Effect of learning project model-based learning on GIS spatial thinking skills students

R W Romadlon*, Y Yusuf, Sarwono

Master PKLH, Universitas Sebelas Maret
*Rohmatwahid88@gmail.com

Abstract: Developing students in geographic information technologies is the main reason for describing things like models and approaches, which is based on classroom learning and focus on theories of teaching and learning technical. This research used quasi experimental True Experimental Design model with pretest-posttest control group design and 45 students of 12th grades of MAS AL ISLAM in academic year 2018/2019 as the population. Purposive sampling with initial data values First Final Assessment were used based on 12th grades Social 1 as the control class and Social 2 as the experimental class. In the control class, GIS learning is applied conventionally while the experimental class is applied Learning Project Based Learning Model-GIS. The data method were analyzed by SPSS 16 software through observation, documentation, and testing STAT (pretest and posttest) with quantitative data analysis techniques. The results showed that the Project Based Learning Model Learning-GIS affecting spatial thinking abilities 12th grades Social 1 students by tests Independent Samples T-test posttest score STAT students who demonstrate the significant value of 0.02 (<0.05). This is consistent with the study of theory about project-based learning model in GIS material as a model approach that is effective to increase the spatial analysis techniques.

1. Introduction

Curriculum implementation in 2013 focused on three aspects, namely cognitive, affective and psychomotor. Implementation of learning, especially geography on map lesson use information technology is still less considered. Students are still used as learning objects without any space to develop creativity in geographic information technologies. This has become one of the main reasons for describing things like models and approaches, which is still based on classroom learning and focus on theories of teaching and learning technical.

Geography has potential to build and develop students' understanding through the use of information technology, one of the spatial information in the field of civil society and all aspects of the earth's surface. Students are encouraged to understand the aspects and the physical processes on shape patterns of earth, ecological characteristics and spatial distribution of the earth's surface [2]. In addition, students are motivated to actively and creatively to examine the influences of culture and experience in human perception of places and regions. Knowledge, skills, and values obtained in geography subjects is expected to build the students' ability to behave, act smart, wise, and responsible in dealing with social problems, economic, and ecological [3].
A person's intelligence is not only owned by the right and left brain, as it is believed by the old paradigm of intelligence, but spreads throughout the brain and intelligence can be developed [7]. One type of intelligence can be improved through the subject matter of geography is spatial intelligence [4]. Someone with spatial intelligence have specific characteristics such as the ability to think spatially (spatial thinking). Through spatial thinking skills students enable to have better understanding the characteristics of the region, control of territory, planning, monitor progress, develop the area, and evaluate the development of the region [8].

According to the goals of learning geography is to provide a spatial thinking skills to students. One of the struggles central to the teaching and learning of geography helps students learning to think spatially [19]. However, geography lesson has not been able to provide these capabilities to students who still serve as the object in order to learning ability and spatial thinking skills are very low and it can be proved by any circumstances [5].

One cause of low spatial thinking skills students are learning geography is still emphasis on the cognitive aspects / knowledge alone. Geography learning paradigm that has been more emphasis on spatial cognitive aspects must direorientasi to spatial thinking abilities [10]. The fundamental weakness of the spatial cognitive aspect is not the establishment of the foundation of the analysis which can be used to deal with all the problems of spatial. A student may have a lot of knowledge about a place, but in other places, the student failed to perform spatial analysis because of what he has learned in the classroom is not the form of the ability to think spatially, but just spatial knowledge [9]. Therefore, spatial thinking should be an important part of the educational curriculum at all levels. Further suggests that GIS and other geospatial technologies can play a strong role in promoting spatial thinking. In fact, many studies have shown the benefits of integrating GIS into the classroom [1].

In line with the foregoing, Golledge and Stimson (1997) argues the need to add a variable called spatial relations ability, which consists of a number of skills such as the ability to recognize spatial distribution and spatial pattern to connect locations, to associate and connect spatially distributed phenomena, to understand and use spatial hierarchy, to regionalize, indicating the direction to the real world frame of reference, to perceive map of verbal description, sketch map, to compare the map, to overlay and combining map [11] [16].

One of the strategies that can help students to have a creative thinking, problem solving, and interaction as well as assisting in the investigation that led to the completion of the real problem is project based learning or project-based learning. Model project administration including one type of active learning. According to Dewey (1997) [6], as a learning model of learning by doing. This means that the learning process is obtained through the activity or activities undertaken their own children or in groups, with the understanding that how children perform work in accordance with a series of steps and a certain behavior [13]. With the process of conducting the process is expected to afford members who are knowledgeable experience of children, so that children are able to understand and appreciate more deeply because of it. Learning model that is effective, efficient, and fun is expected to motivate students in learning so that students in learning activities continue to increase. The learning model is effective, efficient, and fun to be researchers applied a model Project Based Learning (PjBL) [12].

Based Learning Project (Project-based-learning) is a learning model that uses the project / activity as a learning process to achieve competence attitudes, knowledge and skills. The emphasis is on learning-activity aktivias learners to produce products with applied skills of researching, analyzing, creating, until the present learning products based on real experience [14]. The product in question is the result of a project in the form of design, schematics, literary, artistic, technological / crafts, and others. Pesera This approach allows students to work independently and in groups in mengkostruksikan real products.

The advantages of this project-based learning model is developing a total involvement of every individual in the process of learning activities. This learning model is a model student-oriented learning
activities and are also suited to ensuring individual accountability in the discussion / performance group [15]. Additionally PjBL can reduce competition in the classroom and directing learners more collaborative than working alone. In addition, the PjBL can also be carried out independently by the student with the way students construct their learning through the knowledge and new skills, and make it happen in real products [17].

Project Based Learning has the following characteristics: (a) Learners make a decision on a framework, (b) the existence of the problem or challenge posed to learners (c) Students design the process for determining solutions to the problems or challenges posed, (d) learners collaboratively responsible for accessing and managing information to solve problems, (e) the evaluation process is run continuously, (f) learners periodically to reflect on the activities that have been carried out, (g) the final product of the learning activities will be evaluated in kuantitatif; and (h) the learning situation is very tolerant of errors and changes.

1.1. Syntax Model Project Based Learning
Step-by-step implementation of a project-based learning can be explained by the following diagram:

**Figure 1.** Project-based learning steps adapted from Keser and Karagoca (2010) [12]

*Collaborative learning* This is deeply rooted in Vygotsky's view that an inherent social nature of learning, reflected through his theory of the zone of proximal development. Often, collaborative learning is used as a general term for a variety of approaches in education. It involves a joint intellectual effort by students and teachers. Collaborative learning activities can include collaborative writing, group projects, joint problem solving, debates, study teams, and other activities. This approach is closely related to cooperative learning [18].
2. Methodology
This study used quasi experimental design (quasi-experiment) with the consideration ignores the external variables that can affect experimental results. Other considerations are: (1) to identify differences in project-based learning model in the geographic information system materials with conventional learning about spatial thinking ability, and (2) the selection and grouping of research subjects, either the experimental group or the control group, randomly chosen.

This study chosen nonequivalent pretest-posttest control group design as presented in Table 1 below.

| Table 1. Experimental Research Design Moot with pretest-posttest control group Nonequivalent |
|---------------------------------------------------------------|
| Experimental class | pretest | V | posttest |
| control class | A3 | | A4 |

**Information:**
- A1: Measurement of spatial thinking abilities baseline (pretest) experimental class.
- A2: Measurement of spatial thinking abilities end (posttest) experimental class.
- V: Provision of treatment (assisted project-based learning in the classroom experiment Google Earth).
- A3: Measurement of spatial thinking abilities baseline (pretest) control classes.
- A4: Measurement of spatial thinking abilities end (posttest) control classes.

The study was conducted in 12th social MA AL ISLAM Surakarta. Based on the report card Values first half of the chosen 12th social 1 as the control class and social 2 as the experimental class. Chapters that will be studied is the pemenfaatan Map, Remote Sensing and Geographic Information Systems. Utilization of digital maps and prints are used to collect spatial information which is then analyzed using software arc view GIS to overlay technique.

Instrument to measure the ability of spatial thinking is Spatial Thinking Ability (STAT) [4]. The data obtained were then calculated using the t test using SPSS software 16. In addition to using the test to measure the ability of spatial thinking, do also observation and assessment of students' activities during the learning process through observation sheets and questionnaires. The indicators assessed are (1) the student's motivation in doing the project, (2) student activity levels, (3) planning of the project, (4) the students' responses when implementing projects, (5) the product based on the opinions of students, and (6) the ability of spatial thinking of students. Assessment is also made to the results of the student project created by using the assessment sheet products.

3. Results and Discussion

3.1. Data Source
This research using preliminary data by score at First Final Assessment were used based on 12th grades. It’s divide in the experiment and control class by classified score. The score can be shown at table 2.

| Table 2. Score of pretest before treatment |
|------------------------------------------|
| Score range | Control class (freq) | Experiment class (freq) |
|-------------|----------------------|------------------------|
| 51 – 60     | 6                    | 10                     |
| 61 – 70     | 13                   | 11                     |
| 71 – 80     | 2                    | 3                      |
#### Table 3. Score post test after treatment using PJBL GIS

| Score range | Control class (freq) | Experiment class (freq) |
|-------------|----------------------|-------------------------|
| 51 – 60     | 0                    | 0                       |
| 61 – 70     | 11                   | 0                       |
| 71 – 80     | 10                   | 10                      |
| 81 – 90     | 0                    | 14                      |
| 91 - 100    | 0                    | 0                       |

3.2. Normality Test Data

Pretest: testing normality of the research data was performed with SPSS 16 with the calculation results as follows:

#### Table 4. Normality test pre test and post test

| Factor          | Kolmogorov-Smirnov | Shapiro-Wilk |
|-----------------|--------------------|--------------|
|                 | statistics | df | Sig. | statistics | df | Sig. |
| Spatial thinking | Control          | .142 | 21 | .200 *   | .966 | 21 | .648 |
|                 | experiment       | .167 | 24 | .084     | .943 | 24 | .187 |

a. Significance Lilliefors Correction

* This is a lower bound of the true significance.

Post test: testing normality of the research data was performed with SPSS 16 with the calculation results as follows:

#### Table 5. Normality post test

| Factor          | Kolmogorov-Smirnov | Shapiro-Wilk |
|-----------------|--------------------|--------------|
|                 | statistics | df | Sig. | statistics | df | Sig. |
| spatial Thinking | Control          | .170 | 21 | .114     | .941 | 21 | .230 |
|                 | Experiment       | .166 | 24 | .084     | .958 | 24 | .391 |

a. Significance Lilliefors Correction

From the table above it can be concluded that the significant value of the pre-test and experiment control class is 0.648 and 0.187. This means that the data is normally distributed as the results of the calculation is greater than 0.05. As for the post-test, the results of calculation of data in control and experimental class figures obtained 0.230 and 0.391 so this result is greater than 0.05, which means the data above normal distribution.

Homogeneity Test Data. Results pretest and posttest tested similarity variance using F (levene statistics) with SPSS 16.
Table 6. Homogeneity Test for Independent Samples Test T-test

| No. | Data  | Levene Statistic | Sig.  | Conclusion   |
|-----|-------|------------------|-------|--------------|
| 1   | pretest | 0.237            | 0.629 | Homogeneous  |
| 2   | posttest | 0.12             | 0.912 | Homogeneous  |

*Source: homogeneity test results with SPSS 16*

Homogeneity Test calculation results pretest levene statistic shows that the value of 0.237 with 0.629 Sig. The Sig value > 0.05 means STAT pretest results data in the experimental class and control class homogeneous. While the post test results showed a statistically levene 0.12 with 0.912 Sig. The Sig value > 0.05 means STAT post test result data in the experimental class and control class homogeneous. Data pretest and post test experimental class and control class is eligible to test Independent Samples T-test.

3.3. Gain Test Score

The results of the average value of the initial test (pretest) spatial thinking skills in experimental class is 63 and 64 in a control class. There are differences in the average value of the control class and eksperimenetapi not too big. Thus, we can conclude that the control and experimental classes are considered to have the same initial capability. In the experimental group gained an average value of spatial thinking skills in the post test 82 while the control group gained an average value of spatial thinking skills end 71.

Spatial thinking skills in this study are determined based on the difference between the value of the initial test and final test score called gain score. This value is derived by subtracting the value of the final test of each subject with the initial value of the initial test. Gain score describes the spatial thinking skills, both the control and experiment class. Based on data from gain score in mind that the average value of the control class is 17 and for the experimental class 50. The figure shows that the average value of the experimental class is higher than the control class.

Based on the analysis of data through different test (independent samples t test) note that the value of significance (sig) of less than 0.05 (sig 0.05) is sig 0.02. This means that H0 is rejected (the project-based learning materials geographic information system does not significantly influence spatial thinking skills of students) and H1 accepted (project-based learning significantly influence spatial thinking skills of students).

The results of data processing observation and questionnaires to the project during the learning can be stated that: (1) The majority of respondents (88%) say they feel more motivated to learn, (2) the majority of respondents (90%) expressed a more active learning, working sequence of projects, and regular consultation with the teacher, (3) almost all respondents (96%) stated that they implement learning activities and well planned, (4) all respondents (100%) suggests, they have flexibility in their learning activities, nearly all respondents (96%) say they are working to produce a better product than the more friends, and (6) the majority of respondents (86%) shown to increase their spatial thinking skills through mereja produce a final product. The resulting end product of students rated teachers through evaluation sheets obtained good and very good value, no gain value good or not good enough.

4. Discussion

Hypothesis test results indicate that the project-based learning model in the geographic information system materials significantly influence spatial thinking skills of students. This study is also consistent with the results of research conducted by Bowlick, Bednarz, and Goldberg (2016), which revealed that the project-based learning can stimulate the ability of spatial thinking.
The results also reinforce the opinion Grant & Branch (2005) and Mountrakis Triantakonstantis (2012) which states that the project-based learning can improve intelligence. Intelligence is meant here is spatial intelligence demonstrated by the ability to think spatially. A significant effect on project-based learning model in the material system geographic information for the following points.

First, students are more motivated to complete the real and factual issues through the project "Creating Map Flood Prone Areas in Surakarta". This is done because the city of Surakarta is a basin area which has a seasonal flood hazards. Students are required to observe around their homes or using information obtained from other media. As many as 84% of students choose to use a real and factual issues that exist. Students revealed using real and factual issues in the field will be more attractive because it is directly related to their daily lives. Students are challenged to find answers to the problems identified through the project they are working on.

Second, students can play an active role in the learning process. This is proven through observation notes during learning in which students actively participated in the project from the beginning to the end of learning. At the beginning of learning, students were actively identify environmental problems and develop a project plan mapping areas prone to floods in Surakarta. On the implementation of field research, students were active environmental observation. When writing of the results and discussion after the observation, students actively seeking sumberteori, both of the books in the library or Internet browsing via mobile phones and laptops. In addition, students are also actively consult with your teacher and get immediate guidance for improvement projects they are working.

Third, the performance of students during the complete project appear more regularly. This is because all the activities of the student based on the planning or project design and project implementation schedule that was created in the beginning. Before carrying out the project, students planning to create a design project, in this case, students choose residential locations that are vulnerable to flooding. Furthermore, the students put the project implementation schedule, from the allocation of time for the preparation of a research proposal, data collection, to the making of the map areas prone to floods with a certain time limit. This condition affects a student's work in implementing the project became more regular until the project is completed.

Fourth, the students have the flexibility to complete the project. This is because project-based learning to provide more flexibility to students to make a plan and prepare project completion schedule. Students have the freedom to obtain direct guidance from teachers about the progress of the project. Similarly, the freedom to seek and receive information through a literature review, observation, and browsing the Internet to support the project "Make a map of areas prone to flooding in Surakarta".

Fifth, students eager to compete to produce the best. The final product at the project-based learning is the main source of the teacher ratings on student learning outcomes. It encourages students to compete to produce the maximum.

Sixth, the experimental group experienced a significant increase in the field of spatial thinking skills. This happens because project-based learning in matter of geographic information systems to help students understand the spatial aspects that exist in the neighborhood. By combining a variety of spatial information through digital maps and printed maps, students can select areas that are vulnerable to the danger of flooding in the city of Surakarta.

The study also found some weaknesses in its implementation, namely: (1) the time required to complete the project is relatively long. To produce scientific work of geography, students need time for six sessions (three weeks). This is because the earlier the students had never implement project-based learning. In addition, the completion of the project is not enough just in the classroom, but also in the field for data collection.
5. Conclusion

Based on the findings of research and discussion, conclusions can be stated is that (1) project-based learning model with the help of digital maps and thematic maps significant effect on students' spatial thinking skills. Can be explained that the advantages of project-based learning model, among other things: (1) encourage students be challenged to solve real problems through project activities, (2) pupils more active in learning, (3) the performance of the students in completing the project more organized, (4) students have more flexibility to complete the project, (5) students are motivated to compete to produce the best, and (6) of students has increased skills of spatial thinking. On the sideAnother weakness in the implementation of project-based learning is a relatively long time required to complete the project.

Project-based learning geography should be done on an ongoing basis so that students used to carry out the project. Ongoing project-based learning can make the time needed for completion of the project more effective and efficient because students become accustomed to similar activities. Learning geography is also expected to take advantage of technological developments, especially geospatial technologies.

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