

The Education of Mathematics

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Abstract

The objective of mathematics education is not only preparing mathematicians but making well-informed citizens. This is a broad general terms for objective of the teaching of mathematics. And, this might be implemented as “accurate thorough knowledge” or “original logical thinking”. So, teaching mathematics is not the conversation and transmission of mathematical knowledge, but on the aim of preparing well-informed citizens trained in independent, critical thinking.

By the mathematics, sciences become simple, clearer, and easier to be developed. The mathematics is often applied for solving any problem of other field of sciences, either in the physics such as astronomy, chemistry, technique; or social sciences such as economy, demography, and assurance. Those all need an analysis reading ability.

Mathematical skill, therefore, relates strongly with the analysis reading ability in the human intellectual structure. This study is about the relationship between them. And, result of the study shows us as below: Both Mathematical skill and analysis reading ability possess the “high type” of thinking operation. Both also involve the same content of the abstract intelligent, i.e. symbolic and semantic contents. Last but not least, both also use the same product of thinking, i.e. units, classes, relations, and systems. Both can be transformed and have an implication.

Keywords: *Mathematics, Reading, Thinking, Intellectual Structure.*

A. Introduction

The mathematics is an independent discipline of science and is not a branch of the physics.¹ It is media for scientific statement and formulas, but for statement of thinking result and its process. The mathematics is tool and language in many sciences.

¹ Dr. B. Setiawan and others, *Ensiklopedia Nasional Indonesia*, 2nd edition, (Jakarta: PT. Cipta Adi Pustaka, 1990), p. 198.

By the mathematics, sciences become simple, clearer, and easier to develop. The mathematics is often applied for solving any problem of other field of sciences, either in the physics such as astronomy, chemistry, technique; or social sciences such as economy, demography, and assurance.²

Education of Mathematics, therefore, is very important. The philosophers and educators and education foundations, since long time ago had payee their attentions on this importance. Plato (427-347 BC), the disciple of Socrates and a compiler of the complete educational system, for instance, gave a priority the mathematical teaching besides other fields of sciences³ that needed the reading skill.

Whole education institutions along the history showed us also the importance of mathematical skill in life. Therefore, the education of ancient Egypt, India (except caste of Sudra), China, Arab (especially in Kuttab), Greek (especially Athena), and Rome⁴, all gave the priority to the education of mathematics and reading.

In fact, Pondok Modern Gontor Indonesia, as an Islamic Educational Institution, prioritizes education of both mathematics and reading; even more decides the “broad knowledge” and “independent mind” as the part of its mottoes that require adequate level of thinking. This importance really can be treased back to the Islamic teaching: Iqra’ (the command of reading) to increase the human intellectual ability to obey Allah SWT.

This study would concern on the correlation between mathematical skill and analysis reading ability in the human intellectual structure.

B. Definition and Terms of The Mathematics

Mathematics is a study that deals with the properties of and relationship between numbers, qualities, operations, sets, measurements, shapes, etc.⁵ So that, mathematical concepts include

² *Ibid.*

³ I. Djumhur and Drs. H. Danasaputra, *Sejarah Pendidikan*, Second edition, (Bandung: CV. Ilmu, 1974), p. 29.

⁴ *Ibid.*, p. 4-31.

⁵ Morgan L. Walters, *The Holt Intermediate Dictionary of American English*, (New York: Holt, Rinehart and Winston, Inc. 1966), p. 481.

those of number, quality, space, and our number system as a system.⁶

In the terminology of mathematical concept, the terms such as number, quality, operation, set, and so on are well-known. The term “number” as we know is an idea that can answer the question of how many and how much, in regard to collection units. A *numeral* or its equivalent is used to indicate the value number, and numbers are categorized according to their kind and function.⁷ *Quantity* is any arithmetic or algebraic expression that has or represents a certain value or magnitude. Or, it is briefly as an amount, value, or number.⁸ *Set* is collection of elements (object, quantities, etc.) having a certain characteristic or property that distinguishes the element within the collection forms of all other elements in the universe.⁹ *Operation*, is something done by set rules, often as step in a larger process; e.g. the operation of finding a square root, etc.¹⁰

C. Branches of Mathematics

There are many branches of mathematics; either pure or applied mathematics. But, arithmetic and geometry are the main branches of mathematics.¹¹ Algebra is also included. Here there are the following explanations about them:

1. Arithmetic

Arithmetic is a branch of mathematics dealing with the properties and relationship of numbers and the computation with them; the art of using numbers to add, subtract, multiply, divide, etc.¹² it is applied in solving problems. It can be said, everyone of society possess a method to use numbers.

The operation of arithmetic to the real numbers (that involves round number and fraction one) generally has been enough for daily

⁶ Chester W. Harris, *Encyclopedia of Educational Research*, 3rd edition, (New York, The MacMillan Company, 1960), p. 326.

⁷ Morgan L. Walters, *Op. Cit*, p. 325.

⁸ *Ibid.*, p. 644.

⁹ *Ibid.*, p. 735.

¹⁰ *Ibid.*, p. 549.

¹¹ *Ibid.*, p. 40.

¹² *Ibid.*

life. Nevertheless, arithmetic also includes the subject as complex numbers and theory numbers.¹³

2. Geometry

Geometry is a branch of mathematics dealing with space, especially properties, measurements, and relationships of points, and solids.¹⁴ It is consist of Euclid geometry, non-Euclid geometry, and many others geometry.¹⁵

Euclid geometry is such as trigonometry (an enlargement of geometry for triangle) either for horizontal surface or for a ball surface. *Non-Euclid geometry* is developed by refusing the axiom of Euclid about parallel line. Until the present-day, three kinds of geometry was created, i.e. full elliptic geometry, single elliptic geometry, and hyperbolic. And the other geometries that very much are such as analytic geometry that using the equalization of algebra for explaining line and curve.¹⁶

3. Algebra

Algebra is branch of mathematics which represents quantities and relations between them by the use of letters, numerals, and other symbols.¹⁷ It is really an enlarged arithmetic which is its application not only to the numbers, but also to letters. If arithmetic uses the real numbers (round numbers, fraction numbers, and irrational numbers) and complex numbers, algebra also uses the letter such "a + bi", that operated with the method of arithmetic; such as; $p + q$, $p - q$, $1/p + 1/q$, etc.¹⁸

D. The Objective of Mathematics Teaching

The discourse about the purpose of mathematics education is very large. According to David E. Smith, it is changed during the early decades of this century, from preparing mathematicians to making well-informed citizens. This is a broad general terms for

¹³ Dr. B. Setiawan and others, 2nd part, *Op. Cit.*, p. 249.

¹⁴ Morgan L. Walters, *Op. Cit.*, p. 325.

¹⁵ Dr. B. Setiawan and others, 1st part, *Op. Cit.*, p. 198.

¹⁶ *Ibid.*, p. 198.

¹⁷ Morgan L. Walters, *Op. Cit.*, p. 21.

¹⁸ Dr. B. Setiawan and others, 1st part, *Op. Cit.*, p. 198.

objective of the teaching of mathematics. And this might be implemented as “accurate thorough knowledge” or “original logical thinking”.¹⁹ So, the greatest emphasis among the objectives of mathematics teaching, is not the conversation and the transmission of mathematical knowledge, but on the aim of preparing well-informed citizens trained in independent, critical thinking through the study of mathematics.²⁰

William E. Bond also stressed that mathematics education aimed at developing the student’s ability **to think**. This is, in order to equip him with the tool with which he will attack non-mathematical problems.²¹ Mathematics must be a media for statement of thinking result and its process. It is applied for solving any problem of other fields of sciences.

For this, Bond proposed that it is necessary to give the student mathematical literacy for the many occasions that will enable him to recognize mathematical situations which must be referred to a specialist for a solution.²² Eventually, studying mathematics is to be a specialist for a solution.

The students of mathematics should understand the postulation nature of mathematics. They should understand the meaning and significance of the mathematics courses. If this objective is realized, the learner will understand how principles and facts are related to one another, and to the whole content of his mathematics courses. He also will comprehend that mathematics is linked to many other branches of human knowledge and, therefore, is closely related to some of his other school subjects.²³

The term of “well-informed citizens” and “critical thinking” has largely definition in the life areas of contemporary society, because actually the aims of mathematical skills are reflected to them. Alley and Deshler (1979) delineated areas that most students must possess competency to survive in our contemporary society. The areas include:

1. The ability to use measuring devices to determine the size or volume of an object or series of objects.

¹⁹ *Ibid.*

²⁰ *Ibid.*, p. 798-799.

²¹ *Ibid.*

²² *Ibid.*, p. 799.

²³ *Ibid.*

2. Computational skills to determine that size or volume of objects that are not sequential.
3. The relationship of objects, such as equivalent, parallel, similar, dissimilar, and non-equivalent.
4. The ability to estimate or approximate size or volume through a systematic mathematical process.
5. The ability to determine whether sufficient information exists to determine whether a problem can be solved or not.
6. The ability to read and analyze graphic representations of basic number facts, such as graph or maps.
7. The use of basic logic to analyze and solve problems.
8. The use of geometric concepts such as square feet and volume to determine, again, size and quantity.²⁴

Those skills above are urgently needed in the life areas contemporary of society which must be with the critical thinking. This is the objective of mathematics education. So that, learning mathematics is not only comprehending the numbers system and their operational, but the abstract reasoning of it also must be reflected in other areas.

E. Relationship between Analysis Reading Ability and Mathematical Skill

The analysis reading ability and mathematics skill, both are involved as cognitive ability. But, both are different in some dimensions, as reading activity relates with the letters, words, etc. and mathematics or computations activity relates with numbers system and their operations. The relationship between them could be explained as below:

Ability is special term that different from skill. "A human ability is a union of a process(es) and a content(s) inferred from relatively permanent changes in behavior."²⁵ Fleisman and Bartlett (1969), explained that ability is as a product of maturation and learning.²⁶

²⁴ Sudney R. Miller and Patrick J. Schloss, *Career-Vocational Education for Handicapped Youth*, 5th edition, (London: An Aspen Publication, 1982), p. 294.

²⁵ Herbart J. Klausmeir & Richard E. Ripple, *Learning and Human Ability: Educational Psychology*, 3rd edition, (New York: Harper and Row Publisher, 1971), p. 8.

²⁶ *Ibid.*, p. 74.

Much practice and learning are required, for example, to speak French well or to comprehend the concept or principle of biology. Farther, he identified that "one ability may transfer to the learning of a greater variety of a specific tasks involving computation, whereas spatial ability facilitates the learning of broad classes of tasks in mathematics, science, engineering, and other areas.

The difference between ability and skill, that ability is more general and inclusive than skill. The term skill refers to the level of proficiency on a unitary task or a configuration of tasks.²⁷ Then, the implication of both terms in this discourse is using the term ability for analysis reading activity and term skill for mathematical or computational operations.

Analysis reading ability involves identifying, grouping, comparing ability to the facts, data, or ideas based on written language. While *mathematical skill* contain computational skills such as operation of addition, subtraction, multiplying, dividing, integrations, exponents, square root, percents, logs, arc tan, sinus, cosines, tangents, etc. those are some computational skills. Mathematics is often applied for solving any problem of other fields of sciences. As delivered before, that by mathematics, sciences become simple, clearer, and easier to be developed; because collecting relevant and rejecting irrelevant data, making generalizations, and testing the validity of working hypotheses" that urgently needed are included in the computational skills.²⁸

F. Analysis reading ability and mathematical skill in the intellectual structure

In the cognitive domain, the intellectual abilities of human being can be identified from its operation, content, and product. This is suitable with Guilford's concept.

According to Guilford (1966), the definition of ability is a union of an operation, a content, and a product.

Operations of Thinking are involving;

1. Cognition
2. Memory

²⁷ *Ibid.*

²⁸ Chester W. Harris, *Op. Cit.*

3. Divergent Production
4. Convergent Production
5. Evaluation

While *Contents of Thinking* are involving;

1. Figural
2. Symbolic
3. Semantic
4. Behavioral

And *Products of Thinking* are involving;

1. Units
2. Classes
3. Relations
4. Systems
5. Transformation
6. Implications

Five operations, four types of contents, and six products comprise the basic components; therefore, there are $5 \times 4 \times 6 = 120$ projected abilities.²⁹

How are those operation, content, and product in analysis reading ability and mathematics skill?

In analysis reading ability, it uses divergent production more as operational thinking model, but mathematical skill uses convergent production more. There is difference between both. *Divergent production* refers to the generation of new information from given information, where the emphasis is on variety and quantity of output from the same source. Likely to involve what has been called transfer.³⁰ The analysis reading ability is an ability in transferring directly with identifying the main ideas, classifying them, and comparing between them accurately based on the same written units of language as reading source. And *convergent production* is the generation of new information from given information, where the emphasis is on achieving correct or conventionally accepted best outcomes. The

²⁹ Herbert J. Klusmeir & Richard E. Ripple, *Op. Cit.*, p. 81.

³⁰ *Ibid.*, p. 82.

given information determines the response that is accepted as correct. For example, “ $6 : 4 = ?$ ” requires convergent thinking.³¹ So, simply said, whole mathematical or computational skills are requiring convergent thinking in their operations.

In other side, both analysis reading ability and mathematics skill use “symbolic” and semantic content together. Symbolic content is information in the form of signs that have no significant in and of them-self. Such information includes the letter of the alphabet, numerals, musical notation, and any other elements used in coding systems. And “semantic content” is information in the form of meanings attached to words and is thus most important in verbal communication and thinking.³² Learning to recognize words in reading and to operate with numbers involves abilities with symbolic content. And abilities with semantic content are required for understanding verbal concepts and ideas of all types. Guilford associated both types of content with “abstract intelligence”.

Both analysis reading ability and mathematics skill also use the same product of thinking. In Guilford’s system, there are six products by which information in each of the four content areas may be classified:

1. Units

Units are entities, each a relatively segregated or circumscribed item of information. For example; “2” is a symbolic unit, and “baseball” is a semantic unit.

2. Classes

Classes are sets of items of information grouped because of their common properties. Some concepts embody classes; for example; “birds” and “mammals” embody a large number of units, classified according to their common properties.

3. Relations

Relations involve recognized of connections or associations between units information.

4. Systems

Systems are the most inclusive category of the four (units, classes, relations, and systems), it implies organized aggregates of information.

³¹ *Ibid.*, p. 66.

³² *Ibid.*

The other two of the six products do not continue the hierarchy from units through system:

1. Transformations

Transformations involve making changes of various kinds in existing or know information or in usages of this information.

2. Implications

Implications take the form of predictions, statements of expectancy, known or suspected antecedents of events, consequences of certain actions, and other extrapolations of the given information. For example, identifying situation, involves implications from known information. Adding the detailed operations needed to make a briefly outlined plan succeed also illustrates implications with semantic content.³³

G. Conclusion

We could conclude that there is a tied interrelationship between mathematical skills and analysis reading abilities in the human intellectual structure caused of many reasons:

1. Both mathematical skills and analysis reading abilities possess the “high type” of thinking operation. The analysis reading ability needs convergent product thinking, and the mathematical skill needs divergent product thinking.
2. Both also possess the abstract intelligent as both involve the same content, i.e. symbolic and semantic contents. The analysis reading ability relates with the letters, words, etc.; and mathematical or computational skill relates with numbers system, etc. and their operations.
3. Both also use the same product of thinking, i.e. units, classes, relations, and systems. Besides that, both analysis reading ability and mathematical skill can be transformed and have an implication.

³³ *Ibid.*, p. 56-65.

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