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The development of students' worksheets using project based learning (PjBL) in improving higher order thinking skills (HOTS) and time management skills of students

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The development of students' worksheets using project based learning (PjBL) in improving higher order thinking skills (HOTS) and time management skills of students

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Abstract. Time management skills cannot be released with student learning activities in project-based learning. The development of PjBL-based student worksheets is expected to not only empower higher-level thinking skills but also students' time management. This study aims to develop project-based learning worksheets. This research was conducted by using the Plomp design research consisting of preliminary, prototyping, and assessment phases. The results of this research revealed that both of critical thinking and creative thinking skills had increased (medium category) and it was have an impact on improving student time management with an effect size of 14,18 (very high). There was a positive correlation between HOTS with students' time management skill ($r=0,82$). Both of critical thinking and creative thinking were involving mental processes at each stage of project implementation so students must be able to manage their time well. This happens repeatedly and structured. Finally, the implementation of PjBL-based student's worksheet can improve student's higher-order thinking skills and time management skills.

1. Introduction

In 21st Century skills are skills based on thinking skills because they require critical problem solving and creative solutions [1]. These skills must be empowered through the learning process [2,3] and programmed activities [4]. This requires that every learning process should be designed so that students have thinking skills [2,8,11]. Thinking skills that are able to overcome the complexity of conditions [11] and can determine the right decision are high-level thinking skills [3].

Based on the previous study in University of Nusantara PGRI Kediri (academic year 2019/2020), higher-order thinking skills of students in biology education department was still not empowered. This was indicated by the score of students' critical and creative thinking abilities that are still lacking. Critical and creative thinking skills scores on several subjects were still in the low category. This condition was caused by the learning process that is still oriented towards the material, not yet the empowerment of thinking skills. The learning process was still transforming knowledge from lecturers to students. The learning process is still dominated by lecturers. The lecturer explained the material in a lecture followed by a relatively short discussion of time. As a result, students have not been able to analyze, interpret data, evaluate, infer, convey ideas, and self-regulation. Even though the course of



developing teaching materials was a compulsory subject and requires students to arrange a product / innovation based on problems in the field.

Project based learning was a learning model that guides students to be able to solve factual problems [5] through systematic and measurable work stages [6]. The PjBL learning model was able to encourage students to activate mental processes. Especially ability to analyze, evaluate, and interpret. PjBL was known to be active in increasing student creativity on the dimensions of resolution, elaboration, and novelty as well as aspects including fluency, authenticity, and flexibility [6, 7, 8].

Student's worksheet is one of the teaching materials used by students so that the learning process of students is in accordance with the stages of learning. The worksheets that are arranged based on the project based learning are considered capable of empowering students to think at a higher level. PjBL-based worksheets are expected to guide students to be able to solve problems around, formulate ideas, determine tools and materials, arrange schedules, carry out each stage of the project, and communicate project results. Stages of student learning in the project-based learning process must be systematic and limited by time. Therefore, time management is one of the factors that determine the successful implementation of project-based learning. Time management skills are also very necessary for students to be able to complete the learning objectives to the maximum. Until now, the PjBL-based student's worksheet for the subject of developing teaching materials for students majoring in Biology education has never been developed. In addition, the impact of PjBL-based worksheet on higher-order thinking skills and time management skills has never been revealed.

2. Methods

This design research was conducted using the Plomp model (2013). The stages of design research consist of preliminary, prototyping, and assessment phase. At the preliminary phase was conducted needs analysis, content analysis (curriculum), The literature review was aims to arrange worksheet frameworks according to national standards, formulate worksheet-based PjBL specifications (topics, structure of worksheets, number of pages, layouts, stages of student activity, and student learning resources), formulate learning styles and student motivation. At the prototyping phase, the student worksheet was developed. PjBL-based student worksheets consist of covers, instructions for use, concept maps, guides to student learning activities (formulating problems, gathering information, formulating ideas, determining products and schedules, determining tools and materials, determining work stages, implementing project stages by stages, and present the project), and project evaluation criteria. The next steps were self-evaluation (obvious error), expert review by three experts (sequentially experts in the field of Biology learning, STEM learning, and science learning), one to one test, and small group test (to six students who have different academic ability). The last step is the assessment phase by applying student worksheet to students in Biology Education Department (University of Nusantara PGRI Kediri, academic year 2019/2020) (n = 24) who are taking in the Development of Teaching Materials courses for one semester.

All data (critical, creative thinking, and time management skills) were collected as pre and posttest. Critical and creative thinking skills were measured by using instruments integrated with cognitive tests [2,4,11]. Students Time Management Skills Inventory (STMSI) that valid and reliable was used to measure time management skills. STMSI consists of 10 indicators (able to set specific goals, able to determine priority scale, able to arrange activity schedules, timely in completing of each task, understand the division of tasks, able to delegate tasks, able to monitor the use of time during carrying out tasks, able to overcome the additional program/activities outside the schedule, confident of every decision taken, and able to know their own abilities). Data on critical thinking, creative, and time management skills were analyzed and determined the N-gain and effect size [10]. Simple correlation analysis was performed with SPSS 18 for Windows 2010 to determine the correlation between HOTs and time management.

3. Result and Discussion

Based on Table 1, the higher order thinking skills of students in Biology education department have increased. Here, the higher order thinking skills measured was critical thinking skills and creative thinking. Both of critical and creative thinking skills have increased in the medium category with N-gain values 0.44 and 0.53 respectively. The effect size analysis also revealed that the use of PjBL-based student's worksheets influences both of critical thinking skills and creative thinking with the effect size values of 5.69 and 12.77, respectively.

PjBL-based students worksheets that have been developed guide students to: determine problems in class and then gather information from various sources so that students can formulate ideas (solutions) to overcome these problems. Then, students determine the tools and materials needed to develop teaching materials needed and are accompanied by a schedule of activities from beginning to end. Furthermore, students carry out each stage in a monitored manner until presenting the results of the development of teaching materials [6]. The stages must be carried out systematically, in accordance with the specifications of the teaching material developed [11], and taking into account the abilities of each group member. Therefore, the stages in implementing the project can train students to always analyze, evaluate, interpret, and communicate [5].

There was an increase in the score of time management skills between before and after using PjBL-based student's worksheets in high category (0.78). This means that the use of PjBL-based student's worksheets on the development of teaching materials course can improve student skills in managing time with a very large category. PjBL-based student worksheets have guided student learning activities in a structured and organized manner. This shows that every stage of project implementation was carried out regularly, scheduled, monitored, and refers to the learning objectives. These conditions occur repeatedly on several lecture topics so students begin to manage their time well in order to achieve learning goals. These improvements can be seen from the indicators set out in the STMSI instrument used in this study. In particular, the four indicators that have increased with high N-gain are determining priority scale (A), scheduling (B), being on time in completing tasks (C), and understanding the division of tasks (D) (Table 2). Based on Table 2, the four indicators of time management skills have increased in the high category.

Table 1. Pre and post test scores after using the PjBL-based student worksheet

	Mean Test Score		N-gain		Effect Size	
	Pre (a)	Post (b)	Score	Category	Score	Category
Critical thinking	68,70 ± 2,41	82,41 ± 3,66	0,44	Middle	5,69	Very high
Creative thinking	53,22 ± 1,95	78,12 ± 2,72	0,53	Middle	12,77	Very high
Time management	44,66 ± 3.04	87,76 ± 1,12	0,78	High	14,18	Very high

Table 2. Scores of key indicators of time management skills in project-based learning

Mean	Indicators			
	A	B	C	D
pre	55,29	60,71	40,25	48,88
post	92,08	90,75	91,68	88,9
N-gain	0,82	0,86	0,86	0,78
Category	High	High	High	High

Table 3. Correlations between critical thinking skills, creative, and time management

	Critical thinking	Creative thinking	Time management
Critical thinking	1,000	0,708**	0,921**
Creative thinking		1,000	0,744**
Time management			1,000

**) *significant at the 0, 01 level (2-tailed)*

There was a correlation between critical thinking skills, creative thinking, and student time management. These correlations are presented in Table 3. Based on Table 3, the three skills correlate with each other significantly. The highest correlation occurred between critical thinking skills and time management ($r = 0.921$) while creative thinking skills with time management were 0.744 and creative thinking skills with critical thinking were 0.708. Critical and creative thinking skills were including higher order thinking skills. Both of critical and creative thinking skills require mental operations such as induction, deduction, classification and rationalization [6]. The process of critical thinking involves interpreting activities, conducting analysis, evaluating, making conclusions, communicating, and self-regulation [4,7]. Creative thinking also involves mental activities including curiosity, generating a number of ideas, generating new ideas, and elaborating on new ideas that are more varied [3]. Based on the description, there was a mental dimension slice between critical thinking, creative thinking [11], and time management. Mental activities are closely related to efforts to consider the real conditions (each stage of the project) [8,9], the goals / targets that have been set, the allocation of time for project implementation, and the ability to complete the project itself [11]. The linkage of mental processes causes a positive correlation between higher order thinking skills (critical thinking and creative thinking) with time management skills.

4. Conclusion

The students worksheet that are developed using project based learning can enhance higher order thinking skills and time management in the medium and very high influence categories respectively. The student worksheet also has a high influence on improving student time management and improving time management is included in the high category. There was a correlation between higher order thinking skills and time management skills showing that there was a link between mental processes in the critical and creative thinking process with time management as students carry out the project stages.

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