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Link between modern building and Kediri's tradition: An idea to develop teaching-learning equipment

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Abstract. “*Simpang Lima Gumul*” is monument building which the architecture value, symbolic and esthetical value at Kediri. The “*Simpang Lima Gumul*” monument is crossing representation of Kediri's tradition culture and modern building concept. In preliminary study researcher found that student have difficulties for understanding geometry subjects. Contextual teaching-learning based on culture is needed to conserve local culture through transforming it in the context of learning. The aim of this paper is describing indicator of “*Simpang Lima Gumul*” monument based on semiotics study they are denotation, connotation and meta-languages level. The result is used to develop teaching-learning equipment.

Keywords: Simpang Lima Gumul, Teaching-Learning Equipment, Geometry, Ethnomatematics

1. Introduction

This research was inspired by the modernization era that starts to displace local cultures. According to the results of the preliminary study that have been conducted several times by the researcher, it has been found that the elementary students have difficulty in perceiving parallelogram shape in a 2-dimension of a cube drawing as a square shape [1]. This “that as many as 60% of students from three different schools in a city still have difficulty in classifying four sides object such as square, rectangular, parallelogram and rhombus. Four fifth grade of elementary students were asked to draw nets of a given cube” A preliminary study showed that the elementary students have difficulty in perceiving parallelogram shape in a 2-dimension of a cube drawing as a square shape. A preliminary study showed that the elementary students have difficulty in perceiving parallelogram shape in a 2-dimension of a cube drawing as a square shape [2]. While the results of the preliminary study conducted in a school in Kediri on April 1st and 2nd 2019, it has been found that 60% of students experienced difficulties in classifying objects, 40% of students experienced difficulties in differentiating square and rhombus, 70% of students experienced difficulties in finding nets of a shape and 50% experienced difficulties in finding the position of shape after be shifted from a certain position. These issues are urgent matter and have to be solve immediately. The researcher was inspired to create indicator development which associated with local Javanese culture in aim that the conducted learning could be more meaningful, therefore, it facilitates students in learning new concepts by associating mathematic concepts with cultures close to their lives.



2. Gumul 5-Junction Monument (Monumen Simpang Lima Gumul)

Gumul 5-Junction is one of the monuments located in Kediri Regency. Gumul 5-Junction was established as a result of economic progress of the community, the mandate of the King of Kediri in XII Century who once want to unite five districts in Kediri Regency. The blend between the culture of XII century and modern culture is reflected on the shape of the building which resembles the monument of L'Arc de Triomphe Paris. Gumul 5-Junction packs the symbolization of local culture in modern culture. According to the data obtained from the Department of Culture of Kediri, the monument which has 804 meters of building area is supported by 3 stairs with 3 meters of height from the base of the monument, the height of this monument is 25 meters above the surface of the stairs. The development projection of this trading area has entire area of 37 Ha. The number of area width and height of this monument reflects the date, month, and year of the anniversary of Kediri Regency namely March 25th804 AD. The reliefs of the history as well as the existing arts and cultures of Kediri are sculpted on the sides of Kediri's monument. Reliefs on the Monument of Gumul 5-Junction of Kediri is the representation of historical events and the lives of Kediri's people which embodied in 16 panels. There are 9 of 16 reliefs that tell stories about the arts exist in Kediri Regency, namely *jaranan*, *wayang* (both *wayang kulit* and *wayang orang*), *campursari*, *ludruk*, and *qasidah* as the manifestation of performing arts as well as *kakawin* as the manifestation of literary arts during the Royal Era. While 4 of 16 reliefs tell stories about the history of Kediri Regency which in the past was Kediri Kingdom namely the era of Kediri Kingdom (the origin of Kediri Regency) and the era Dutch colonization. While 3 of 16 reliefs still yet to be identified. The building shape of Gumul 5-Junction in this research was used as the basis of indicator development of spatial thinking of students. This research was an instrument development study with ethnographic approach by using 4D (define, Design, Develop, Disseminate) instrument development theory. Through literature study, interview, and observation on the shape/structure of Gumul 5-Junction, the author developed learning instruments based on Javanese culture. This paper is aimed to describe the physical form of Gumul 5-Junction in reference to the meaning of denotation, connotation, and myth (meta-languages) which used as the basis in developing learning instruments with 4D stages (Define, Design, Develop, Disseminate)

3. Semiotic, connotation, denotation, and myth (meta-languages)

To be able of fulfilling their live needs, in particular, humans must establish relationships with others. Communication is the means used to connect with others. Other signs were created to be able of understanding each other in communication. Those signs are visual, auditory or kinesthetic from the simple into the complex ones, therefore, semiotic study was established that discusses about the correlation of those signs. Semiotics itself studies systems, or rules, and conventions that allow those signs to have meaning[3]. So, semiotics is a science that studies about the signs created as the basis to communicate. In order to be understood, the similarity of meaning is required to understand those signs, connotation and denotation is one of the techniques to understand the signs in semiotics. Denotation is used to describe the meaning of semiotics. Denotation to describe definitional, literal, or common sense of a sign is specifically discussed about the relation of a sign with the signification. At the connotation level, it refers to associations of social and personal cultures such as ideologies, emotion, and others. At the myth level, it is functioned to reveal and provide justification for dominant values apply in a certain period.

4. Spatial Thinking

Spatial thinking is the process of thinking universally, each individual from different disciplines might define it into different contexts as well. *Spatial thinking is based on a constructive amalgam of three elements: concepts of space, tools of representation, and processes of reasoning* [3]. This definition states that there are three main keys of spatial thinking namely the concept of space, means of representation and reasoning process. While Bernard & Lee (2006) in [4] proposed that *spatial thinking as a constructive combination of three mutually reinforcing components: the nature of space,*

the methods of representing spatial information, and the processes of spatial reasoning. Based on that definition, the researcher interpreted that the concept of space is the main object of spatial thinking, representation means (spatial representation information method) is required to process the object into information or new concept namely representations. There are two types of representation such as internal representation (cognitive process) and external representation (visual, verbal, and auditory)[1]. Representations are used in various ways and methods (graphics (text, image, and video), tactile, auditory, and kinesthetic) to describe, explain, and communicate structure, operation, and function of the objects including the relation between the objects. The representation and reasoning processes allow the transformation of size, shape, color, form, position, or transformation of new meaning/information/idea on the studied objects. So, the spatial thinking process is depending on the method/way of someone in interpreting through denotation, connotation or myth (meta-languages) and using the natures of spatial object to formulate problems, find answer, and propose solutions that contain representation, transformation, and spatial reasoning. The spatial structure of an object can be formed through a relation of visualizations of spatial objects by a reasoning while transformation is used to find the relation of objects through the natures attached on those objects. Spatial thinking in this research is the process of spatial thinking which encompasses representation, transformation, and spatial interpretation/reasoning. The definitions of representation, transformation, and spatial reasoning in this research are described as follow

4.1. Representations

Representations are internal processes in which visualizations are required to transform those ideas to be concrete and understandable by others. *Those representations are formed from perception and action* [5]. This statement means that representations are established based on perception and action. This statement indicates that the perception occurs inside the mind (mental) that formed based on what we feel (see, hear, touch) combined by what we think (associated with the conceived memory and concept) and what we conclude (interpretations in the form of idea or information). This conclusion is the idea or information which still in the mental process referred to as interpretations. The idea then revealed in verbal, visual, or kinesthetic manner (manifestation of idea or information) so it can be understood by others that referred to as external interpretations, thus, there are two types of representations namely internal representation and external representation.

4.2. Transformations

Transformations are required on either internal or external representation. Inferences and judgments on mental or external representations require mental or actual transformations of the representations [5]. This statement shows that there are two types of transformation namely mental transformation and actual transformation that contribute in representation process. Drawing conclusions, assessing, and evaluation both internal and external representations require either mental or actual transformation. Actual transformation in this discussion is the transformation process of verbal, visual or kinesthetic expression and mental transformation is the transformation process of idea/information on internal representation process.

4.3. Reasoning

Reasoning is an essential matter in the daily life. The tendency to recall the past to find answers of a particular problem is one of the manifestations of analogical solution conducted by us as the embodiment of reasoning in the daily life. Spatial reasoning is the reasoning used in spatial thinking. Spatial thinking is a thinking process in which someone able to visualize objects that can be accepted abstractly through objects or symbols. *Reasoning processes provide the means of manipulating, interpreting, and explaining the structured information. Representations and transformations are the components that enter into complex spatial reasoning. In actual practice, spatial reasoning often uses several representations, several comparisons, and multiple transformations*[3]. The argument above indicates that the processes of representation and spatial transformation contain spatial reasoning. To

construct a new information/idea, the process of associating with relevant information by selecting or filtering the acquired information, manipulating, interpreting, and then communicating the new idea/information. In addition, [6] defined *perception as the process of recognizing (being aware of), organizing (gathering and storing), and interpreting (binding to knowledge) sensory information*. The definition above is indicating that on the other words, perception processes are required to construct new information/idea such as recognizing, organizing, and interpreting sensory information. The process of recognizing object is identifying objects through the five senses to gain relevant information/idea, organizing is started by selecting relevant information/idea then organizing the information/idea in such a way (manipulating it) and interpreting as the process of interpreting the information/idea until the internal conclusion has been acquired. The processes of spatial reasoning in the discussion of this research include the perception and concluding processes. The perception processes include recognizing, organizing (began by selecting information, manipulating, and organizing), and interpreting sensory information/idea. The concluding process is expressing sensory information/idea into visual, verbal, or kinesthetic information/idea.

5. Research Method

This research was an instrument development study with ethnographic approach. The theory of instrument development used in this research was a theory proposed by Thiagarajan namely 4D (Define, Design, Develop, and Disseminate). Validity and reliability tests were performed on the results of the developed indicators to obtain valid indicators that used to develop learning instruments. This writing discusses about the process of associating the interpretations of connotation, denotation, and myth (meta-languages) in spatial thinking on the indicator development of Gumul 5-Junction for learning instruments.

6. Result and Discussion

In general, the stages of the indicator development are presented as follows.

6.1 Defining stage, this stage was aimed to determine and define the requirements needed in learning.

The activities in this defining stage were front-end analysis, student analysis, concept analysis, assignment analysis, and the specification of learning objectives.

6.1.1 Front-End Analysis

The front-end analysis was performed to determine the basic problem required in the instrument development of spatial thinking based on Javanese culture. At this stage, the analysis toward curriculum, relevant learning theory with future demand, and the congruity of Javanese culture with spatial material were performed, thus, assessment pattern which considered as suitable is acquired.

6.1.2 Student Analysis

This activity was performed to analyze the characteristics of students that match with the design and the development of learning materials that have been performed in front-end analysis, these characteristics include background, academic ability of students, the levels of cognitive, affective, and psychomotor development of students.

6.1.3 Concept analysis

The concept analysis was aimed to systematically identify, specify, and formulate relevant concepts which will be developed in the components of spatial thinking based on Javanese culture on cognitive and affective domains based on front-end analysis.

6.1.4 Assignment Analysis

Assignment analysis is the identification of primary skills required in curriculum-based learning. This assignment analysis was made as a basis in the component development of spatial thinking based on Javanese culture on psychomotor and affective domains.

6.1.5 Specification of Learning Objectives

Specification of learning objectives was aimed to formulate indicators based on the results of assignment analysis and concept analysis which adjusted to the basic of Javanese culture. The

indicator development based on Javanese culture at this stage was formulating indicators specifically in cognitive, affective, and psychomotor domains in accordance with the basis of Javanese culture.

- 6.2 *Designing Stage*, this stage was aimed to design indicators for the development of learning plan, student worksheet, and the assessment which contains cognitive (process-product), affective, and psychomotor domains.

6.2.1 *Media Selection*

This media selection activity was conducted to determine the proper media in presenting spatial thinking instrument of elementary school students based on Javanese culture which made based on the developed indicators. The process of this media selection was adjusted to the results of assignment analysis and concept analysis, characteristics of students, and the selection result of Javanese culture that relevant to spatial thinking.

6.2.2 *Format Selection*

The format selection of spatial thinking instrument of elementary school students based on Javanese culture was performed to design content, strategy, and learning resources that compatible with the characteristics of students and Javanese culture which relevant to the indicators of the main component of Javanese-based spatial thinking that have been developed.

6.2.3 *Initial Designing*

The main activity in the end of designing activity was the construction of “the main/primary indicators of spatial thinking of elementary school students based on Javanese culture” which will be made as the reference to discover the spatial thinking of students on the instrument that will be developed namely learning instruments such as learning implementation, student worksheet, and assessment.

- 6.3 *Developing Stage*, the aim of the development stage was to produce the draft of main components of thinking spatial based on Javanese culture and the development indicators of learning instruments which will be used to develop instruments such as learning implementation, student worksheet, and assessment.

The results of indicator development based on Javanese culture are described as follows.

Table 1. The Development Results of Spatial Thinking Indicators

Visual-Spatial Thinking Modes	Definition	Main Indicator
Visual-Spatial Thinking that produces representations (BSVR)	The process of spatial thinking which orientated on perception, memory, interpretation, and modeling the acquired information.	1. Creating a perception of an object 2. Associating the existing knowledge/concept into the mind/memory 3. Producing an idea or information 4. Expressing information/idea which acquired in visual-verbal manner (connotation, denotation, or myth) or auditory.
Visual-Spatial Thinking that produces transformations (BSVT)	a. The transformation process of idea/information on internal representation process.	1. Expressing idea/information within the mind 2. Transforming old idea/information into new idea within the mind

	b. The transformation process of verbal, visual, or kinesthetic forms on external representation process.	1. Expressing idea/information the form of verbal expressions (connotation, denotation, and/or myth). 2. Transforming idea/information of verbal (connotation, denotation, and/or myth), visual, or kinesthetic expressions, thus, transformations of shape, size, color, form, position, or meaning/information/new idea occur.
Visual-spatial thinking that produces reasoning (BSVP)	The processes of spatial reasoning which include: a. Perception processes (organizing (started by selecting information, manipulating, and organizing), interpreting sensory information/idea) b. Concluding Process (expressing sensory information/idea into visual, verbal, or kinesthetic information/idea.	1. Selecting sensory information/idea 2. Manipulating sensory information/idea 3. Organizing sensory information/idea 4. Interpreting sensory information/idea 5. Expressing information/idea into visual, verbal (connotation, denotation, and/or myth) or kinesthetic information/idea.

The indicators of spatial thinking based on Javanese culture in Table 1 is used to discover the spatial thinking processes of students that include BSVR, BSV, and BSVP when solving geometric problem that developed through Table 2. The results of indicator development of Gumul 5-Junction-learning instrument are presented in Table 2 as follows.

Table 2. The Results of Indicator Development of Gumul 5-Junction-Learning Instrument

Cultural Element	K1 Spiritual Indicator	K2 Affective Indicator	K3 Cognitive Indicator	K4 Psychomotor Indicator
Building shape of Gumul 5-Junction (modern)	Practicing religious teachings embraced by them by praying before conducting learning activities	1. Showing responsibilities on their assignments by collecting data, processing data, and reporting observation results based on the determined time. 2. Respecting the arguments of others when solving	1. Determining scale comparison from simple sketch of Gumul 5-Junction's images 2. Expressing the building of Gumul 5-Junction in a simple sketch of	1. Addressing geometric shape from the building of Gumul 5-Junction (connotation, denotation, and/or myth) 2. Addressing geometric elements

		problems, processing data, and presenting argument or the obtained result.	3. Determining the magnitudes of angles on the building sketch of Gumul 5-Junction 4. Determining the surface area of Gumul 5-Junction's building based on the building sketch that has been made. 5. Determining the volume of Gumul 5-Junction building's surface based on the building sketch that has been made	that form the building of Gumul 5-Junction (connotation, denotation, and/or myth) 3. Addressing the types of angles exist on the forming elements of Gumul 5-Junction (connotation, denotation, and/or myth) 4. Expressing the method to determine the magnitudes of angles on the building sketch of Gumul 5-Junction by using protractor (connotation, denotation, and/or myth) 5. Mentioning the method to determine the surface area of Gumul 5-Junction's building based on the building sketch that has been made (connotation, denotation, and/or myth) 6. Addressing the method to calculate the volume of surface area of Gumul 5-Junction's building based on the building sketch that has been made (connotation, denotation, and/or myth)
Reliefs (traditional and modern)	Respecting the teaching of the embraced religion by being	1. Expressing honesty when finishing assignments by collecting data, processing data, and	1. Identifying the elements of geometric shape from the relief frames of Gumul 5-Junction. 2. Selecting an	1. Expressing the geometric shape from the relief frame located on the building of Gumul 5-Junction (connotation,

	obedient to the rules apply in the school	reporting the observation result 2. Respecting the arguments of others when solving problems, processing data, and presenting arguments or the obtained result.	image of an object that located on the reliefs of Gumul 5-Junction. 3. Determining the shifting of object image located on the reliefs of Gumul 5-Junction selected by the student 4. Determining the magnification of object image located on the reliefs of Gumul 5-Junction selected by the student	denotation, and/or myth) 2. Mentioning the objects that exist on the images of reliefs of Gumul 5-Junction (connotation, denotation, and/or myth) 3. Mentioning symmetrical and non-symmetrical objects exist on the images of reliefs of Gumul 5-Junction (connotation, denotation, and/or myth)
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7. Conclusion

The conclusions that can be presented are as follows.

- Local culture can be made as the source of learning instrument development
- Indicator development can be done in accordance with the user need.
- Indicator development should always refer to Core Competencies and Basic Competencies that have been determined.
- The indicators that have been developed can be used as the basis of learning instrument development.

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