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Original Research Article

Some Measures of Teaching Mathematical Culture to Students Appropriate with the General Education Program in Mathematics 2018 through the Topic: Natural Logarithm – 6th Grade in Vietnam

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Abstract

Mathematical culture is an abstract concept in relation to fundamental characteristics in the quality and thinking of math learners. Not only does teaching math help learners obtain rules, methods, and strategies for solving the math problems in the process of math study but it also shows the learners with the reality value of learning math in tight relation to nature and society. In the context of innovations in the General Education Program in Mathematics 2018 and the educational objectives in the new era of Vietnam, teaching mathematical culture to students calls for special interest and determined action. On the basis of fundamental characteristics in the concept of Mathematics and objectives in the General Education Program in Mathematics 2018, we proposed some solutions of teaching Mathematical culture effectively by demonstrating examples in the topic: "Natural logarithm" – 6th grade Math. Teaching Mathematical culture at schools still draws little attention and emphasis. Proposing some measures of supporting teachers to overcome this difficulty shall make a positive impact on students' and teachers' awareness of the meaning and role of Mathematical culture in the process of learners' comprehensive development.

Keywords: Mathematical culture, General Education Program in Mathematics 2018.

1. INTRODUCTION

According to the contents of General Education Program 2018, "Mathematics education makes a contribution to the formation and development of key qualities among students, general abilities and mathematical abilities with the factors as follows: mathematical thinking and reasoning, mathematical modeling, mathematical problem solving, mathematical communication, mathematical learning tools and means; It is necessary to provide key knowledge and skills as well as opportunities for students to understand and apply mathematics into practice. Mathematics education generates links among mathematical ideas, between Mathematics and reality"[3]. In parallel with the rapid development and change of society in the digital era, perspectives on teaching and learning Mathematics have undergone evolutions.

Educators Zemelman, Daniels and Hyde stated that: "Teachers need to support students in developing skills which will be in daily use for problem – solving, including the capability of explaining ideas, researching information and working with others on a problem in various situations" [1].

In reality, teaching and learning Mathematics in general education still exist various shortcomings: "Our mathematics teachers spend a lot of time on providing students with the knowledge in the curriculum and focus mainly on training students' math solving skills"[1]. Thus, realizing the objectives when building the General Education Program 2018 still exist a lot of difficulties and the perspectives of teaching and learning mathematics in Vietnam fail to well - met with those all over the world. In this article, the authors propose a number of measures with the desire to build the habit of teaching and learning Mathematics to guarantee harmony and integrity between the factors of mathematical knowledge, methodological knowledge and the spiritual value. The above factors are components of Mathematical culture.

2. RESEARCH METHODS

2.1. Group of Theoretical Research Methods

Research, analyze, compare, synthesize,... research works, monographs, theses, dissertations, scientific conference reports, scientific articles,... related to topic to clarify tool concepts, systematize related theoretical issues and build the theoretical framework of the topic.

2.2. Group of Practical Research Methods

Questionnaire survey method; Interview method; Observation method.

2.3. Experimental Method of Pedagogy

Organizing pedagogical experiments and teaching plans are built and designed based on the proposed exploitation orientations. Evaluate feasibility and effectiveness.

2.4. Support Method Group

Mathematical statistical methods.

Method of obtaining expert opinions.

3. CONTENT

3.1. Mathematical Culture

3.1.1. Definition of Culture

Culture is a sophisticated concept characterized by various factors. “Culture or civilization, in a broad sense, generally includes knowledge, beliefs, arts, ethics, laws, customs and a number of other capabilities and habits possessed by humans as a member of society"[4].

According to the Vietnamese Dictionary, "Culture refers to the totality of material and spiritual values created by humans in the historical stage; includes human activities aimed at satisfying the needs of spiritual life; includes knowledge, scientific knowledge; high capability in social activities, manifestation of civilization; includes culture of an ancient historical period, determined on the basis of a totality of relics found with similar characteristics"[8].

According to the UNESCO, culture is interpreted in two senses: broad sense and narrow sense. In the broad sense, "Culture is a complex - a totality of spiritual, material, intellectual and emotional characteristics… portrays the identity of a family community, village, region or nation, society... Culture includes not only art and literature but also lifestyle, basic human rights, value systems, traditions, beliefs..."; In the narrow sense, "Culture is the totality of symbolic systems (symbols) that regulate behavior and communication in a community, giving that community its own characteristics"[9].

In conclusion, culture is interpreted and defined in various ways. Through research, we believe that *Culture is a product of historical and natural processes, marked by time and space, crystallized from the material and spiritual values of people in the productive and evolutionary labor process. On that basis, culture in different aspects of social life is formed and developed with its own characteristics.*

3.1.2. Mathematical Culture

Throughout the process of researching mathematics, intellectual qualities, personal abilities, a number of specific skills of each person will be formed, trained and developed; therefore; thinking and qualities are absorbed and enhanced sustainably. Those factors generate a Mathematical culture for each individual.

According to author Tran Kieu, “Mathematical culture is a collection of mathematical knowledge, skills and thinking habits characterizing mathematics to culturally adapt to situations (if necessary) in life. ”[5]. Mathematical culture not only stays within the subject but it is also spread and applied every day through people's daily activities. Solving real-life problems according to a plan through the process of analyzing, selecting, synthesizing information, evaluating effectiveness and appropriateness... demonstrates a systematic thinking style with mathematical features.

According to author Bui Van Nghi, "Mathematical culture includes the totality of valuable knowledge, methodological knowledge of mathematics and the spiritual values laid deep inside that knowledge"[1]. In the same way, Mathematical culture also consists of hidden spiritual values, which brings a very unique characteristic of the subject.

According to author Nguyen Canh Toan, "Mathematical culture includes all of the qualities and abilities firmly formed through studying and researching mathematics, with such sustainability that even if one forgets all mathematical knowledge, then those qualities and abilities still remain"[6].

3.1.3. Fundamental Characteristics of Mathematical Culture

The product of the process of researching Mathematics is not only thinking, knowledge, and intellectual abilities but also style, habits, thinking and in general, the "quality" of Mathematics. Knowledge, after a period of infrequent use and lack of contact, will gradually go away. However, the most important and valuable thing are the mathematical thinking and qualities formed sustainably during the process of learning Mathematics, always despite gradual disappearance of Mathematical knowledge. That creates a basic and very unique characteristic of the subject.

According to author Do Thi Lan Anh, characteristics of Mathematical culture are that Mathematical culture is associated with mathematical thinking; It is shown through the language of Mathematics; It is is associated with life [5].

It is determined that Mathematical culture has characteristics associated with the following factors:

- Factor 1: Thinking

Learning Mathematics is learning the ways and methods of thinking. Having a mathematical culture refers to having a method of thinking. The method of thinking is not limited to the internal scope of the subject, that is, it is not attached to a specific Math content. It is expanded in other subjects, other fields and in real life. The thinking factor is created throughout the process of teaching learning culture to learners. Through various ways and expressions of logical thinking, intuitive thinking, critical thinking, abstract thinking..., the thinking characteristics of Mathematical literature are generated.

- Factor 2: Language

Expressing, presenting, arguing for proving, criticizing, or refuting... with the ability of analyzing, reading, and understanding tables, diagrams, drawings, formulas and symbols have created characteristics in Mathematical culture. That is the Language factor. Systematic logic, generalization, accuracy and neatness in mathematical language have a great importance not only in learning but also in application of knowledge in life.

- Factor 3: Reality

Mathematics derives from reality. Learning and researching math is applied to solve problems in practice. Applying knowledge, skills, rules and methods in the process of learning Mathematics into social life creates a reality factor - a characteristic of Mathematical culture. It contributes to building the value system of Mathematical culture and connecting science and life as well as thinking and reality.

- Factor 4: Attitude

Honesty - respect of right things and appropriate attitude to things and situations, knowing how to share and listen to right things, criticizing, debating, struggling with wrong situations, uniting and cooperating in solving problems, using ways of thinking, observing, evaluating, behaving and believing are created in the process of learning Mathematics to build the attitude characteristics of Mathematical culture. It creates unique qualities and "styles" of Math learners.

- Factor 5: Aesthetics

It is necessary that students feel the aesthetics of Mathematics in the process of studying and researching Mathematics, thereby gaining an aesthetic perspective in other fields. The sophistication, sensitivity, imagination and abstract thinking of math learners create a unique perspective, a unique style in perceiving and evaluating certain objects and phenomena. Through various solutions, approaches and formulations, history of formation and development, regularity, it helps learners form an aesthetic factor.

3.2. General Education Program in Mathematics 2018 is Appropriate with Teaching Mathematical Culture to Students

General Education Program in Mathematics 2018 stated the objectives very clearly that “Math contributes to the formation and development of students' key qualities and general abilities at levels appropriate to the subject.”; “Match contributes to the formation and development of mathematical capability”; “Having general, basic and essential mathematical knowledge and skills helps develop the ability to solve problems with interdisciplinary integration between Mathematics and other subjects"; "It creates opportunities for students to experience and apply mathematics into practice"; “Having a relatively general understanding of the usefulness of mathematics for each related profession is considered a basis for career orientation, as well as the minimum capacity to self-study problems related to mathematical problems throughout life.” [3]. Thus, teaching Mathematical culture to students is very necessary and consistent with the objectives of the program. With integrated content revolving around three strands of knowledge: Numbers, Algebra and some elements of analysis; Geometry and Measurement; Statistics and Probability are very favorable in the organization of teaching Mathematics in general and the formation and development of factors in Mathematical culture in particular, which will finally head towards the comprehensive development of learners.

3.3. Some Measures to Teach Mathematical Culture in Consistancy with the Objectives of the General Education Program in Mathematics 2018

Measure 1. Fostering mathematical thinking ability among students.

The fundamental role of teaching is to provide students with knowledge, practical skills, educate personality and develop thinking. Thinking is divided into various levels and forms such as intuitive thinking, critical thinking, abstract thinking, argumentative thinking... Math teaching aims to develop students' cognitive aspects equally, forms learners the habit of applying thinking abilities in thinking, judging and solving problems in life. This ability will persist even though previous mathematical knowledge may have disappeared - this is the value that Mathematical culture brings to students.

Example 1. Practice thinking skills by solving a math perform the calculation in a logical way:

$$a)\ A=\frac{2.8^4.27^2+4.6^9}{2^7.6^7+2^7.40.9^4};\quad b)\ B=\frac{\left(\frac{2}{3}\right)^3\cdot\left(-\frac{3}{4}\right)^2\cdot(-1)^5}{\left(\frac{2}{5}\right)^2\cdot\left(-\frac{5}{12}\right)^3};$$

Orientation of Teaching: In the above math, students have to do a lot of consecutive exponentiation. If the

learners perform exponentiation by each base, they will meet difficulties in calculating with results being big numbers, which takes a long time. Teachers need to support students in analysis and evaluation (analytical thinking) of the math problem through the interchanging relationship between the bases of exponentiation in calculations. Determining the bases of calculations, seeking relationships and transformations between bases, presenting correct and easy-to-understand solutions, following transformation rules and logical reasoning are requirements that teachers need to pay attention to in students' solutions. In specific:

$$a)\ A=\frac{2.8^4.27^2+4.6^9}{2^7.6^7+2^7.40.9^4}=\frac{2.\left(2^3\right)^4.\left(3^3\right)^2+2^2.\left(2.3\right)^9}{2^7.\left(2.3\right)^7+2^7.2^3.5.\left(3^2\right)^4}=\frac{2.2^{12}.3^6+2^2.2^9.3^9}{2^7.2^7.3^7+2^{10}.5.3^8}=\frac{2^{13}.3^6+2^{11}.3^9}{2^{14}.3^7+2^{10}.3^8.5}$$

$$=\frac{2^{11}.3^6.\left(2^2+3^3\right)}{2^{10}.3^7.\left(2^4+15\right)}=\frac{2.\left(4+27\right)}{3.\left(16+15\right)}=\frac{2.31}{3.31}=\frac{2}{3}.$$

$$b)\ B=\frac{\left(\frac{2}{3}\right)^3.\left(-\frac{3}{4}\right)^2.(-1)^5}{\left(\frac{2}{5}\right)^2.\left(-\frac{5}{12}\right)^3}=\frac{\frac{2^3}{3^3}.\left(\frac{3}{2^2}\right)^2.(-1)}{\frac{2^2}{5^2}.\left(-\frac{5}{2^2.3}\right)^3}=\frac{-\frac{2^3}{3^3}.\frac{3^2}{2^4}}{-\frac{2^2}{5^2}.\frac{5^3}{2^6.3^3}}=\frac{\frac{1}{2.3}}{\frac{5}{2^4.3^3}}=\frac{1}{2.3}.\frac{2^4.3^3}{5}=\frac{2^3.3^2}{5}=\frac{8.9}{5}=\frac{72}{5}.$$

In the process of learning mathematics, teachers need to generate learning situations, bring learners into activities, thereby training thinking and the ability to apply knowledge in practical conditions, contributing to the formation of good habits of thinking in all activities.

Measure 2. Practicing Mathematical language as a regular activity.

Mathematical language is an important factor to train thinking while fostering natural language. Math language is like a natural language, with both syntactic and semantic aspects to ensure coherent thinking, correct understanding of the problem and tell the right problem needed to be said. During the teaching process, teachers need to regularly train students to express themselves clearly and logically according to the rules of mathematical reasoning; have arguments and convert mathematical language into ordinary language, helping students read and exploit information through tables, models, drawings and symbols as well as apply in practical situations.

Example 2. Practicing Mathematical language during the process of teaching the definition of the nth power of natural number a

The nth power of natural number a is the multiply of n equal factors, each of which is equal to a :

$$a^n=\underbrace{a.a.a.\ldots.a}_{n\ \text{factors}\ a}\qquad (n\in\mathbb{N})$$

a^n is read as "a to the power n" hoặc "the nth power of natural number a", a is base, n is exponent

Orientation of Teaching: In fact, many students have mistakes in exponentiation: $2^3=6$ hay $4^2=8$. This is partly due to the fact that students fail to properly and clearly understand the concept of powers of natural numbers. Therefore, while teaching this concept, teachers should organize activities to identify and demonstrate the concepts and requirements for exponential language expression. It is necessary to understand new terms such as "base" and "exponent", ask students to express in words or mathematical language the exponential operations, specify the base and exponent, point out common mistakes so students can learn the rules in solving math problems.

Measure 3. Strengthening practical factor in teaching Mathematics.

High abstraction and universal practice create a very unique feature of Mathematics. Teaching Mathematics is providing learners with tools, methods and rules to solve problems not only within the subject but, most importantly, real-life issues. It is necessary for students to understand the practical characteristics of Mathematics and improve their ability to apply and form the habit of applying mathematics to life. The new perspectives and objectives of the General Education Program in Mathematics 2018 aim to enhance the factor of practice (reality) in teaching Mathematics. This is the right direction.

Example 3. Strengthening practical factor and the ability to apply mathematics into practice for students through the problem: "The Earth has a mass of about 60.10^{20} tons. Every second the Sun consumes 60.10^{20} tons of Hydrogen gas. How many seconds does it take for the Sun to consume an amount of Hydrogen gas with a mass equal to the mass of the Earth?

Orientation of Teaching: The time it takes for the Sun to consume an amount of Hydrogen gas equal to the mass of the Earth is: $\frac{60.10^{20}}{6.10^{6}} = 10^{15}\left(s\right)$.

Applying mathematics into practice helps students see the universal meaning of mathematics in life and the value of learning and equip them with knowledge that is helpful in solving real-life problems. This helps them become conscious of regularly applying learned knowledge flexibly in life. Thereby, contributing to realizing the objectives set by the General Education Program in Mathematics 2018.

Measure 4. Fostering the right attitude through learning cases in Mathematics.

Mathematics not only helps people think logically, but also in the process of learning mathematics, they will form the right habits, virtues and attitudes through learning situations. The highly abstract nature of mathematics requires students to brainstorm a lot, sometimes quite stressfully; Solving many difficult problems requires students to persevere in thinking, predicting, trying again and again, drawing this picture and that picture, finding this way and that way… Therefore, it is meaningful and important in educating students' attitudes towards real life situations.

Example 4. The World Health Organization (WHO) announced the official name of acute respiratory infection caused by the corona virus (nCoV) is Covid 19. In an experiment to assess the growth rate and infectivity of this virus, scientists found that with 5 virus individuals, after 30 minutes, the number of individuals increases five times. So after 5 hours from the above 5 individuals, how many virus individuals are replicated? What do you think about the replication rate of this virus? Present your understanding of Covid19 and how to prevent infection.

Orientation of Teaching: After 30 minutes, from 5 virus individuals, the number of viruses replicated is:

5^{11} = 48 828 125 (virus individuals)

The replication speed of viruses is very fast, after a short period of time from just 5 individual, the number of viruses has increased to more than 48 million individuals. Students present their understanding of the Covid19 virus and how to prevent infection. Teachers propagate, disseminate and guide students to prevent epidemics, ensure health and complete study tasks.

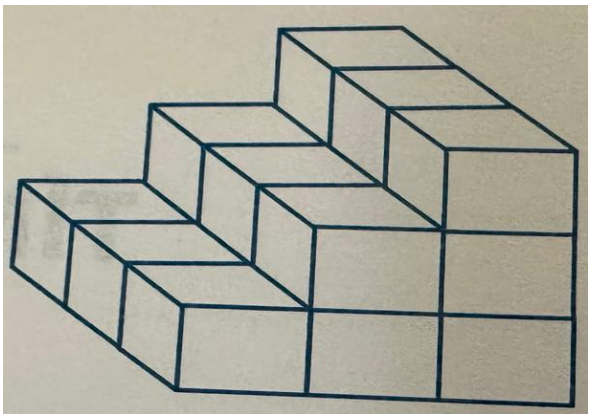
Through practical or hypothetical situations, in addition to teaching and equipping knowledge as an educator, teachers help students form and practice the right habits, virtues, and attitudes. In the process of teaching Mathematics, teachers often rarely create opportunities for integrated education. Through the above measures, we expect teachers to have a multi-dimensional perspective and be responsible in integrating and connecting with personal education activities in the process of teaching the subject. In addition, through difficult math problems that require learners to be persistent and patient to find reasonable solutions to the problems, students will gradually form good qualities that the learners may not realize themselves.

Measure 5. Improving the ability to imagine and form aesthetics through studying Mathematics.

Teaching mathematics at school needs to improve the students' the capacity of imagination, form true aesthetic feelings, recognize the beauty of mathematics through structure, optimal solutions, worthwhile applications of mathematics into life, the perfect logic of propositions, theories and the beauty of geometric shapes with harmony in proportion, size and symmetry. The aesthetics of mathematical inventions is essentially the beauty of creativity, passion and patience, the will to overcome difficulties and the right research method. Math teaching needs to let students clearly see the value hidden in each knowledge.

Example 5. A construction project needs to pour a concrete block as shown in the picture, knowing that the concrete block is made up of cubes with sides of 50cm.

Determine the volume of concrete to use



Orientation of Teaching: The cube is made up of 3 layers of concrete blocks. The bottom layer has 3.3=9 cubes of the same size. The middle layer has 3.2=6 cubes. The top layer has 3.1=3 cubes. The volume of each small cube is 50^3 (cm^3). Therefore, the volume of concrete needed is:

$\left(3.3+3.2+3.1\right).50^3 = 18.125\ 000 = 1\ 250\ 000\left(cm^3\right)$

The ability of imagination has a very important role in learning math, doing math and applying into real life as some objects or mathematical objects are not easy to see by eyes.

In addition, the teacher mentioned the history of formation and development, and stories of

mathematicians so that students could feel the features of creative labor, the value hidden behind seemingly rough formulas and rules of the subject.

Example 6. Discovering the beauty of mathematics through some regular exponential math problems

1^2	=	1.1	=	1
11^2	=	11.11	=	121
111^2	=	111.111	=	12321
1111^2	=	1111.1111	=	1234321
11111^2	=	11111.11111	=	123454321

Teachers can organize discovering activities for students to find out the regularity and feel the "beauty" in the results of mathematical operations. Thereby fostering more love and interest in the subject.

Example 7. Forming aesthetic emotions, evoking passion, curiosity and interest in learning for students through the "exponential loop" problem.

The teacher asks a question: "Do you think there exist numbers that are exactly the sum of the cubes of their digits? Which number is that? And how many such numbers are there? Students discover knowledge through suggestions from the teacher.

Let's give a simple illustration: Let's try to find another number. For example: $153 = 1^3 + 5^3 + 3^3$. Let's calculate together to verify the above result. It has been pointed out that there are only 5 unique numbers that have this special characteristic:

$1 = 1^3$

$153 = 1^3 + 5^3 + 3^3$

$370 = 3^3 + 7^3 + 0^3$

$371 = 3^3 + 7^3 + 1^3$

$407 = 4^3 + 0^3 + 7^3$

The teacher expands on the problem through exploration and discovery of "exponential loops" through a random illustration. Students should choose any number they like, for example: the number 352 has the total cube of digits: $3^3 + 5^3 + 2^3 = 160$, do consecutive times of taking the sum of the cubes of the digits of 160: $1^3 + 6^3 + 0^3 = 217$. We can continue with the above principle with the number 217 and wait for the wonder in the exponential loop: $2^3 + 1^3 + 7^3 = 352$. Thus, after 3 times taking the sum of the cubes, it will return to original number. Students continue to explore this wonder through any numbers.

4. CONCLUSION

New perspectives in building the General Education Program in Mathematics 2018 along with new teaching approaches and trends have gradually changed the habits of teaching and learning Mathematics at schools. Mathematics teaching not only provides learners with theorems, formulas, rules, methods along with only academic mathematical arguments but also aims to exploit and generate conditions to help students see the meaning of mathematics, the value of mathematical knowledge in practical situations, aiming to develop the cultural beauty of Mathematics for those who study and do mathematic, beauty of thinking and qualities. Mathematical culture, along with other factors, is related to the value system and abilities of each student, need to be properly cared for and developed. By providing different approaches to the concept of mathematical culture along with analyzing basic characteristics, the authors have proposed 5 measures to apply in teaching Mathematics in general education to form and develop Mathematical culture for learners.

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