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The Impact of Gi-Gi Model on the Ability of Developing Lesson Plan and PCK of Physics Prospective Teacher Undergraduate Students

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ABSTRACT

This study aimed to assess the effect of GI-GI model on students' ability of developing physics lesson plan and pedagogical content knowledge (PCK). A non-equivalent control group design was used to the quasi-experimental research in this study. The research was conducted to students who took cources of Physics Lesson Plan in Study Program of Physics Education, Jember University, Odd semester year 2016/2017. The GI-GI model was applied to the experimental group and lecture-based traditional model was applied to the control group. The both two groups were taught by the same instructor and used same books. The task of developing physics lesson plan and questionnaire of PCK were applied to both groups as pre-test and post-test. Data that collected of this study were score of students' ability (a) to formulate indicators and learning objective based on physic syllabus, (b) to determine matters that relate to the objective formula, (c) to decide strategies that use for teaching and learning relate to a and b, and (d) to develop instrument of learning assessment (process and product). Components of PCK were subject matter knowledge (SMK), instruction representation and strategies (IRS), instructional objective and context (IOC), and knowledge of student understanding (KSU). Data were analyzed using descriptive and inferensial statistics (t-test). The results of the study revealed that GI-GI model were more effective in improving students' ability of developing physics lesson plan and PCK compared to lecture-based traditional activities. The study can be concluded that GI-GI model significanly influenced to students' ability in producing of physics lesson plan and PCK.

Keywords: *GI-GI model, physics lesson plan, PCK*

INTRODUCTION

Physics student candidates are students on pre-service programs that are prepared to become physics teacher candidates who can teach professional physics in high school. The physics teacher is said to be professional if he can carry out the lesson and implant the lesson effectively. Faulty and Savage (2013) states that effective learning is influenced by effective learning planning and mastery of pedagogical content knowledge or Pedagogical Content Knowledge (PCK). The task of professional teachers is to make lesson plans and to implement them in effective and efficient learning. Good planning is influenced by teachers' ability on content, pedagogic, and pedagogic content knowledge (Shulman, 1986; Russell & Loghran, 2007).

To be a professional teacher, it needs to be well prepared. The preparation is not sufficient to provide only the ability of physics and pedagogical knowledge, but also pedagogical content knowledge (Shulman, 1986; Trowbridge & Bybee, 1996; NRC, 1996; NSTA, 2003; Etkina, 2005). It can be interpreted that the teacher is not enough to only have deep physics skills or content knowledge, but also must have the ability or knowledge about how to peddle content (pedagogical content knowledge) professionally (NRC, 1986, Shulman, 1986 Loughran, et al., 2012) or subject specific pedagogic. PCK is basically a blend of pedagogic knowledge with content knowledge (Hilas & Hildebrandt, 2010). Thus, to become a physics teacher a professional must master physics, knowledge of teaching, and knowledge of teaching physics. For that we need a curriculum that can meet those needs.

The curriculum of Physics Education Program of FKIP University of Jember equips students' ability and skill in teaching physics through the course group of teaching and learning (*Matakuliah Proses BelajarMengajar/MKPBM*). This group of subjects is courses on Strategy of physics instruction, physics learning evaluation, physics learning media, and physics lesson plan. Through this course group is expected to produce an effective high school physics teacher, which can make students have good physics skills and knowledge. AAPT (2009) argues that to produce students who have good physics skills and knowledge determined by several things, among others is the teacher's skills in developing lesson plan and has good PCK. A good learning plan is a plan that can integrate objectives, materials, strategies, and evaluations (Farmer & Farrel, 1980; Cruickshank, 1990; Cole & Chan, 1994).

As previously mentioned, the Physics Learning Planning course is one of the subjects in MKPBM group. As with other MKPBM courses, students are expected to have pedagogical knowledge (learning strategies, media, and evaluation), knowledge of content (physics), and a combination of both knowledge of learning planning and knowledge of high school physics (PCK). Competence targeted at the Physics Learning Planning course is the students have the knowledge and skills to make physics lesson plan in high school. Without having a PCK it is impossible to make good learning planning. The knowledge and skills of the students about the planning of physics learning, in the curriculum of Study Program or Lembaga Pendidikan Tenaga Kependidikan (LPTK) is given on average in semester V or after three other courses of MKPBM group are given. Thus, with the curriculum will facilitate students in learning to plan physics learning.

Although students have taken the course of Physics Learning Planning, but in reality, there are still many students who are less skilled in developing learning planning. In addition, PCK owned by students also cannot be exhilarating (Indrawati, 2016). This can be shown from the observation of the researchers in previous years or in almost every student force, it is found that students still have difficulties in planning the lesson and are still having difficulty when linking the knowledge of the content and pedagogic knowledge or the student's PCK is still weak. The difficulties are apparent during the final project guidance, planning the lesson during course of micro teaching, and taking the Field Experience Practice (FEP) program. Based on the observation on the ability of physics faculty students of FKIP University of Jember for several classes who are taking learning practice and final project on learning in the final semesters, it is found that most of the students are less skilled in: (a) formulating indicators or learning objectives; (b) determining the material to be planned in the lesson; (c) defining techniques, methods, and instructional media according to the stated objectives, and (d) developing appropriate assessment methods.

The problem can occur due to several factors, namely: students are given less contextual assignments with learning problems done in schools, ability and skill to formulate goals, find and develop less rare learning strategies that are relevant to the planning of the objectives and the material to be delivered, as well as develop assessment instruments that fit the goals and strategies of learning. The assigned tasks tend to be less inviting students to think at high level (high order thinking) and are mechanistic. In addition, students' difficulties in planning lessons cannot be obtained directly. The task of planning lessons is usually individual, so that students have less opportunity to exchange opinions. In addition, the tasks assigned to students are rarely rewarded. In general, the task of the students in the lesson of physics lesson planning is less directed to the practice and less related to the facts in the field or less leads to level 6 for the Indonesian National Qualification Framework S1 Program (PP No. 8/2012). Thus, it can be said that the strategies used in the course of Physics learning planning less effective. Therefore, the needs for an effective learning strategy alternative that can make students have the competence to plan a lesson of high school physics and PCK adequate.

The GI-GI model is one of the developmental learning models that has been valid to develop students' competence in designing physics learning strategy for high school, effectively used for learning on the Teaching and Physics Learning Strategy, and make student learning activity in high category (Indrawati, 2015). The GI-GI model also has significant effect on students' ability in developing the learning result assessment instrument (Indrawati, 2016). The term GI-GI is an acronym of Group Investigation and Guided Inquiry. According to the model developers, the philosophy of the model is that students can discover knowledge grouply with the guidance of the instructor or lecturer. Physics Learning Planning course is a group with two other courses in the MKPBM group, the GI-GI Model with its elements is also estimated to be suitable for lecturing courses in Physics Learning Planning.The elements of a learning model consist of syntax, reaction principle, support system, social system, and the instructional and nurturant effect (Joyce, et al., 2014). The elements of the GI-GI model (Indrawati, 2015) can be described as follows.

Syntax

The first phase: Constructing of Concept,

- Form groups
- Define topic (material)
- Explore information
- Find a product plan (declarative and / or procedural knowledge)
- Create a draft plan of findings
- Preparing for guidance

The second phase: Asking for guidance on instructor or lecturer (Guiding),

- Determine the schedule of guidance according to the lecture schedule;
- Conduct guidance (discussing the results of its performance and findings, arguing about its findings, and soliciting lecturers' advice where necessary, etc.);
- Lecturers assess the ability to argue groups and individuals by using guidance assessment rubrics, as a form of group and individual performance appraisals.

Phase three: Formulate and test the hypothesis (Hypothesizing)

- The group discusses the results of the guidance
- The group explores/explores and examines theories
- The group improves/refines its findings
- The group formulates the hypothesis of its findings
- Groups create drafts to be communicated/ presented in class

Fourth phase: Communicating and assessing results (Communicating and assessing).

- Each group presents its performance results and findings;
- Other groups ask questions;
- Other groups and lecturers provide an assessment of the performance results, findings, and the ability to argue the presenter group. This system is a form of

objectivity and transparency in the assessment.

Reaction Principle

In implementing the GI-GI model, the lecturer or instructor provides time for guidance activities on the assigned task (making a physics learning plan), including planning the objectives, materials, strategies, and planning techniques and assessment instruments.

Social System

Social system is done by students doing group work, at that time students can build cooperation exchanged opinions / ideas / ideas to produce a good product (Learning Implementation Plan). In addition, the relationship between students and lecturers is also awakened, so lecturers / instructors are required to be able to serve students well so that students are free or do not feel afraid in argument (put forward his idea).

Support System

To implement this model, students are required to actively seek information related to the given task. In addition, lecturers should also provide key textbooks in the form of high school physics syllabi, modules, textbooks, hand-outs about physics and the theory of assessment strategies, or others that can be used as student referrals.

The Instructional Effect of GI-GI Model

GI-GI model is that students can:

- plan (formulate) the secondary physics learning objectives or indicators,
- plan the material (material organization),
- plan the learning strategy (model, method, technique and/or media) in accordance with the objectives,
- plan methods and assessment instruments for both process assessment and learning outcomes, and students have a good PCK.

The Nurturant Effect of GI-GI Model

GI-GI model is students have high-level thinking skill and students' social skills are developed, and students have high satisfaction since they are able to produce their own product (physics learning plan for high school).

Based on the above elements, the GI-GI model has advantages and disadvantages. The advantages of the GI-GI model (Indrawati, 2015) are that students can develop their social skills (interaction between students and relationships with lecturers built), students have the courage to express an idea (creative thinking skill and critical) developed, develop their thinking skills at high level Order thinking), can train activities and be scientific. The advantages are expected to apply GI-GI model suitable for courses that are allied with courses Teaching Learning Strategy, Physical Learning Evaluation, or Group Learning Process Teaching Course (MKPBM). The weakness of the GI-GI model is that lecturers or instructors should take time to conduct guidance. To overcome this weakness, guidance is done by the way of rejecting the problems that arise in each group and group with the same set of problems simultaneously. Because of the allied Physics Learning Planning course with course of Physics Learning Result Evaluation and Learning Physics Teaching Course, it is possible that GI-GI model is suitable for lecturing of Physics Learning Plan.

As previously mentioned, that the MKPBM group course is a subject group that integrates pedagogical knowledge and content knowledge (pedagogical content knowledge), the GI-GI model is also expected to have a significant effect on students' pedagogical content knowledge. It is therefore necessary to prove whether the GI-GI model can affect students' ability to plan lessons and PCK.

Based on the above description, this study aims to prove the influence of GI-GI Model on the ability of students in making physics lesson plan and Students' PCK.

METHOD

Based on the problem and the purpose of the research, then to answer the formulation of the problem need to test. This research is a quasi experimental research using non-equivalent design post-test only control group. Quasi experiments are used because not all of the variables and conditions in the experiment can be arranged and controlled strictly, as randomizations cannot be performed on the students to be sampled. Thus, sample selection is done by random class, meaning it is not possible to manipulate all relevant variables (Fraenkel & Wallen, 2009; Cohen et al., 2000). The post-test only design was chosen in this study because the study aimed only to observe the effect on students' achievement in planning of high school physics learning and pedagogical content knowledge between the experimental and control classes after the treatment was given instead of the pre-test data. To analyze students' competency improvement after being treated.

The population in this research is the students of Physics Education Study Program of Jember University Faculty of Physics and Physics Learning Program semester academic year 2016/2017, with total sample of 23 students. The samples were divided into two groups, each as the experimental group and the control group. The experimental group consisted of 12 students, while the control group consisted of 11 students. The experimental group received a GI-GI model, while the control group used the usual lecture model. After the end of the lecture, students in both classes (experiment and control) were given the task of developing a physics learning plan for high school for one lesson. Individual assignments include: (a) formulating learning indicators or objectives, (b) planning materials, (c) planning strategies, and (d) planning engineering and assessment instruments. The task is a take home exam (done at home) within 1x24 hours (two days).

After the tasks were collected students in both groups were given a questionnaire to measure student PCK by using instruments developed by Jang, et al. (2009). This instrument consists of four indicators, namely: SMK (Subject Matter Knowledge), IRS (Instructional objectives and Strategies), IOC (Instructional objective and Contex), and KSU (Knowledge of Student Understanding). Each component contains 7 (seven) items, as in Table 1. Each item is scored by using a Likert scale with predicate never, rarely, sometimes, often, and always consecutively given a score of 1 to 5 points . The items of each PCK indicator can be shown in Table 1.

Table1. *Items of each indicator in the PCK (Chang, et al., 2009)*

	A. SMK		B. IRS
1	My teacher knows the content he/she is teaching	1	My teacher uses appropriate examples to explain concepts related to subject matter
2	My teacher explains clearly the content of the subject	2	My teacher uses familiar analogies to explain concepts of subject matter
3	My teacher knows how theories or principles of the subject have been developed	3	My teacher’s teaching methods keep me interested in this subject
4	My teacher selects the appropriate content for students	4	My teacher provides opportunities for me to express my views during class
5	My teacher knows the answers to questions that we ask about the subject my teacher knows the answers to questions that we ask about the subject	5	My teacher uses demonstrations to help explaining the main concept
6	My teacher explains the impact of subject matter on society	6	My teacher uses a variety of teaching approaches to transform subject matter into comprehensible knowledge
7	My teacher knows the whole structure and direction of this SMK	7	My teacher uses multimedia or technology (e.g. Power Point) to express the concept of subject

C. IOC		D. KSU	
1	My teacher makes me clearly understand objectives of this course	1	My teacher realizes students' prior knowledge before class
2	My teacher provides an appropriate interaction or good atmosphere	2	My teacher knows students' learning difficulties of subject before class
3	My teacher pays attention to students' reaction during class and adjusts his/her teaching attitude	3	My teacher's questions evaluate my understanding of a topic.
4	My teacher creates a classroom circumstance to promote my interest for learning	4	My teacher's assessment methods evaluate my understanding of the subject
5	My teacher prepares some additional teaching materials	5	My teacher uses different approaches (questions, discussion, etc.) to find out whether I understand
6	My teacher copes with our classroom context appropriately	6	My teacher's assignments facilitate my understanding of the subject
7	My teacher's belief or value in teaching is active and aggressive	7	My teacher's tests help me realize the learning situation

Data collection is done by each student doing practice teaching arround 20-30 minutes. When one student is teaching, the other students observe and provide an assessment by filling out a questionnaire containing the 28 items (Table 1). At the time one of the students practice teaching (as a teacher), the other students act as students and also as assessors. This measurement is done in the experimental class and control class. For the experimental class, each student is assessed by 11 students and for the control class; each student is rated by 10 students.

The ability to plan physics and PCK learning is analyzed descriptively. After that, to test the research hypothesis used parametric statistics independent sample t-test, with the help of SPSS program. Independent sample t-test was used Because the analyzed data consisted of two groups that were either unrelated (independent sample) or unrelated.

RESULT AND DISCUSSION

To answer the problem formulation, the data were analyzed descriptively and then tested statistically by using independent t-test. The students' competency assessment description consists of frequency distribution, mean (mean), and standard deviation (s) in each group.Based on the results of the data analysis, the ability to plan the learning for the average of four components a, b, c, and d and the average pedagogical content knowledge (PCK) for the four components of SMK, IRS, IOC and KSU in the experiment class and control class can be described as below.

Ability to Plan Learning

From the data analysis, the students' ability in planning of learning with four components (a, b, c, and d) was obtained on average for 12 students of experiment class and 11 students of control class as in Table 2.

Table2. *The average score of four learning ability plans Experimental and control classes*

Experiment class			Control class		
No	**Score**	**SD**	**No**	**Score**	**SD**
1	75	4,08	1	74,75	3,4
2	81	4,08	2	66	4,89
3	78,25	2,36	3	72	2,45
4	85,5	1	4	68,75	2,5
5	77,75	6,34	5	72,75	3,2
6	82	3,56	6	77	5,29
7	83	2,45	7	71,5	3
8	82,5	2,08	8	65	4,08
9	81,5	1,9	9	62	5,4
10	83	1,15	10	71,5	3
11	84	1,63	11	63,25	5,38
12	81,5	1,91			
Total	975	32,54	**Total**	764,5	42,59
Mean	81,25	2,71	**Mean**	69,5	3,87
SD	2,93	1,54	**SD**	4,87	1,17

Table 2 shows that the average ability to make experimental class lesson plans is higher than control class, ie (Me = 81.25, SD = 2.93) and (Mk = 69.5; SD = 1.17). To determine the influence of GI-GI model on the ability of physics teacher candidate in making learning planning can be determined by t-test (inferential statistic) after the data homogeneity test. Since the data are normally distributed, the t-test is used and the results can be shown in Table 3.

Table3. *Independent Samples Test*

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Value	Equal variances assumed	4.907	.038	7.086	21	.000	11.75000	1.65816	8.30166	15.19834
	Equal variances not assumed			6.936	16.124	.000	11.75000	1.69396	8.16120	15.33880

Analysis

Ho: Average The experimental and control classes are the same

H1: Average The experimental and control classes are different

Decision

Based on Table 5, the value of t = 7.086 with a significance value of 0.000. Thus to reject or accept Ho can be done by comparing the significance with ½ α (0,025). Since the result of significance is 0,000 or less than ½ α (0,000 <0.025), it can be concluded that Ho is rejected. In other words, there is a difference in the ability to plan learning between the experimental class students and the control class. Based on the results of hypothesis testing, it can be said that there are significant differences in the ability to plan learning between students who learn by using the model Gi-GI and students who study without a GI-GI model. It can be said that students' ability in planning learning in groups whose learning using GI-GI model is better than students who do not use GI-GI model. Thus it can be concluded that the GI-GI model has a significant effect on the students' ability in planning the learning, compared with the learning model applied to the control class.

Pedagogical Content Knowledge (PCK)

The results of GI-GI model impact data analysis on PCK descriptively for the experimental class and control class can be shown in Table 4 and can inferably be shown in Table 5.

Table4. *The average score results of the four components of PCK of experiment and control class*

Experiment class				Control Class			
No	**Score**	**Scale 100**	**SD**	**No**	**Score**	**Scale 100**	**SD**
1	22	79	1,34	1	19,81	71	1,94
2	22,72	81	0,9	2	20	71	2,04
3	22,81	81	0,98	3	19,72	70	1,79
4	22,9	82	1,04	4	19,63	70	1,74
5	23,09	82	1,04	5	19,45	69	1,81
6	23,27	83	0,78	6	20	71	1,55
7	23,18	83	0,87	7	19,9	71	1,44
8	23,09	82	0,83	8	19,72	70	1,27
9	23,27	83	0,78	9	19,36	69	1,12
10	23,18	83	0,87	10	19	68	1,18
11	23,27	83	0,9	11	18,81	67	0,98
12	22,9	82	1,3				
Total	275,68	984,57	11,63	**Total**	215,4	769,29	16,86
Mean	22,97	82,05	0,97	**Mean**	19,58	69,94	1,53
SD	0,36	1,28	0,19	**SD**	0,39	1,40	0,36

Table 4 shows that the average PCK for the four components of SMK, IRS, IOC, and KSU experimental classes is higher than control class, ie (Me = 82.05; SD = 1.28) and (Mk = 69.94; SD = 1.4). To determine the significance of the impact of the GI-GI model on PCK student physics teacher candidates can be shown in Table 5.

Table5. *Independent Samples Test*

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Value	**Equal variances assumed**	.532	.474	23.045	21	.000	12.27273	.53256	11.16522	13.38024
	Equal variances not assumed			22.929	20.179	.000	12.27273	.53526	11.15683	13.38862

Analysis

Ho: Average The experimental and control classes are the same

H1: Average Experiment Class

Decision

Based on Table 5, the price t = 21,045 with a significance value of 0.000. Thus to reject or accept H0 can be done by comparing the significance with ½ α (0,025). Since the result of significance is 0,000 or less than ½ α (0,000 <0.025), it can be concluded that Ho is rejected. In other words, there is a difference between PCK between experimental class and control class. Based on the results of hypothesis testing, it can be said that there are significant differences between PCK students who learn by using the model Gi-GI and students who study without a GI-GI model. It can be argued that PCK in the learning group using the GI-GI model is better than students who do not use the GI-GI model. Thus, it can be concluded that the GI-GI model has significant influence on PCK of physics teacher candidate students, compared with the learning model applied to the control class.

The differences occur in all components of ability (a, b, c, and d) between two groups. This can happen because during the learning process, students' difficulties can be observed during the guiding process of formulating and testing hypotheses, and when communicating results. In addition, the difficulties students have immediately get feedback (feedback). Thus, during the assessment process (assessment) students are expected to have no difficulty and the results of learning to be good. This is in accordance with the results of the study (Hattie & Timperley, 2007) which states that feedback has the potential to have a significant effect on student learning achievement. In addition, one of the methods used in the GI-GI model is collaborative. Collaborative is a key way that students can develop thinking and reasoning, and solve problems (Cho & Jonassen, 2003; Jonassen & Kim, 2010). Collaborative is done from the first phase to the fourth phase of communicating activities (communicating). This requires students to develop their skills in higher-order thinking, as students should. Thus, the GI-GI model with its syntax and other elements is appropriate for learning in the Physics Learning Planning course.

CONCLUSION AND SUGGESTIONS

Based on the results and the discussion as described above it can be concluded that the application of GI-GI model in the course of Physics Learning Planning have a significant effect on the students' skills in planning the learning and PCK students prospective physics teacher FKIP Jember University, academic year 2016/2017. Each component of Planning and PCK in the classroom learning by using GI-GI model is higher than a class without using a GI-GI model.

Based on the conclusions, there are some suggestions, namely: in implementing the GI-GI model for the Physics Learning Planning course, the tasks assigned to students for the four learning planning components must be clear and hierarchical. That is, before the student skilled (mastered) of component a, it is advisable not to proceed to component b. Neither for components c and d. In addition, the tasks assigned to the student must be markedly in accordance with the work to be done in the school, meaning that the assigned task should refer to the secondary school curriculum and level 6 of Indonesia National Qualification Framework. Thus, the assessment for the Physics Learning Planning course should use authentic assessment, so that students can demonstrate their real knowledge and skills.

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