

SCIENTIFIC BASIS AND SOME MEASURES TO IMPLEMENT MATH EDUCATION ASSOCIATED WITH PRACTICALITY

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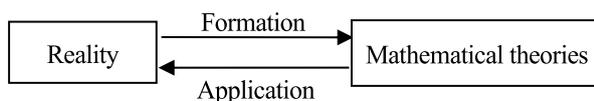
Abstract: Math education associated with practicality is an important requirement in comprehensive innovation in teaching mathematics towards developing learners' ability. The paper explores the scientific basis, proposing a measure to implement mathematical education linked to practicality and illustrate via a number of math teaching situations in high school.

Keywords: Mathematics, practicality, math education, students, teachers.

1. INTRODUCTION

Mathematics which is like a tool to use in different jobs plays an important role in life. The characteristic of mathematics is the high abstraction (multi-level), the abstraction of mathematics distinguished from the abstraction in other sciences, that is: multistage successive abstraction (abstraction of abstraction). In this way, from the first abstract concepts of mathematics, people continue to build a new and more general abstract concept. (For example: from ordinary physical space \rightarrow 3-dimensional space \rightarrow n-dimensional space; from the set with the same number of elements \rightarrow natural numbers \rightarrow rational numbers \rightarrow real numbers \rightarrow complex numbers;...).

However, for the high level of abstraction, it is not easy to apply mathematical knowledge effectively in reality. In order to use mathematics effectively, we need to master the two-way relationship between mathematics and reality. The two-way relationship between mathematics and reality can be represented by the following diagram:



Although there are many different approaches, understanding and expressions of mathematics and the relationship between mathematics and practice, the concepts are unified: Mathematics is the science of relationships about the amount and shape of the real world space. The development process of mathematics demonstrates that practical needs are the cause of the development of mathematics, and also indicates the practicality (understood in a broad sense) is the object of mathematics.

Teaching associated with practical use is an indispensable need and the goal of all knowledge activities. With practical origins and diverse application

of mathematics, the process of mathematical education should be linked to practice in order to promote the awareness and develop learners' ability.

2. LITERATURE REVIEW

2.1. Research on the relationship between Maths and practicality

2.1.1. Situation and role of teaching Mathematics in relation with practicality

In research works about teaching mathematics (Nguyen Thi Tan An, 2014; Nguyen Ngoc Anh, 2004; Bui Huy Ngoc, 2003), although approaching from different directions, these authors have focused on building a number of measures to implement mathematical education in association with practice through teaching specific contents at all levels and grades: use practical examples, exploit mathematics history, practise ability to model mathematics, attach mathematics to the practice of vocational training in universities.

Nguyen Canh Toan (2004) clarifies the need to innovate the current method of teaching mathematics focusing on the need to apply math to solve practical problems.

In teaching mathematics, Hoang Tuy (2001) also points out many problems are "not correct." Most importantly, teaching still focuses heavily on theory, practicing based on the sample while understanding about the origin of mathematical knowledge as well as the ability to apply mathematics to practice are poor.

Research works from different directions of mathematical education in Vietnam such as Nguyen Thi Tan An (2014), Nguyen Ngoc Anh (2004), Bui Huy Ngoc (2003), Phan Thi Tinh (2013) have mentioned that the current status of teaching mathematics now is not really associated with reality. Referring to this result, along with the research and practical investigation, we find that the content of the program as

well as the method of teaching mathematics in our country now still focuses heavily on academic knowledge and lack of knowledge contact and practical application. Another obstacle is because math knowledge and method are the result of the process of abstracting different situations and practices, it is not easy to see directly the applications of mathematics in practice.

These difficulties and shortcomings are influenced by many factors, including the lack of knowledge and general skills needed to link the content of teaching Mathematics with practice of teachers and students. In general, math knowledge such as functions, equations, systems of equations or statistical probabilities can have many applications in life, production, transportation; however, not every teacher can recognize, explain and use it. On the other hand, the way to approach and manage education still focuses heavily on theory to meet the requirements of examination and evaluation, making both teachers and learners not pay attention to the practicality of Mathematics.

However, the research works affirm the necessity and potential of implementing mathematics education in association with origin and application into practice.

2.1.2. Some results of teaching Mathematics associated with reality

The research results of teaching mathematics associated with reality have been shown in many research works, including some works in the following fields:

- From mathematical logic perspective, Nguyen Anh Tuan et al. (2014) analyzed the relationship between mathematics, mathematical logic, philosophy, how to apply in the process of teaching mathematics expressed through three forms of thinking of mankind in practice, that is concept, judgment and reasoning.

- Phan Thi Tinh (2013) built 6 measures to enhance the application of mathematics to practice in teaching Statistical probability and Linear planning for Mathematics students: building content connection; reinforcing knowledge through practical penetration; exploiting mathematical history; exploiting a system of practical exercises; practising the steps of applying mathematics to reality; applying PISA point of view in testing and evaluation.

- Nguyen Anh Tuan and Le Ba Phuong (2014) approached this problem in the direction of applying Mathematics to other subjects, and they built 4-step process using basic math to solve practical problems

expressed through some practical examples for Industrial University students.

- In teaching Mathematics in high school: In order to strengthen the mathematics applied circuit and apply Mathematics in teaching Mathematics in high school, Nguyen Ngoc Anh (2004) based on 5 orientations and 4 principles built and used the system of 60 extreme exercises with connect subjects content and practicality in teaching Math in 12th grade along with teaching instructions necessary for high school teachers.

- Approaching the problem of exploiting the actual content in teaching Arithmetic and Algebra in order to increase the ability to apply mathematics to practicality for junior high school students, Bui Huy Ngoc (2003) determined 7 typical situations, 6 elements of the ability to apply mathematics to practical and 8 measures to exploit content in teaching Arithmetic and Algebra in junior high school.

In general, the research results show the needs, abilities and techniques of Math teaching associated with practicality (understood in a broad sense, including practicality in internal Mathematics and in other subjects).

It also shows that practicality and mathematics are related to each other and constantly changing and developing. The continuous improvement of the quality of mathematics education to well exploit this relationship is a necessary issue, set at all levels and grade learning mathematics.

3. METHODS AND RESULTS

3.1. Research methods

In this article, we use the following research methods: - Theoretical research method: analysis and synthesis of theoretical basis; - Practical investigation method: examining practicality; - Methods of summarizing experience and applying: orienting solutions, proposing measures and developing illustrative examples.

3.2. Scientific basis for proposing measures to implement math education in association with practicality

The building measures are based on the following scientific grounds: - Clarify the requirement of math education in connection with practice in a specific way; - Contribute to innovating the content of mathematical education associated with practice in teaching mathematics when implementing programs, exploiting textbooks and other types of documents; - Contribute to innovating methods (methods, techniques, forms) of teaching Math towards the goal of attaching math

education to practice; adjust the content and method of testing and evaluating the results of mathematics education to focus on the criteria to assess the ability to apply math to solve some practical problems of students; - Approach to implement the perspective of the PISA international student assessment program at the age of 15 (the age at the end of compulsory education), assessing students' universal ability to Math, science, reading comprehension, practical problem solving in order to make recommendations that need to be adjusted on the purpose, content, and method of teaching mathematics for students to meet the requirements of knowledge and skills of applying mathematics to practice to meet the challenges of future life.

3.3. Some measures to implement math education associated with practicality

3.3.1. Helping teachers have a proper and complete understanding of a number of theoretical and practical issues of implementing math education in association with practice

The comparison between Mathematics with some other scientific disciplines show that despite originating from practice and serving practice, the object of mathematics is not from practice but from the result of a multistage abstraction process.

Mathematical knowledge was originally formed directly from the need to explore and discover reality of human, serving simple requirements such as counting, measuring and calculating. However later on, knowledge and mathematical methods became more general or tools of other sciences. Additionally, some knowledge was born owing to the needs of mathematics development. In other words, the application of mathematics to practicality is also presented in many levels, from direct to indirect, simple to complex, low to high level.

That leads to the concept of "practicality" in teaching Mathematics that should be understood in a broad sense: - *Internal demand for mathematics is also the practicality of mathematics.* This is a practical environment most commonly used by teachers in teaching mathematics, but to exploit this, it is necessary to link the content in Math textbooks to the knowledge of teachers in Mathematics. - *The demand for another subject is a practical form of Math.* This is a practical environment that is interdisciplinary, quite close to the learning activities in the school, creating favorable conditions for teaching Mathematics and other subjects. However, to exploit practicality, it is necessary to have interdisciplinary knowledge of both teachers and

students; - Social life is the practice of mathematics, which is also the ultimate goal of mathematical manipulation. However, for the knowledge and methods of mathematics at higher levels (due to multiple abstractions and multi-levels), both teachers and students are not easy to see and understand the application of the mathematical tools.

Normally, to apply mathematics to practical solutions, people proceed in the following order: "Practical situation → mathematical modeling → using mathematical methods to solve → Adjust the results to match the original situation and answer the question" with four following steps:

- *Step 1: Building practical problems from practical situations* (maybe or maybe not depend on conditions and students)

- *Step 2: Mathematical modeling to transform practical problems into mathematical models and problem statement.*

- *Step 3: Using mathematical tools to solve pure math exercises.*

- *Step 4: Transforming the results of solving math problems to the results of practical problems* (give the answer to the original situation if there are any) (Nguyen Ba Kim, 2004).

3.3.2. Clarifying opportunities, requirements and ability to implement mathematics education in association with practicality. Then, defining the goal of teaching Math attached to the requirements of application in practice

Strictly following the principle of education "learning with practice, education combined with production and reasoning labor associated with practice" poses the requirement of implementing Mathematics teaching in association with practicality. For each content (lessons, chapters, sections, circuits - knowledge topics,...), teachers need to master the relationship with practice to concretize into specific requirements, criteria, typical components to meet the goal of teaching Mathematics associated with practicality.

In teaching Mathematics at high school, mathematics education combines with practicality to meet the following teaching objectives: - Contributing to implement better performance of knowledge creation tasks; - Contributing to strengthen math skills and application of math skills; - Building scientific worldview, developing mathematical culture for students; - Developing capacity for problem solving and specific mathematical competencies: logical thinking and reasoning capacity, calculating competence, ability

to use sign language and modeling,...; - Improving the interest in learning Mathematics and career orientation for students.

3.3.3. Choosing and building the content of teaching Mathematics which shows the relationship between mathematics and practicality

For each content (lesson, chapter, section, sequence of knowledge, subjects,...) in the program, textbooks and reference materials, based on the goal of subject, teachers select content to teach in class, emphasize on strengthening contact with practice. Moreover, it is necessary to proactively teach students the necessary knowledge for the operation of math with practice. Simultaneously, teachers need to compile and design problems with practical content to exploit and use in the process of teaching mathematics.

3.3.4. Selecting and coordinating different methods, forms, techniques of teaching Mathematics

Based on determining goals and content, teachers choose appropriate methods, techniques and forms of teaching to achieve high efficiency in teaching mathematics in association with practicality. In particular, it is necessary to exploit the benefits of supporting means in teaching mathematics, especially technical and information technology facilities.

3.3.5. Adjusting content and form of examination, evaluation

Based on the requirements associated with practice identified in the goal of teaching mathematics, teachers need to develop the content and form of examination and evaluation accordingly. Furthermore, teachers also need to add questions and exercises with practical content, set out the requirement to apply Mathematics to solve practical problems in accordance with the level of learners in the process of building and compiling test papers.

Besides, teachers need to create interest, let students practise the ability to apply mathematics to practicality for students through activities: + Encouraging motivation (opening, middle and ending) in the process of teaching Mathematics; + Using illustration of the content of internal math lessons, other subjects and real life. More specifically, clarifying the steps to implement applying mathematics to solve practical problems; + Organizing instruction and practice for students to initially use mathematics to solve some relevant practical problems within the scope (through extracurricular activities). Thereby, form consciousness and ability to manipulate, partly construct mathematical knowledge from life.

3.4. A sample of the implementation of mathematical education associated with practicality in teaching mathematics in high school

Example 1. Design situations that encourage motivation. In order to design a situation that encourages motivation in Mathematics from real life, teachers can follow the steps below: - *Studying the content of the lesson to determine the requirement of encouraging motivation in teaching;* - *Finding, collecting the origin and application of knowledge, mathematical methods needed to motivate the lesson;* - *Applying the reasoning of encouraging motivation to build the situation to exploit the relationship specified in the above steps;* - *Teachers put the situation of encouraging motivation into the lesson plan.*

Examples of situations of encouraging motivation that suggest a beginning and intermediate in teaching the concept of “Derivative” at high school: After studying the content of the “Derivative” in textbooks, teachers choose activities that motivate an introduction to the concept of “Derivative”; learn about the origin and application of “Derivative” in Physics; explain the relationship between the concept of “Derivative” with the problem of instantaneous velocity calculation in Physics, leading to the need to find the form of limit

$$\lim_{x \rightarrow x_0} \frac{f(x) - f(x_0)}{x - x_0} \text{ in that } y = f(x) \text{ is a function.}$$

Example 2. Direct students to self-study after-school when learning the application of vectors.

Teachers can assign tasks to learn about vectors and application of vectors in practice (Mathematics, other subjects, in life) through the following contents:

* *In Mathematics:* - How are vectors related in length?; - Can we use a handheld calculator, Maple software, GeoGebra to assist in calculating the length of vectors, angles, and scalars of two vectors?

* *In other subjects:* Vector is used as a tool to solve what kind of maths in other subjects such as Physics, Chemistry, Geography,...

* *In Physics:* How is the vector used to calculate the factors in the motion problem? In the problem of analyzing, synthesizing and balancing? In the calculation problem of force? Examples: + How to apply vectors to calculate the force when the force does not move in the direction of the force? (“*work and power*”, page 154, Physics 10); + Explain why when the object moves in a direction perpendicular to the force, work is 0? Comparing work which is produced by force of the same direction of movement and work which is

produced by force (of the same magnitude) with the direction of the angle of movement of 45° ?

* *In geodetic, measuring, geological and astronomical science:* How to apply vectors to calculate in such situations as distance or height?

* *Vector application in real life:*

Situation 1: Find manifestation and explanation by vector knowledge for signs and road markings?

Situation 2: How to apply the knowledge of vectors in force synthesis problem to explain the phenomenon of using wind force when controlling sailing boats to run against the wind?

4. DISCUSSION AND CONCLUSION

Math education associated with practicality is a problem related to many different factors and areas of research. In this article, we only approach the problem of understanding the scientific basis and measures of mathematical education associated with practicality, including: - Analyzing the relationship between mathematics and mathematics in practice; - Clarifying requirements, opportunities and ability to implement mathematics education in association with practice; presenting concepts, approaches and orientations for implementing mathematics education in association with practice; proposing some measures and examples of implementing Mathematics teaching associated with practice at high school.

There is always a gap between theory and practice, especially with high-abstract mathematical knowledge. Therefore, to implement the goal of mathematical education in association with practice, mathematicians, educational researchers and teachers of Mathematics need to continue studying and cooperating to concretize how to implement with each content of mathematics at all levels and grades to meet the requirements of comprehensive education innovation, meeting the goal of international integration, especially in the context of the world cultural and economic development trend industrial revolution 4.0.

REFERENCES

- Anggi Anggaraa (2017). Are students more interested in solving mathematics problems related to reality?, 4(9): Selected Papers of 3rd World Conference on Science and Mathematics Education (SCI-MATH-2017).
- Bui, H.N. (2003). *Strengthening the exploitation of actual content in teaching Arithmetic and Algebra to improve the ability to apply maths into practice for junior high school students.* Doctoral thesis in Education Science, Vinh University.
- Freudenthal Hans (1982). *Mathematics in science and around us.* Science and Technology Publishing House.
- Hoang, C. (1997). *Methods of teaching mathematics in secondary schools* (First edition). Education Publishing House.
- Hoang, T. (2001). There is much uncertainty about teaching mathematics in high school. *Tia Sang magazine*, 12, 35-40.
- Nguyen, A.T. (2012). *Logical curriculum and Math history.* University of Education Publishing House.
- Nguyen, A.T. - Le, B.P. (2014). Strengthening contact with career practice in basic Mathematics teaching for students of Industrial University. *HNUE Journal of Science, Educational Sci.*, 59(1), 3-11.
- Nguyen, B.K. (2014). Mathematics education focuses on competence development. *HNUE Journal of Science, Educational Sci.*, 59 (2A), 7-13.
- Nguyen, B.K. (2015). *Mathematics teaching methods.* University of Education Publishing House.
- Nguyen, C.T. (2000). Should teaching be so. *Journal of Research Education*, 1, 27-31.
- Nguyen, C.T. et al. (2001). *Dictionary of mathematical terms.* Dictionary Encyclopedic Publishing House.
- Nguyen, N.A. (2004). *Strengthening application math circuits and applying mathematics in teaching mathematics in high school.* Ministry-level scientific research project - Code B2004-HN04-06, Hanoi University of Education 2.
- Nguyen, T.T.A. (2014). *Using mathematics to develop quantitative understanding abilities of 10th graders.* Doctoral thesis in educational science, Hue University.
- Pham, V.H. (Ed.), Nguyen, G.C., Tran, T.T. (1981). *Education of Mathematics subject.* Vietnam Education Publishing House.
- Phan T.T. (2013). *Strengthening the application of mathematics to practice in teaching Statistical probability subjects and linear planning for pedagogical math students.* Doctoral thesis in educational science, VNIES.