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Comparing the Inculcation of the Value of Rationalism from the Australia and Malaysia Mathematics Textbooks

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Abstract: This research seeks to compare the inculcation of the value of rationalism through the form four mathematics textbooks from Victoria (Australia) and Malaysia. One textbook is analyzed from each of the countries. Two chapters were chosen from both of the textbooks, namely Linear Equations and Trigonometry. Contents analysis was used to analyse evidence of the value of rationalism. Five characteristics of the value of rationalism are identified namely reason, explanation, abstraction, logical thinking and theorem. We found inculcation of the value of rationalism was moderate. However, the value of rationalism with characteristics of hypothetical reasoning was missing from both of the textbooks. Both textbooks inculcate the value of rationalism with characteristics of reasons fairly moderately. The inculcation of the value of rationalism with the characteristic of explanation appeared significantly in both textbooks. In contrast, the inculcation of the value of rationalism with characteristics of abstraction and theorem appeared only in the Mathematics Form 4 of the Malaysian textbook. This study highlights the need to inculcate the value of rationalism more thoroughly, especially the value of rationalism with characteristics of reason, hypothetical reasoning and logical thinking. The inclusion of the value of rationalism in the mathematics textbooks will enable students to understand mathematical concepts more deeply and meaningfully.

Keywords: Mathematical values, Value of rationalism, Reason, Explanation, Abstraction, Logical thinking, Theorem and hypothetical reasoning

Introduction

Textbook is considered as a main source of knowledge, skills and values to students. However, are the textbooks having enough qualities to advance students' knowledge, skills and values? The textbook is commonly to be used in any teaching and learning processes in the classroom (Hiebert, Gallimore, Gamier, Giwin, Hollingsworth & Jacobs, 2003). However, Bishop (1988) argue that mathematics teaching is distant from real life situation, and does not how mathematics idea come into mind.

Value is one of the important domain, beside cognitive and effective. Cao, Seah and Bishop (2006) states that "Values are standard for making judgments on what in important…, and they occupy a more central place in our belief system compared with other affective qualities such as attitudes and beliefs…" (page 483). According to Bishop (1988), values can be categorized into three, i.e., general educational values, mathematical values and mathematics educational values. General education values are values related to moral and ethical, however mathematics educational values are values related to pedagogical approaches. However for the purpose of this article, one of the mathematical values, especially the value of rationalism will be the only focus of discussion.
There were a few research indicated that, the mathematical values can be identified in the mathematics textbooks from Singapore, China dan Australia (Cao, Seah, & Bishop, 2006; Seah, & Bishop, 2000). According to Stacey and Vincent (2009) secondary mathematics textbooks in Australia follows a general pattern of introducing new content with explanatory text with one or more worked examples, before presenting a set of exercises for students to solve. Are mathematics textbooks interesting enough for students to learn mathematics?

Are mathematics textbooks having qualities to instill the mathematical values, especially value of rationalism to students?

Value of Rationalism

Mathematical values are qualities related to the characteristic of the mathematics itself and concern how the discipline of mathematics is developed by mathematician from different cultures (Bishop, 1988). Mathematical values are related to the aspect of epistemological mathematics as a discipline (Bishop, 1988; Cao, Seah, & Bishop, 2006; Seah, & Bishop, 2000). The value of rationalism is one of the values in the mathematical values category.

Value of rationalism concerns the use of logic skills available and thus it emphasises the range of values associated with those skills, such as reason, explanations, hypothetical reasoning, abstraction, logical thinking and theories (Bishop 2008; Bishop, Clarke, Corrigan & Gunstone, 2006). The value of rationalism is the most dominant value underpinning teaching and learning mathematics, because it involves logical ideas, hypothetical and reasoning (Bishop, Clarkson, FizSimons & Seah, 2000; Seah & Bishop, 2000).

The mathematical values, namely the values of rationalism could be inculcated to the students during the learning processes in the classroom. The inculcation of the values of rationalism might be happened either explicitly or implicitly. Through the learning processes, the content of the textbooks will be explored by the students and at the same times, either explicitly or implicitly, the value of rationalism could be inculcated into the value's system of the students. Therefore what kind of values and how the values are embedded throughout the mathematics textbooks are very important as sources of experience to students.

There were a few studies about comparing the inculcation of the mathematical values through mathematics textbooks from various countries (Seah & Bishop, 2000; Cao, Seah and Bishop (2006). Comparing the mathematics textbook from China and Australia, Cao, Seah and Bishop (2006) concluded that, the China textbook demonstrate more emphasis on inculcation the value of rationalism, than the Australian textbook under studied. Generally the textbooks from both countries (China and Australia mathematics textbooks under studied) feature the value of rationalism logical connectors and introduction of theorem and formula through proof more prominently.

Another research was conducted by Seah and Bishop (2000) to compare the inculcation of the mathematical values in mathematics textbooks from Australia and Singapore. They concluded that, inculcation of the values of rationalism in Singapore mathematics textbooks was strongly communicated through the use of logic connectors such as 'thus', 'so', 'therefore' and 'hence', all of which imply cause-and-effect and deductive reasoning. Generally, the values of rationalism had been found and emphasized in Australian and Singaporean textbooks (Seah & Bishop, 2000).

Objective of the Research

Generally, the focus of this research is to identify and compare the mathematical values (specifically the value of rationalism) inculcated through the mathematics textbooks of Malaysian and Australian curriculum. Two objectives were to:

- identify the value of rationalism in the Malaysian and Australian mathematics textbooks.
- compare the strengths and weaknesses of the value of rationalism in the Malaysian and Australian mathematics textbooks.

Methodology

The analysis involves one Year 10 secondary school's mathematics textbook from Malaysia and Victoria, Australia. The mathematics textbook from Victoria, Australia is TVA Mathematics Textbook (pseudonym), while from Malaysia is TMA Mathematics Textbook (pseudonym). Two chapters were chosen from each of the textbook, namely "Linear equation" and "Trigonometry". Contents analysis approach is used to analyse the data. Focus of the analysis were the value of rationalism in both textbooks. Analysis were based on the characteristics of the mathematical values, namely value of rationalism as described by Bishop (2008), Bishop, Clarke, Corrigan & Gunstone, 2006, Seah & Bishop (2000), Cao, Seah, & Bishop (2006) and Dollah (2007) and

Dollah, Saad and Abdullah (2014) (Table 1). Research validity and reliability were identified through experts' opinion and member checking validation.

Data Analysis

The discussion about value of rationalism is based on six characteristics, namely reason, explanation, hypothetical reasoning, abstraction, logical thinking and reasoning (Table 1).

Value of Rationalism - Reason

The inculcation of the value of rationalism with characteristics of reasons from the whole chapters of "Linear equation" and "Trigonometry" throughout both textbooks were fairly moderate. The inculcation of the value of rationalism with characteristics of reasons were identified from the used of the words such as "why" and "because" to obtain reasons. Generally, both textbooks rarely contain the words ask for "reason" from the readers or students (see Table 2).

One example of the used of "why" in a mathematics problem from TVA textbook is: **"***Which formula should they use? Why?"* (TVA/LE /pg58/2.01/VR002). Another example involving the uses of "because" as the following: "*Solving a linear equation, such as 2x + 1 = 7, means finding the value of x that makes the mathematical statement true. In this case there is only one answer, x = 3. We know this is true because 2 × 3 + 1 = 7*". (TVA/LE/ pg78/2.07/VR007).

Throughout the TMA Mathematics textbook, there were a few texts involve the word "why". One example is in the following excerpt: "*Using two sinusoid graph drawn on the same axis as illustrated, explain why populations of foxes and rabbits changed cyclically*" (TMA/Trigo/ pg252/9.2c/VR006).

Table 1. Value of rationalism - characteristics

Characteristic	Description
Reason	Giving reasons should enable the people affected by the decision to understand why a particular decision was made (Ombudsman Western Australia, 2016); Reason for the action/ cause and effect (Seah & Bishop, 2000).
Explanations	Explanation refers to an act of explaining the process and product of an act (Rubin, 1992); Explanation is made for students understand mathematical concepts (Dollah, Saad & Abdullah (2014) Explanation on mathematical concepts.
Hypothetical reasoning	A proof involves reasoning from something that is known/ a hypothesis;These are rules of the form A ← (B ← C), which means, "A is true if adding C to the rule base causes B to be true." (Bonner, 1988); Hypothetical reasoning or reasoning under assumptions is a key concept of logic (Schroeder-Heister, 2014).
Abstraction	We claim that the essence of abstraction in mathematics is that mathematics is self-contained: An abstract mathematical object takes its meaning only from the system within which it is defined (Mitchelmore & White, 2004); Abstraction is a process of generalisation, removing restrictions, eliminating detail, removing inessential information (Ward, 2003); Abstraction involved (Cao et al., 2006)' Conceptual process by which general concepts or rules are derived from the usage or specific examples.
Logical thinking	Logical thinking is a process that involves moving from one related statement (antecedents) or thought to another (consequents) (Study.com, 2015). Interconnecting mathematical ideas – inductive and deductive reasoning (Durant-Law, 2013). Reasoning is a process of thought that yields a conclusion from precepts, thoughts, or assertions (Johnson-Laird, 1999).
Theorem	Theorem—a mathematical statement that is proved using rigorous mathematical reasoning. In a mathematical paper, the term theorem is often reserved for the most important results (Richeson n. d.); Introduction of theorem and formula through guided induction (Cao et al., 2006).

Value of Rationalism - Explanation

Inculcation of the value of rationalism with characteristic of explanation is identified very significantly throughout both textbooks. The inculcation of the value of rationalism-explanation can be identified from the

layout/presentation by both chapters from both textbooks. Generally the layout/presentation both of the textbooks are almost similar. Each of the chapter from both of the textbooks begin by giving a list of learning objectives, followed by explaining about some mathematical concepts (including examples and exercises), rich task and end with mathematical questions under the topic "Review".

Learning Objective of the Chapter

Both textbooks begin each of the chapter by highlighting the learning objective. One example of learning objective is taken from the chapter "Linear equations" of TVA mathematics textbook as the following:

- *identify different types of mathematical graphs and their names solve linear equations.*
- *sketch linear equations.*
- *find the equation of a straight line from data and a graph.*
- *solve simultaneous equations using the method of substitution and the method of elimination.*
- *sketch and solve linear inequalities.*
- *make mathematical models of real-world situations.*

(TVA/LE /pg53/Intro/019).

One example of learning objective is taken from the chapter "Linear equations" of TMA textbook as the following excerpt:

- *Learning objectives.*
- *Understand the concept of the slope of the line.*
- *Understand the concept of the slope of the straight line in the Cartesian coordinate system.*
- *Understand the concept of intercept.*
- *Understanding and using the straight-line equation.*

(TMA/LE/pg113/Intro/VR020)

Learning Objective of Each Topic

However, only TMA mathematics textbook have learning objectives for each topic in every chapters. Below is one of the example of the learning objective of the topics in Malaysia mathematics textbook:

- *Learning outcome*
- *To determine "rise" and "run" between two given coordinates on a straight line.*

(TMA/LE/pg114/5.1/VR021)

Table 4.1.1 Inculcate the value of reason

TVA Maths			**TMA Mathematics Malaysia**				
Topic	Use of "why"	Use of "Because"	Topic	Use of "why (mengapa)"	Use of "because (kerana)"	Use of "because reason (sebab)"	(alasan)
2.01							
2.07		Note (TVA/LE/ pg78/2.07/…).	5.2b				Math Problem (TMA/LE/pg122/5.2b/…).
9.01		Note (TVA/Trigo/ pg290/9.01/…).	5.4a		Note (TMA/LE/ pg127/5.4a/VR4)		
		Note (TVA/Trigo/ pg290/9.01/…).					
9.05			5.4e		Note (TMA/LE/ pg131/5.4e/VR5)		
9.06		Note (TVA/Trigo/ pg310/9.06/…).	9.1f			Activity (TMA/LE/ pg241/5.4e/…)	
9.07		Note (TVA/Trigo/ pg317/9.07/…).	9.1g			Example (TMA/LE/ pg243/9.1g/…)	
			9.2c	Note (TMA/Trigo/ pg252/9.2c/…)			

Introduction of the Chapter

There are two ways to introduce the topic, namely through history of mathematical concept and application of mathematical concepts in real life situation. The TVA mathematics textbook use both ways to introduce the

chapters. One example of the used of history when TVA mathematics textbook inserting photographs of Rene Descartes to introduce the chapter “Linear equation”. Another example involve the application of mathematical concepts of “Using simultaneous equation to maximise profit in business” that can be found in the TVA mathematics textbook.

The TMA mathematics textbook mostly used application of math concepts in real life situation as introduction of the chapters. One example, the concept of topology is used as introduction of the chapter of “Linear equation”. Another example, the used of “estimating the position, distance and altitude of a place on earth” as introduction of the chapter “Trigonometry”.

Main Contents

The TVM mathematics textbook contains main contents or concepts through sub topic “Big Idea”. Generally, the sub-topic “big ideas” is presented after the sub-topic "Activity". One example of “Big ideas” from the chapter “Linear equations” by the TVM mathematics textbook gives explanation about what is function, examples of functions, terms and symbols of functions. (TVA/LE/pg54/.06/VR023). Another example of “Big ideas” is from the chapter of the Trigonometry that explaining about trigonometric ratios, namely sins, cosine and tangent using the mnemonic forms, such as SOH (Sine equal Opposite over hypotenuse), CAH (Cosine equal Adjacent over hypotenuse) and TOA (Tangent equal Opposite over Adjacent) (TVA/Trigo/pg298/9.03/VR024).

However, throughout the TMA mathematics textbook, the notes/big ideas are not presented under specific subtopic as in TVA textbook. Usually notes/big ideas are given at the beginning of each subtopics, before the students are exposed to activity or math questions. One example of notes/Big ideas of mathematical concepts discussed in the TMA mathematics textbook is about determining an angle in any quadrant of a unit circle using “trigonometry” (TMA/Trigo/pg231/9.1a/VR025).

Worked Examples

The value of rationalism with characteristics of explanation by both textbooks are shown through the use of worked examples. Generally, in every topic under the chapters "Linear equations" and “Trigonometry” throughout both of the textbooks, these are highlighted in a specific sub-topic called "worked examples” before some mathematical problems or exercises.

In the TVA mathematics textbook, the worked examples are shown in more detail compared to in the TMA mathematics textbook. The worked examples in the TVA mathematics textbook, Not only explain about “plan of procedure” and “solution execution” to the mathematical problem but also attached with links to some source of references (TVA/LE/pg61/2.02/VR027).

The Worked examples in the TMA Mathematics textbook is shown by giving the solution and short note about history of the related concepts. One example of worked example is about mathematical problem involving unit circle. The worked example explained about the solution and also with an insert. The insert contains a short note about history of trigonometry is attached to the mathematics examples (TMA/Trigo/pg323/9.1a/VR029)

Value of Rationalism - Hypothetical Reasoning

The inculcation of the value of rationalism with characteristic of hypothetical reasoning cannot be identified in both of the textbooks under reviewed.

Value of Rationalism - Abstraction

The value of rationalism with the characteristic of abstraction only can be identified from the TMA mathematics textbook, but cannot be found from TVA Mathematics Textbook. Based on TVA mathematics textbook, both chapters under studied did not end with generalization, but only with mathematics problem as exercises. Nonetheless the value of abstraction is identified in the TMA mathematics textbook through concept mapping in

form of diagrams. The concept mapping is presented at the end of each of the chapters (Linear equations and Trigonometry) which were labelled as "summary".

For example, the concept mapping in the topic of Trigonometry is given in diagrammatic form that comprise of the main topic in the chapter of "Trigonometry II".

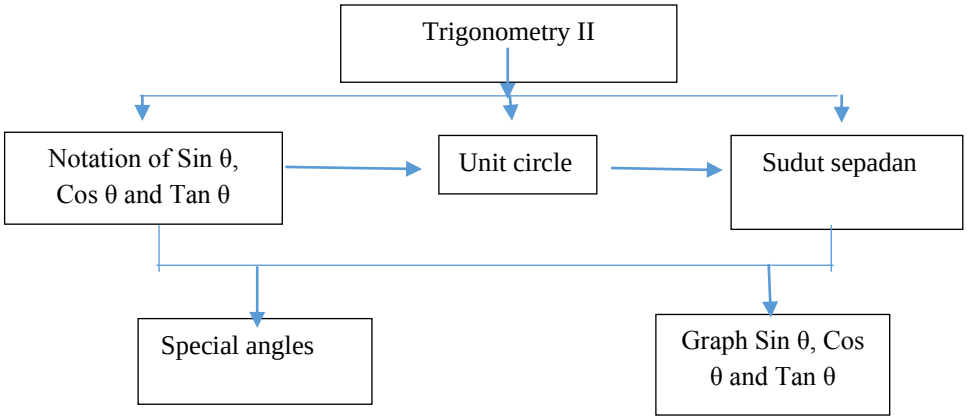

Diagram 1. The concept mapping in the topic of Trigonometry (TMA/Trigo/pg253/ConceptMap/VR030)

Value of Rationalism - Logical Thinking

The inculcation of the value of logical thinking is identified from both of the chapters "Linear equations" and "Trigonometry" of both of the textbook. The Inculcation of the value of logical thinking is identified in two ways, namely deductive and inductive reasoning. Generally, the value of logical thinking is identified through work examples and activities. The TVA mathematics textbook is more emphasized on deductive reasoning then inductive reasoning. However the TMA textbook fairly emphasized on both, namely deductive and inductive reasoning.

Inductive Reasoning

The Inductive reasoning is identified when the mathematics task aimed to formulate a generalization based on specific pattern of observation. The TMA mathematics textbook more emphasized on inductive reasoning than TVA mathematics textbook. The inculcation of the value of logical thinking is identified through work examples and activities from both of the textbooks.

One example of inductive reasoning from the chapter "Linear equation" of TMA mathematics textbook is when the activity aimed to formulate a formula of gradient of straight line based on pattern of gradient obtained from a few pairs of point on straight line given (TMA/LE/pg118/5.2a/VR031).

The Inductive reasoning is rarely identified through TVA textbook. All the inductive reasoning from TVA Mathematics textbook can be identified through activities. One example of inductive reasoning from TVA Mathematics textbook is the activity involves a toy car moving down an adjustable slope. The activity is to conclude pattern of relationship between gradient and speed of an object moving down the slope (TVA/LE/pg64/2.03/VR033).

Deductive Reasoning

The deductive reasoning is identified when reasoning goes from general (multiple premises that are considered to be true) to specific (conclusion). Deductive reasoning is identified very significantly from both of the textbooks.

Here is an example of the deductive reasoning from TVA mathematics textbook from the chapter "Linear Equation". The example come from worked example about determining the x-intercept and y-intercept for the given equation ($3x - 5y = -15$). The deductive reasoning is when the x-intercept and y-intercept are determined

from premis namely "the line cutting the x-axis (when y = 0) and the y-axis (when x = 0)". (TVA/LE/pg61/2.02/VR034)

Another example of logical thinking through deductive reasoning from the chapter of "Linear equation" of TMA mathematics textbook through application of general mathematics concepts, namely gradient, y-intercept and x-intercept, to find coordinates when a straight line passing through y-axis (TMA/LE/pg125/5.3b/VR037). The premises such as gradient, y-intercept and x-intercept are considered as true to find specific conclusion, this is coordinate when a straight line passing through y-axis.

Value of Rationalism - Theorem

The inculcation of the value of rationalism with characteristic of theorem is only identified in the TMA mathematics textbook, but cannot be identified in the TVA mathematics textbook. The inculcation of the value of theorem in the TMA mathematics textbook happened only in a few cases through activities. All of the activities involved to prove mathematical formulas using inductive approaches.

One example of the inculcation of the value of rationalism with characteristic of theorem is through an activity to prove formula of gradients "gradient = $\frac{y2-y1}{x2-x1}$ " is similar to the " $-\frac{y-intercept}{x-intercept}$. "

(TMA/LE/pg124/5.3b/VR039).

Discussion and Conclusion

Generally, the inculcation of the value of rationalism can be identified from both of the chapters, namely "Linear equation" and "Trigonometry", of the textbooks under studies. However, the inculcation of the value of rationalism is moderate to all of its characteristics, namely reason, explanation, hypothetical reasoning, abstraction, logical thinking and theorem.

Three characteristics of the value of rationalism were identified from both textbooks under studied, namely reason, explanation and logical thinking. The inculcation of the value of rationalism with characteristics of reasons from both textbooks are fairly moderate. The used of words or phrases that ask the students to give reasons from both textbooks are rarely appeared. The inculcation of the value of rationalism with the characteristic of explanation appeared very significantly in both of the textbooks.

Logical thinking is another characteristic of the value of rationalism that gave emphasize moderately by both of the textbooks. The characteristic of logical thinking can be found through activities and worked example in both of the textbook. However, based on the research comparing the inculcation of mathematical values in mathematics textbook from Australia and Singapore that was done by Seah and Bishop (2000), the value of rationalism in Singapore mathematics textbooks was strongly communicated through logical thinking, namely deductive reasoning.

The Malaysia mathematics textbook is more diverse in inculcating the value of rationalism. This is supported by the finding that, the characteristic of value of rationalism namely abstraction and theorem only can be found in the Malaysia mathematics textbook. However, based on the research comparing the inculcation of mathematical values in mathematics textbook from Australia and China that was done by Cao, Seah and Bishop (2006), the value of abstraction only can be found in China Mathematics Textbook. However, from this research that involves the TVA Mathematics textbook and the TMA Mathematics textbook, the value of rationalism with characteristics of hypothetical reasoning is missing from both of them.

This study highlights the need to consider the inculcation of the mathematical values, especially the value of rationalism more thoroughly and significantly in the mathematics textbooks. There are many characteristics of the value of rationalism that can be found in the mathematics textbooks from both of the country, such as reason, explanation, and logical thinking. However the textbooks should put more emphasized on inculcating the values of rationalism, especially the characteristics of reason, hypothetical reasoning, logical thinking and theorem, so that students will understand mathematical concepts more deeply and meaningfully.

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