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How do Indonesia and New Zealand facilitate their students in learning statistics? A comparative study on the intended mathematics curriculum

Abstract: Students' learning outcomes can be influenced by the intended curriculum as the main guidelines for teachers in facilitating their students to learn. Comparative study can be conducted to evaluate to what extent the intended curriculum of a country is designed to give an opportunity for students to learn compared to the other countries. The present comparative study was aimed at describing the similarities and differences between Indonesia and New Zealand in facilitating their students in learning statistics. To gain this objective, the official documents of curriculum of those Countries were analyzed qualitatively. The analysis was focused on the expected competence. The results show that New Zealand provides more facilities for their students in learning statistics through statistical investigation and literacy than Indonesia. At the particular level, both Indonesia and New Zealand give the same content but the depth of the discussions given to their students is different. These results could be beneficial for both countries as well as the others as the consideration to improve the quality of their curriculum.

Keywords: comparative study, Indonesia and New Zealand, intended curriculum, statistics.

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Introduction

An education held by a country has the aims and purposes which might be different from the other countries because of the existing difference in terms of the national philosophy of education which they are referring to. Education plays a crucial role in a country as well as for the citizen of that country as it can be used as a means for promoting good quality of the economy, society, and human being. According to Idris, Hassan, Ya'acob, Gill, and Awal (2012), the essential purpose of education is to facilitate individuals to become knowledgeable and internalize the attitudes and moral values of their society so that they can actively and efficiently participate in developing their society as well as contribute to the development of their country. Furthermore, Bhardwaj (2016) states that the education conducted by a country, basically, is intended to educate people so that they become better citizens who have a good character and time management, more confidence in doing something useful and communicating with others, and also successful in pursuing their desired goal.

In general, the practice of the implementation of education can be divided into three forms of education. These three forms of education consist of formal education, non-formal education, and informal education. The formal education, which it becomes the focus of this study, is a well-organized and structured form of education in which it has to involve the educator, the student, and the educational institution and also it cannot be separated from a curriculum (Dib, 1988; Grajcevci & Shala, 2016). Glatthorn, Boschee, and Whitehead (2009) define curriculum as the widely accessible plans which are intentionally developed to be used as a

guideline for conducting educational activities in the schools and the realization of those plans in the classroom with all of the unplanned things in the learning environment which might affect the process of educational activities. Such unplanned things are well-known with the term 'hidden curriculum'. Referring to this definition, it can be said that the curriculum does really matter in conducting educational activities. The importance of the curriculum is also supported by Wijaya (2017) who revealed that the performance of students could be affected by the curriculum.

Actually, the curriculum should not be defined in only one fixed definition because it has various definitions that rely on the point of view and agenda of each educational authorities or stakeholders (Su, 2012). For instance, Su (2012), through her study on the various perspectives of curriculum, summarized the concepts of curriculum into five perspectives from the narrowest one to the broadest based on its components; namely curriculum as a set of educational objectives, as content of subject matters, as plans, as documents, and as programs for experiences. In the narrowest perspective, curriculum is seen as set of desired educational objectives that should be achieved by students through educational activities. In contrast, in the broadest perspective, curriculum is perceived as holistic and interactive programs for experiences in which it not only covers the planned components such as documents in the form of syllabus (content of subject matter, educational goals, instructional methods, and assessment), but it also covers the learning environment and extracurricular activities, hidden curriculum, and cultures.

The perspectives on the curriculum proposed by Su (2012) are similar to the model of curriculum in which it divides into three levels; namely the intended curriculum, implemented curriculum, and attained curriculum (Eggen, Pelgrum, & Plomp, 1987; Hirsch & Reys, 2009; Leung, 1992; Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002; van den Akker, 2003). Of these literatures, the intended curriculum could be specified as the official, standard, and national documents issued by the government in which it usually includes the rationale or philosophical foundation of conducting education, the learning objectives or the expected learning outcomes, the content standard of learning that is expected to be learned by the students, and the methods that can be used by the teachers to facilitate students to learn in the learning process. Arguably, the intended curriculum is the curriculum that lies on the level of educational system of a country. The intended curriculum which is implemented in educational institution (i.e. school) and classroom, then, is perceived as the implemented curriculum. Similarly, the implemented curriculum reflects contents, methods, strategies, and activities of learning which are actualized by the teacher throughout the process of learning in the classroom. The last, what the students have experienced and gained through that learning process facilitated by the teacher is known as the attained curriculum. Such three levels model of curriculum, later, could be expanded by adding the potentially implemented curriculum as a level between the intended and implemented curriculum (Hirsch & Reys, 2009; Schmidt, Raizen, Britton, Bianchi, & Wolfe, 2002; Valverde et al., 2002). The potentially implemented curriculum, also well-known as the textbook curriculum, refers to the instructional material that are used to support in understanding and implementing the intended curriculum and it can be in the form of the textbook, workbook or educational software (Hirsch & Reys, 2009; Schmidt et al., 2002; Valverde et al., 2002).

Considering the aforementioned model of curriculum, it can be argued that the intended curriculum is the crucial thing for conducting education in a country due to its significant influence towards the implemented and attained curriculum. Other than that, Hirsch and Reys (2009) states that the implemented curriculum provides a guidance in developing textbook and assessment as a tool to monitor the program of school and students learning. In addition, what students attained (i.e., achievements and attitudes) from the learning process facilitated by their teachers, eventually, determined by the intended curriculum. The empirical study conducted by Zuzovsky (2003) showed that the implemented curriculum is the determining factor, although it is not the one and only, of students' learning outcomes.

To know the students' learning outcomes, what students know and can do, the assessment should be conducted. The assessment could be conducted locally, nationally, or internationally. International assessment has attracted the attention of many countries and even some of those countries decided to reform their educational system, which it may include the intended curriculum, after taking into consideration on the results of that international assessment. The two international assessments which commonly have gained more attention than others from many countries are the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS). PISA is a triennial assessment which is aimed to assess the students of 15 year olds in reading literacy, mathematics literacy, and science literacy (OECD, 2019). PISA is considered as the assessment which not relies on the curriculum standard (Volante, 2018;

Wijaya, 2017) because such assessment is focused on examining students' competence in generalizing and applying what they have learned in school in unfamiliar setting (OECD, 2019). In contrast, TIMSS, which is a quadrennial assessment conducted to examine the fourth and eighth grades students in science and mathematics, is the assessment which uses curriculum of three levels as previously mentioned (Mullis & Martin, 2017). Consequently, when we are discussing about the intended curriculum of a country, then referring the results of TIMSS becomes much more relevant. Furthermore, Mullis and Martin (2017) also states that the data of TIMSS results combined by the context questionnaire scales can be utilized to monitor the possibly impact caused by the certain educational policies and detect exactly in which areas students are less success than expected.

The TIMSS assessment is constructed based on the two dimensions, namely content dimension that reflects the subject matter (i.e., mathematics and science) and cognitive dimension that reflects the students' process of thinking (Mullis & Martin, 2013, 2017). In case of mathematics subject at the fourth grade, the content dimension comprises of three content domains, namely number, measurement and geometry, and data. While at the eighth grade, it comprises of four content domains, namely number, algebra, geometry, and data and probability. Data, as one of content domains that appears at fourth and eighth grades, is considered as the important content that should be learned by every student at school by means of understanding, handling, and using data to solve problems. Because statistics is concerned with working on the data, the aforementioned statement becomes relevant along with the necessity of students to be facilitated in learning statistics at school. In addition, Christozov, Chukova, and Mateev (2007) argued that learning statistics is so important as it applies in many field. Discussing about handling data and statistics, one of the countries that should be considered in this case is New Zealand. Forbes (2014) states that "New Zealand has been leading the world in terms of the data handling, and in more recent years, data visualisation approach in its school statistics curriculum" (p. 1). Moreover, the latest TIMSS results in Mathematics (Mullis, Martin, Foy, & Hooper, 2015b, 2015a) showed that New Zealand at the position between intermediate international benchmark and high international benchmark in which the New Zealand students perform best in the data and data and probability domain. Accordingly, it would be interesting to study about the curriculum of New Zealand specifically in the data and probability domain.

The results data of international assessment, especially TIMSS, provides such a wide opportunity for us to perform a cross-national or international comparative study. This type of study is conducted to compare the two or more countries at the national context in which the objects of study can be in the form of the educational system and policy, national regulation, and political issue (Cai, Mok, Reddy, & Stacey, 2016; Wahlström, Alvunger, & Wermke, 2018). In the context of educational system and policy, some of the objectives of comparative study as mentioned by Postlethwaite (Cai et al., 2016) are to identify the possible contributing factors to the educational system and outcomes as well as to describe the similarities and differences between educational systems and interpret the possible reasons behind the existence of them. This study, therefore, was intended to analyze the similarities and differences between intended curriculum of Indonesia and New Zealand in the domain of statistics because Indonesia has a low performance in TIMSS, especially in the data domain (Mullis et al., 2015b, 2015a).

Research Methods

This is a comparative curriculum study (Cai et al., 2016) in which the cross-national qualitative study with documentary methods (Mangen, 1999) were carried out in this study. The main object of this study was the intended mathematics curriculum of Indonesia and New Zealand. As a consequence, to achieve the objective of this study, the official documents of intended mathematics curriculum of both countries were analyzed qualitatively. The documents that were analyzed in the present study were the Regulation of Minister of Education and Culture of the Republic of Indonesia Number 37 of 2018 on Amendment to Regulation of Minister of Education and Culture Number 24 of 2016 on Core Competencies and Basic Competencies of Subject Matter in Curriculum 2013 for Units of Primary and Secondary Education (MoEC, 2018) and the New Zealand curriculum for English-medium teaching and learning in years 1–13 (MoE, 2015). The analysis of these documents was begun with the preliminary investigation into educational structures of those two countries (see Table 1) and after that the analysis was continued on the national mathematics curriculum. Lastly, we analyzed on the learning objectives in statistics domain and the extent to which the statistics contents are designed to facilitate students to learn statistics.

Table 1. An overview of Education System in Indonesia and New Zealand

Age Range	New Zealand			Indonesia	
	Year	Typical Curriculum Level	School Level	School Level	Grade
5-6	1	Early Level 1	Primary school		
6-7	2	Level 1		Elementary school	1
7-8	3	Early Level 2			2
8-9	4	Level 2			3
9-10	5	Early Level 3			4
10-11	6	Level 3			5
11-12	7	Early Level 4	Primary school or intermediate school		6
12-13	8	Level 4		Junior high school	7
13-14	9	Early Level 5	Secondary school; Junior secondary school		8
14-15	10	Level 5			9
15-16	11	Level 6	Secondary school; Senior secondary school	Senior high school	10
16-17	12	Level 7			11
17-18	13	Level 8			12

(Christozov et al., 2007; KICE & NZQA, 2015; MoE, n.d., 2015; Torar & Wahono, 2016)

Results and Discussion

In Indonesia, the existing curriculum was designed in order to facilitate their students to develop their competences in which these competences comprise of spiritual attitude competences, social attitude competences, knowledge competences, and skills competences (MoEC, 2018). The last two competences, then, were divided into core competences and basic competences. The core competences among the subject matters are not different, while the basic competences among the subject matters were set to be different. In the case of mathematics subject matter, there are five focus or scope of mathematics materials that are expected to be learned by students in elementary and high school. These are the concepts and operations of number, relation and algebra, measurement and geometry, statistics and probability, and calculus. What students expected to learn those five mathematics scopes when they are learning at school from 1st grade of elementary school until 12th grade of senior high school is set by basic competencies in knowledge and skills domain as well.

As for in New Zealand, the 'Mathematics and Statistics' is considered as one of eight learning areas specified in the New Zealand curriculum. That learning area is not considered as "Mathematics" because of some differences between them in terms of ways of thinking and the ways of solving problems (MoE, 2015). This learning area, then, derived into three strands, namely number and algebra, geometry and measurement, and statistics. The statistics strand is divided into three focus of learning competences, i.e., statistical investigation, statistical literacy, and probability. In contrast to the mathematics curriculum of Indonesia, what students expected to learn or achieve is set by the levels, i.e., level 1 up to level 8 (see Table 1). These levels are created with the aim to provide an opportunity for their students to understand the concepts within mathematics and statistics "at their own pace and go as far as they feel comfortable with" (Christozov et al., 2007).

Considering the structure of education system in Indonesia and New Zealand as provided in Table 1, the comparisons between both countries in facilitating their students to learn statistics are be presented in Table 2 up to Table 9. Such interesting result in which the statistical literacy is explicitly mentioned in the intended curriculum of the New Zealand. The statistical literacy is one of competencies required to be developed by the students in the era of fourth industrial revolution. This literacy minimally includes the understanding towards the rationale of collecting data, the data collected by using random and non-random sampling techniques, data privacy issue, the way to create descriptive analysis, the reason behind the data adjustment, and predictive modeling (Gould, 2017). Even though in the intended mathematics curriculum of Indonesia does not mention explicitly the competence of statistical literacy, the provided descriptions in Table 4, for instance, has represented that the intended mathematics curriculum of Indonesia also facilitates their students to develop their statistical literacy by means of learning statistics.

The result of this study also showed that students in New Zealand are facilitated to learn statistics in every year of the study, from year 1 up to year 13. In contrast, at the several grades, the students in Indonesia

are not facilitated to learn statistics (see Table 2, Table 7, and Table 8). Moreover, students in New Zealand is facilitated to learn statistics earlier than students in Indonesia in which the students in New Zealand start to learn statistics at the Year 1, while the students of Indonesia start to learn statistics when they at the Grade 3. Therefore, when the students of Indonesia and New Zealand are sitting down at the same age or year, the content learned by students of New Zealand more advanced than Indonesia.

Table 2. The competence in statistics expected to be achieved by students by the end of year 2

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	-
	Basic Competence in the Skills Domain	-
New Zealand	Statistical Investigation	Employ the statistical enquiry cycle (posing and solving questions; collecting, classifying and counting, and presenting category data; and discussing the results) as a means of investigation activities
	Statistical Literacy	Construct an interpretation of the statements made by the other students based on the statistical enquiries and probability activities

Table 3. The competence in statistics expected to be achieved by students by the end of year 4

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	Give an explanation towards the data related to the student itself in which that data is displayed in the form of pictogram
	Basic Competence in the Skills Domain	Display the data about the student itself in the form of pictogram
New Zealand	Statistical Investigation	Carry out investigations through the cycle of statistical enquiry (i.e. pose and answer the problems; collect and handle the categorical and whole-number data)
	Statistical Literacy	Make a comparison towards the statements with the attributes of simple data displays from probability activities and statistical enquiries

Table 4. The competence in statistics expected to be achieved by students by the end of year 6

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	Give an explanation towards the data related to the student itself and his surroundings in which that data is displayed in the form of bar chart
		Give an explanation towards the data related to the student itself or his surroundings and the methods used to collect that data
		Explain the data display related to the student itself and compare it to the data from his surroundings in the form of data list, table, pictogram, bar chart, or line chart
	Basic Competence in the Skills Domain	Collect the data related to the student itself and his surroundings and display that data in the form of bar chart
		Analyze the data related to the student itself or his surroundings and the methods used to collect that data
		Organize and display the data related to the student itself and compare it to the data from his surroundings in the form of data list, table, bar chart, pictogram, or line chart
New Zealand	Statistical Investigation	Carry out investigations through the cycle of statistical enquiry (i.e. collect and handle multivariate categorical, whole number and time-series data to find Solutions to the question; recognize pattern and trend within and between the sets of data; and communicate the findings by using data displays)
	Statistical Literacy	Make a judgment towards the other students' work on presenting the findings of the statistical enquiries and probability activities

Table 5. The competence in statistics expected to be achieved by students by the end of year 8

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	Explain and compare the mode, median, and mean of the ungrouped data in order to determine which value best represents that data
		Analyze the relationship between the data and data display (table, line chart, bar chart, and pie chart)
	Basic Competence in the Skills Domain	Solve a problem related to mode, median, and mean of the ungrouped data
		Display and interpret the data in the form of table, line chart, bar chart, and pie chart
New Zealand	Statistical Investigation	Devise a plan and also carry out investigations through the cycle of statistical enquiry (i.e., decide the suitable variables and methods to collect data; recognize any patterns and trends by means of working on multivariate category and time-series data; visualize the comparison of distributions; and present the findings properly)
	Statistical Literacy	Conduct an evaluation towards the other students' statements on the findings of the statistical enquiries and probability activities

Table 6. The competence in statistics expected to be achieved by students by the end of year 10

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	Analyze the data according to the data distribution, mode, median, and mean to make a conclusion, decision, and prediction
	Basic Competence in the Skills Domain	Pose and solve the problem related to the data distribution, mode, median, and mean to make a conclusion, decision, and prediction
New Zealand	Statistical Investigation	Carry out the cycle of statistical enquiry such as make a comparison sample distribution by using centre, spread, and proportion measures
	Statistical Literacy	Make a judgment on the statistical enquiries or probability activities conducted by the other students which includes, for instance, the judgment about the validity of obtained results

Table 7. The competence in statistics expected to be achieved by students by the end of year 11

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	-
	Basic Competence in the Skills Domain	-
New Zealand	Statistical Investigation	Carry out the cycle of statistical enquiry such as manage the sources of variation through the use of random sampling and make an informal inference
	Statistical Literacy	Make a judgment towards the reports issued in the media based on the aspects of data display, statistics, and methods used to derive a claim

Table 8. The competence in statistics expected to be achieved by students by the end of year 12

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	-
	Basic Competence in the Skills Domain	-
New Zealand	Statistical Investigation	Carry out the cycle of statistical enquiry including work with random sampling techniques and exploratory data analysis as parts of the investigation towards phenomena
		Make an informal predictions and recognize the influence of sample size on the variability of an estimate

Country	Aspect	Description
	Statistical Literacy	Make a judgment based on the statistical concepts to the report by means of make an interpretation towards the risk and relative risk and identify the errors either caused by or not caused the random selection

Table 9. The competence in statistics expected to be achieved by students by the end of year 13

Country	Aspect	Description
Indonesia	Basic Competence in the Knowledge Domain	Determine and analyze the central tendency and distribution of the data which represents in the form of histogram and the table of frequency distribution
		Explain the characteristic of the data which normally distributed
	Basic Competence in the Skills Domain	Determine the solutions to the problem related to the data displays from the result of measurement and enumeration in the form of histogram and the table of frequency distribution
		Solve a problem related to normal distribution and its inference
New Zealand	Statistical Investigation	Carry out the cycle of statistical enquiry including conduct experiment using the principles of experimental design and survey and work with the additive model and linear regression as parts of conducting investigation towards the phenomena
		Determine the estimation and confidence interval for proportion and means, recognize the concept of the central limit theorem, and conduct randomization or resampling to determine the quality of evidence as a means of drawing a conclusion
	Statistical Literacy	Make an evaluation towards the large-scale of statistically based reports by means of posing critique on the emerged causative-relationships claims and interpreting the existed margin of error

Conclusion

This comparative study was reported the findings on the similarities and differences of the intended curriculum of Indonesia and New Zealand in facilitating their students to learn mathematics. From the results of this study, it is hoped that those results can be useful for Indonesia, especially, and New Zealand as one of the consideration in refining and improving the intended mathematics curriculum as a means to give a more facilitation for students to learn statistics deeply. The future works is encouraged to conduct comparative study on the textbook that are used in Indonesia and New Zealand to learn statistics.

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