

Challenge Mathematics with the Element of Narrative Learning — A case for preservice teachers' practical competency

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Keywords : Mathematics teacher education, Narrative learning, Mathematics activities

Abstract : In the pre-service teacher education, besides the regular teaching practice, the extensive practical activities can be designed for developing students' mathematics content knowledge and mathematics pedagogical content knowledge. In this paper, a series of practice-based mathematical activities named Challenge Mathematics with the element of narrative learning is reported. The result of the study is teaching practice in different forms is absolutely essential for developing the pre-service teachers' practical competency.

Introduction

According to the MT21 Report (Mathematics Teaching in the 21st Century), what decided the differences in the achievement among the students from various countries should be the curriculum gap found in TIMSS and a preparation gap caused by the configuration of learning experiences during the teacher preparation (Schmidt et al., 2007). It is reported that the countries whose school students continuously perform well on the international benchmark tests have the teachers who have been trained with extensive educational opportunities in mathematics as well as in the practical aspects of teaching mathematics to students. The relationship between the quality of teaching and the achievement of teacher education has been manifested. Thus, what the pre-service teachers learnt and grasped in their teacher preparation study has attracted attention.

Knowledge for teaching requires both content knowledge and pedagogical content knowledge (Committee on the Study of Teacher Preparation Programs in the United States, 2010). Content knowledge is conceptualised as a deep understanding of the content to be taught (Baumert

et al., 2010; Krauss et al., 2008), and the pedagogical content knowledge is defined as the knowledge necessary to make the content accessible to students (Krauss et al., 2008). In the mathematics teacher education, the mathematics content knowledge is related to number, geometry, algebra, function and data as well as the history of mathematics. The mathematics pedagogical content knowledge can be divided into three as instructional planning, student learning and curricular knowledge (Schmidt et al., 2007) which is a combination of mathematics pedagogy and general pedagogy. Under the curriculum of mathematics teacher education, the students can learn both content knowledge and pedagogical content knowledge systematically. However, to the pre-service teachers, only learning every line on mathematics and pedagogy is not enough. In order to deepen understanding towards mathematics and pedagogy, the more practical experience during teacher preparation given, the better teacher will be trained.

The practical experience in the mathematics teacher education in Japan is accumulated mainly in the school practice lasted 3 weeks. According to the description by Davis and Hersh, most school practices performed

ordinarily. Centered on the subject such as problems to solve, or a method of calculation to explain, or a theorem to prove, the main work will be done in writing, usually on the blackboard. If the problems are solved, the theorem proved, or the calculations completed, then the teacher and the class know they have completed the daily task (Davis & Hersh, 1981). It seems that the plan of instruction is executed, but it is lack of the learner-focused perspective.

Meanwhile, narrative learning is introduced to wake up learning motivation and children's initiative. Narrative learning is a kind of transitory system which prepares children for learning activity proper. It combines play and learning in a specific way in which learning is embedded in the play frame (Hakkarainen, 1999, 2004). Hakkarainen and Bredikyte organised experimental works in the primary schools and kindergartens in Finland as well as in Vilnius, Lithuania. After having participated some parts of their experimental work almost on each September from 2011, it is noticed that narrative learning can be designed in the school environment. Specifically, in Naruševičiūtė's narrative learning practice done with Grade three children in the Genio primary school, Lithuania, the project designed as an imaginary play combined with story-telling, music and mathematics was developed by the teacher's role play and children's construction. For example, being one part of this project, a mathematics class with the task to find out the algorithm of plus and minus with two or more digits and exercise how to do, was started by the clue which is a series of code received from a Fairy who was the heroine of the whole play. In order to read the code, the algorithm of plus and minus became the basic means. Thus, the children were engaged in mathematics study. In the schooling environment, the tasks and assignments of narrative learning are embedded

in the storyline by transforming the learning content and concepts into elements of children's journey in a playworld (Hakkarainen & Bredikyte, 2014).

As mentioned above, in the pre-service teacher education, besides the regular teaching practice, the extensive practical activities can be designed for developing students' mathematics content knowledge and mathematics pedagogical content knowledge. However, the lack of opportunities for practices in developing the pre-service teachers' teaching ability is the current situation. Consequently, based on the theory of narrative learning, Challenge Mathematics which is a series of mathematics activities is organised for our students to accumulate their practical experience. This paper reports on one part of these activities and discusses its implication and limitation. Furthermore, direction will be proposed for next mathematics activities.

Challenge Mathematics with the element of narrative learning

The current situation is that children dislike mathematics, even escape from it. In order to attract children's attention, the proactive learning, the ability to express, and language activities have been put forward by the MEXT, Japan in the general policies regarding curriculum formulation of Course of Study for Elementary Schools. If the advocacy is put into action, it can only be meaningful. The implement of policies the MEXT presented is decided by the people working in the front line of education. It is considered that as long as the class teachers improve their traditional style of teaching, the children will change their attitudes toward learning. If the pre-service teachers in the study of mathematics education take part in the teaching practice in many patterns, they will broaden their horizons, as well as improve their practical competency. Therefore, on the basis of

mathematical activities, introducing the element of narrative learning, a series of practice-based activities named Challenge Mathematics was designed for our students to rich their practical experience.

The first series of Challenge Mathematics was held on each Saturday afternoon in the autumn of 2015. The participants consisted of children with their parents from different primary schools and our students studying in the mathematics education. There were 4 rounds in Challenge Mathematics, once a week. The mathematical content of each round is different. Following the binary, there is the tessellation, Pythagorean tuning and the regular polyhedron. In the activities, in order to enhance children's motivation to challenge a few complicated problems, an imaginary playworld, an usual method in the narrative learning, was introduced. Following Naruševičiūtė's practice, a role named Detective S played by our student is for the common thread connecting these 4 rounds. The first round of Challenge Mathematics named "Get out of the maze " will be reported in the following way.

The purpose of Round 1 is to review the base-10 numeral system, to understand the structure of base-2 numeral system, and to convert from a base-10 integer numeral to its base-2 equivalent.

There are two tasks in this round. The first is for the participants (children and their parents) to find out the meaning of base-2 numeral system by themselves through the activities and group discussion. The other is for the students to foster their sense of the taking part like children, and to enhance their dialogue skills for children's learning.

Episode 1

Since they have no personal acquaintance with each other, after 12 children and their parents were divided into 4 groups, it was time for

them to introduce themselves. At this moment, Detective S knocked the door suddenly. With the query such as Who, it was eerily quiet in the room. After Detective S came into the room, the children stampeded to ask questions (Fig.1).

Children : What is your name?

Children : What are you doing here?

Children : Are you somebody's friend?

Children : Why do you come here?

The appearance of Detective S broke the unfamiliar among the anticipants, and brought the message cards for each child. The message cards are written in Maya script which represents the Maya numerals (Fig.2) . With the hint such as "how many ancient civillisations are there" "did the ancient people write, how did they write", after searching on the internet and discussing in the group, the participants read the Maya script, and write down the numbers.



Fig. 1



Fig.2

Episode 2

Detective S came back. She was glad to find each group read the Maya script. In order to develop the dialogue, our student asked the questions as the children did.

Student : The message is the number, isn't it?

Children : We don't understand the meaning of the cards.

Children : How can we know?

Detective S took out some pieces of maze for children to walk. The outgate of maze is the room number. As the instructions from the map hanging on the door, the children got an envelope.

Episode 3

The envelope is the 2nd hint. There is one hint card and a piece of paper written down the algorithm of divided by 2 in the envelope (Fig.3). According to the algorithm, the children divided each number by two, and write down all the remainders in order. After comparing the remainders consisted of 0 and 1 with the hint card, numbers were translated into words. Each group received their message finally.

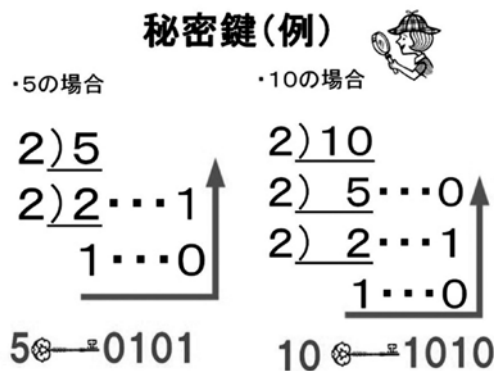


Fig.3

Episode 4

Detective S appeared again. In this episode, Detective S and our students tried to help the participants to understand base-2 numeral system through the algorithm of divided by 2. Using the presentation by power point and blocks in different color and size, whether the children grasp the meaning of base-10 numeral system is confirmed. On the understanding of base-10 numeral system, the positional notation with a radix of 2 was introduced. Same as base-10 numeral system, moving the blocks in different color and size is used to understand base-2 numeral system clearly (Fig.4, 5).



Fig.4

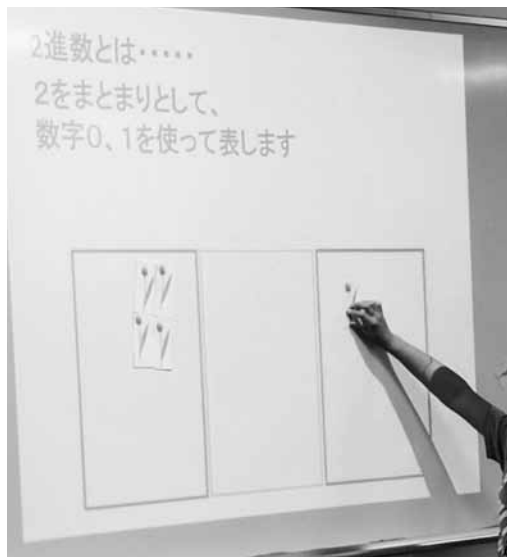


Fig.5

In this Challenge Mathematics, it is aimed at that the participants are engaged actively in the learning. According to the simple questionnaire, most of all chose the item as “interesting”, “being enthusiastic” . Several valuable suggestions are left for us to improve, such as the explanation which is difficult to understand, and the inflexible of our students’ instruction.

Discussion

As reported above, the purpose of Challenge Mathematics is to develop pre-service teachers’ practical competency. Meanwhile, the mathematical content related in each round of Challenge mathematics is constructed to broaden children’s knowledge. After solving several problems with the current learnt knowledge, children would learn some new mathematics knowledge which not written on the textbook. In order to keep children’s motivation, the theory of narrative learning was adopted. In the activities, dialogue among participants and pre-service teachers centred on the topics offered by the role characters and hands-on learning are emphasized. However, how to organise mathematical content into dramatic story, and how to explain one concept or theorem or formula from different points of view will have to wait for a solution. Passive teachers are those who leave students to perform as well as their own resources will allow; active teachers press all students to grow regardless of their background (Wenglinsky, 2002). The purpose of mathematics teacher education is joint mathematics content knowledge and mathematics pedagogical content knowledge associated with more practical experiences. In the next project of Challenge Mathematics, the pre-service teachers’ competency for planning and implementing current curriculum will enable to develop.

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