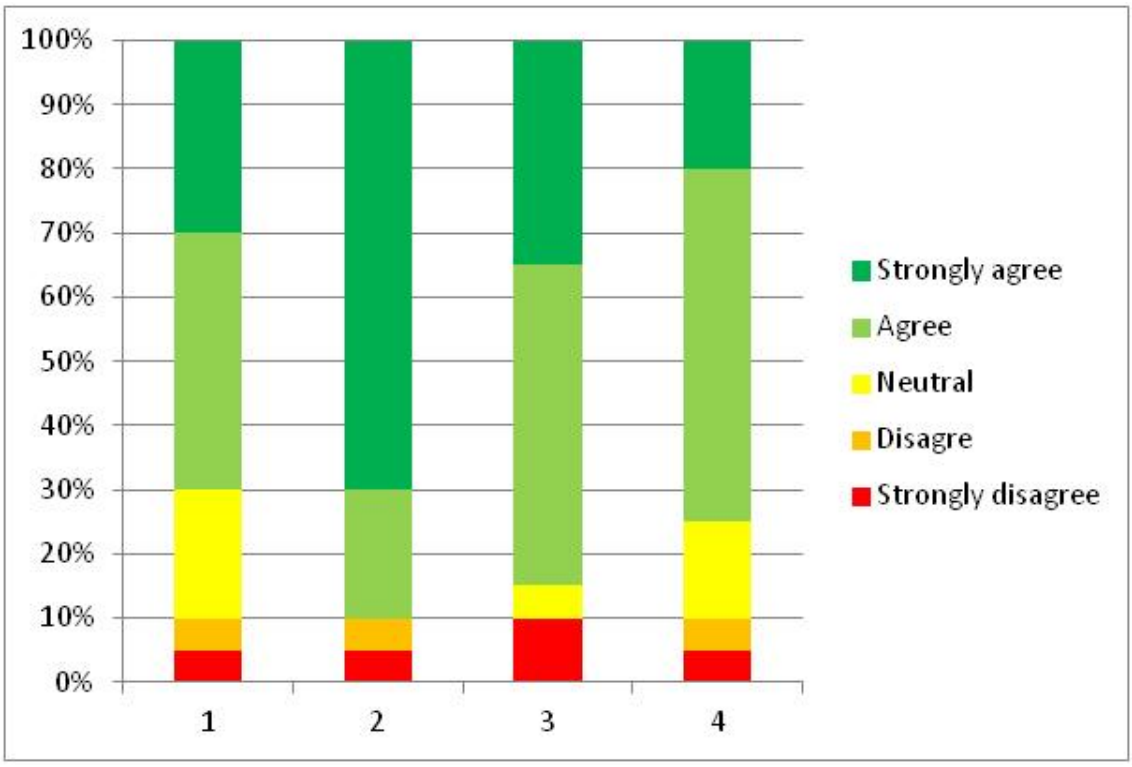

Figure 1

3.1.4. Significance of inclusion of TA for different types of pupils

This group consisted of two questions, one of them was open ended, the other was multiple choice. The question "Do you think dramatic forms help more considerably poor performers or high performers in mathematics? Why?" was answered as follows: 13 respondents stated they were more suitable for poor performers (even those who do not usually perform well in mathematics can be outstanding in TA; this approach develops understanding; mathematics becomes less abstract; there is friendly atmosphere in the class) and 7 respondents believe these activities are equally as beneficial for both groups of pupils (the opportunity for the weaker and better pupils to cooperate; division of tasks; the differences not so apparent). None of the respondents suggested that TA would be suitable exclusively for talented pupils.

The second, multiple choice question focused on the age group for which TA are suitable. 9 respondents recommended they be used only at primary school, 11 stated that age was not important.

3.2. Possible use of various types of TA in mathematics education

The list of TA presented in this section cannot be exhaustive. We present types of activities highlighting important features of the use of theatre activities.

***P situations suitable for improving learners' ability to solve mathematical problems*:** The goal of this type of activities is to introduce pupils to some subject matter, to bring them closer to the situation and to enable them to grow familiar with the situation. Experience shows that if pupils get familiar with the situation they can then solve problems of higher difficulty than those that correspond to their age and mathematical knowledge (Jančařík, Novotná, 2011). TA may help them grasp the situation. In the following text we present three examples of TA for teaching mathematics.

Example 1 – Bus: The first example is the didactical environment Bus (Jirotková, Hejný, 2010). It represents the simplest type of a TA. Pupils directly role play specific situations and with their help solve the related word problems. When getting familiar with the environment Bus pupils dramatize word problems with the number of passengers on the bus. The children either get the role of a passenger or they play the activity using puppets. The goal of the activities is to mediate real situations to pupils and introduce them to the idioms for description of the action. A similar activity is Stepping (Slezáková, 2007). Pupils in this case act out situations of moving by a given number of steps.

Example 2 – Solving equations: A more demanding type of dramatization is dramatization of abstract problems in which finding a specific solution is less important than demonstration of principles on whose basis the given problem is solved. A very nice case of such dramatization is solution of simple linear equations. In this case dramatization has the form of arrangements that help to show relationships among terms.

***P situations suitable for getting insight into the situation*:** This type of dramatization is role playing of situations that do not serve problem solving but whose aim is to get insight into the situation. An example of these problems may be for example problems with motion. When role playing, pupils can rehearse different scenarios how the situation may proceed and apply the gained insight in the subsequent formal solution of the problem.

I situations – Improvisation: Improvisation in lessons of mathematics can have various forms, from simple activities to very complex plays. In the following text we focus only on simpler activities that are suitable for younger pupils. More advanced improvisation activities in mathematics education are discussed e.g. by Gerofsky (2011).

The following text describes two improvisation techniques and the potential of their use in teaching.

Pantomime: A selected pupil draws a concept he/she is meant to act out to the class without using any words. The rest of the class guess what the concept is. This activity can have the form of a competition among two groups when each group sends one representative and then tries to guess in a time limit what the concept is. This activity was developed in a very interesting way by L. Šilhánová, who perceives pantomime as one of the three core activities (together with verbal description and drawing) and who distilled it into her mathematical game Tandemat (Šilhánová, 2011).

This activity provides to the teacher interesting feedback on what associations pupils have in connection to the concepts and how they visualize them.

Chain: The task for a group of pupils is to describe a given concept without using the term for it. Pupils take turns to add only one word to the description. This activity is very demanding as it is crucially important for pupils to relate and adapt their own ideas to the actual development of the situation.

4. Concluding remarks

Results of the research survey clearly show that teachers are interested in TA. It was surprising that only two teachers had prior experience of TA from their primary and secondary schooling. This only proves that Czech teachers of mathematics seem to have a background in traditional methods. Apart from these two exceptions all teachers came across TA in their teacher training. It is obvious that a teacher's previous experience can significantly influence his/her ability to get an insight into cognitive processes of a student who meets new, for him/her often surprising concepts, properties, relations and activities (Novotná, 2000).

It is also interesting to note that two respondents who did not come across TA in their teacher training answered they were considering to use them in their teaching practice. The authors of the paper are planning in-depth interviews with these two teachers which should give them a better insight into teachers' beliefs and ways of their work with pupils, into their willingness to use new methods.

The questionnaire survey also showed that teacher believe one of the important functions of TA in education is its motivational function. Pupils are attracted to it e.g. because it is something new and thrilling. It can function as a link between mathematics and other disciplines pupils are interested in. It may seem to them that it is not mathematics at all. A big advantage is the variety TA episodes offer. They are of different nature and never become routine or boring easily. They facilitate connection of mathematics to real world.

Theatre activities have not yet become commonly used teaching strategies in Czech schools. Teachers who try to implement them need to get acquainted with the basic principles as well as with advantages and dangers they can encounter when using these activities. They can never achieve this unless they undergo

training in Drama Education. That is why we are convinced that Drama Education must become part of pre-service primary school teacher training.

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TEACHING AND LEARNING MATHEMATICS THROUGH MATH THEATRE ACTIVITIES

Antonín Jančařík, Kateřina Jančaříková, Jarmila Novotná and Jana Machalíková ☜

It is a notoriously well-known fact that pupils as well as their parents often consider mathematics as a difficult and boring subject. Instead of studying mathematics (and other subjects) many pupils prefer to spend most of their time watching TV programmes or playing electronic games or texting with their mobile phones, exchanging pictures, exchanging videos, competing etc.

One way of bringing pupils back to the "playing field" of education is to use similar tools, i.e. to communicate the learning of mathematics in a non-traditional way as a game through theatre or communication activities. These methods of learning mathematics target on all types of pupils.

The aim of the workshop is to get participants acquainted with the methodology of teaching and learning mathematics using theatre and communication activities. Attention will be paid also to the development of specimen of teaching materials and methodology for using specially designed theatre scenarios with mathematics as a main topic for learning in a direct or indirect approach.

The first session of the workshop will focus on the framework in which the activities concerned are developed. The basic ideas of teaching and learning mathematics using theatre and communication activities will be presented. The impact on improvement of pupils' personal qualities and abilities (creativity, memory, relationship to the environment, thinking processes, ability to observe and listen to other people's ideas, ability to uncover possible obstacles, clear presentation of ideas, ability to admit one's mistake, ability to accept and use somebody else's ideas it they are more suitable, solving conflicts etc.) will be discussed and summarized.

In the second and third sessions, specific examples of teaching and learning mathematics through communication and theatre activities will be discussed. Starting with specimen from existing activities (such as competition about mathematics communication MathFactor or improvisation Improliga), the participants will learn about the pros and cons of the activities, rules for their successful creation and implementation. Attention will be paid to the development of guidelines to teachers on how to design math theatre scenarios and how to apply them and motivate pupils to learn, understand and appreciate

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mathematics. Developing communication skills and creativity will be part of the methodology.

The second session will focus on mathematics conversations, the third on theatre activities with the special attention paid to improvisation. The themes of the scenarios could be an interesting theorem, a mathematical method, an application of mathematics, but it must be made simple enough to enable a non-expert to understand it, enjoy it and appreciate it.

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http://www.le-math.eu/

Examples of activities:

http://www.youtube.com/watch?v=eL5Q4_SBgYU
http://mathfactor.uark.edu/
http://www.euromath.org/index.php?id=86

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