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The Role of Context in Third Graders' Learning of Area Measurement

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Abstract

Many researches showed that the most of students find the difficulty in measuring area. The formula of area tends to be taught directly without involving the conceptual basis and the area measurement are separated from children's daily experiences. For this reason, the teaching and learning of area measurement was designed and link to a set of students' experience-based activities. The context of this research is Indonesian traditional handicraft namely anyaman. The study is situated in the context of implementing an Indonesian version of Realistic Mathematics Education, labeled as PMRI in Indonesia. Design Research methodology comprising preliminary design, teaching experiment, and retrospective analysis is applied. This research described the investigation of the context as preliminary of teaching and learning about area measurement held in 3th grade of primary school SDN 119 Palembang. The result of the teaching experiment showed that problem embedded in a context could encourage the students to develop the idea of area measurement concept. The strategies through emergent modeling showed how students' contribution could be used to develop gradually their reasoning of area measurement concept. In the experience-based activities for learning area measurement, emergent modeling played an important role in the shift of students' reasoning from informal level towards formal mathematical concepts of area measurement.

Key words: *Area measurement, Anyaman, design research, PMRI*

Abstrak

Beberapa kajian menunjukkan kesulitan siswa dalam melakukan penghitungan luas. Siswa lebih cenderung dikenalkan dengan penggunaan rumus tanpa melibatkan konsep itu sendiri dan pembelajaran luas terpisah dari pengalaman siswa sehari-hari. Hal tersebut mendasari untuk mendesain suatu pembelajaran luas dan menghubungkannya dengan aktivitas berdasarkan pengalaman siswa (experience-based activities). Tujuan dari penelitian ini adalah untuk melihat pemahaman (reasoning) siswa tentang konsep luas dengan menggunakan konteks kerajinan tradisional anyaman dan menghasilkan suatu local instruction theory untuk konsep luas dari informal ke formal dengan pendekatan PMRI. Metodologi yang digunakan adalah design research dengan tahap preliminary design, teaching experiment dan retrospective analysis. Penelitian ini mendeskripsikan bagaimana kerajinan tradisional anyaman memberikan kontribusi pada siswa kelas III SDN 119 Palembang untuk memahami konsep luas. Hasil dari teaching experiment menunjukkan konteks anyaman dapat merangsang

siswa untuk mengembangkan pengetahuan mereka tentang konsep luas. Seluruh strategi dan model (emergent modelling) yang siswa temukan, gambarkan serta didiskusikan menunjukkan bagaimana konstruksi atau konstribusi siswa dapat digunakan untuk membantu pemahaman awal mereka tentang konsep luas. Dalam aktivitas berdasarkan pengalaman siswa untuk pembelajaran luas, emergent modelling mempunyai peranan penting dalam memahami konsep luas dari level informal ke formal.

***Kata Kunci** : Pengukuran luas, anyaman, desain Riset, PMRI*

Introduction

The study of area measurement is an important part of the primary school curriculum because of the relation of the basic concepts of area measurement with other mathematical ideas. The applications of area concept influence the students' understanding for other domains in higher grade (cavanagh, 2008).
Researches in the field of mathematical education showed the poor understanding of area measurement involving the concepts. The emphasizing of teaching and learning of area measurement should not only in using the formula but also giving the students of opportunity to study the pattern, identical unit, and structure of the array (Fauzan, 2002; Van den Heuvel-Panhuizen & buys, 2004; Cavanagh, 2008). In Indonesian traditional approach of education, the teacher and textbook tend to move quickly to the using of formula for the areas of basic shapes without giving the students the opportunity to study the pattern and structure of array (Fauzan, 2002). Although children know the measuring instruments and apply the formula that dominates to solve the problems of area, there is no guarantee that they understand what measurement of area is.
Aforementioned issues in the teaching and learning of area measurement background this research to design instructional activities for area concepts. Area concept is the understanding how a specified unit can cover a flat surface iteratively and completely (Cavanagh, 2008). In this research, the researcher involves Indonesian traditional handicraft, *anyaman*, as the context in preliminary of teaching and learning about area measurement. This traditional handicraft is one of materials of culture teaching in primary school. *Anyaman* has the potential basic concept of measurement area and it is real for students as the preliminary of teaching and learning about area. It is relevant with Freudenthal's idea that stresses mathematics as human activity and the need to connect mathematics to reality through problem situation. *Anyaman* as problem situation could contribute to the emerging of mathematical practices.

Theoretical Framework

In this research, students' thinking of area measurement was emphasized in some aspects. The aspects used are the selection of the square unit, the unit iteration, the counting of measurement unit, and the use of formula of area. Children need to develop the understanding of area as a specified unit that covers a flat surface

completely. Therefore, traditional handicraft was used as contextual situation and experience-based activities to build upon students' reasoning of area measurement. Thereby, realistic mathematics education literature was needed in explaining these.

1. Area Measurement

Area measurement is a number of measurement units needed to cover a region (Fauzan, 2002). Cavanagh (2008) also stated, "the basis of area measurement lies in understanding how a specified unit can be iterated until it completely covers a flat surface, without leaving gaps or everlaps".

Measuring area could use a variety of way. Area is a number of two-dimensional surfaces that has a boundary and that can be quantified in some manner (Baturo and Nason, 1996). Building upon students' reasoning of area measurement, they need practice of activities that is able to stimulate their idea.

Actually, students have their own understanding of measurement that is happened unwitting in their daily life. They have known some of attribute such as weight, length, and area, but they have no sense of them and how measure them accurately. For instance, students can compare big and small cake directly. In this case, the students involve naturally in a situation of discussion about quantities (Ginsburg & Seo, 2001). Firstly, students learn to recognize the word of quantity or of magnitude in presenting the objects, furthermore they compare two object directly. Afterwards, they start to learn how to measure and to link the objects with quantity (Clements & Stephan, 2001). There are conceptions on measurement of area if we want to teach it namely *comparing and ordering, units of measure, and estimating and measuring of area* (Reys, Suydam and Lindquist, 1984).

Considering the aforementioned idea, Clement and Stephen (2001) separated five important idea of basic concept about area measurement in instructional activities. The basic concepts are described in the following table:

Table 1. The basic concept of area

Foundational concepts	Description
1. Partitioning	The mental act of cutting two dimensional space without a two dimensional unit
2. Unit Iteration	Cover region with area unit with no gaps or overlapping
3. Conservation of area	Understand that the area of a region does not change although rearrange and cut its part to form another shape
4. Structuring and array	Understand that an area as truly two dimensional
5. Linear measurement	Area measurement is the product of two linear measurements.

Those give the students a series of instructional activities that help them learn initial area concepts. Clement and Stephen (2001) also formulated instructional activities for area measurement:

1. Investigate covering regions with a unit of measure.

Students should realize that there are to be no gaps or overlapping and that the entire region should be covered.
2. Understand how to structure arrays.
   Figure out how many squares in pictures of arrays, with less and less graphic information of clues (Battista et al., 1998).
3. Understand how the length of the sides of rectangle can determine the number of units in each row and the number of rows in the array.
4. Understand how multiply the two dimensions as a shortcut for determining the total number of squares.

2. Indonesian Version of Realistic Mathematics Education (PMRI)

The concept of mathematics is abstract and this case make the students feel difficult to learn mathematics. Consequently, students lack experience and comprehend the mathematical concept in daily life. PMRI provides and develops an approach of new way of teaching mathematics implementing strategies that enables students to become more active thinkers. In PMRI, students are free to explore their ideas and strategies, and the teacher in developing student's idea acts the guidance. The activities are one effort through realistic problem in a variety of situational.
Treffer (1987, in Zulkardi 2002) defined five tenets for Realistic Mathematics Education, namely:

1. *Phenomenological exploration or the use of context*
   The instructional activities started from informal or situation that is experientially real for students to the basis of formal concept.
2. *Using models and symbols for progressive mathematization*
   It used models and symbols as transition from a concrete context to formal knowledge.
3. *Using student's own contribution and production*
   Students were free to construct and describe their ideas and strategies in solving the problem. This opportunity will force the students to be a greater initiative when they construct and produce their own solution.
4. *Interactivity*
   Learning process of students is not a solo activity but it occurs in a social context.
5. *Intertwinement*
   An integrating a variety of mathematics topic in instructional activity.

3. Measurement context

The world of students in primary school relates to playing game and art such as dancing, singing, and plaiting. This situational should be function by teacher to design instruction. In this research, we use Indonesian traditional handicraft related to plaiting namely *anyaman* as a context to support the students in understanding the basic concept of area measurement. Students sometimes feel lacking of interest with mathematics. We expected by combining mathematics and traditional handicraft the students more attractive to study.
Anyaman will form a pattern of squares. In the beginning of measurement process, we pose the problem of comparison to students. Comparing is the basis of measurement. The comparing activity embodied in traditional handicraft was used as preliminary for teaching and learning of area measurement. In this activity, we expected the students

would use squares as a benchmark in comparing. The need benchmark in comparison supports the emergence of unit measurement. This handicraft encourages the students in understanding the concept of unit iteration and measuring unit.

Methodological Approach

1. Design Research Methodology

The aim of design research is to develop a local instructional theory through collaboration of teacher and researcher in teaching and learning process (Gravemeijer & Eerde, 2009). Consequently, methodology used in this research is design research. The set of experience-based activities will be design for students in grade 3 of primary school as approach to understand area measurement. In this research, a sequence of instructional activity for area measurement contains conjecture of students' strategies and thinking, and the traditional handicraft, *anyaman*, is used as the starting point in teaching and learning process.

This research consists of three phases in iterative process. Iterative process means there are invention and revision in the designed instructional activity during research. Design research phases are described below:

1. Preliminary design
2. Teaching experiment
3. Retrospective analysis

2. Hypothetical Learning Trajectory and Local Instruction Theory

Freudenthal (1991, in Gravemeijer & Eerde, 2009) argued that students should be given the opportunity to develop their idea in constructing mathematics. Teacher can choose the appropriate activities as foundation to stimulate students in thinking and constructing mathematics. In this process, the teacher should anticipate what students mental activities emerge with seeing the learning goal. This envisions or anticipation was called hypothetical learning trajectory (Simon, 1995, in Wijaya, 2008).

HLT is the hypotheses or conjectures how students' reasoning and thinking develop with a context in instructional activity given on a day-to-day basis in classroom. As Gravemeijer (2004) elucidated three components of HLT namely learning goal, instructional activity or means used in learning process and conjectures of learning process how to know students' reasoning and thinking that emerge and develop in classroom. In preliminary design, HLT functions as a guideline of learning material for teaching experiment and as guideline of interview, of teaching, and of observation for teacher and researcher. Consequently, there is a connection between instruction theory and teaching experiment (Bakker, 2004). In this connection, there are conjectures instruction theories that could be revised and redevelop for the next instruction activities based on retrospective analysis or after teaching experiment.

He description of the set of instructional activities in the domain area measurement is given in a local instruction theory. The local instruction theory, a theory about a possible learning process for a given topic along with the means of supporting that process, offers a travel plan that will be acted into teaching experiment.

3. Research Subject

A classroom teaching experiment was conducted in grade 3 of a primary school in Palembang that is SDN 119 as the school lab of PMRI UNSRI. Twenty children of 3th grade will work in groups of five.

4. Data Collection

In this research, audio visual and written data were used to get various data**.**

Results and Analysis

Anyaman has the potential for teaching and learning about area measurement that includes comparing, ordering, and measuring. The research question is how this Indonesian traditional handicraft can be used as the context for preliminary of teaching and learning for basic concept of area measurement in grade three of primary school?
The context was embedded the problems to build the sense of area measurement. The problems are: the sizes of *anyaman* determine its prize and two *anyamans* with different size of unit have equal area. The problems aim to stimulate the students to find the benchmark in measuring. The unit of *anyaman* finding by students is the benchmark. The bigger size of units, the fewer units covering the plate surface.

1. Unit as the benchmark in comparing area

Students present their strategies in comparing two and several *anyamans*. One of the strategies is the using of natural unit as the benchmark other than the placing *anyaman* on top of the other. Comparing of two *anyaman* is not difficult for students, but it is different for several *anyamans*. That is why the students choose the unit in comparing area. This strategy showed that the students understand the connection between the unit and the object and the students had gotten the precision of area measurement basic concept. The Figure 1 describes the students' strategies.

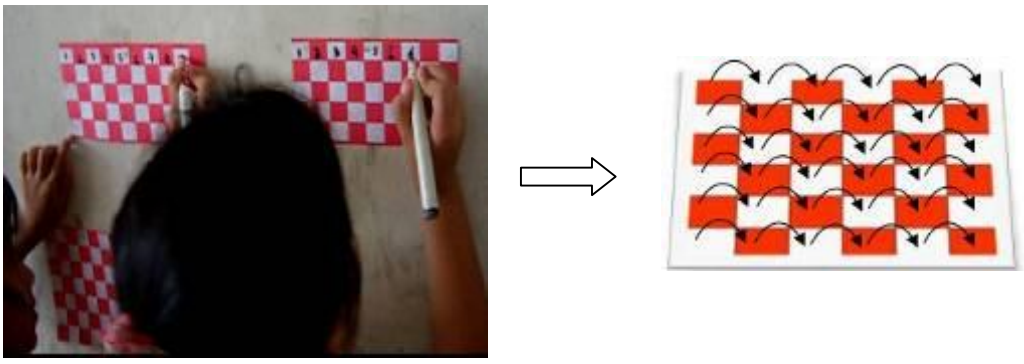

Figure 1. Unit as the benchmark

The students' achievements of area measurement basic concept in informal activities (Indonesian traditional handicraft) are the identical unit, the unit iteration, and the conservation of area.
The students also reason their strategy about conservation of area in comparing two *anyamans* that have the different size of unit whit the equal area (Figure 3). The

students' process in finding and understanding the basic concept of area was described in Figure 4 (see in the appendix).

Figure 2. Identical unit

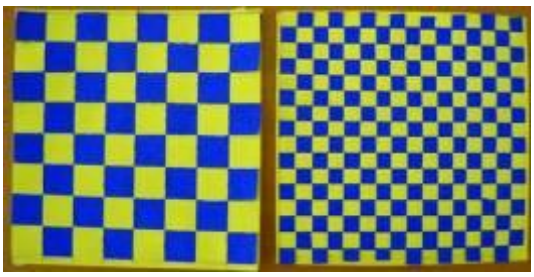

Figure 3. Different size of unit

2. Learning Trajectory from informal to formal

The description focused in developing of the students' understanding from Indonesian traditional handicraft as informal knowledge to formal about basic concept of area measurement. In formal, the students reinvent the formula for area of rectangle as the shortcut in measuring area and they are also able to estimate the irregular shape.
The detailed list of activities is available from the author. There are bridge activities from informal to formal. The activities are transparency and *anyaman*, making our own unit, and using geoboard. The emergent modeling that develops from informal to formal was described in figure 5 (see in the appendix).

a. Transparency and *anyaman*
   Anyaman turn into measuring instruments to measure the object was shaped in transparency. In this activities, the students' representation showed that they need an instrument in measuring area. They plot object of transparency on the *anyaman* and counting the unit of *anyaman* in measuring the area. The Figure 6 illustrate students' strategies.

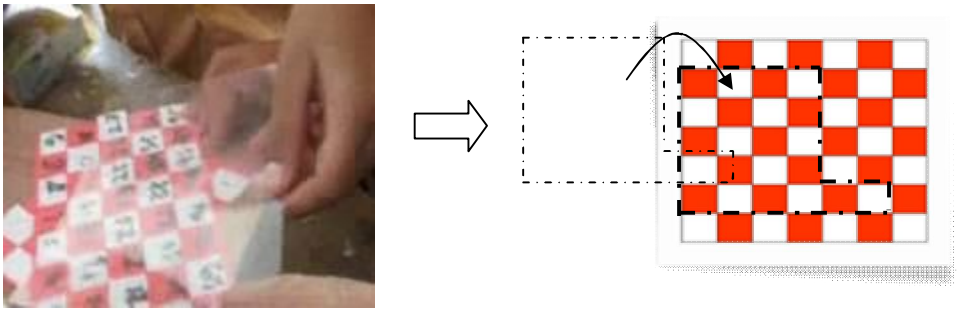

Figure 6. *Anyaman* as the measuring instrument

b. Making our own unit
The square unit is the unit chosen by students in measuring area. The square unit is the duplication of the unit of *anyaman*. Students' understanding developed from making our own unit to square paper. It is started from how students' strategy in measuring their books. They copied the books on the paper and measured them by fitting the blocks of unit on top of the copy. The models shaped graph paper (Figure 7).

Figure 7. Measuring instrument as the *model –of* situation that means the iteration unit of *anyaman*

c. Geoboard
Geoboard aided the students to complete the emergent modeling of their understanding about the unit. Students invented the triangle unit as the partition of square unit (Figure 8).

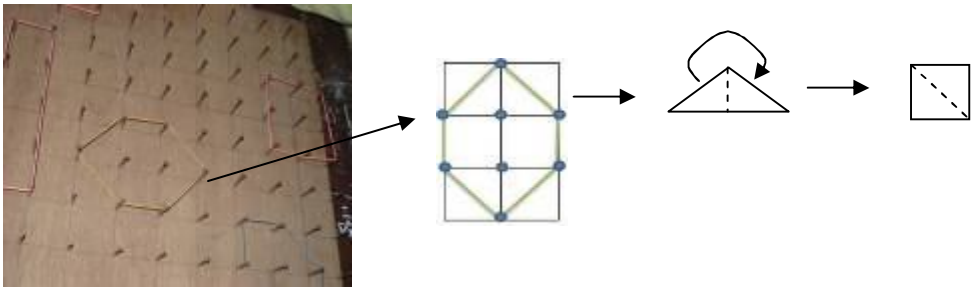

Figure 8. Partition of square unit

In general, students invented and developed their own model in interpreting the situational problems. In *anyaman* students came up with an idea to use unit of *anyaman* as the benchmark to compare the size.
In referential level students' idea was followed up by the use of *anyaman* as measuring instrument to measure the object of transparency. Moreover, the use of square unit became the base of the emergence of student-made measuring instrument as the *model of* situation.
In general level students started to use their instrument (graph paper) as *model for* measuring the area of objects. The use of student-made measuring instrument as *model for* area measurement showed that general level of modeling has been accomplished by students. The unit and the model invented by students play the important role to bridge experience-based activities to formal level in teaching and learning about area measurement.

Conclusion

The use of context of *anyaman* gave the crucial effect as the assistance of developing students' motivation in studying area measurement. in mathematical practice, the use of this context bring the students into situation to reinvent and to understand the basic concept of area measurement. The context guided the students to explore and to use the information in solving the problems.
Area measurement is better not to be introduce by applying formula directly, but students should be given the opportunity to understand the pattern and structure of array that exist in a region. *Anyaman* as a context is suitable for preliminary teaching and learning the concept of area measurement. Through the preliminary activity of area measurement which traditional handicraft *anyaman* that is used as situational, students get more understanding some basic concept of area measurement. Students know identical unit, unit iteration, and students also know how to compare by using unit (square) as a benchmark

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Appendix

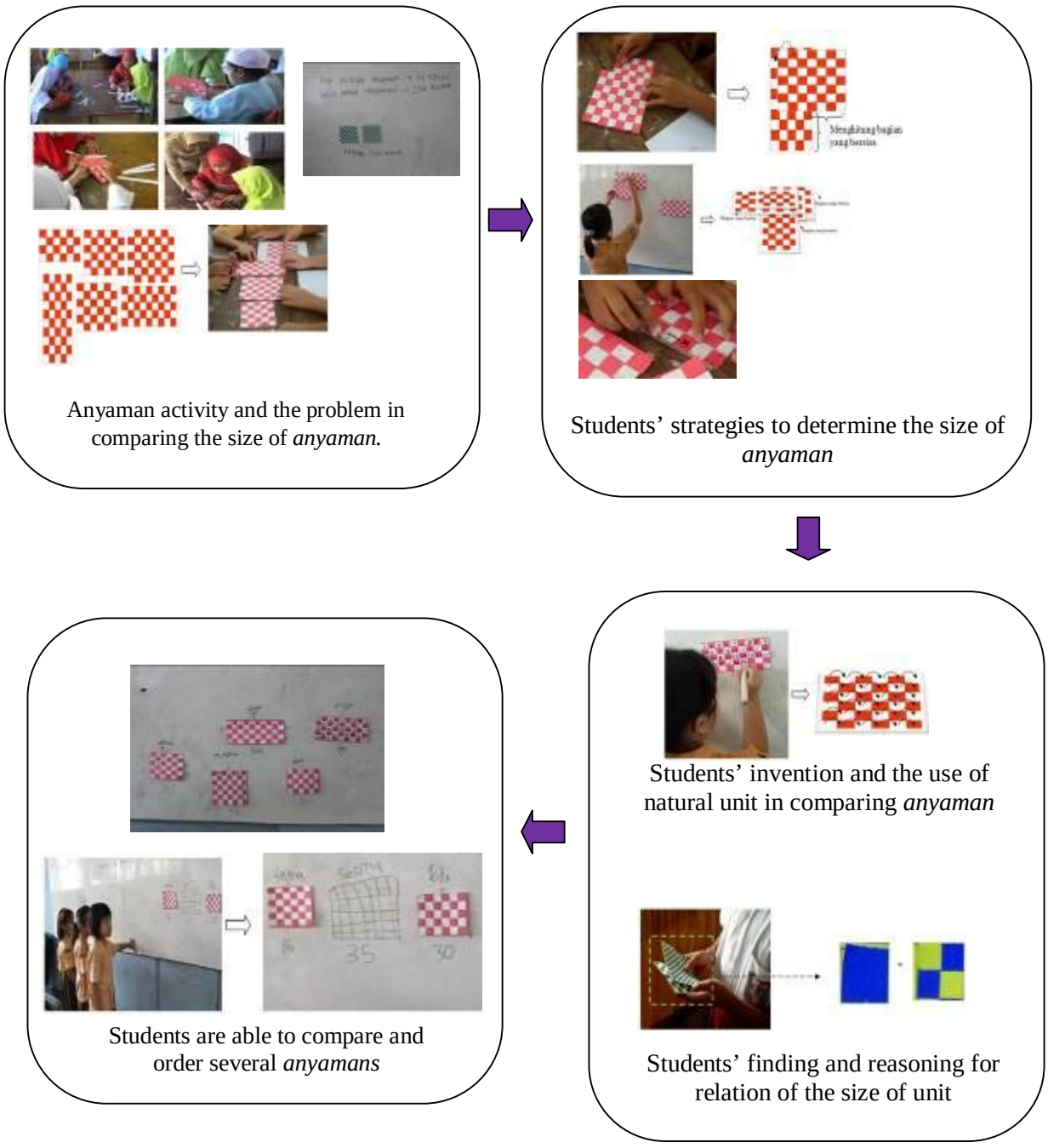

Figure 4. The scheme of students' process in reinventing and understanding the basic concept of area measurement in Indonesian traditional handicraft

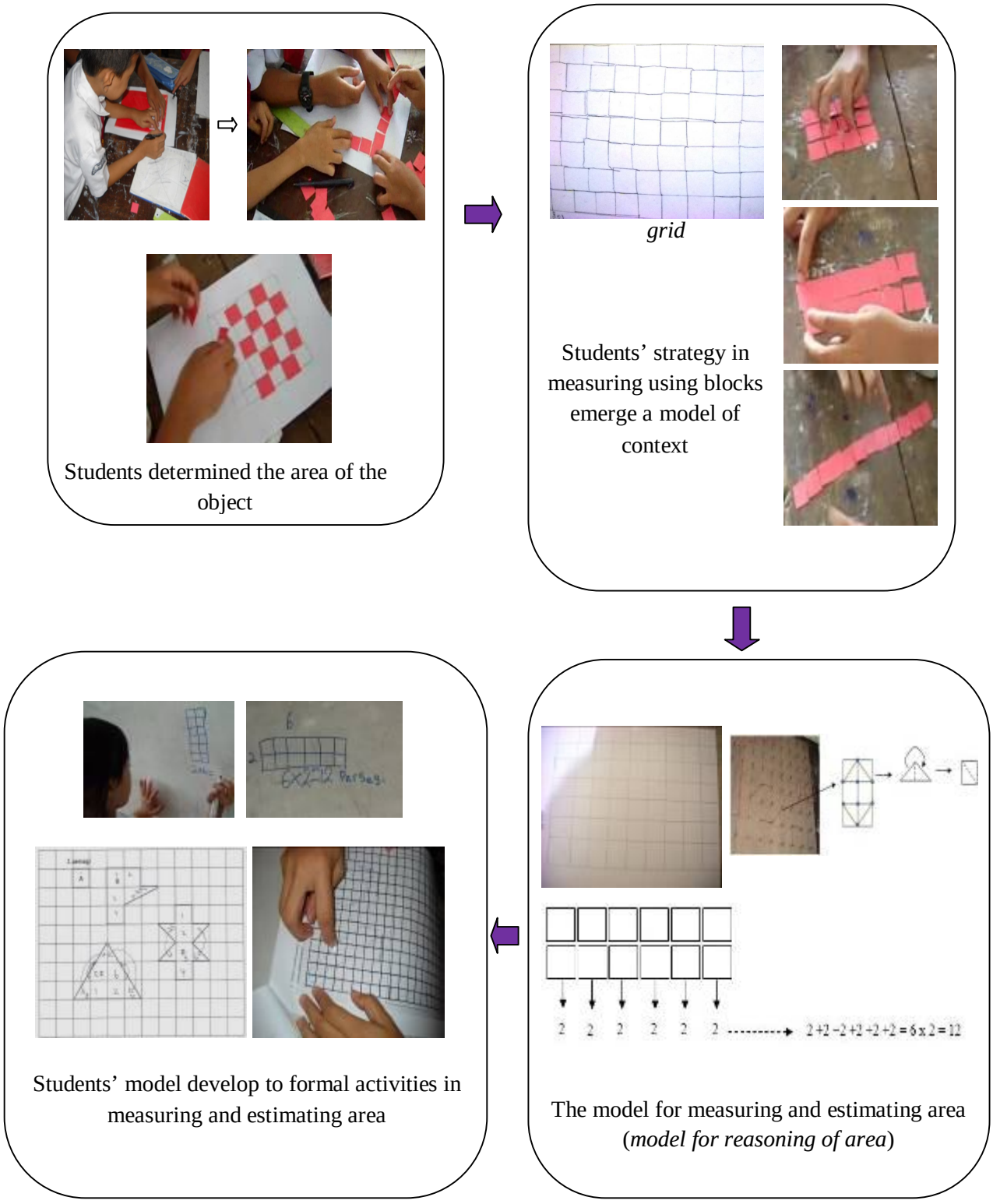

Figure 5. The scheme of emergent modeling process from situational to formal measurement