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Engage Spatial Thinking in Geography Teaching Material

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Abstract
The main competence of students in solving the problem of geography is that students are able to think of spatially. One important component supporting the achievement of the competence is the availability of teaching materials that engage spatial thinking. For this purpose, this study aims at including spatial thinking in geography teaching materials. This study used a procedure of systematic design of instruction by Dick and Carey (2001), each step is done in stages to produce a final product that is valid. In conclusion, in that procedure, spatial thinking can be included with either the geography teaching materials. However, this study is still limited to teaching materials of hydrology of geography teacher candidates in Indonesia, and focus on one component of spatial thinking, which is spatial concept. In the future, this research will be complemented by two other spatial thinking components, namely the representation of tools (media/ instructional technology), as well as the thinking process (input-process-output). The interesting issues are finding the most influential components to increase spatial thinking ability and determining its effectiveness if those three components are applied in a lesson.
***Key words**: Spatial Thinking, Teaching Material, Geography.*

Background

The main competence of students in resolving issues of geography is ability to think spatially. Therefore, spatial thinking is considered as the key of success of one's career in geography (Metoyer & Bednarz, 2017). Spatial thinking is a cognitive skill that can be used to transform and combine information based onthree components; (a) spatial concept, (b) representation tool, and (C.) thinking processes (NCR, 2006). The taxonomy was compiled by Jo and Bednarz (2009) and has been cited by many cross-science studies.

Various science disciplines use spatial thinking as object of their studies (Michael et al, 2014). Even according to Carrera and Asensio (2016), spatial thinking is very vital to be studied by the students of science, technology, math and engineering, as well as geography as study using spatial as one of its perspectives (Gabler et al, 2007).The students are very competent with spatial thinking skill.

Some studies on geography concerning on spatial thinking, such as the use of digital image of field to improve the understanding of spatial thinking (Carrera &Asensio, 2016), GIS to improve spatial thinking skill (Lee &Bednarz, 2009; Bearman et al, 2016; Metoyer &Bednarz, 2017), spatial thinking learning with local atlas (Chu et al, 2016), the role of teachers in spatial thinking learning (Jo &Bednarz, 2014), the assignment of writing Journal to improve spatial thinking skill (Hooey & Bailey, 2005). Although those studies have different focus and object of

studies, they show the concern of geography on spatial thinking, which still continues up to now.

The representation of elaboration of the research on geography of spatial thinking up to now is more dominated by how to use a medium/ tool/ technology, for example GIS, while there are only a few studies related to textbooks/ teaching materials. Even (Scholz et al, 2014) explains that textbook for spatial thinking skills is still relatively new. One of them was conducted by Jo and Bednarz (2009, 2011), who used taxonomy to evaluate the questions of the textbook. Previously, Martin (1996) also evaluated geography book for high school and higher education, and then (Scholz et al, 2014) came with a focus on evaluating geography book of University in the world. Therefore, there are still many opportunities and gaps for research on textbooks related to spatial thinking, for example how to include spatial thinking into geography teaching materials. So, it is not only limited to evaluate the available book, but also how to develop the teaching materials which are connected with spatial thinking.

Based on the problems above, this study is more directed at how spatial thinking is included into geography teaching materials. The rational is; (a) teaching materials, especially the text book, is the primary need of teachers, and play an important role as a teaching media (b) teaching materials can be designed specifically for the achievement of particular competence in geography, such as using digital image and GIS for teaching materials (Carrera & Asensio, 2016; Metoyer & Bednarz, 2017), using Internet for teaching materials (Martha & Gary, 2000), and taking advantage of equipment at school as supporting teaching materials (Wathore, 2012), (c) spatial thinking can be integrated into curriculum, especially teaching materials, "*It can be learned and taught formally to students by using appropriately designed tools, technologies, and curricula*" (NCR, 2006).

The rationality is used as a basing of thinking, that teaching materials which are developed specifically for geography learning can improve students in accordance with the objectives of learning. Similarly, if spatial thinking is included into teaching materials, it can increase spatial thinking skill too. For example, the writing model of book entitled "Essentials of Physical Geography" (Gabler et al, 2007), is a book which leads to spatial thinking. Based on taxonomy ST (Jo & Bednarz, 2009), spatial concept (primitive-complex), the use of tool (figures, maps, diagrams, chart), thinking processes (input-the-output) can be found on the presentation strategy of the book.

Presentation strategy is associated with how teaching materials are organized for a particular purpose, in this case is spatial thinking. The practical step can be done by organizing the materials with the concept of thinking spatial (concept of space), organizing questions of exercises/discussion and tasks which lead to spatial thinking (the processes of reasoning), and organizing the presentation of the images and data which lead to spatial thinking (tools of representation). The level of complexity can use the taxonomy of think spatial by Jo and Bednarz (2009), and can be adjusted to the cognitive level that will be achieved through teaching materials. Teaching materials can be compiled based on the importance of the material will be presented, that is by selecting material, which is by choosing the available material modifying, or creating a new material (Morrison et al, 2004).

Whatever the form, all materials used in learning are defined as teaching materials (Tomlinson, 1998) which are designed systematically for the implementation of teaching and learning process. Systematic design of a teaching material can be done through the procedure of development. One of them is procedures model by Dick and Carey (2001).This model has clear steps which are easy to follow, as well as suitable for small unit such a creating textbook/modules. The selection of a model depends on the needs of the developer, adjusted to the development goals.

The purpose of developers in this study is to produce teaching material which is valid and connected to spatial thinking. In particular, this study is adjusted to the learning objectives which want to be achieved, which is the understanding of spatial concept of hydrology course of geography teacher candidate in Indonesia.

Method

The development model employed in the present study refers to the procedural model by Dick and Carey (2001), with stage; (1) analyzing the needs and goals, (2) analysis the learning process, (3) analyzing the learners and context, (4) formulating learning objectives performance, (5) developing instruments, (6) developing learning strategies, (7) choosing and developing learning materials, (8) designing and implementing formative evaluation, (9) revising, (10) evaluating summative. For the purpose of the development of this research, the researcher only used up to step 9, which is revising the final product.

Formative evaluation is a stage of assessment that will generate the final product, then revise it and become a final product of teaching materials and valid to be uses. Formative evaluation in step 8 used 4 types of instrument, 3 instruments for expert validation (validator) and 1 instrument to know the response of students toward teaching materials which are produced.

Three validators consist of; (a) expert of learning technology, as validator of presentation feasibility, (b) expert of hydrology material, as validator of the feasibility of contents, (c) expert of Indonesian language, as validator of the feasibility of language. The result of revision of validator was tested again to 10 students to give feedback. The final revision of the response of students is the final product. The data generated in evaluating formative was analyzed by using quantitative descriptive (scoring).

Result of the Research

The result in this study is the result of formative evaluation of experts' validation test to teaching materials, and the result of limited test in the form of students' response. The data and explanation can be described as follows.

Table 1. The Result of Validation Test from Learning Technology Experts for the feasibility of Presentation

No	*Component*	*Score*	*Category of Assessment*
1	Clarity of the title	4	Good
2	Order of the presentation	4	Good
3	Clarity of the material discussion	4	Good
4	Clarity of illustration/ image/ example	3	Moderate
5	Clarity of summary	4	Good
6	Clarity and conformity of discussion and exercise with the indicator	2	Poor
7	Clarity and conformity of assignment with the indicator	3	Moderate
Average of assessment		3.43	Good

Information:

1. The interval of assessment is from 1 to 5 (very poor – very good)
2. Criteria:

OS>4 (very good); 3<OS≤4(good); 2<OS≤ 3 (moderate); 1<OS≤2 (poor); and OS= 1 (very poor), OS: obtained score.

Based onthe assessment in Table 1, it can be known that there are 4 components which are classified into category of good, 2 components in the category of moderate, and 1 component in the category of poor. In general, the product of teaching material which is the result of development is categorized **good** (score of 3.43) in the presentation. The component which is categorized poor was then revised and consulted back to experts. The weakness of this productis onthe conformity of discussion and exercise with the indicator.

The next one is the assessment of content/ material from experts, in order to get the truth of the content. The assessment result of valiadator is presented in table 2 below.

Table 2. The Result of Validation Test from Hydrology Material Experts for the Feasibility of Content

No	**Component**	**Score**	***Category of Assessment***
1	Conformity of basic competence and indicator with the material in each chapter	4	Good
2	Conformity of material order	4	Good
3	Scope of material	3	Moderate
4	Appropriateness of illustration/ figure/ example	4	Good
5	Appropriateness of geoperspectives	4	Good
6	Conformity of summary with the material and indicator	4	Good
7	Conformity of discussion and exercise with material and indicator	3	Moderate

8	Conformity of assignment with material and indicator	3	Moderate
Average		3.62	Good

Information:

1. The interval of score is from 1 to 5 (very poor–very good)
2. Criteria:

OS>4 (very good); 3<OS≤ 4(good); 2<OS≤3 (moderate); 1<OS≤2 (poor); and OS= 1 (very poor), OS: obtained score.

From the table above, it can be known that there are 5 components which are classified into category of good and 3 components in the category of moderate.In general, validators assess that the content of teaching material which is the result of development is appropriate and classified into category of **good** (score of 3.62). The component which was considered moderate was not revised because in general it is good. It means that there is no mistake in concept found that can cause a bias of understanding in students.

The assessment from language experts was also used to get the truth of language. Assessment result of validators is presented in table 3 below.

Table 3. The Result of Validation Test from Language Experts for the Feasibility of Language

No	Component	Score	*Category of Assessment*
1	Easy to read	5	Very good
2	The clarity of content/ information	5	Very good
3	The clarity of sentence arrangement	4	Good
4	The appropriateness of language use	4	Good
5	The simplicity of language (effective and efficient)	4	Good
6	Appropriateness of punctuation	4	Good
7	The clarity of relationship between sentences	4	Good
8	The appropriateness of font size and type	4	Good
9	The appropriateness of space	4	Good
10	The appropriateness of the use of illustration	5	Very good
Average score		4.3	Very good

Information:

1. The interval of score is from 1 to 5 (very poor –very good)
2. Criteria:

OS>4 (very good); 3<OS≤4(good); 2<OS≤3 (moderate); 1<OS≤2 (poor); and OS= 1 (very poor), OS: obtained score.

From the data of table above, it can be known that there are 3 components which are classified into category of very good, and 7 components in category of good.In general,the teaching material, which is the result of development, in terms of linguistic is included in the category of very good (score of 4.3). Language plays an important role as aconnector of ideas and information in teaching materials.If the language is appropriate, the students will be easier to receive the information in teaching materials. The result of revision ofexpert draft validation

experts then was tested to 10 students to get data onthe ease of teaching material to be understood, the readability, and the interest of teaching materials. The test results are presented in table 4.

Table 4. The Result of Students' Opinion on the Interest, Easiness to Read, and Easiness to Understand

No	Component	Average score	Category of Assessment
1	Interesting cover design	4.6	Very good
2	Clarity of title	4.8	Very good
3	Clarity of preview	4.4	Very good
4	The order of material	4.8	Very good
5	Clarity of summary	4.6	Very good
6	Geoperspektive is easy to be understood	4.8	Very good
7	Clarity of exercise and discussion	4.6	Very good
8	Clarity of assignment	4.6	Very good
9	Force to think spatially	4.4	Very good
10	Attract students	4.6	Very good
	Average	4.62	Very good

Information:

1. The interval of score is from 1 to 5 (very poor –very good)

2. Criteria:

OS>4 (very good); 3<OS≤ 4(good); 2<OS≤3 (moderate); 1<OS≤2 (poor);and OS= 1 (very poor), OS: obtained score.

Based on table 4 above, from 10 components of assessment, there are 2 components lower than the others, which are clarity of preview and force to think spatially. Those two components are still in the category of very good, so they do not need to be improved. Overall, teaching material, which is the result of the development,is considered **very good** (score of 4.62). It means that students respond positively to all components of teaching materials and do not find obstacles in understanding and reading the material. They also seem very interested in the teaching materials. Students' response also shows conformity of the assessment from the three experts, who assess that teaching material which is result of development is categorized good-very good (presentation, content, language).

Discussion

The result of this research proves what has been stated by NCR (2006), that spatial thinking can be taught through curriculum, in this case is device in the form of teaching materials. Teaching material developed is assessed very good in encouraging to think spatially. Several things that are considered to streng then spatial thinking in teaching materials are (a) strategy of presentation of the text, (b) and the components of teaching material.

The way of presenting the content in the text influences the understanding, and by understanding the content in the text means taking the meaning of what has been read.

Therefore, the content of spatial thinking in the text is presented with a narrative from the easiest to more complex, and a paragraph should strengthen the previous paragraph. In addition, it is also important to add pictures appropriately in the text in order to expand and enrich the text. Narrative text set in paragraph is reinforced with images which encourage understanding of spatial thinking. Images can be in the form of map, illustration, particular location object, diagrams, or any images related to the reinforcement of spatial thinking. After arranging the content in the text which has been strengthened with images, the next thing to beconsidered is the component of teaching material in each chapter.

Component of teaching materials is considered good if it can direct and strengthen the description of the material in each chapter. For example book entitled "Essentials of Physical Geography" (Gableret al, 2007), its components are integrated in presenting content of physical geography (spatial, physical phenomena, environment). The components are (a) preview, (b) define and recall, (c) discuss and review, (f) consider and respond. Furthermore, these components are also adapted in the presentation of each chapter of teaching materials developed, with the following reasons:

1) Preview
   The function of preview plays a role as the activator of cognitive strategy. The way to activate cognitive strategy can use the images, diagrams, analogy and paraphrase. Guiding question swhich are similar to preview also can be used for this purpose. In this case, the teaching material developed directs paraphrase and guiding questions to the understanding of spatial concept, according to the direction of learning objectives.
2) Define and Recall
   Function of this component is similar to the summary, and hypothesized to be able to increase the retention.
3) Discuss & Review
   The function of the component of discuss is to measure the things that have been known by students after learning activity. Component of review is important to be done what has been studied. It is used to retain the retention. In this study, it is also used to evaluation the mastery of material that has been delivered with understanding spatial thinking.
4) Consider & Respond
   This component is functioned as synthesizer, shows the relationship between the concept, procedures and the principle that has been taught. It can improve the meaning and can provide the motivational influence to students. In this study, teaching materials developed use the assessments which direct the understanding of spatial concept, which is of contextual. Students are given space to find out, collect data and present data by using spatial concept.

Integration of those components and the presentation of content in the text are believed to be entry point on teaching materials generated, so that it isconsidered very good by students in encouraging spatial thinking.

Conclusion and Suggestions

Based on the discussion of the result, it can be concluded that spatial thinking can be included well into the teaching materials developed and also can be assessed very good in encouraging spatial thinking. The research process has been through the development procedure coherently, but it is still limited and involves small subject. Therefore, it is suggested to try this procedure with other subjects, so that it can be used as a comparison. In addition, this study only direct on one component of spatial thinking,which is spatial concept, while two other components (the use of tool and thinking process) are not included yet in teaching materials. In the future, this study will be enhanced by involving both components, and components which positivelygives influence on spatialthinking in geography, and the effectiveness if those three components included in teaching materials.

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