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The elementary school teachers' ability in the length measurement

Julie H.

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Abstract

The purpose of this study was to describe the elementary school teachers' mathematical ability (1) to develop students' activities which constructed longer than, shorter than, and as long as concepts, (2) to develop students' activities which constructed standard unit on the length measurement, and (3) to develop a problem which used by student to construct why a conversion activity on the unit of the length was useful in the daily life after they have participated in the Realistic Mathematics Education (RME) workshops. Curry and Outhread said if teachers knew more about the growth of students' conceptual understanding of the length, they would be better able to teach that topic [4]. Therefore, in the workshop, teachers were asked to learn more on the stages of the measurement teaching and learning process and why each stage was important. This capability was described by the results of a test which was content of four problems given to teachers after they have attended the workshop. Research subjects in this study were 14 elementary school teachers at Yogyakarta. The results of the

study were as follows: (1) only four of 14 teachers who had the first ability; (2) all teachers had the second ability; and (3) all the teachers did not have the third ability.

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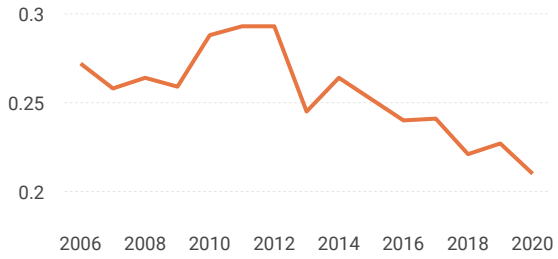

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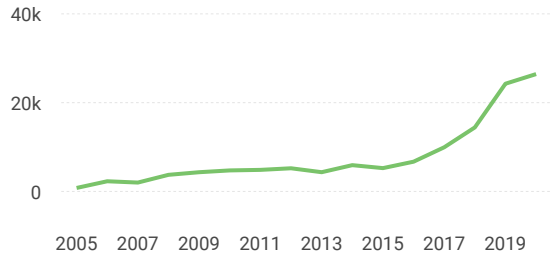

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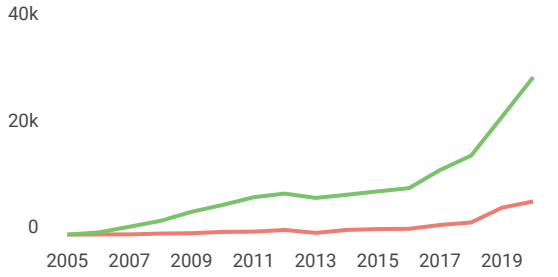

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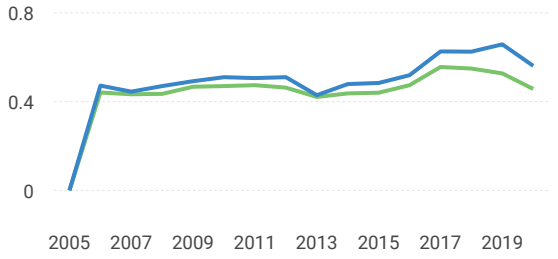

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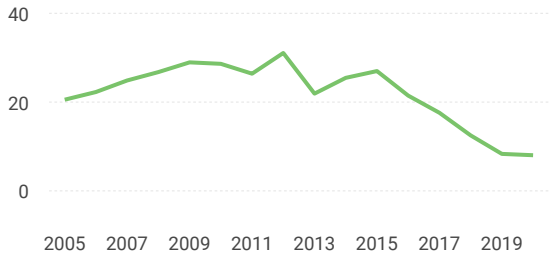

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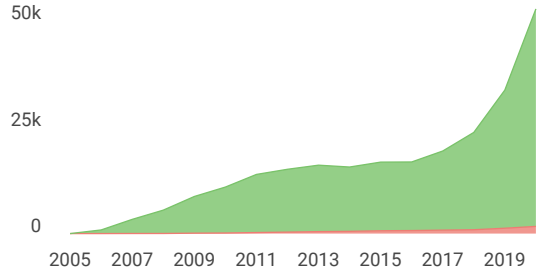

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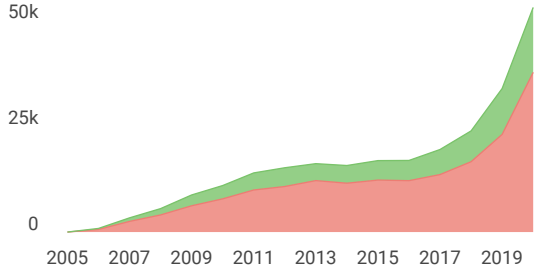

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1st International Conference on Applied & Industrial Mathematics and Statistics 2017 (ICoAIMS 2017) is organised by Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, Malaysia. Our co-organisers are Institut Teknologi Sepuluh (ITS) Nopember, Surabaya, Indonesia, Society of Industrial and Applied Mathematics (SIAM), Malaysian Mathematical Sciences Society (PERSAMA) and Malaysian Institute of Statistics (ISM). This international conference is a biannual conference, started in 2017. The main topics of the conference is divided into six categories; Pure Mathematics, Applied Mathematics, Computational Mathematics, Statistics & Applied Statistics, Operational Research and Mathematics Education including Engineering & Industrial Applications.

The keynote presentations are provided especially to show the contribution of Mathematician and Statistician in engineering and industrial application towards research and knowledge sharing where our conference theme for this year is 'Bridging Mathematics & Industry'. We have five keynote speakers which from Department of Statistics Malaysia, Creative Vision Sdn. Bhd., Malaysia, Universiti Pertahanan Nasional, Malaysia and Institut Teknologi Sepuluh Nopember (ITS), Indonesia.

ICoAIMS 2017 was an overwhelming success, attracting the delegates, speakers and sponsors from many countries and provided great intellectual and social interaction for the participants. Without their support, the conference would not have been the success that it was. I trust that all the participants found their involvement in the Conference both valuable and rewarding. Once again, I would like to convey my deepest appreciation for all contributions and wish you success in the years ahead. Hope to see you again at ICoAIMS 2019.

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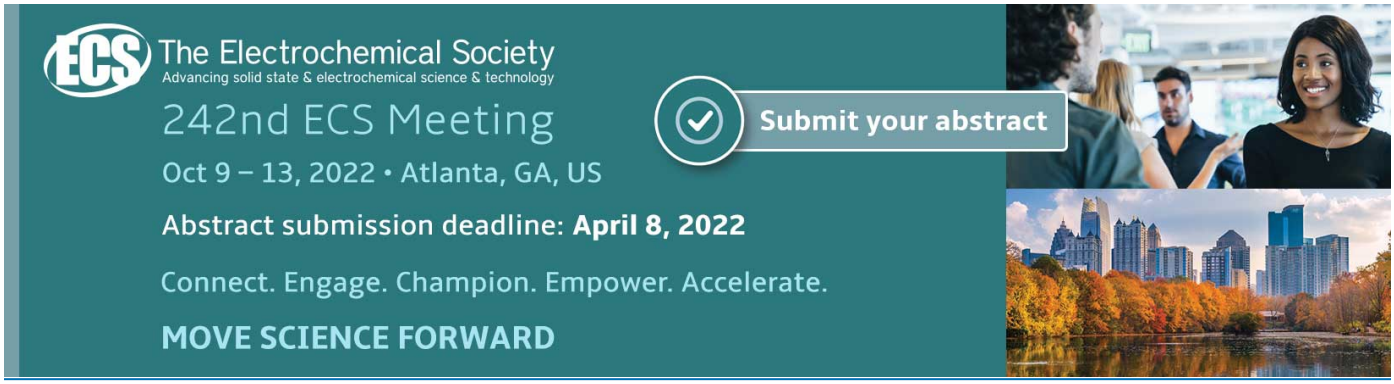

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The elementary school teachers' ability in the length measurement

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Abstract. The purpose of this study was to describe the elementary school teachers' mathematical ability (1) to develop students' activities which constructed longer than, shorter than, and as long as concepts, (2) to develop students' activities which constructed standard unit on the length measurement, and (3) to develop a problem which used by student to construct why a conversion activity on the unit of the length was useful in the daily life after they have participated in the Realistic Mathematics Education (RME) workshops. Curry and Outhread said if teachers knew more about the growth of students' conceptual understanding of the length, they would be better able to teach that topic [4]. Therefore, in the workshop, teachers were asked to learn more on the stages of the measurement teaching and learning process and why each stage was important. This capability was described by the results of a test which was content of four problems given to teachers after they have attended the workshop. Research subjects in this study were 14 elementary school teachers at Yogyakarta. The results of the study were as follows: (1) only four of 14 teachers who had the first ability; (2) all teachers had the second ability; and (3) all the teachers did not have the third ability.

1. Introduction

Patricia F. Campbell et al. said that mathematical skills and pedagogy abilities of primary teachers were directly and positively related to achievement of students taught by them. There was a significant relationship between the knowledge achieved by the students with the teachers' perception. The teachers' perception was defined as (1) the paradigm of teachers on mathematics teaching and learning process, and (2) the care of teachers to the tendency of students' math skills. The teachers' mathematical knowledge related with teachers' care to the tendency of students' mathematical skills. The teacher mastery of the mathematics knowledge and the pedagogy developed their mathematics teaching and learning process paradigm. So, one of the things that need to be enhanced to improve students achievement was teachers' mathematical abilities [2].

Kanisius Demangan elementary school wanted to increase student achievement in mathematics. Based on the Patricia F. Campbell et al.' research results which has been described before, the one effort that could be done to achieve the Kanisius Demangan elementary school's expectations was to improve the teachers' mathematical skills. The effort was made by researchers to improve the teachers' mathematical skills in that school was to provide mathematics workshops for teachers. Teachers' math skills would be upgraded divided into four areas, namely: numbers, geometry, measurement, and statistics. In this paper, the author would be presented only a small part of the

research results obtained in this study. The study's result would be presented in this paper only related with the teachers' ability in the length measurement after teachers attended the workshop.

The purpose of this study was to describe the elementary school teachers' mathematical ability (1) to develop students' activities which constructed longer than, shorter than, and as long as concepts, (2) to develop students' activities which constructed standard unit on the length measurement, and (3) to develop a problem which used by student to construct why a conversion activity on the unit of the length was useful in the daily life after they have participated in the RME workshops.

2. Theoretical Framework

In 2002, Sutarto Hadi developed a professional development model for junior high school teacher. The model was developed by Sutarto Hadi in his study were as follows: (a) to conduct workshops for junior high school teachers who would be the subject of the research, (b) to conduct classroom practice, and (c) to make a reflection. From his research, Sutarto Hadi concluded that the development model of teacher professionalism developed in this study was a good model for the professional development of mathematics teachers in Indonesia, in particular to introduce a new approach in teaching mathematics [10].

Learning was not only a transferring knowledge activity, but an activity that encouraged students to build or construct their own knowledge. A meaningful learning presented the knowledge and cognitive processes that students need to solve problems [1]. In such the learning process, students construct the meaning through the existing learning experiences, seek clarity, think critically, and also do a justification. Based on the understanding about the meaningful learning, teachers must have the knowledge of how to facilitate a material to their students. Shulman classified the teachers' knowledge into three classes, namely: (1) material content knowledge, (2) pedagogical knowledge, and (3) pedagogical content knowledge (PCK) [8, 9]. Shulman explained that PCK conceptualizes the ways of representing the subject that makes it comprehensible to others [8]. That was, PCK conceptualizes ways of representing and formulating a teaching material so that it could be understood by others. Furthermore, Shulman redefined PCK as 'special amalgam of content and pedagogy that was uniquely the province of teachers, its own special form of professional understanding [9]. That was, PCK was a blend of content knowledge and pedagogy that was the hallmark of teachers, and this was a special form of their professional understanding. A few years later, Cochran refined the notion of PCK as follows

> "Pedagogical content knowledge was an integrated understanding that was synthesized from teacher knowledge of pedagogy, subject matter content, student characteristics, and the environmental context of learning. In other words, PCK was using the understandings of subject matter concepts, learning processes, and strategies for teaching the specific content of a discipline in a way that enables students to construct their own knowledge effectively in a given context." [3]

From the expert explanation about PCK, it could be concluded that a deep understanding of the subject matter and pedagogical knowledge was a crucial thing to be mastered by teachers in implementing the teaching and learning process. But the teachers' understanding about these two things was not an understanding of two things separately. A teacher should be able to integrate understanding of the subject matter and pedagogical knowledge so as to help students to construct knowledge. This was in line with the opinion of Curry and Outhred who said that if teachers knew about the development stage of students' conceptual understanding in the measurement of length, area, and volume, teachers would be able to teach these topics [4].

For the Indonesian context, the competence that a professional teacher must possess was regulated in the Republic Indonesia Law Number 14 of 2015 about Teachers and Lecturers. The competencies that must be possessed by a professional teacher were described in Article 10 and in the Article 10 Explanation as follows [11]: (a) a pedagogic competence was the ability to manage learners; (b) a personality competence was the ability of a steady personality, morals, wise, and authoritative and be a role model of learners; (c) a professional competence was the ability of mastery of subject matter

widely and deeply; and (d) a social competence was the ability of teachers to communicate and interact effectively and efficiently with learners, fellow teachers, parents or guardians of learners, and the surrounding community.

The philosophy of RME was mathematics as a human activity. It meant learning mathematics should be able to make the students thought that there was mathematics in human activities, and it was be used by them in real life [5]. So, the learning process of mathematics first of all should not be connected with mathematics as a deductive system that was well organized and formal, but it should be connected with mathematics as a human activity [5]. If the mathematics which was learned by the student was connected with a formal deductive system, then the student will view that mathematics was resulted by the human thinking; it was an abstract and was not related to real-life. So, they will think that they could not find mathematics and using mathematics in their life [7]. There were five main characteristics in the RME [5, 6, 7], namely: (a) phenomenological exploration, (b) bridging by the vertical instrument, (c) student contributions, (d) interactivity, and (e) intertwining.

3. Results and Discussion

The materials learnt and discussed by teachers in this workshop were as follows: (a) the longer than concept, (b) the shorter than concept, (c) the as long as concept, (d) the long estimation, (e) the long measurement, and (f) the unit length conversion.

The descriptions of the workshop process experienced by the teachers when the teachers studied and discussed about length measurement materials and PMR approach to cover length measurement materials were as follow: (a) a facilitator asked the participants what concepts were on the length measurement; (b) some participants expressed their opinions; (c) the facilitator and participants discussed about any concepts that exist in the length measurement, namely: longer than, shorter than, as long as, and the length estimation; (d) the facilitator asked the participants what the stages in concept building were longer than, shorter than, or as long as; (e) some participants expressed their opinions; (f) the facilitator and participants discussed about the building stages of the longer than concept, the shorter than concept, and the as long as concept, namely: (1) comparing the length of two objects directly, (2) comparing the length of two objects indirectly, i. e. using other media, such as ice cream stick, the part of the body, etc., as a measuring tool, (3) comparing the results, and (4) estimating and measuring; (g) the facilitator asked the participants what activities were used by teachers to build the student knowledge about the starting point of the measurement, how to read the measurement results in the non-standard measurement tool, and why was important to use a length standard unit; (h) some participants expressed their opinions; (i) the facilitator and participants discussed activities which were to build students' knowledge about the starting point of the measurement, how to read the measurement results in the non-standard measurement tool, and why was important to use a length standard unit, namely (1) making a ruler using a sequence of beads as standard, (2) measuring the length of the one object in the class, (3) using students as a tutor to help students which had difficulty to determine the starting point of the measurement and to “read” the measurement result, (4) discussing that how to determine the starting point of the measurement and to “read” the measurement result, (5) discussing thatt why the measurement results were different, (6) introducing the measurement tool using a length standar unit, such as a ruler, a gage, etc., (7) measuring the length of the one object in the class using the tool, (8) using students as a tutor to help students which had difficulty to determine the starting point of the measurement and to “read” the measurement result, (9) discussing that how to determine the starting point of the measurement and to “read” the measurement result, (9) discussing that were the measurement results still different, (10) measuring the length of the one object in the class using a broken ruler, (11) using students as a tutor to help students which had difficulty to determine the starting point of the measurement and to “read” the measurement result, (12) discussing that how to determine the starting point of the measurement and to “read” the measurement result, and (13) discussing that were the measurement results still different; (j) the facilitator asked the participants what was the length standard unit and how it relates; (k) some participants expressed their opinions; (l) the facilitator and participants discussed about the

length standard units and how did they relate each others; (m) the facilitator asked the participants what problems could be made to construct the student knowledge about the unit length conversion; (n) some participants expressed their opinions; (o) the facilitator and participants discussed a problem that could help students to construct their knowledge about the unit length conversion, for example: Mr. Jaja would make a pipeline connection from a water source into his house. For that, Pak Jaja requires 2 pipe length 90 cm, 3 pipe 175 cm long, and 5 pipe 55 cm long. The length of one pipe was 3 meters. How many pipes should Mr. Jaja buy?; and (p) the facilitator and participants discussed why the Mr, Jaja problem could help students to construct their knowledge about the unit length conversion, and how to used this problem help students to construct their knowledge about the unit length conversion.

After the participants attended the workshop, participants were given tests related to the length measurement material. There were four questions asked by the facilitator in the test. The four questions in the test were as follows: (a) what were the steps that students need to do so that students could build the longer than concept, the shorter than concept, and the as long as concept?; (b) what were the steps that students need to do so that students could build up knowledge about the length standard unit?, (c) why did we need a length standard unit?, and (d) please, give a problem example that could give an idea to students that why they need to learn about the length unit conversion?

Descriptions of the results achieved by the workshop participants after they attended the workshop were as follow:

a. The answers for the first question were as follow:
   1) Observing concrete objects, comparing the length of objects observed, measuring using non-standard gauges, such as: span, fathoms, beads, etc., and measuring using standard gauges, such as rulers, gauges and so on. There were four teachers who answered it.
   2) Preparing objects that had different length, comparing them so that it was known which objects longer than, shorter than, or the same length with one object. There were five teachers who answered it. There were processes that were not done by the five teachers after the students were invited to compare the length of these objects, namely: (a) performing measurements with non-standard and standard measuring instruments, and (b) comparing the measurement result of the length of these objects as a basis to draw conclusions which the objects longer than, shorter than, or the same length with one object.
   3) Observing two or more objects that had different lengths, and comparing two or more different objects. There were five teachers who answered it. These five teachers were the same as the five teachers in group 2. There were processes that were not done by the five teachers after the students were invited to compare the length of these objects, namely: (a) performing measurements with non-standard and standard measuring instruments, and (b) comparing the measurement result of the length of these objects as a basis to draw conclusions which the objects longer than, shorter than, or the same length with one object.

From the teacher's answer to question 1, the researcher concluded that there were only four teachers who had the ability to explain the stages that students need to do so that students could build the longer than concept, the shorter than concept, and the as long as concept.

b. The answers for the second question were as follow:
   1) Students were required to measure the length of an object by using non-standard units, such as: depa, span, ice cream stick, beads, etc., compared their measurement results with their friend measurement results, drew conclusions on comparing results, introduced measuring tools that have standard length units, such as: rulers, gauges, etc., measured the length of an object by a measuring instrument having a standard unit. There were four teachers who answered it.
   2) Determining the length of the object by using a measuring device using non-standard units, such as: depa, span, cubit, etc., comparing the measurement results obtained using a measuring instrument having standard units, and directing the students to use a measuring instrument having standard units to produce the same measurement results. There were four teachers who answered it.

3) Measuring the length of the object by using a measuring instrument that used non-standard units to obtain different measurement results, measuring by using a measuring instrument that used the standard unit so that obtained the same measurement results. There was one teacher who answers so.
4) Measuring the length of two objects using a non-standard unit measuring device, comparing the measurement results obtained using a non-standard unit measuring device with their friends, showing the weakness of the measurement by using a non-standard unit, introducing the student to the length standard unit, using a measuring instrument that has a standard unit. There were five teachers who answered it.

From the teacher's answer to question 2, the researcher concluded that all teachers had ability in explaining about stages that need to be passed by the students so that students could build knowledge about the length standard unit.

c. The answers for the third question were as follow:
   1) To equate perceptions of measurement results and to make easy if we want to know the length of an object. There were four teachers who answered it.
   2) So that everything could be measured with the same standard, so as to produce the exact length of the object. There were five teachers who answered it.
   3) In order for the measurement results to be universally accepted. There were three teachers who answered it.
   4) So that the measurement results could be accepted anywhere and we could compare the length of the object accurately. There were two teachers who answered it.

From the teacher's answers to question 3, the researcher concluded that all teachers had the ability to explain the reasons why humans need a length standard unit in their life.

d. The answers for the fourth question were as follow:
   1) Measuring the length of the classroom by using a ruler that has a cm unit and a meter unit, asking students which measuring tools they were easier to use, and making a conclusion based on the results. There were four teachers who answered it.
   2) Pak Hartoyo had 43 meters rope. The rope would be used to tether five cows. For each cow required a rope along the 8.5 meters. What was the remaining of Pak Hartoyo's rope? There were four teachers who answer so.
   3) Pak Hartoyo had 43 meters rope. The rope would be used to tether five cows. For each cow required a rope along $8\frac{1}{2}$ meters. What was the remaining of Pak Hartoyo's rope? There was one teacher who answers it.
   4) If someone wanted to buy a cloth to a fabric store, then it was more common to use a meter unit compared to a cm. There were four teachers who answer it.
   5) If someone wants to buy a cloth material to a fabric store, then it is more common to use a meter unit compared to a cm. When you want to set the boundaries of typing using MS word software there were using inch units, but we could also change it into cm units. There was one teacher who answers it.

From the teacher's answers to question 4, the researcher concluded that all teachers did not have the ability to create a problem that could inspire students that why they need to learn about the length unit conversion.

4. Conclusions

From the discussion, then there were two conclusions that could be made, namely:

a. The workshop process given to teachers was as follows: (1) the teacher was given a problem to solve, for example: what concepts that exist in the length measurement, (2) the facilitator asked several participants to deliver their the solution, and (3) The facilitator and all the participants held a discussion to discuss the settlement that has been submitted and made conclusions related to the settlement of the problem.

b. The abilities of teachers would be measure in this study with the test were the ability (1) to develop students' activities which constructed the longer than concept, the shorter than concept, and the as long as concept, (2) to develop students' activities which constructed standard unit on the length measurement, and (3) to develop a problem which used by student to construct why a conversion activity on the unit of the length was useful in the daily life. The results of the study were as follows: (1) only four of 14 teachers who had the first ability; (2) All teachers had the second ability; (3) All the teachers did not have the third ability.

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