Analyzing Thai curriculum indicators on the basis of PISA competencies in science and mathematics

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Abstract. A great challenge of Thai students becoming quality global citizens considerably depends on an ability of education to provide sufficient knowledge, skills, and attributes, especially, in science and mathematics, to acquire competencies necessary for their lives in 21st century. Unfortunately, Thai students’ competencies in science and mathematics assessed by the Programme for International Student Assessment (PISA) still fall behind other students in several countries. This study analysed Thai Basic Education Core Curriculum indicators based on their relevancy to PISA key competencies in science and mathematics, and the key competencies that the core curriculum focuses on were found. Unfortunately, neither those focused competencies in science nor mathematics resulted in any predominant PISA results. This obviously illustrates that only a well-constructed curriculum cannot ensure quality of student learning, but the core curriculum is also required to be well-understood by teachers, who are responsible for delivering a quality learning to their students. It is anticipated that this study could provide a better understanding for Thai teachers that there is still plenty of rooms for improvement in student learning so that Thai students are well-prepared to confront challenges of the future awaits.

1. Introduction

Knowledge of science and mathematics has proven itself to be a foundation of technology advancement, which brings about rapid globalisation as well as transformation of how people learn things. Approaches that teachers are currently educating their students by passing on as much knowledge as possible may no longer be suitable to support the development of people’s 21st century skills. A new approach of student learning requires teachers to adjust their roles from only being a teacher to be “a coach” or “a learning facilitator” [1]. Especially, teachers in science, mathematics, and technology can play an extremely important role since they are able to give students a perspective of the significance of science and mathematics to several aspects of the world.

One of the tools for measuring student’s competencies in science and mathematics is the Programme for International Student Assessments (PISA) organised by the Organisation for Economic Co-operation and Development (OECD). PISA is internationally acknowledged for reflecting a current state of the education system of a participating country in preparing its 15-year-old students to encounter challenges of the world awaits [2]. Since the first participation in 2000, Thailand has been struggling in achieving better PISA results [3]. However, a particular group of Thai students, for example, those from science high schools and demonstration schools, outperformed average PISA scores of students from OECD
countries [4-6]. It should be noted that education provided by these schools is constructed based on indicators of the Thai Basic Education Core Curriculum [7], which are also used by most schools in the country. This is a preliminary evidence that the core curriculum itself is sufficiently potent to maximise student competencies measured by PISA.

Regarding the current core curriculum being considered sufficient for developing an effective student learning, Thai education had been reformed through a number of revisions of the core curriculum since 1960 [8]. Several years later, in 1999, the National Education Act was enforced followed by the publication of a new core curriculum in 2001. Purpose of the published core curriculum was to encourage schools and community to increasingly contribute to student learning. The core curriculum underwent another crucial revision again in 2008 to make it more practical for implementing in schools. Currently, most schools in Thailand are using this core curriculum, which consists of learning standards and indicators that was under minor revision in 2017. It is important to be noted that the current curriculum was initially designed based on standards, not competencies. This significant reason of the core curriculum not focusing on building student competencies might cause PISA results of Thai students to be relatively constant since 2000.

Although the core curriculum is standards-based, this does not limit possibilities of teachers to deliver a quality competencies-based learning, which could support students in surviving the 21st century. This study aimed to prove that the core curriculum can enable teachers to do so. Therefore, an analysis of the core curriculum was carried out on the basis of PISA competencies in science and mathematics. Results of the analysis were compared to the PISA results to find out correlations between them so that it can be understood that at which particular area out of the overall competencies that Thai students are still able to improve further.

2. Method

Study procedure was applied as follows:

- Compile indicators of the Thai Basic Education Core Curriculum for junior high school courses and separate them according to grade 7 to 9 (Mattayom 1 to 3).
- Analyse and categorise the indicators on the basis of PISA key competencies in; science, namely, explaining phenomena scientifically, evaluating and designing scientific enquiry, and interpreting data and evidence scientifically; and in mathematics, namely, formulating situations mathematically, employing mathematical concepts, facts, procedures and reasoning, interpreting, applying and evaluating mathematical outcomes, and mathematical reasoning [9-10]. The curriculum manuals (revised edition 2017) in accordance with the basic education core curriculum 2008 were also studied for further description of the indicators [11-12].
- Calculate percentages of the indicators in each category to find proportion of grade 7 to 9 indicators that are relevant to the PISA key competencies.
- Compare the calculated percentages of the indicators to PISA results in separate categories of the key competencies to see correlation between them.

3. Results and Discussion

3.1. Analysis of the Thai Basic Education Core Curriculum

Analysis of the Thai Basic Education Core Curriculum clearly shows that it has already included expected student behaviours, which are similar to the key competencies assessed by PISA. For the core curriculum indicators in science, Figure 1 shows that proportion of explaining phenomena competency is relatively constant at 47.2, 48.7, and 46.9 percent for grade 7, 8, and 9, respectively. However, proportion of evaluating scientific enquiry competency falls from 20.4 percent in grade 7 to 20.0 and 12.9 percent in grade 8 and 9, respectively. In contrast, interpreting data competency increases from 32.4 to 40.2 percent during grade 7 to 9. Moreover, an average of the percentages of the core curriculum indicators explicitly shows that the core curriculum in science focuses on student ability in elaborating surroundings using scientific knowledge they have gained and increasingly emphasises on educating
student to scientifically interpret data and evidence they found. However, the curriculum still lacks indicators that would direct teachers to conduct learning that encourages students to design a scientific enquiry and evaluate it.

![Proportion of the PISA key competencies in science found in grade 7 to 9 (Mattayom 1 to 3) of Thai Basic Education Core Curriculum indicators.](image)

| Scientific Competencies                        | Grade 7 | Grade 8 | Grade 9 | Average |
|-----------------------------------------------|---------|---------|---------|---------|
| Explaining phenomena scientifically            | 47.2%   | 48.7%   | 46.9%   | 47.6%   |
| Evaluating and designing scientific enquiry   | 20.4%   | 20.0%   | 12.9%   | 17.8%   |
| Interpreting data and evidence scientifically  | 32.4%   | 31.3%   | 40.2%   | 34.6%   |

Figure 1. Proportion of the PISA key competencies in science found in grade 7 to 9 (Mattayom 1 to 3) of Thai Basic Education Core Curriculum indicators.

On the other hand, such trends were not observed in the core curriculum indicators in mathematics as can be seen in Figure 2. This could be due to a strong correlation between mathematical contents and processes that makes them inseparable so that the key competencies are not equally distributed throughout all grades. Nevertheless, considering the core curriculum as a whole, all key competencies were proportionately established. It can be seen by taking all the core curriculum indicators of grade 7 to 9 into account, average percentages of the core curriculum indicators relevant to formulating, employing, interpreting, and reasoning competencies are 23.9, 28.2, 23.9, and 24.0, respectively.
### Mathematics Competencies

| Competency   | Grade 7 | Grade 8 | Grade 9 | Average |
|--------------|---------|---------|---------|---------|
| Formulating  | 16.1%   | 31.3%   | 24.3%   | 23.9%   |
| Employing    | 37.5%   | 18.1%   | 28.9%   | 28.2%   |
| Interpreting | 30.3%   | 18.1%   | 23.4%   | 23.9%   |
| Reasoning    | 16.1%   | 32.5%   | 23.4%   | 24.0%   |

**Figure 2.** Proportion of the PISA key competencies in science (left) and mathematics (right) found in grade 7 to 9 (Mattayom 1 to 3) Thai Basic Education Core Curriculum indicators.

#### 3.2. Relationship between proportion of the indicators and PISA results

Firstly, it should be noted that the core curriculum indicators being analysed in this study were subjected to a minor revision in 2017 after its creation in 2008. However, PISA results in science and mathematics used for making a comparison to the analysis of the indicators are from PISA 2012 and PISA 2015. Since the revision of indicators in 2017 was not made in a significant detail of the core curriculum, it can be assumed that there has been only a slight change in the core curriculum. Hence, a comparison between the analysis of the indicators and PISA results in 2012 and 2015 should be considered valid.

Since science was a major focus of PISA 2015, results of student’s scientific competencies were reported in detail and were to be analysed in the study. Relationship between percentages of the core curriculum indicators and PISA 2015 results in science is shown in Figure 3. Percentages of Thai students with performance at level 2 and above of PISA scale were included in the comparison. It was reported that level 2 can be recognised as a baseline that 15-year-old students at this level are able to take a part in real-world situations related to science and technology using their scientific knowledge and skills. The relationship shown is Figure 3 can illustrate how scientific competencies were developed in Thai schools.
Figure 3. Comparison between percentages of the Thai Basic Education Core Curriculum indicators classified by key competencies and percentages of students with PISA 2015 results in science with performance of level 2 and above.

Despite the fact that the core curriculum mainly focuses on practicing students to be able to explain phenomena scientifically, percentage of students with performance at level 2 and above in this key competency is at 52.3%, which is lower than that of the other two key competencies. Based on an assumption made in this study that the core curriculum indicators sufficiently emphasise educating students to construct explanations for things surrounding them, it suggests that there are plenty of rooms for improvement in this particular student competency. It should be acknowledged by teachers that responsibility for enhancing student performance in this category falls upon them. Therefore, teachers are obliged to give it a best trial to understand of the core curriculum indicators thoroughly so that they are able to come up with classroom activities that could strengthen student not only in explaining phenomena but also in all key competencies. In contrast, evaluating and interpreting key competencies do not take up proportions in the core curriculum as large as the explaining, percentages of students with performance at level 2 and above is slightly greater in these areas. However, average percentages of student in OECD countries that performed at level 2 or above are much greater than those of Thailand (77.8% for evaluating and 78.1% for interpreting). This reminds us that it should not be misunderstood that Thailand’s education has already done well with these two key competencies, but more Thai students can still be developed towards their maximum potential.

Since mathematics is a main focus of PISA 2012 study, its results were used to build explanations on the relationship between the PISA results in mathematics and percentages of the core curriculum indicators. In should be noted that reasoning key competency was excluded from the comparison since there is no data available for PISA 2012. Figure 4 shows that percentages of indicators in every category are similar, in contrast to the trend in percentages of students that performed at level 2 and above. This figure can be comprehended that Thai students are rather capable of solving mathematical problems and interpreting results back to answer the question than trying to understand and converting a real-world situation into mathematical representations.
Several mathematics textbooks available for teachers to use in Thailand are found to contain problems that they do not require students to formulate circumstances into a mathematical representation. Although some problems attempt to integrate mathematics into situations, they are not quite realistic in a number of ways, such as surreal velocity of a vehicle, too large volume of a particular container, and an impossible length of a typical object. Therefore, teaching students using problems in those textbooks would result in a lack of an opportunity for students to exercise their formulating skill, hence, only 45.2% of Thai students were able to meet level 2 and above in this particular key competency. Importance of this issue is not only that Thailand did not perform well compared to other countries, but it reflects that the future Thais are not yet ready to encounter real-world problems that need to be solved mathematically.

4. Conclusion
The analysis of the Thai Basic Education Core Curriculum illustrated that it consists of indicators that could potentially be used to design a competencies-based learning, including all key competencies measured by PISA. This study has distinctly shown that the core curriculum is not the only factor responsible for Thai 15-year-old students were not performing well in PISA. Regardless of the curriculum being constructed based on competencies measured by PISA, teachers’ understanding of the core curriculum is foremost a significant factor since students are not ones utilising the core curriculum but it is teachers who form a link between the two. Most importantly, this study is not only to raise awareness of low PISA performances in science and mathematics of Thai students, but to also excite realisation that if there still has nothing been done to reform an education system of a country towards the 21st century, its future citizen would be left far behind other countries in this dynamic world.
5. References

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