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TEACHING MATHEMATICS AT PRIMARY SCHOOLS FROM THE PERSPECTIVES OF FREUDENTHAL'S THEORY OF REALISTICS MATHEMATICS EDUCATION

Pham Xuan Chung - Pham Thi Hai Chau
Vinh University

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Abstract: The article introduces some theoretical background of Freudenthal's theory of Realistic Mathematics Education and addresses the situation of mathematics teaching in Vietnamese primary schools. The article proposes some of implications to increase the use of authentic problems in mathematics teaching in Vietnamese primary schools. These suggestions aim at helping students apply mathematics in different real life situations and acknowledge the importance of mathematics in daily life.

Keywords: Realistic Mathematics Education (RME), realistic problem, realistic situation, Primary mathematics.

1. INTRODUCTION

Theory of Realistics Mathematics Education is concerned with the connection of mathematics with reality and the self-discovery of knowledge via students' experiences.

There have been many studies which investigate and acknowledge the theory. In many countries, it has been applied in teaching Mathematics and outstanding educational breakthroughs have been achieved.

Basing on the perspective of Theory of Realistics Mathematics Education, we briefly discovered how Maths has recently been taught in Vietnamese elementary schools and then proposed some suggestions for teachers to adopt this theory into the implementation of certain activities: the presentation of new knowledge, practice - production, extra curriculum, and testing and assessment.

2. CONTENT

2.1. Theory of Realistics Mathematics Education

Since 1971, Freudenthal Institute has introduced and developed the theory of mathematics teaching and learning called Theory of Realistics Mathematics Education [1; pp. 1952] with two main points: 1) Mathematics must be connected to practice; 2) Mathematics should be seen as a human activity.

For the former standpoint "Mathematics must connect with reality", teachers, during the teaching process, have to assist students to realize how mathematics is related to their daily life situations. The former is meant that students should be provided with chances to participate in activities to develop their maths knowledge under teachers' instructions. In other words, for the achievement of maths, students need experiences via learning activities.

According to some studies, Theory of Realistics Mathematics Education potentially develop students' understanding of maths.

Some studies mentioned that the principle, according to mathematical education practices, have the potential to develop understanding of mathematics in students, such as: Streefland (1991), *Fractions in Realistic Mathematics Education,* A Paradigm of Developmental Research, *Kluwer Academic Publisher, Dordrecht* (Mathematics Education Research Journal, Vol. 3, No. 2); Gravemeijer (1994). *Developing realistic mathematics education, Utrecht, Cdß Press*; De Lange (1996), *Using and applying mathematics in education, Im A. J. Bishop, et al, International handbook of mathematics education, Part one, Dordrecht: Kluwer Academic*, pp. 49-97,... [2; pp. 2].

Theory of Realistics Mathematics Education has been used in the teaching of maths in a number of countries, with the Netherlands pioneering in 1993 and having since attained positive results. This has proved the role and the successful implementation of this theory in schools. At the initial practice, the Netherlands achieved high performance in the assessments of TIMSS 1995 and 1999 [3], [4]. So far it has been globally ranked high with an advanced educational system. Some US schools are using teaching materials of Theory of Realistics Mathematics Education cooperatively developed by Wisconsin University and Freudenthal Institute through MIC (Math in Context) project. It is the successful

Email: phamxuanchung77@gmail.com

application in the Netherlands that inspired the US to adopt this theory into their teaching context. MIC project led instructional materials for grades 5-9. Then Freudenthal Institute and the University of Western Cape in South Africa initiated Remesa (Realistic Mathematics Education in South Africa) project, aiming to study and develop the impact of creative math materials on a practical basis. Along with the United States and South Africa, Theory of Realistics Mathematics Education also fits the curriculum in teaching mathematics in other countries such as Portugal and England, etc. [2; pp. 2].

2.2. The current situation of mathematics teaching in Vietnamese primary schools is viewed from the perspectives of Theory of Realistics Mathematics Education

Before 2002, Vietnam's educational program was significantly influenced by those of some countries such as the former Soviet Union, Germany, France, etc. which focused on a scientific and rigid system of knowledge and standard theory guidelines. Activities for the practice and application of mathematics into real-life situations were not properly respected, and many needed skills were insufficiently trained.

With a mission to innovate in accordance with educational requirements to train humans of the new era being dynamic and adaptable to the modern life, the 2002 program of mathematics instruction in Vietnamese schools was directed towards: lessening theoretical rigidity, enhancing practical application, prioritizing learners' self-achievement of knowledge. After a period of implementing the program as claimed by Do Dinh Hoan, "*The knowledge of mathematics at elementary level is derived from reality and applicable in learning as well as in everyday life. Certain content related to social matters has recently been integrated in a number of mathematics books. However, teaching still focuses more on "theory" and "advancement" rather than on "applicability". This partly causes heavy workload and a loose connection between teaching and reality of local life*" [5; pp. 67].

Referring to the development of school educational curriculum within the past 60 years, Tran Kieu supposed that it "*has yet to discharge the tendency of an academic curriculum and still favors the system criterion; the logical development of knowledge still lacks practical application* [6; pp. 2]. Followings are some principles and teaching methods which we claim as "learning by doing", "promoting practice and combining manufacture" and highly respect the application of mathematics into real life.

2.3. Some orientations to help primary school teachers teach Maths effectively basing on Theory of Realistics Mathematics Education

In parallel with Theory of Realistics Mathematics Education, Bui Van Nghi stressed, "*Teaching math is not merely to teach mathematical knowledge to students, but also to teach its culture; so it is vital to indicate the meaning and the application of knowledge so that students can realize where maths originates and how applicable it is to real life.*" [7; pp. 3-7]. According to Nguyen Ba Kim, "*To teach a piece of knowledge [...], the optimal technique is to let it be integrated into appropriate situations for students to gain it voluntarily, actively and creatively."* [8; pp. 81].

The application of Theory of Realistics Mathematics Education into maths instruction is in accordance with the requirements of the general educational curriculum, including the promotion of practice and application, the integration of maths with reality. However, this application should be appropriate to get the optimal results, as claimed by Tran Vui, "*We appreciate the need to connect mathematics to the real world in maths instruction at schools. Meanwhile, we are well- aware of the need to help students realize the practicality of maths. How this becomes reasonable and effective is the key issues that have drawn much attention from educational researchers"* [9; pp. 77].

On the basis of teacher's role in relating maths to reality, the process of maths teaching at elementary level combined with Theory of Realistics Mathematics Education can proceed with three levels:

- Level 1: Teachers actively involve and integrate knowledge with reality;

- Level 2: Teachers suggest and assist students to relate knowledge with reality;

- Level 3: Teacher let students actively relate knowledge with reality.

These three levels are illustrated with the following activity of area calculation for rectangles [Math 3, pp. 152].

At level 1, the teacher set the problem, "The back yard at Ha's house is rectangular, 8m long and 5m wide. What is the area of the yard?" Practical elements are integrated into the problem in order to inspire and motivate students to solve the problem. Students simply apply the formula they have been taught for the calculation.

At level 2, the teacher shows a rectangular object (door, table surface, etc) and requires students to set and solve the problem of area calculation. To accomplish the task, students need to specify the length and width of the object, then outline the problem and calculate its area.

At level 3, the teacher asks students to calculate the area of any rectangular object they can observe. This requires students to find a real-life rectangular object, measure its length and width, and then calculate the area. At this level, students self-manage everything and hence familiarize themselves with exploring the relationship between knowledge and reality, and practice applying maths into real life.

Basing on Theory of Realistics Mathematics Education and the current situation of Maths teaching in Vietnam, we propose a number of orientations to improve the effectiveness of teaching mathematics at elementary level through the instruction and the assessment of learning outcomes.

2.3.1. For activities forming new knowledge.

The history of Mathematics formation and development shows that most math knowledge originated from reality and the needs of human life. These theory's viewpoints prioritize the connection between teaching and reality, and providing opportunities for students to explore knowledge.

Accordingly, in the teaching of new Mathematics knowledge for elementary school students, teachers should start with practical situations, lead students to detect and resolve problems in order to build new knowledge by themselves. With a practical situation, the student will feel excited to solve problems and hence form their own motivation for and objectives of learning. On completion of problem-solving activities, students will better understand the nature of the new knowledge.

This orientation is also in line with the inclination of the general educational program, which includes innovative teaching methods towards "active learning activities through the organizing and guiding students to self-examine and self-discover in order to achieve the predetermined goals" [6; pp. 2].

Example 1: The unit on the matter of "Equal fractions" [**Math 4**; pp. 111] is designed as follows:

There are two identical paper tapes, one is $\frac{3}{4}$ colored and the other $\frac{6}{8}$ (see *Figure 1*).

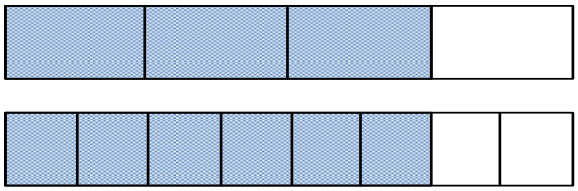

Fig. 1

As $\frac{3}{4}$ equals $\frac{6}{8}$, there comes $\frac{3}{4}=\frac{6}{8}$; to elaborate, $\frac{3}{4}=\frac{3\times 2}{4\times 2}=\frac{6}{8}$ and $\frac{6}{8}=\frac{6:2}{8:2}=\frac{3}{4}$

Therefore, basic features of fractions are "*If both the numerator and denominator of a fraction are multiplied with the same natural number other than 0, the new fraction equals the original one"* and "*If both the numerator and the denominator of a fraction are divisible by a natural number rather than 0, the new fraction equals the original one.*"

Teachers can design activities from the following situation: "*Mom has two identical cakes. Mom cuts and gives* $\frac{3}{4}$ *of one cake to the older brother, then* $\frac{6}{8}$ *of the other to the younger. (see Figure 2). The two brothers both think that the pies are unequal. Help Mom to solve the problem."*

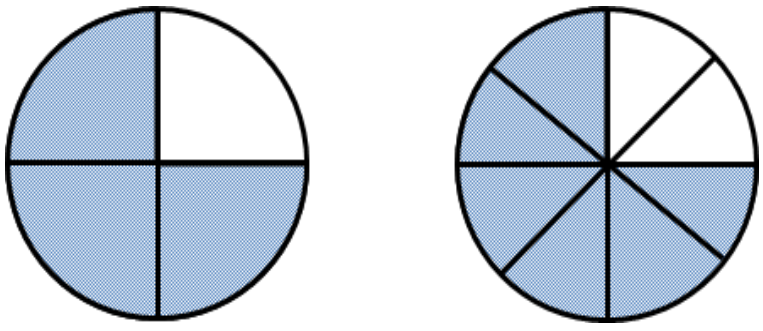

Fig. 2

This is a practical situation that requires students to

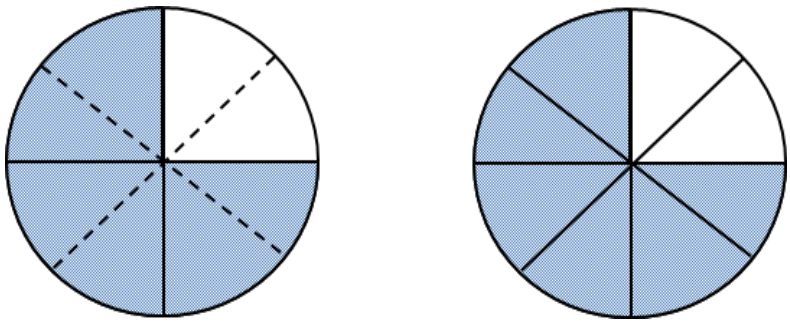

Fig. 3

compare the two pies. In order to address the situation, the teacher should organize the following activities: - Use a model circle as a prompt for students to realize each share of the first cake must be split into 2 equal portions so that the three initial portions of the older brother's pie turn six; - Ask questions, lead students to draw outcomes: The first cake is now divided into 8 portions and so the older brother has $\frac{6}{8}$ of it. (see *Figure 3*); his initial pie is $\frac{3}{4}$ of the cake or $\frac{6}{8}$ as a result of students' division; the two pies are equal.

After the problem is figured out, students can conclude $\frac{3}{4}=\frac{6}{8}$. Through these activities, teachers help students understand that the initial fraction for the older brother's pie is $\frac{3}{4}$. When each piece has been divided into two equal smaller ones, the number of portions in both the pie and the initial cake double, which means both the numerator and denominator are multiplied with 2 and hence the faction is $\frac{6}{8}$. Now it comes $\frac{3}{4}=\frac{3\times 2}{4\times 2}=\frac{6}{8}$. Accordingly, students thoroughly understand that if both the numerator and denominator of a fraction are multiplied with the same natural number other than 0, the new fraction equals the original one.

Similarly, the division of the younger brother's pie and the initial cake by two clarifies $\frac{6}{8}=\frac{6:2}{8:2}=\frac{3}{4}$ and thereby help understand the nature of the other property.

2.3.2. For experiment and practice activities

Experiment and practice activities occupy a large volume of math curriculum at elementary level. Therefore, teachers should focus on applying Theory of Realistics Mathematics Education to these activities. Students can practice with the knowledge and skills in real life through the exercises with practical elements, from which they will realize that mathematical knowledge is an essential tool for human life. Also through practical math problems, students can build new knowledge for themselves. We propose a number of orientations as follows:

- Reduce algorithm memorizing exercises while increasing those with practical content, especially open exercises to enhance students' flexibility in resolving problems.

Example 2: A geometric review session in **Mathematics 4** includes a problem "*In order to pave a rectangular classroom floor, square ceramic tiles with 20cm sides are used. How many tiles are needed to pave the whole floor which is 5m in width and 8m in length; slits between tiles are trivial."* [**Math 4**; pp. 173].

With provided sizes of the floor and tiles, students are supposed to use the data and apply the formulas as well as algorithms to solve the problem. Regular problem solving with available data will form passive habits and fail to promote students' flexibility and activeness towards real-life situations. Based on the above problem, the teacher can set it more flexible as follows: "*The rectangular floor in uncle An's house is 8m in length and 5m in width. Uncle An wants to have it paved with square ceramic tiles. Help him choose tiles of the right size and calculate the required number.*" For this open problem, students can choose the tile's size, find out which sizes are popularly used for paving floors (via observing houses of their own, their grandparents, friends, etc.). This flexible problem will generate students' abilities to observe and solve the problem in different situations.

- Design practical problems which are beneficial to students' real life, providing them with more soft skills, socio-cultural knowledge, moral education, etc.

Example 3: In the lesson "Multiplying with two-digit numbers" [**Math 4**], teachers can set a problem as follows: *"Each mature tree is known to be able to absorb 17kg of carbon dioxide and generate 12kg of oxygen each year. If 45 trees are conserved, how much absorbed*

carbon dioxide and generated oxygen will there be each year?" This problem gives students some real-life matters such as the role of trees to human life, the amount of carbon that each mature tree can absorb and the amount of oxygen it can generate each year (data for referential purposes only). At the same time, the problem sets an educational message: people should consciously plant and conserve trees, prevent deforestation, limit the use of matters made from wood, save papers, etc.

2.3.3. For extracurricular activities

In extracurricular activities, teachers have more opportunities to connect mathematics with reality, as students are exposed to real life. Therefore, teachers should organize and diversify more extracurricular activities integrated with mathematical knowledge to help students consolidate and further memorize knowledge and skills.

For example, after the lesson on area calculation of rectangular objects, on such occasions as hang-outs or working activities, teachers can ask students to measure the length and width of a door, a garden, etc. for area calculations. Teachers can also extend this lesson to two objects of the same width but one with length doubled or tripled, etc. that of the other (students are asked to measure and identify the proportion themselves), then ask students to compare the areas of the two objects without any detailed calculation.

In addition, teachers should suggest students apply mathematical knowledge at home, such as explaining why the home television is so-called 40 inched. To answer this question, students have to learn about inch as a measurement unit, measure the diagonal line of the TV in centimeters and finally converse the units from centimeters into inches. Thereby, students consolidate mathematical knowledge and calculating skills, as well as increase their general knowledge.

2.3.4. For testing and assessment

For the application of Theory of Realistic Mathematics Education into testing and assessment, it is advisable to notify that: - Testing and assessment should be administered both inside and outside classroom; - It is necessary to focus on problems associated with reality; - Testing and assessment should focus on the process of students' discovering new knowledge, as stated in Freudenthal's point 2 (students participate in activities to generate Maths knowledge); - Beside the assessment of students' maths skills, the process should also include some real-life skills such as socio-natural knowledge and personal sense.

3. CONCLUSION

It is appropriate and necessary for Freudenthal Institute's Theory of Realistics Mathematics Education to be applied in the process of maths teaching practices in Vietnamese primary schools. Enhanced association of the teaching process and reality, as well as the provision of opportunities for students' self-exploration and discovery of knowledge will help them to absorb and memorize knowledge in a positive and voluntary manner and skillfully apply knowledge of mathematics to their real life.

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