PROCEEDING ISBN : 978 – 979 – 16353 – 7 – 0

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Value's of Mathematics Education and Citizenship Education

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Abstract

Currently, the Indonesian plane of life is miserable, inparticular on behavior. It is shown by the mushrooming acts of corruption, bribery, anarchy, public deceiving, traffic incompliance, etc. This mean any problem in nation character. The nation character building is the duty of citizenship education. The mission of citizenship education in Indonesian is develop or build the nation character as the instructional effects and nurturant effects. Whereas, another courses include mathematics course have to develop the nation characters through the nurturent effect of the instructional. This paper discussed about the relationship between values of mathematics education and characters contained in Citizenship Education.

Key word: *value, character, mathematics, citizenship*

1. Introduction

Objective condition of Indonesian national life today is heartrending. It is shown by the mushrooming acts of corruption, bribery, anarchy, public deceiving, traffic incompliance, etc. President Susilo Bambang Yudoyono is concerned with the Indonesian National condition related to nation morality (Sumargono, 2010). This condition shows that something has gone wrong in our nation. One of the Indonesian weaknesses is the inconsistency in holding values (Sumodiningrat and Nugroho, 2005). The term "consistent" becomes the keyword of the Indonesian weakness. The other weakness is "incompliance" to law and regulation.

The nation character can be builded through Citizenship Education or Civics Education. The vision of Citizenship Education is to improve values and attitudes by developing values and characters as instructional effects and nurturant effects, while the other subjects have to develop activities containing nurturant effects of values/characters development within students (Ministry of National Education, 2010). Citizenship Education as a medium of state character building and citizen empowerment has to be able to build Indonesian citizens who have life values. The life values among others are collaboration, negotiation, communication, creatively critical, positive attitudes, and empathy (Soedjadi, 2007).

The mathematics characteristics are agreement, consistency, and principle compliance (Hardi Suyitno, 2008). Today, most of the mathematics learning process follows social constructivism paradigm. One of the pedagogical implications of social constructivism is learning process has to explicitly include values related to mathematics and its application in the community or socially, meanwhile, students should respect social messages in mathematics curriculum and should have confidence, knowledge, and skills to be understood by the mathematics user community. Therefore, mathematics education has to be a part of values education including education for building civilized nation and nation which complies with values agreed by the society or the nation. General educational, mathematical and specifically mathematics educational values do not exist mutually exclusive of one another. Some values fit into two or all three of the categories (Seah, 2008). The problem is whether there is a relation between values in mathematics and its learning with values and Citizenship Education.

2. The Nature of Mathematics

According to social constructivism, mathematics is the result of organized human activities, a social construct, a cultural product, and knowledge that is possibly wrong just as other knowledge (Ernest, 1998). Mathematics has characteristics such as abstract, general, objective, formal, rational, theoretical, and is closely related to justification (Ernest, 1991). Mathematics has abstract objects, deductive axiomatic structure, self evident epistemological concept, artificial, inabsolute truth, non empirical, advantage as the source of thinking, and advantage as a deductive tool (Wittgenstein in Hardi Suyitno, 2008).

a. Mathematics Objects

Basic concept of elementary mathematics branch is abstraction of experiences (Klein, 1985). Numeral and Euclidean geometry concepts are strongly influenced by experiences. However, a number of mathematics concepts are born from human mind creation with or without the help of experiences.

According Dienes (Bell, 1981), abstraction in mathematics is based on intuition and empirical experience. Circle concept can be gained through observation of various objects such as wheel, plate, coin, well lid, and bucket surface. Each object has various

characteristics. One of the similar characteristics is the shape. If one pays attention to geometric shape and ignores the other characteristics like thick, big, color, material, etc., then a circle concept is formed. Below are results of mathematics abstraction from a number of problems.

1. Mr. Karya fished in a river and put catfishes in a bag. On his way, he gave three catfishes to his grandchildren. Upon arriving at home, there were seven remaining catfishes. How many catfishes were caught by Mr. Karya?
2. Mrs. Broto bought a bottle of frying oil. On his way, she gave three liters of oil to her daughter-in-law. Upon arriving at home, there was seven liters of remaining oil. How many liters of oil did Mrs. Broto buy?
3. A city bus departed from a station with some passengers. Upon arriving at the first bus stop, three passengers got down and no passenger got on. Before arriving at the second bus stop, there were seven passengers. How many passengers were there when the bus left the station?

The mathematics model of those problems is "**x – 3 = 7. x = ...?**" Variable x represents catfishes, oil, passengers, etc. In those examples, the similar and essential characteristic is that of related to quantity rather than color, species, weight, height, etc. This result of abstraction focuses only on quantity and ignores the other characteristics. After turning to be mathematics model, variable x becomes artificial. Besides through abstraction process, mathematics objects are also built through idealization.

Mathematical objects is **abstract** in nature which means that mathematics objects are mind objects. Mathematics truth is only **mind truth** and not empirical truth.

b. Mathematics characteristics

Pure mathematics merely consists of deductions with logical principles and is a set of statements in form of "p contains q" with p and q as meaningless symbols (Russel, 1951). All mathematics concepts are derived from logical concepts through explicit definition and theorms in mathematics may be derived from logical axioms only with logical deductive (Carnap, 1961).

Hilbert, a formalist, states that mathematics is a game played with symbols determined randomly based on rules applied randomly and the game is subject to formal requirement of **consistence** (Kattsoff, 1949). Mathematics structure is formulated by

symbols and logic constructs set of axioms. According to Hilbert, by considering mathematics as a game, people who understand mathematics have to know and understand as well as comply with the rules in mathematics.

Main components in every mathematics branch are concept, axiom, and theorem (Klein, 1985). Concepts are stated in form of formulation called definition. Definition is the result of social agreement of mathematicians. Definition is a rule of mathematics game. Axiom is a statement whose truth does not require proof or self evident trust. Axiom is stated for a particular objective regardless of the realization, arranged not for expressing experience but for expressing impossibility to imagine different things (Wittgenstein, 1978). All mathematicians agree that axiom is stated based on agreement. Axiom is essential since deductive thinking needs premises; therefore, main premises (primitive statements) which are not the results of deductive thinking have to be determined. Axiom consists of undefined elements and the relations among them (Soehakso, 2001). Mathematics epistemological concept is the Euclidean theory; that is theory which position axioms on the top system and is self evident trust (Wittgenstein, 1978). All mathematic statements should comply with axiom. Formation system of a mathematic formal system is started by determining axioms and derivative rules. Statements in mathematics system have to be coherent from one to another.

Theorem is a statement derived from statements of which the truth has been previously accepted. Theorem is mathematics information stated as a principle. Sometimes theorem is stated in forms of formula. Mathematics theorem is a result of deductive inferred from a set of axiom (Kline, 1985). Theorem truth has to be proven deductively. Proofs are a set of deductive arguments in which each contains premise and conclusion. The close relationship between theorem and proof is the characteristic of mathematics grammatics (Wittgenstein, 1978). One is said to understand a theorem if s/he also understands the proofs. The theorem is proven as an effective and efficient tool to arrange mathematics proofs and solve other mathematics problems. Kline (1960) states that

"*… mathematics is a method of inquiry known as postulational thinking. The method consists in carefully formulating definitions of concepts to be discussed and in explicitly stating the assumptions that shall be the basis for reasoning. From this definitions and assumption conclusions are deduced by application of the most rigorous logic man is capable of using*".

Postulational thinking means thinking based on postulate or axiom. Mathematics method is through process of stating definition of a particular concept. Furthermore, the defined concepts become the basis of thinking. Conclusion is derived from a number of definitions and axiom by using meticulous and accurate logic. A mathematics system can be described by a simple scheme as in Figure 1.

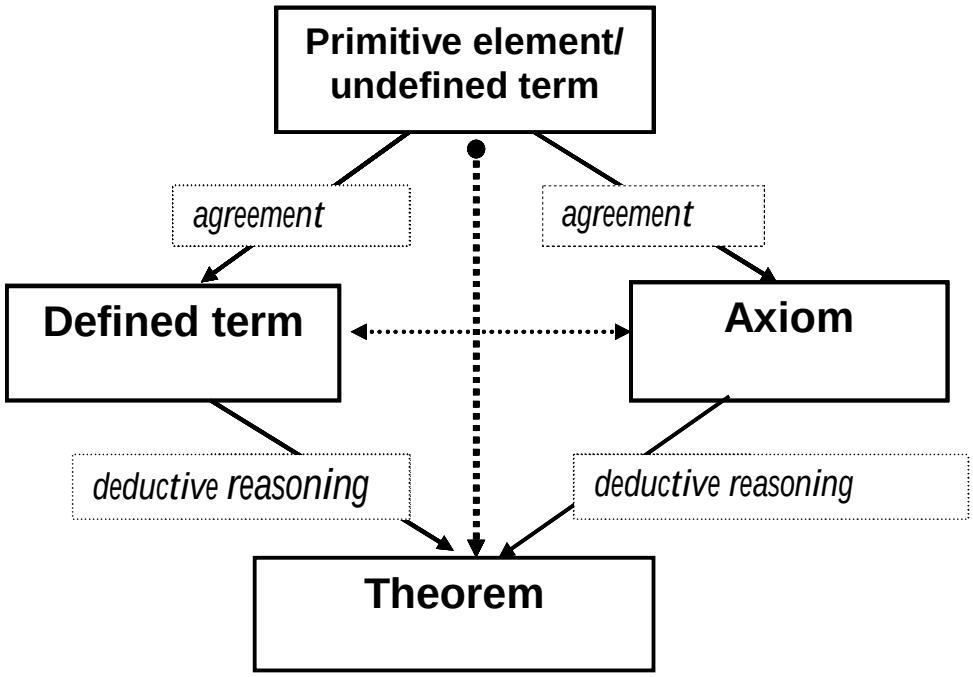

Figure 1 Mathematics system scheme

c. Mathematics Truth

Wittgenstein thinks that mathematics is a set of language games and truths, errors, and proofs depend on acceptance of language agreement rules (Hardi Suyitno, 2008). Mathematics is a language and fulfills a number of rules as those of games, consisting of a number of consistent systems, definition and axiom as the stated rules which are based on a variety of applications, needs or interests, and the truths are as the results of mathematicians' social agreements (Hardi Suyitno, 2010[a]). Mathematical truths are based on language agreements, or in other language wordings and the agreed rules are the keys to reinforce and legalize mathematical truths. In short, mathematical truths are not absolute truths, instead truths which include **coherent truths, relative in nature, and resting on agreements.**

In geometrics branch there are several different geometrics systems as a consequent of different axiom formulations. In Euclidean geometric system of parallel

axiom it is stated that "**At most one line can be drawn through any point not on a given line parallel to the given line in a plane**" while in Lobachevkian geometry system, the parallel axiom differs from that of formulated by Euclides, "**There exist two lines parallel to a given line through a given point not on the line**" (Prenowitz and Jordan, 1978).

Riemannian geometry system of parallel axiom states that "**There exists no parallel line**" (Prenowitz and Jordan, 1978). Striking differences among axioms bring about contradictive differences to theorems. Euclidean geometry: "**The measures of the interior angles of a triangle always add up to 180^0**. Lobachevkian geometry (hyperbolic geometry): "**A hyperbolic triangle has measures of angles that sum to less than 180^0**". Riemannian geometry (elliptic geometry): "**The sum of the interior angles of a triangle is greater than 180^0**". According to Gauss, hyperbolic geometry and elliptic geometry are consistent geometric systems. He states that any attempt to reveal a contradiction and an inconsistence in non-Euclidean geometry has failed. (Greenberg, 1974). Based on Gauss' opinion, what lies between Euclidean geometry of parallel axiom is independent. It implies that if Euclidean geometry is consistent, Non-Euclidean geometries are also consistent. Mathematicians, Edward Kasner and James Newman state that Non-Euclidean geometries prove that mathematics is only restricted by laws of thinking (Livino, 2009). In other words, mathematics is not restricted by observation, dogma, or anything else.

d. Mathematics as a problem solver

In pre-university level, mathematics is a tracing pattern activity and relationship, creativity, problem solving activity, and a means of communication (Ministry of National Education, 2007). Mathematics has a close relationship with social and political life is every period of human civilization, and mathematics is a tool used in daily human life (Court, 2006). Mathematics is a mind tool, science language, knowledge regulation, and deductive conclusion drawing. In addition to mathematics as a tool, it also functions a language (Leonhardy, 1962). Pure mathematics is related to discovery and confirmation of axiom about mathematics concept to prove theorem, while applied mathematics is related to ideas and problems for studies on nature or real world. The main value of mathematics developed through deductive process is giving

power to human to organize science and ability to predict natural phenomena. In brief, mathematics is a strong bridge between human and the external world.

Figure 2 shows procedure of applied mathematics to solve real world problems (adapted from *The Psychology of Learning Mathematics*, R. F. Skemp,1975, p. 238).

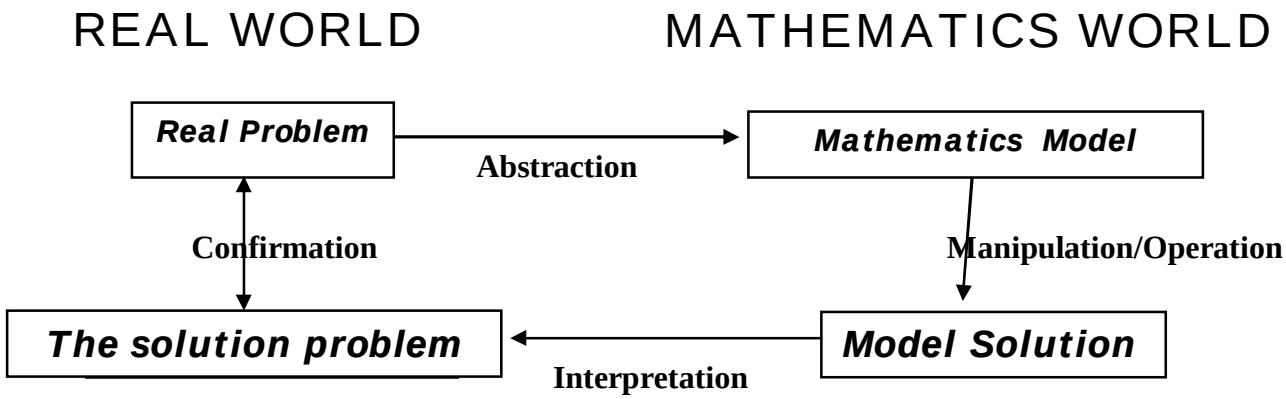

Figure 2

Mathematics as a tool of thinking also has a weakness. Mathematics, like language, has inadequacy to express ideas. Logic viewed as the core of mathematics also has inadequacy to express ideas. Like any other tools in general, effectivity and accuracy of the use depend on the user's mastery of the tool and of what, where, and when the tool is used.

3. Values in Mathematics Education

Mathematics Education characteristics among others are demanding logical, analytical, systematic, critical, creative, and innovative thinking ability, and emphasizing on concept mastery and logarithm as well as problem solving (BSNP 2006). Values in mathematics include agreement, independence, consistency, universality, and strictness (Soedjadi, 2007). In *Curriculum Guideline: Mathematics: Intermediate and Senior Divisions* published by Ontario Ministry of Education, Canada, it stated that

> *"Values education is an integral part of the school experience. In the mathematics classroom it is important that the teacher provide students with regular opportunities to reflect on the values and issues that arise from the subject matter and from the interaction of the students and the teacher"* (Ontario Ministry of Education, 1985).

Values in mathematics as an integral part of learning experience are very important. Values in mathematics and values in subject of mathematics can be grown through teaching-learning process of mathematics. The values are contained in mathematics and delivered by teacher through the available opportunity in teaching-learning process, including the process of interaction between teacher and students. Class condition, rules and administrative procedure, language used by teacher and students, and learning model bear values (Roulet, 1995). According to Bishop (1999),

> *...values in mathematics education are the deep affective qualities which education fosters through the school subject of mathematics. They appear to survive longer in people's memories than does conceptual and procedural knowledge, which unless it is regularly used tends to fade.*

Therefore, teacher has to determine messages or values that s/he will instill to the students. Mathematics media can be used to instill values to lead to social, moral, political problems, etc. The o of mathematics education is in order that students intelligently discuss a particular issue and have an instrument to analyze and debate, so that they are competent and skillful to be curious people and skeptics, have ability to ask questions like a politician, ability as that of a journalist, ability as that of a religious leader, and ability as that of a scientist.

4. The nature of Citizenship Education

The Indonesian dream reflected in the Preamble of The 1945 Constitution is as the guideline of determining the Indonesian national visions. One of which is to educate the life of the people. Citizenship Education scientific dimension includes politics, law, and moral (BSNP, 2006). Important topics in Citizenship Education among others are human rights, democracy, national paradigm, and state defense. The vision of Citizenship Education is as a medium of nation and character building and citizen empowerment (BSNP, 2006) and to build Indonesian people to the fullest (Decree of DIRJENDIKTI No. 43/DIKTI/Kep/2006). Citizenship Education has to be able to form good citizens—citizens who are capable to do their rights and duties in nation and state life, which is in line with The 1945 Constitution (BSNP, 2006). Citizenship Education has to be able to form students to be citizens with Pancasila soul who have nationalism and love the motherland, state defense awareness, democracy, unity (respect diversity), and sense of civilized humanity. Pancasila values are the nation dreams realized in life (Kaelan dan Zubaidi, 2007). Furthermore, Indonesian citizens should be intelligent, highly competitive, and disciplined. A whole human's characteristics are religious,

civilized, human, and loving the motherland. A whole human should be able to put "good" and "right" together.

Indonesia is a democratic country. Sense of nationalism, loving the motherland, and state defense awareness mean that every Indonesian citizen shall have commitment to upholding the Unitary State of the Republic of Indonesia (NKRI). According to Andrews, consensus ensuring the upright stance of modern nation's constitutionalism in reformation process to realize democracy, generally relies on three elements of consensus, which are: (1) *the general goal of society or general acceptance of same philosophy of government*, (2) *the basis of government*, (3) *the form of institutions and prosedures* (Kaelan, 2010). The keyword is **'consensus'**.

Competency aspects that will be developed in Citizenship Education include civic knowledge, civic skills, civic disposition (BSNP, 2006). In Citizenship Education, civic disposition is considered as the most substantial and essential one compared to the other aspects. Attitudes like religious, tolerant, honest, just, democratic, respecting differences, respecting law, respecting other people's rights, having sense of social solidarity, etc., reflect attitudes that every Indonesian citizen should have.

Citizenship Education as the medium of nation and character building is the nation character education. According to Thomas Lickona, character education is education that has to mainly consider values such as wisdom, respecting others, individual responsibility, solidarity, and conflict solver with peace (Doni Koesoema, 2010). National main (character) values that shall be realized in Indonesian citizens are, for instance, faithfulness, intelligence, loving the motherland, state defense awareness, democracy, civilized humanity, competitiveness, discipline, compliance with law, awareness of diversity and justice. The core of those values includes spirituality, solidarity, discipline, and independence. To build powerful NKRI, it also requires having citizens with strong characters who possess keywords like agreement, compliance, and consistency.

5. Values in Mathematics Education and citizenship Education

Learning model selected by teacher can also take a role in transferring values that will be absorbed by the students. Cooperative learning model will be very helpful for growing cooperation values, respecting other people's opinions, human right awareness, and democracy. Problem solving strategy can help to grow creativity, diligence, and persistence. Teaching-learning process with collaborative nuance can help to grow willing and cooperation attitudes. Teaching-learning process with competitive nuance can help to grow courage to face challenges and improve competitiveness. In Indonesia, Realistic Mathematics Education (RME) has been applied since 2006 and is called PMRI. Mathematics learning with PMRI approach

trains students to exercise discipline, independence, negotiation, and respecting other people's opinions (Amin, 2010).

Mathematics learning by using problem solving strategy grows creative, intelligent, diligent, persistent, and highly competitive humans. Open-ended mathematics problems are useful to instill creativity, open mind, and like other values that can be grown through mathematics learning with problem solving strategy in general. National Defence topic shows that every citizen has to be diligent and persistent to face challenges, threats, disturbances, and hindrances. Mathematics learning with problem solving strategy can be applied to instill those characteristics.

Logic material can be used as a medium to improve intelligence. Statistics material, for instance, can select cases about the number of women having higher education than men, so that it can be used to revisit gender equality. Equation material can be used to grow values of equality, balance, justice, and human right. Quadric equation material with various changeable universal set can be used to give direction that every problem solving should always consider context or environment.

Example

Determine a solution from $2x^2 + 7x - 4 = 0$, if x is

a. Natural number,
b. Whole number,
c. Rational number.

The answer for problem a is "no solution", for problem b is "the solution is -4", and for problem c are "-4 and ½". Values contained in this universality can also be related to values of human right awareness. In addition, universality can also be used to instill National Paradigm concept as well as tolerance and it will be useful for the harmony of societal and national life, and for the world's peace.

Arithmetic modulo material can be used to instill tolerance and strengthen regional autonomy policy. For example, in the classroom, teacher divides the class into five groups and each group is assigned to arrange addition table. Addition result for Group I is 4 + 4 = 4, for Group 2 is 4 + 4 = 3 for Group 3 is 4 + 4 = 2, for Group IV is 4 + 4 = 1, and for Group V is 4 + 4 = 8. They cannot blame each other since each group uses its own rule.

Problem "Find the n th term of a sequence 0, 0, 4, 12, 24, 40, 60,…." can be used by teacher to instill life values. The success of answering the problem for elementary/secondary school students requires intelligent, diligence, **meticulousness,** fighting spirit, experience, and fortune. Diligence contains **hard working** and **tenacity**. Inherent intelligence is gained, for instance, when a baby is in the mother's womb, the parents pray a lot and do smart activities. Experience means that children have to do a lot of exercises or, in other words, diligently studying. Fortune is only gained by people

who are close to God. It is as a realization of values of believing to God or **faithfulness.**

Equation learning can be used to instill **fairness.** Learning concept of fraction in terms of division can be used to instill fairness. The following is an example of a small part of a learning material about the meaning of fraction: Mrs. Mami has two children, Ali and Budi. She wants to share some cake to both of her children ***fairly***, that is by dividing the cake into two same sizes. For her, ***dividing fairly is very important*** because ***fairness results to peace*** and ***unfairness may result to enviousness, hatred,*** and ***dispute.***

Deductive-axiomatic mathematics system can be related to life in the society having local cultural values which have to be respected and is considered as a value standard like the positions that definition and axiom are occupied in mathematics. In mathematics, in a certain context, people may set a rule

$a * b = 2a + 3b$ or $a * b = 3a - b$ or $a * b = a^2 - 5b$ or the others.

In societal and national life, there is always an agreement which may be in form of rules that have to become a guideline like definition in mathematics. Therefore, if values of compliance with principles and consistency in mathematics are already instilled in students, compliance with principles, compliance with rules, and discipline will also be instilled in their soul. Freedom in determining a set of rules or the use of symbols in mathematics system can be used to instill freedom, limited independence, democracy, and tolerance.

Postulational mathematics is useful for compliance with life values that have become belief. If one has already determined (with belief) a particular religion that will be held, s/he will comply with all of what the religion teaches. As a result, s/he will become a faithful and moral person according to her/his religion. Tolerance among religious followers can be instilled through value of mathematics universality and that mathematics contains systems with different structures. If every Indonesian has determined Pancasila like the position of axiom in mathematics, they will always uphold values in Pancasila and will not do deeds against the values. Since based on The 1945 Constitution article 27 verse (3) "Each citizen shall have the right and duty to participate in the effort of defending the state", consistency and compliance values can also be used to instill state defense awareness.

Mathematics applied aspects can develop competence and students' attitudes, develop students' competence in applying mathematics to solve problems outside mathematics field or problems in daily life (Suryanto, 2002). This competence development has an essential role for forming competent citizens.

In mathematics teaching learning process, when the teacher is reminding the students not to cheat in an exam, there are values of honesty and good morality which

are related to educational values in general and, in this case, it also includes Citizenship Education values. When the teacher asks the students by saying "Determine the solution set of the following quadric equation in two ways, then compare the two ways", it means that the students are doing activities in the area of pure mathematics. The value it contains is "transparency". When the teacher says "Please check again if you have answered correctly! Don't only rely on calculator when counting, check one more time!", the mathematics education value is "being careful and wise".

Conclusion

The above discussion shows that there is a relation between values in mathematics and Citizenship Education. It means that mathematics education is potential to grow values desired to grow in Citizenship Education. The problem is **how to revitalize mathematics education to contribute in building nation character**. The other crucial problem is how to grow awareness in mathematics society that mathematics education has potency to play a role for achieving success of nation character building. The use of mathematics and mathematics education for instilling values in Citizenship Education will be optimum if planned through curriculum and other learning instruments as well as the teacher's readiness. The question is "Is there any place for mathematics philosophy in school curriculum?" Place in curriculum does not mean to be explicitly in form of a subject, but implicitly in form of mathematics values and mathematics education; they are contained in curriculum until the process of learning mathematics and the instruments. In short, mathematics has a role in citizenship education.

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