



Ministry of Education, Youth and Sport
Education Research Council

Article

Mathematics Teaching: Improving Student Learning Achievements in Mathematics in Grade Eight.

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Received 3 December 2018; Accepted 2 May 2019

Abstract

This study hypothesizes that teacher quality and instructional quality are the classroom-level determinants that most directly affect student learning and achievements in mathematics in Grade 8 of lower secondary schools in the Cambodia educational context. This study is conceptually designed under the framework developed by Nilsen, Gustafsson, and Blomeke (2016), Danielson (2007), McEwan (2014), Anderson, Krathwohl, and Airasian (2001) and OECD (2017). The framework covers 1) learning expectations, 2) teacher quality and 3) instructional quality.

Key Words: Quality, teacher quality, instructional quality

Citation: Khieu, V., Om, S., Souk, S., & Khy, P. (2019). Mathematics teaching: improving student achievements in mathematics in grade eight. *Cambodia Education Review*, 3(1), 84 – 97.

Introduction

When parents or guardians send their children to school, they generally expect that the school system will equip their children with general and technical knowledge and critical thinking skills as well as the

behavioral values necessary and relevant to their everyday and future lives. To address this concern, learning in schools requires active and productive facilitation and guidance provided by well-trained, qualified, responsible and model-driven teachers. Thus, teachers have to be well equipped with good knowledge of subject content as well as effective skills in pedagogical practices, assessing learner context, assessing learning outcomes, learner performance and 21st century skills as well as positive and role-model behavioral conducts (Association of Teacher Educators and Rowman & Littlefield Education, 2009; Darling-Hammond, 1999; Blomeke, Olsen, & Suhl, 2016; OECD, 2017).

Research methods and scope

The Cambodian school system today is not able to produce quality learners with relevant knowledge and critical thinking skills to meet the needs of the new trends of the internet-driven market in the 21st century (World Bank Group, 2018; Tandon & Fukao, 2015; Education Quality Assurance Department, 2018). In its report “Growing Smarter,” the World Bank (2018) stated that “*Cambodia rural children have to attend ill-equipped schools with underprepared teachers*”. The national mathematics assessments of Grade 8 in 2014 and 2017 showed that the majority of Cambodian school students are going to school and sitting in classrooms, but true learning is not provided in the school system (Table 1). Tomlinson (1999) stated that, “*In the truest sense, teaching is not finished until learning occurs for each learner. Teaching without learning is an oxymoron.*”

Table 1: National assessment of mathematics by grades in 2014 and 2017

Subject	Year	Grade	Average correct answers/passed
Mathematics	2014	8	44.0
Mathematics	2017	8	47.0

Source: (Education Quality Assurance Department, 2018)

The Education Quality Assurance Department (2018) conducted an assessment of mathematics proficiency in Grade 8 in 2017 found that about 67% (or two out of every three questions) of the mathematics assessment items of cognitive domain (the most basic level) are not answered by students.

Conceptual framework

Teachers matter the most in the student learning and achievement (Darling-Hammond L. , 1999; Kyriacou, 2009; Zuzovsky R. , 2003; McEwan, 2014). Therefore, this study hypothesizes that teachers ‘qualifications and their instructional quality are the classroom-level determinants that most directly affect student learning and achievements in mathematics in Grade 8. This study is conceptually designed under the framework developed by Nilsen, Gustafsson and Blomeke (2016), Danielson (2007), McEwan (2014), Anderson, Krathwohl and Airasian (2001) and OECD (2017). The framework covers 1) learning expectations, 2) quality teachers and 3) instructional quality.

Methods

Fifteen lower secondary schools in the Battambang province and fifteen lower secondary schools in the Prey Veng province were purposefully selected based on the results of the national mathematics assessment conducted by the Education Quality Assurance Department of the Ministry of Education, Youth and Sport in 2017. The assessment found that the average passing rate of the 15 schools in Prey Veng province was 46% and the average passing rate of 15 schools in Battambang province was 63%, among the highest passing rate in the national assessment.

A survey questionnaire was distributed to teachers that included questions on the status of teacher’s housing, educational and teacher-training background as well as their classroom experience and continuous learning skills. It also asked teachers to conduct a self-evaluation of their understanding of mathematical concepts, skills in defining mathematical concepts and written statements of learning outcomes as well as the practices of Cambodia’s five-step teaching norm and classroom-based assessment practices.

A series of in-depth interviews were conducted with 15 teachers in order to seek clarity on the views of mathematics teachers regarding learning expectations, common practices of Cambodia’s five-step teaching norms and practices, pedagogical practices, assessment practices and the understanding of learner context.

The participants were teachers at the selected schools who were responsible for teaching mathematics at Grade 8 in the academic years 2015–2016, 2016–2017 and 2017–2018. The profiles of teachers cover different aspects that affect classroom activities and student learning and achievements. This study did not consider the effect of the school’s

physical factors or the school's management factors on students' learning achievement.

The questionnaires were distributed to the 15 selected schools in Prey Veng and 15 selected schools in Battambang; however, only 14 schools from Prey Veng province and 9 schools in Battambang province returned the questionnaires. As this study focused on the selected schools, it may not represent the whole system of schooling. Despite this limitation, this study may shed some light on root causes that affect the quality of learning in mathematics in lower secondary schools in Cambodia.

In order to measure the level of understanding of mathematical content among teachers, a series of competency tests needs to be conducted. This study used a self-judgment method to measure their understanding on three mathematical concepts: algebra, geometry and statistics. The self-judgment method depends very much on the truest sense of the response.

Findings and Discussions

Teacher quality

Tertiary qualifications in major subjects

Continuous professional development is inevitable for teachers, but not all professional development programs are effective. To be effective, professional development programs should cover subject specialization, learner context, assessment skills and pedagogical practices. The results of the survey showed that a small percentage of mathematics teachers had pursued a tertiary degree in the subject they teach at schools to improve their competency in content knowledge. Of the 42 respondents, 19 did not mention the subject they studied at tertiary level and 14 (33%) graduated with a bachelor's degree in mathematics, one in physics, one in history, one in geography, two in Khmer literature, two in biology, one in accounting and one in agriculture. So, nine (21.5%) of the 42 respondents completed a bachelor's degree in a subject other than mathematics but were still asked by their school principal to teach mathematics. The teachers who specialized in social science and other subjects shared the same sentiments – *“If I rejected the proposal of my school principal, what can we do with the students, as they are eager to learn the subject of mathematics? Even though I do not understand most of the contents and formulas in the school textbooks.”*

Reading habits

Reading can provide clarity of new contents and concepts in different fields. Most of the mathematics teachers in this study do not have a habit of reading. It was asked if they had read any articles or books in general (rather than about mathematics) for less than 30 minutes, more than 30 minutes or more than 60 minutes in the last week. Of the 42 respondents, 29 (69%) did not spend any time reading articles or books, 6 (14%) spent from 30 to 60 minutes reading an article or a book and 3 (7%) spent less than 30 minutes reading an article or a book. Of the 30 Prey Veng teacher respondents, 22 (73%) did not read any books or articles and of the 12 Battambang teacher respondents, 7 (58 percent) did not read any books or articles. Battambang teachers have better habits in reading books or articles. Of the 30 Prey Veng teacher respondents, only eight expressed their habits of reading at least 30 minutes last week and of the 12 Battambang teacher respondents, five expressed their habits of reading at least 30 minutes last week.

In order to test the accuracy of the reading self-reporting among the mathematics teachers, the survey asked the respondents to recall an author and title of the book or an article they read last week. Of 42 teacher respondents, 35 did (83%) not give a response to the question, five (12%) read only math textbooks and two (4.5%) read self-help books, but they could not remember the author of the book.

Internet-based learning-Google, YouTube, Khmer Academy, Khan Academy

As is to be expected in today's internet-driven society, the majority of Cambodia teachers have smartphones and access to internet services. 97% of the 42 respondents owned a smartphone and had access to the internet for Facebook. The majority of teachers knew about internet-based learning websites and applications. The core sources of mathematics learning were listed as Google, YouTube, Khan Academy and Khmer Academy. Among the 42 respondents, 20 often use Google to seek clarity on mathematics and other contents, 16 knew about Google but never used it and only six knew nothing about Google. Of the 42 respondents, 24 often use YouTube to seek clarity on mathematics and other contents, 14 knew about YouTube but never used it for mathematics learning purposes and only four knew nothing about YouTube. Of the 42 respondents, five often used Khmer Academy to seek clarity on mathematics, 13 knew about Khmer Academy but never used it for mathematics learning purposes and

24 knew nothing about Khmer Academy. Of 42 respondents, no one used Khan Academy. Of these, 17 knew about Khan Academy but never used it and 25 knew nothing about Khan Academy. Comparing the use and knowledge among the mathematics teachers of internet-based learning websites and applications of the two provinces, of the 30 Prey Veng teacher respondents, 16 (53%) used Google for learning mathematics and other content and of the 12 Battambang teacher respondents, 4 (33%) often use Google for learning mathematics and other content. Of the 30 Prey Veng teacher respondents, 18 (60%) used YouTube for learning mathematics and other content and of the 12 Battambang teacher respondents, six (50%) used YouTube for learning mathematics and other content. Of 30 Prey Veng teacher respondents, four often used Khmer Academy to learn mathematics and of the 12 Battambang teacher respondents, one often used Khmer Academy to learn mathematics. Of the 42 Prey Veng and Battambang teacher respondents, no one used Khan Academy, though 17 of them knew about it.

Classroom experience

Many studies such as Blomeke, Olsen, & Suhl (2016), Danielson (2002) and Kyriacou, (2009) confirm that the number of years of classroom experience is not a major factor for ensuring true learning within the classroom; however, experienced teachers are more confident in communicating with different types of learners. About 90 percent of the mathematics teachers surveyed have more than six years of classroom experience. Comparing the years of classroom experience between the two provinces, of the 30 Prey Veng teacher respondents, 22 (73.3%) have at least six years of classroom experience, only three (10%) have less than six years of classroom experience and five (16.6%) did not answer the question. Of the 12 Battambang teacher respondents, five (41.6%) have at least six years of classroom experience, two (16.6%) have less than six years of classroom experience and five (41.6%) did not answer the question. The 2017 national mathematics assessment revealed that Battambang outperformed Prey Veng by 17%; however, Prey Veng teachers have more years of classroom experience than Battambang teachers, 73.3% versus 41.6%. It is therefore concluded that years of classroom experience do not ensure true learning in the classroom.

Quality of teacher training

The quality of learning within the classroom depends heavily and largely on quality teachers and quality teachers are the products of quality

teacher training and education. The majority of mathematics teachers had graduated high school before they attended teacher training programs at regional teacher centers. All of the respondents have completed the same national teacher training program and curriculum but they did different types of teacher training programs. Of the 42 respondents, seven were the products of the 7+3 teacher training program introduced in 1984 and four were the products of 8+3 teacher training program introduced in 1988. It is noted that of 42 respondents, two had graduated with a bachelor's degree before they attended the teacher training program at regional teacher training program. Data shows that of 30 mathematics teachers from Prey Veng, 21 (70%) had graduated their high school certificates before they attended the teacher training program at regional teacher training centers. Of the 12 Battambang respondents, seven (58%) teachers had achieved their high school certificates before they attended the teacher training program at regional teacher training centers. The results of the national mathematics assessment in 2017 revealed that Battambang outperformed Prey Veng by 17 percent in their passing rate. The difference of the quality of teacher training programs at Battambang and Prey Veng needs to be carefully studied.

Instructional quality

Content knowledge

Mastering content knowledge and the concepts of mathematics are core values for effective learning, teaching and instruction in mathematics. In order to define the level of understanding of mathematic contents and concepts, the respondents were asked to conduct a self-judgment of their understanding of three mathematic concepts defined the school textbook – algebra, statistics and geometry – at three different levels: 100% understanding, more than 75% understanding and less than 75% understanding. The study did not cover the concepts of numbers and measurements and did not break down the three concepts into the sub-areas of each concept.

Algebra

Even though many of the teachers have been teaching mathematics for more than six years in schools, the self-judgment showed that the majority of mathematic teachers need to develop a better understanding of algebraic concepts. Of the 42 respondents, nine (21.4%) stated that they have 100% understanding of the algebraic concepts in the school textbook, 30 (71.4%) have more than 75% understanding and three (7.1%) have less

than 75% understanding. The 2017 mathematics national assessment revealed that 47.3% of students passed the 2017 national mathematics assessment. This leads to the conclusion that content knowledge is very important for teachers to engage learners in the learning process and to ensure clarity of the algebraic concepts for their students. Clarity on mathematics concepts and applications for learners requires that mathematics teachers master the content, concepts and applications. Comparing the two provinces, of the 30 Prey Veng teacher respondents, five (16.6%) self-reported they had a 100% understanding of algebra concepts, 23 (76.6%) had a more than 75% understanding of algebra concepts, and 6.6% reported an understanding of less than 75%. Of the 12 Battambang respondents, four (33.3%) reported a 100% understanding of algebraic concepts, seven (58.3%) reported more than 75% understanding and one (8.3%) reported they had less than 75% understanding.

This study revealed that Battambang Grade 8 students outperformed Prey Veng Grade 8 students in the national mathematics assessment in 2017, as Battambang teachers have a higher level of understanding of algebraic concepts.

Geometry

The teachers reported a low level of understanding of geometry concepts. Of the 42 respondents, five (11.9%) reported they had a 100% understanding of geometry concepts, 31 (73.8%) reported a more than 75% understanding and six (14.2%) reported a lower than 75% understanding. A comparison of the levels of understanding of geometry concepts among teachers in the two provinces found that Battambang teachers have a higher level of understanding of geometry concepts and their students outperformed Prey Veng students in the national mathematics assessment in 2017 by 17%. 10% of Prey Veng teachers reported 100% understanding on geometry concepts and 16.6% of Battambang teachers reported 100% understanding on geometry concepts. 76.6% of Prey Veng teachers reported more than 75% understanding of geometry concepts and 66.6% of Battambang teachers reported more than 75% understanding of geometry concepts.

Statistics

The 2017 national mathematics assessment of Grade 8 revealed that less than 40% of students (38% in probability and 28% in statistics) gave correct answers to the test questions. The national assessment gave a heavier weight to the capacity of school teachers in delivering the learning

outcomes of the lessons on statistics in the school textbooks and the teachers are not able to finish the lesson on statistics as it stands at the last pages of the school textbook (Education Quality Assurance Department, 2018). This study found a high level of understanding of statistical concepts among teachers in the two provinces. Of 42 respondents, 45.25% reported 100% understanding of statistics concepts, another 45.25% reported more than 75% understanding of statistics concepts and 9.50% reported less than 75% understanding of statistics concepts.

A comparison for the level of understanding of statistical concepts among teachers in the two provinces showed that Battambang teachers have a higher level of understanding of statistical concepts than the Prey Veng teachers. 43.3% of Prey Veng teachers reported a 100% understanding of statistics concepts and 50% of Battambang teachers reported a 100% understanding of statistics concepts. 46.6% of Prey Veng teachers reported more than 75% understanding of statistics concepts and 41.6% of Battambang teachers reported more than 75% understanding of statistics concepts. 10% of Prey Veng teachers reported less than 75% understanding of statistics concepts and 8.3% of Battambang teachers reported less than 75% understanding of statistics concepts.

Demonstrated practical exercises in the school textbook

The structure of mathematics textbooks is organized in the format of contents, theories, formulas, examples of mathematical processes, practical exercises and extra exercises. When asked to conduct self-judgment on their confidence in demonstrating the practical exercises in the school textbook, of the 42 respondents, only three teachers (7%) confirmed they had 100% confidence in demonstrating the mathematical process of the practical exercises in the textbook, 29 teachers (69%) reported a confidence of more than 75% that they could demonstrate the practical exercises in the school textbooks and 10 teachers (24%) reported a confidence of less than 75% to demonstrate the practical exercises in the textbook.

A comparison of the level of confidence among the teachers in the two provinces in demonstrating the practical exercises in the textbooks illustrated that the Battambang teachers have slightly higher confidence than the Prey Veng teachers. 6.6% of Prey Veng teachers reported 100% confidence in demonstrating practical exercises compared to 8.3% of the Battambang teachers. However, 73.3% of Prey Veng teachers reported they had more than 75% confidence, in comparison to only 58.3% of

Battambang teachers. 20% of Prey Veng teachers secured less than 75% confidence and 33.3% of Battambang teachers secured less than 75% confidence in demonstrating practical exercises in the Grade 8 school textbook.

Demonstrated practical exercises from other sources

In today's internet-based society, mathematics and other subjects can be learned from internet sources in Google and YouTube and practical exercises can be taken from these sources. In order to measure the level of confidence among teachers in demonstrating mathematical exercises from different sources other than school textbooks, the respondents were asked to conduct self-judgment, rating themselves either 100% confident, more than 75% confident and less than 75% confident.

Of the 42 respondents, 13 teachers (31%) reported they had 100% confidence in demonstrating practical exercises from sources other than school textbooks, 29 teachers (69%) confirmed their confidence of more than 75% and no teacher expressed that they have less confidence than 75%. However, among the teachers from the two provinces, Battambang teachers expressed lower confidence than Prey Veng teachers in terms of demonstrating mathematical exercises from other sources rather than school textbook, 33.3% vs 25%.

Defined learning outcomes in statistics lessons

The survey requested respondents write a statement of a learning outcome or a learning objective of a lesson on statistics in Grade 8, as they regularly do during the academic year. Of the 42 respondents, only one wrote, "Students knows average, median and mode." With this statement in mind, mathematics teachers need to develop knowledge and skills in defining learning outcomes.

Teaching hours/week and numbers of students/class

Class size and teaching workload really affect classroom management and the instructional process, contributing to lower or higher learning achievements among learners. The average number of students in one class in the two provinces is 47 students and the average number of hours per class each teacher has to teach is 18 hours per week. The teaching workload of the Prey Veng teachers is much higher than that of the Battambang teachers. The class size of the two provinces is not very different but the average number of hours taught is. Every Prey Veng teacher has to spend 19 hours per week to meet their teaching

responsibility, while every Battambang teacher has to spend 15 hours per week to take their teaching responsibility.

A deeper review of the teaching workload of the mathematics teachers in Battambang and Prey Veng revealed a significant difference. 40% of Prey Veng teachers take at least 20 hours per week for their teaching workload, but only 8% of Battambang teachers take at least 20 hours per week for their teaching workload. 23% of Prey Veng teachers take less than 18 hours per week for their teaching workload, but 59% of Battambang teachers take less than 18 hours per week for their teaching workload.

Instructional process

The five-step teaching model has been applied in all general education levels in Cambodia for more than three decades, including teacher training centers, the National Institute of Education, and all school subjects. The five-step teaching model is compulsory within the system as teachers and schools are expected to be inspected by education inspectors from both provincial and national levels. The core element in promoting learning is to answer the question of how much the teacher is directing learning in his/her mathematics classes?

The result of classroom observations conducted by the research team found that the Cambodian classroom and school context have been organized in a traditional way for generations by seating students at desks, passively listening to teachers, while teachers stand in front of the class, lecturing and demonstrating concepts, contents, theories, formulas or practical exercises. Cambodian classrooms feature more teacher-directed teaching and less learner-oriented instruction, which covers lectures, lesson summaries, question-and-answer periods.

The in-depth interviews explained that learning mathematics in the classroom today means covering the contents defined in the school textbook in order to comply with requirements of the school inspectors.

Conclusion and Recommendations

Content knowledge

The core problems in promoting students' learning of mathematics is that most teachers have not mastered the concepts, contents and formulas of mathematics themselves. A series of self-guided learning materials needs to be developed and made available for teachers. The self-

learning materials should be developed in response to an inquiry and concept-based approach.

Learner-centered pedagogy

Learner-centered pedagogy is well-known among teachers in Cambodia. However, group work is the most popular and a best recognized method applied by teachers. In order to ensure that group work is fruitfully used, a step-by-step guide on the applications of learner-centered pedagogy needs to be developed. The guide should govern the philosophy of student-centered learning, outlining the significance of each step and application of the guide.

Other aspects to be considered in designing learning or applying any type of instructional pedagogy are classroom design and student context. Classroom design currently in Cambodia is very traditional and therefore it is hard to conduct learner-oriented classroom activities. Teachers find it hard to explain types of learners and their preferences in the Cambodian context. It is significant that a self-learning text on learner context or different types of learners needs to be developed and tested among teachers.

Continuous learning habits

A habit of reading is a competency for life-long learning and seeking clarity regarding new knowledge and concepts. Cambodian teachers need to develop this habit or skill so that they can guide their students to read different contents and concepts from different sources. Promoting reading should start with teachers.

Lesson planning

The current practice of planning a lesson is to focus on covering the contents and texts written in the core textbooks rather than paying attention to learning, particularly to poor learners. In order to ensure the existence of learning among learners, it is necessary that lesson planning should shift its focus from contents and texts written in the textbooks to concepts of learning and expected learning outcomes. This requires a study of the effectiveness of the current lesson planning and its practicality with school teachers.

References

- Anderson, L. W., Krathwohl, D. R., & Airasian, P. W. (2001). *A Taxonomy for Learning, Teaching and Assessing: A revision of Bloom's Taxonomy of Educational Objectives*. New York: Addison Wesley Longman, Inc.
- Association of Teacher Educators and Rowman & Littlefield Education. (2009). *Visions for Teacher Educators*. Plymouth, UK: Association of Teacher Educators and Rowman&Littlefield Education.
- Blomeke, S., Olsen, R. V., & Suhl, U. (2016). Relation of student achievement to the quality of their teachers and instructional quality. In T. Nilsen, & J. E. Gustafsson, *Teacher Quality, Instructional Quality and Student Outcomes* (pp. 21-47). AG Switzerland: IEA Research for Education .
- Danielson, C. (2007). *Enhancing Professional Practice: A framework for teaching*. Virginia : Association for Supervision and Curriculum Development.
- Darling-Hammond, L. (1999). *Teacher Quality and Student Achievement: A Review of State Policy Evidence*. Washington: Center for the Study of Teaching and Policy, University of Washington.
- Education Quality Assurance Department. (2017). *Results of Grade 8 student achievement from the national assessment in 2017*. Phnom Penh: Ministry of Education, Youth and Sport.
- Education Quality Assurance Department. (2018). *Results of Grade 8 Student Achievement from the National Assessment in 2017*. Phnom Penh: Ministry of Education, Youth and Sport.
- Kyriacou, C. (2009). *Effective Teaching in Schools: Theory and Practice*. Cheltenham: Nelson Thornes .
- McEwan, P. J. (2014). Improving learning in primary schools of developing countries: a meta-analysis of randomized experiments. *Review of Educational Research* , 353-394.
- Nilsen, T., Gustafsson, J. E., & Blomeke, S. (2016). Conceptual Framework and Methodology . In T. Nilsen, & J. E. Gustafsson, *Teacher Quality, Instructional Quality and Student Outcomes* (pp. 1-20). AG Switzerland: IEA Research for Education.

- OECD. (2017). *Understanding teachers' pedagogical knowledge* . Paris: OECD.
- Tandon, P., & Fukao, T. (2015). *Educating the Next Generation: Improving Teacher Quality in Cambodia*. Washington, DC: World Bank.
- Tomlinson , C. A. (1999). *The Differentiated Classroom: Responding to the Needs of All Learners*. Alexandria, VA: Association for Supervision and Curriculum Development.
- World Bank Group. (2018). *Growing Smarter: Learning and Equitable Development in East Asia and Pacific*. Washington, DC: World Bank.
- Zuzovsky. (2003). Teachers' Qualifications and Their Impact on Student Achievement Findings from TIMSS-2003 Data in Israel.
- Zuzovsky, R. (2003). CURRICULUM AS A DETERMINANT OF LEARNING OUTCOMES. *Studies in Educational Evaluation*, 279-292.