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IMPROVING STUDENTS SPATIAL REASONING WITH COURSE LAB

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Abstract

Geometry flat side material is crucial subject for students in senior high school. As the development of technology that increases very rapidly, it provides a chance to develop Media Interactive Learning (MPI) such as Course Lab MPI 2.4. This study was conducted to create a valid interactive multimedia teaching material, practical, and effective. Since there are correlated between spatial reasoning and student learning achievements, the influence of Course lab on the improvement of spatial reasoning is also seen. Spatial reasoning has three aspects that are mental rotation, spatial orientation, and spatial visualization. This study is a development model consisting plomp as design composed of three phases. The results obtained through this research interactive multimedia teaching material course lab based on geometry flat side were valid, practical, and effective. Students' test scores average changed at 25 with a standard deviation of 7.07. The test results statistically demonstrated the value which means there were some differences in the average score of the initial test and final test. Course lab also led to improving students' spatial reasoning. The multimedia developed was effective in improving both student learning achievements and spatial reasoning.

Keywords: Course Lab, Spatial Reasoning, Geometry

Abstrak

Materi bangun ruang sisi datar memiliki peranan penting dalam pelajaran matematika siswa SMP. Perkembangan teknologi yang semakin pesat, memberikan kesempatan kepada pendidik untuk mengembangkan Media Pembelajaran Interaktif (MPI) contohnya *Course Lab 2.4*. Penelitian ini dilakukan untuk menghasilkan bahan ajar multimedia interaktif yang valid, praktis,dan efektif. Penelitian ini merupakan penelitian pengembangan dengan model plomp sebagai rancangan yang terdiri terdiri atas 3 fase. Hasil yang diperoleh melalui penelitian ini adalah bahan ajar multimedia interaktif berbasis *course lab* pada materi peluang dan statistika telah valid, praktis, dan efektif. Nilai tes siswa rata-rata mengalami perubahan sebesar 25 dengan simpangan baku 7,07. Hasil pengujian secara statistik menunjukkan bahwa terdapat perbedaan nilai rata-rata tes awal dan tes akhir. Course Lab juga dapat meningkatkan kemampuan penalaran spasial siswa. Kesimpulan dari penelitian ini bahwa modul multimedia *course lab* meningkatkan hasil belajar dan kemampuan penalaran spasial siswa.

Kata kunci: Course Lab, Penalaran Spasial, Geometry

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Currently, we can get information very fast, easy and cheap from various sources although it's good or bad. To select and sort information received, we need thinking and reasoning skills. The reasoning is a competence that can be trained and developed. Based on the general objectives of mathematics learning formulated by National Council of Teachers of Mathematics (NCTM) reasoning ability is one of mathematical knowledge. This ability does not appear but needs to be trained continuously and sharpened. Santrock (2011) states that reasoning is a thought that applies inductive logic and deduction to obtain a logical conclusion. From several definitions above can be concluded that

reasoning is a process of thinking that uses logic and evidence to get a conclusion in the form of knowledge. reasoning, one of three aspects of TIMSS, is not only finding solutions to routine problems but also including foreign situations, complex contexts, and multistep difficulties (Suarsana, Widiasih, & Suparta, 2018). Seen from its strategy, reasoning divided into two types: spatial reasoning and verbal reasoning (Hardman & Macchi, 2003).

Spatial reasoning is a crucial component of mental ability (Linn & Petersen, 1985; Mayer & Massa, 2003; Bosco, Longoni & Vecchi, 2004; Maeda & Yoon, 2013) in the process of mathematical thinking (Sinclair, *et al*. 2016). Spatial reasoning refers to the ability to generate, retain, retrieve, and alter visual images so they are well structured (Lohman, 1994). This capability involves the rotation, retention, and transformation of visual information in a spatial context. Spatial reasoning ability can be trained to improve student learning outcomes (Cheng & Mix, 2014; David, 2012; Lowrie, Logan, & Ramful, 2017; Ramful, Lowrie, & Logan, 2017). This makes the ability of spatial reasoning be taught at all levels of Education (dU.S. National Research Council (NRC) Geographical Science Committee, especially now when the development of spatial reasoning capabilities is expressed as one of the objectives of mathematics education from the level Kindergarten to university (Cheng & Mix, 2014; Sinclair, *et al*. 2016; IEA, 2012) To prepare students for excellence in various fields, students must be trained to develop and foster spatial reasoning abilities (Wright, Thompson, Ganis, Newcombe, & Kosslyn, 2008). The school is an appropriate and strategic place to develop that ability; the development process can be integrated into every learning activity.

The quality of education can be realized if the learning process is organized effectively, it means that the learning process can run smoothly, directed and by the purpose of learning. There are many factors that influence the learning process, both of learners themselves or from other factors such as educators, teachers, facilities, environmental, and instructional media used. Students who are actively and creatively powered facilities as well as teachers who master the material and effective delivery strategy will raise the quality of learning. However, to achieve the maximum results, there are many factors still a constraint.

It is viewed from the side of the learning process, geometry flat side material has an important role in math, especially for junior high school students. Geometry is one the problematic material due to it requires spatial reasoning ability (Bustang, Zulkardi, Darmawijoyo, Dolk, & van Eerde, 2013). Therefore, we need a media that can increase students' interest so that they can improve their motivation and comprehension of the geometry flat side material.

Learning media is something that can be used to deliver the message (learning materials), so it can stimulate students' attention, interests, thoughts, and feelings in learning activities to achieve the goal of learning (Santyasa, 2009). As the development of technology that increases very rapidly, it provides an opportunity for educators to develop Media Interactive Learning. One of the learning media is multimedia modules. Learning by using multimedia modules are expected to motivate students to learn independently, creatively, effectively and efficiently. With multimedia modules, it is

expected to reduce the saturation of the students due to during the learning process done by most teachers had been facing to face methods that caused students became bored and tired. Thus the students' motivation decreased. Ones of the applications software are Web Blog, Macromedia Flash, Course Lab, and so forth that belong to edutainment, a mix of education and entertainment. One of the software that is used the most in education is Course Lab. It is a software to arrange multimedia teaching materials for e-learning which is powerful and easy to use. Course Lab offers What You See Is What You Get an environment that is free from programming to produce interactive teaching materials that can publish on the internet, Learning Management System (LMS), and CD-ROM.

Course Lab application is an opensource software that can be used creating teaching materials. By using this application we can create a teaching material that can later integrate with web-based Learning Management System. Course Lab is a solution to overcome the various problems faced by teachers in the use of teaching materials or modules that still refer to a very broad subject where the students are difficult to understand the material provided by the teacher. Course Lab application usage is almost similar to Microsoft PowerPoint application usage, so teachers who are used to create teaching materials by using Microsoft PowerPoint will not find any difficulties in making the teaching material by using this one.

This research is to learn more about the advantages of Course Lab when used by students in independent learning on Geometry flat side material. This study aims to create a valid, practical, and effective interactive multimedia learning material by using Course Lab on geometry flat side for junior high school students. The effectiveness can be seen as students learning achievements and spatial reasoning ability.

METHOD

The participants of the study were junior high school students grade VIII in SMPN 12 Mukomuko Bengkulu. The study was designed research study. The model used follows the general model of research design by Plomp (2013) which composed of three phases: preliminary research, prototyping, and assessment phase. In preliminary phase, it used an analysis of the problem and the study of literature. Prototyping phase is the stage of prototyping. Assessment phase is the phase of assessing whether the user can use the media and would like to apply, as well as to determine the effectiveness of the media developed. The effectiveness sees through students learning achievement and spatial reasoning ability test.

Evaluation methods used in this study was a formative evaluation that took place in all the phases and the development cycle. According to Tessmer (1993) formative evaluation has several layers. In this study, formative evaluation used is as follow: a) Expert review. At this stage, the expert group (an expert in the field of study, expert instructional design) provides an assessment and advice on the products developed, b) self-evaluation is conducted to use checklists the essential characteristics or design specifications. c) Evaluation of one-to-one (done by users who are representative of teachers or students), d) Small group or micro-evaluation: involving small groups of students by using the product in a normal

situation. At this stage, the evaluator observed and interviewed the respondents, e) Field test. The instrument used for this development was the media sheets validation, guidelines for self-evaluation, questionnaires, interview guidelines, achievement test, and spatial reasoning test.

Students' questionnaire responses arranged in the form of Likert scale. The data from interviews with respondents were qualitative they were analyzed qualitatively. How to explain qualitative data consists of three stages, Reduction the data, data presentation and taking a conclusion (Miles & Huberman, 1992). Reduction the data is a selecting activity, focusing, abstracting and transforming raw data collected.

Learning achievement data were analyzed by comparing the results of pre-test and post-test by using *t*-test. It was done to know the differences between these two values significantly. The research hypothesis is:

$$H_0: \mu_1 = \mu_2$$
$$H_1: \mu_1 > \mu_2$$

Explanation:

μ_1: average students' learning achievement before using interactive modules course lab based

μ_2: average students' learning achievement after using interactive modules course lab based

Improving spatial reasoning is also analyzed by comparing the result of pre-test and post-test. The indicator of spatial reasoning can be seen in Table 1.

Table 1. Indicators to Measure Spatial Reasoning

Construct	Spatial reasoning aspects	Item Characteristics
Mental rotation	Rotates 2D and 3D objects clockwise and counterclockwise	Determines results after 2D and 3D objects played. Distinguish between reflection and rotation
Spatial Orientation	Imagine yourself in a room Reading the map	Determining the position of an object relative to the observer
Spatial Visualization	Symmetry, patterns, 2D and 3D forms and their relationship, reflection	Visualizing the outcome of folding/unfolding a particular configuration Constructing a solid from a given net and vice versa. Matching pieces and parts Finding the symmetry in an object Reflecting an object

(Ramful, *et al*. 2017)

This framework developed into 45 questions. It, spatial reasoning test, used to measure spatial reasoning of students. The spatial reasoning test is given to students before and after studied using course lab.

RESULTS AND DISCUSSION

The analysis to identify problems and needs in the development of interactive module based on course lab. The data includes an interview with teachers and students, collected documents syllabus, and textbooks of geometry flat side. According to the interviews obtained information about spatial students ability to geometry flat side. The use of teaching book or textbook by students are still lacking. The students receive data from the teacher. Methods used teaching limited in face to face with a way of explaining the matter, giving examples, and exercise so students less motivated and untrained imagination in space. Teachers also have never been writing material that can help students in learning geometry flat side. Development of interactive module based course lab designed to facilitate limitations in learning. The use of course lab as the media in the presentation of material can provide view and animation into the room interesting and able to motivate students in learning so spatial ability students also increase. According to teachers and students, interactive module based on course lab very interesting and can be used by students to independent study.

The result of syllabus analysis served in line with competence to be accomplished students. Analysis some textbook in geometry flat side sides available aims to seeing how the contents of a book, the manner of presentation of, examples, and exercise with syllabus lecture prevailing. The referral used is several mathematical books teaches in Junior High School. The material on these books has covered competence to be accomplished students. The presentation of material geometry flat side by the syllabus. But, there is a difference in some the introduction of the book. The introduction of the matter at module also adjusted to syllabus and that textbook that is.

Prototyping multimedia module based Lab Course starts with designing a flowchart and storyboards multimedia modules. Based on the developed storyboard flowchart-based multimedia module Course Lab. Storyboard cover, manual, competence, training, and evaluation. The design phase began to design and structure multimedia module. Display early module presenting home, the authors, and a menu containing a list of the choice matter who want to be studied by students. At the beginning of subjects, sub-basic begins with the presentation of competence base and learning experience. Followed by the presentation of matter and exercise. At the end given interactive module evaluation for students who compilation of exercise of all sub-subjects. Based on systematic and structure interactive module designed produced a prototype. The first prototype of the start of the title interactive module a button navigator menu “start” and menus the authors are presented. The navigator menu “star” useful to lead students start opening module interactive. A title module and menu the team present in Figure 1.

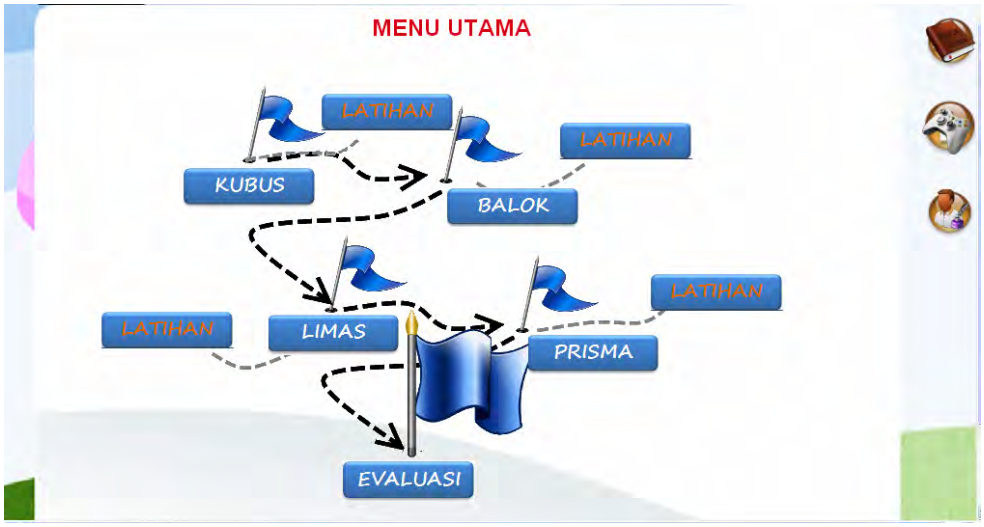

Figure 1. Main Menu

The initial view of the module serving the home, instructions for use, and a menu that lists the material selection to be studied by students. At the end of the given evaluation module for students, that contains a collection of questions retraining all sub-subject. The primary menu display is made not bound to each other between the sub-subject. Students could open opportunities menus or statistical menu sequence. Lastly, students are given an evaluation form about the exercises all subjects. The presentation of module takes into three aspects of spatial reasoning that is spatial orientation, mental rotation, and spatial visualization. The design of interactive modules can be seen in Figure 2.

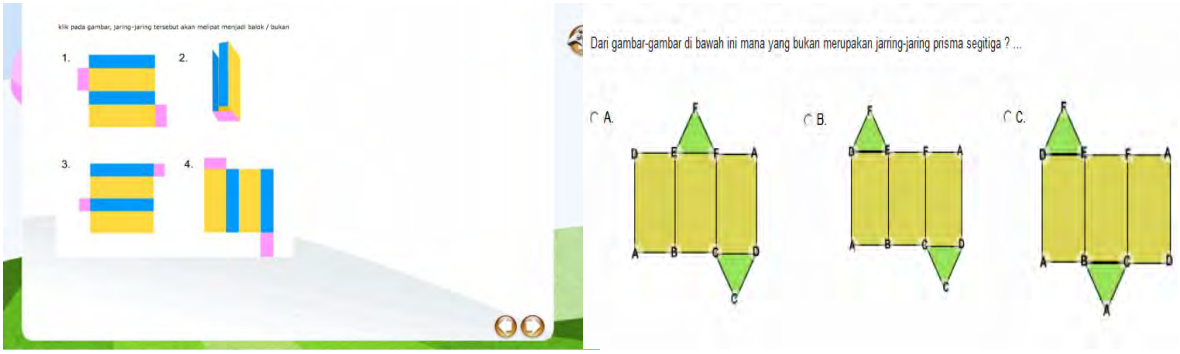

Figure 2. Module Interactive

After prototype module revised based on the evaluation conducted by the research team, followed by a reviewer. Expert review of data collected through the sheet validation and suggestions were made orally or in writing. Review the aims to see the validity of module to achieve module valid. Review the data collected through validation sheets and advice delivered verbally and writing. Judgment rendered includes four aspects presentation of material, the feasibility, languages, and graph. The assessment was on the presentation of materials with average 3.73, the feasibility with

average 3.76, language with average 3.9 and graph with average 3.89. The small evaluation group involving ten junior high school students representing the population target. All students involved derived from SMP 12 Mukomuko. Practicality of data collected through the survey. The analysis score for the survey shows that interactive module based on course lab have practically used by students.

Testing was also carried out to see the effectiveness interactive module developed and to get information to further improvements to module developed. The effectiveness of data collected in pretest scores and posttest of students. The use of module by students at each meeting satisfying enough. The first meeting of cube material can well understand by students. The second matter beams learned prism on third meeting, and limas in the fourth. Pretest conducted in the first meeting before the learning that starts. Question has been tested is the question evaluation is contained in interactive module. About the same tested back on the tests conducted after the research phase. Tests late aims to obtain data to study for students after implementation of learning using module developed. That test scores students rata-rata changed as much as 25 with byway 7.07 raw. This data showing how a change in value ranges from 17.93 until 32.07. Seen from rata-rata test scores the beginning and final test, there has been increasing scores of the students 17.93 until 32.07. The results of testing statistically showing that the $t_{count} > t_{table}$ which means that there are differences the average score a pretest and posttest. Seen from the average test scores, been an increase in a value sufficiently significant. Thus, can be concluded that module interactive developed effective in improve learning outcomes students. In other words, the spatial ability of students increased after using module interactive based on course lab. Test results of pretest has increased enough significant impact on a pretest.

Real understanding to matter has an influence good against study results students who can be seen of its study results satisfactory. The results of the learned person depend on what had been known to own, whether it is concepts, the purpose, and motivation that affects interaction with material that learned (Prahmana, Zulkardi, & Hartono, 2012). Understanding and the application of knowledge and experience gained through examples and exercise contained in module expand and refine knowledge and students increase of understanding of material learned. The training gives learning experience that can help mastery aspects change behavior, develop the capacity to think in solving problems, and helping the learning process effective (Prahmana, 2017).

The effectiveness also is seen through spatial reasoning test which consists of 3 aspects. A sample of the spatial reasoning question can be seen in Figure 3

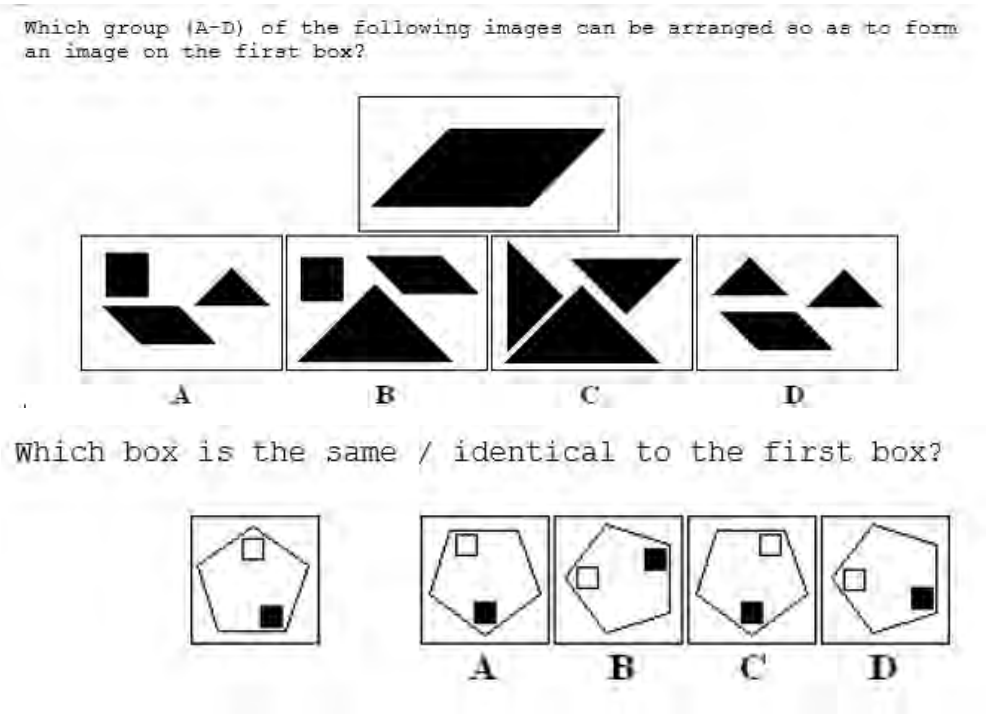

Figure 3. Sample of Spatial Reasoning Test

Means and standard deviations presented in Table 2. We then analyzed performance differences by the three spatial constructs. Course lab was very useful in enhancing scores of spatial visualization and mental rotation but not spatial orientation scores. It may be causing that students need different aspects of training to establish proficiency and sophistication level (Lowrie, *et al*. 2017). The Three critical components of spatial orientation involve object perspective, map perspective, and sense of direction, so it might be necessary to challenge students to solve such tasks with less reliance on manipulatives, consequently encouraging more excellent use of imagery (Hegarty & Kozhevnikov, 1999; Lowrie, *et al*. 2017). This activity can improve the spatial reasoning ability students faster.

Table 2. Means and Standard Deviations of Spatial Reasoning Aspects Using Course Lab

Measure		Spatial Visualization	Mental Rotation	Spatial Orientation
Pretest	Mean	5.95	5.97	5.95
	SD	2.66	2.80	2.66
Posttest	Mean	7.41	7.48	6.28
	SD	3.38	3.45	2.5

The analysed performance differences are by the three spatial reasoning constructs. The course lab was effective in improving scores of students' spatial visualization and mental rotation. But it was no significant improvement in spatial orientation scores statistically. Nevertheless we can conclude that spatial reasoning can enrich with training (Uttal, Miller, & Newcombe, 2013; Revina, Zulkardi, Darmawijoyo, & van Galen, 2011; Hendroanto, *et al*. 2018; Wright, *et al*. 2008; Shanty & Wijaya, 2012).

CONCLUSION

The findings of experts' review showed that multimedia module Course Lab based already has content validity (relevancy) and construct (consistency). Validity assessment includes aspects of the feasibility of the content, presentation material, language, and a graph. Every aspect validated has been considered valid regarding content and construct. The evaluation results involving a small group of ten students showed that the prototype multimedia module had been practically developed. Presentation of the material in this module is easy to understand, the language used is clear and easy to understand. The effectiveness module observed through students' learning achievements and spatial reasoning test after using multimedia module indicated that the module was effective.

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