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The Effect of Transformative Blog Pages to Solve Real-World Physics Problems

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ABSTRACT

A blog page is a vital tool to share and discuss information in real-world problem-solving. Unfortunately, this potential of blogs rarely was used to facilitate the problem-solving in specific physics topics. This study aimed to describe and examine a blog transformation in improving students' problem-solving. Through 40 university students, this study compared two physics learning sessions using transformation blogs and modules as resources. The results showed the advantages of blog transformation. We also discussed the differences between students' cognitive levels based on the new taxonomy of educational objectives. Instructors can model this study in designing a transformative technology to solve, map, and improve students' problem-solving skills in the semiconductor topic.

Keywords: Blog, problem-solving, physics, technological pedagogical content knowledge.

INTRODUCTION

The Information and Communication Technology (ICT) grows quickly in every field, including in education. Survey of Indonesian Internet Service Provider Association showed that internet users extremely increased. Among the varieties of internet platforms, blogs often are chosen to search for an article, information, data collection, and relevant opinion (Lee, 2018). Most researchers use a blog page for enhancing literacy competencies including writing and reading skills (Akçay & Arslan, 2010; Miyazoe & Anderson, 2012; Mohamed, Al, & Alsayadi, 2015; Okan & Ula, 2013; Rahimpour, 2014; Rahman & Yunus, 2012), collaborative learning (Amir, Ismail, & Hussin, 2011; Shen, 2012), constructivism approach (Noel, 2015), and decision-making (Mansor, 2011).

Although many researchers have used the web to address problem-solving in the physics area (Karyotaki & Drigas, 2016; Ryan, Frodermann, Heller, Hsu, & Mason, 2016), a limited number of researchers have explored blogs to enhance students' problem-solving

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skills. Recent studies show that the technology integration framework provided a systematical design to address effective physics or science learning through a transformative model (Angeli, 2005; Jang & Chen, 2010; M. Niess & Gillow-Wiles, 2017; Srisawasdi, 2012). This framework was first proposed by expanding the view of Pedagogical Content Knowledge (PCK) to Technological Pedagogical Content Knowledge (TPACK), or ICT-PCK. This was knowledge about affordance tools, pedagogy, and content that transformed a difficult topic into effective learning. Jang and Chen (2010) reported that students had a better understanding of potential electricity after joining a technology transformation class. Niess and Gillow-Wiles (2017) documented that the transformative model affected to pre-service teachers in a particular physics topic. However, few researchers have conducted studies about specific physics topics, especially in advanced physics material (Alev, Karal-Eyuboglu, & Yigit, 2012; Melo-Niño, Cañada, & Mellado, 2017; Srisawasdi, 2012). In addition, researchers have only used blogs as the supporting system of TPACK to show effective learning without a deep explanation (Alev et al., 2012; Jang & Chen, 2010).

This study aims to explore the question of how to describe students' responses in solving real-world semiconductor physics problems by using a transformative blog. More specifically, this study will examine the improvement of students' problem-solving skills between internal initial and external semiconductor after treatment using the transformative blog topic. Students' problem-solving skills mapping is also conducted to know the achievement level after the treatment.

Real-World Problem-Solving Approach

Real-World Problem Solivng (RWPS) is derived from a realist perspective indicating that the reality of the world does not depend on the observer (Palm, 2006). This paradigm carries on the meaningfulness of an abstract topic and Piaget's formal operational stage (Santrock, 2011). The realists also believe that courses are more meaningful when starting from a real context to an abstract concept. Consequently, RWPS is a part of real problem-solving, which students need to identify concepts in the process of problem-solving (Mcdaniel et al., 2016). However, researchers consider RWP is a crucial problem that illustrates authentic problems from real life to concepts (Anderson et al., 2001; Dostál, 2015; Lunenberg, Dengerink, & Korthagen, 2014; Palm, 2006). Although students can do a fundamental qualitative analysis of a phenomenon (Docktor, Strand, Mestre, & Ross, 2015), RWP serves as a bridge between real context and complex problems. Therefore, Karyotaki and Drigas (2016) suggested using RWP in learning to improve meta-cognition in problem-solving. This is increasingly meaningful when RWP starts from a real context of an abstract concept and combines with technology to involve students in problem-solving and other thinking skills (Hwee & Koh, 2017).

Problem-solving often establishes connections between novice physics learners and professional physicists (Docktor et al., 2016; Docktor & Mestre, 2014; Gök, 2012). In resolving physics problems, a student should use the main strategies based on knowledge and patterns (Bajracharya & Thompson, 2016). Learning abstract concepts may result in low motivation in students learning. Studying physics topics in the context of everyday life may make learning much more fun for students. Students may not learn meaningfully if students only solve problems without having patterns or strategies or experience on how to resolve them. Therefore, Polya (1973) proposed the problem-solving model, namely understanding problems, planning solutions, executing the plans, and looking back. This model includes dividing problems into easy parts (Rokhmat, Marzuku, Wahyudi, & Putrie, 2019). However, problem-solving in physics is still considered by traditional learning as a skill that emphasizes mathematical procedures and quantitative analysis (Docktor et al., 2015).

Blog Page

Using blogs or weblogs allows instructors to design and apply the learning process as technology-based problem-solving learning. One definition states that a blog is a personal web containing comments, videos, articles, and pictures (Sawmiller, 2010). This means blog contents facilitate instructors in designing various kinds of problem-solving purposes. Another definition states that blogs are part of websites consisting of simple pages providing information chronologically (Gabriela, 2012). The blogs are not just searching tools for information but (a) help to understand concepts, (b) improve student learning through learning styles that they can choose, (c) produce literary works with guidance, (d) encourage self-reflection, critical thinking, collaboration, and (e) establish bridges between learning at home and school (Sawmiller, 2010). In addition, blogs have advantages for students and instructors, such as easy to use, appropriate for sharing, exploring, communicating, and interacting (Y. Lee, 2018). However, most people believe that blogs are personal comments; therefore, it is incredible to create content in blogs. Although this argument exists, there have been many universities using blogs (e.g., blog.umg.ac.id, blog.ui.ac.id, and blog.unya.ac.id) as a show of creativity to present the work of students and instructors.

Moreover, the advantages of blogs include improving learning environments (Al-rahmi & Zeki, 2016). They can play a role as a simple web-based creative problem-solving like previous researches (Chanayotha & Na-songkhla, 2015; Kuo, Chen, & Hwang, 2014; Li, Li, & Luo, 2015). Kuo et al. (2014) explained that creative problem solving effected to enhance intuitive and analytical thinking. This has similarities with a transformative blog to solve problem-solving because students communicate with others by sharing, writing comments, and posting information in the blogs (Sophonhiranrak, Suwannatthachote, & Ngudgratoke, 2015). These students' actions can help students to communicate with higher-order thinking skills in blogs because creative thinking needs to be used to solve non-routine problems (Forster, 2008).

Blog Transformation

In this study, the transformative view is used as a theoretical framework because it systematically integrates complex physics topics in technology appropriate design as content knowledge transformed into ICT-TPACK (Angeli & Valanides, 2009) or e-TPACK (Angeli, Valanides, Mavroudi, Christodoulou, & Georgiou, 2015). Although there are two perspectives on the TPACK development between integrating (Koehler, Mishra, & Yahya, 2007) and transforming (Angeli, 2005) knowledge, new perspectives have started from expanding of pedagogical content knowledge (PCK) to TPACK (Angeli, 2005; Koehler & Mishra, 2005; M. L. Niess, 2005). The transformative paradigm was determined as a reference for the development of technology because it provides identification content knowledge, teaching strategy, and TPACK in context (Angeli & Valanides, 2013). Before the implementation of lesson plans, teachers can not be separated from five essential elements, namely, subject matter knowledge, pedagogical knowledge, knowledge of learners, knowledge of context, and technological knowledge (Angeli & Valanides, 2009). The main purpose of teaching is how subject matter knowledge can be well understood by students. In addition, RWP has been changing rapidly; thus, technology innovation can be a way to access and resolve problems in teaching complex physics topics (Moehring, Schroeders, Leichtmann, & Wilhelm, 2016).

In this study, based on the transformative framework, technological transformation procedures were utilized. This procedure of design is shown in Figure 1, indicating a blog design developed by modifying from the instructional system design (ISD), namely identifying the difficult topic, selecting the topic to be transformed with technology, transforming the topic by integrating technology, content, and pedagogy. The transformation followed the affordances because the selected pedagogy, content, and technology were problem-solving, semiconductor topics, and blogs. Figure 1 shows the transformation blogs to solve the RWP.

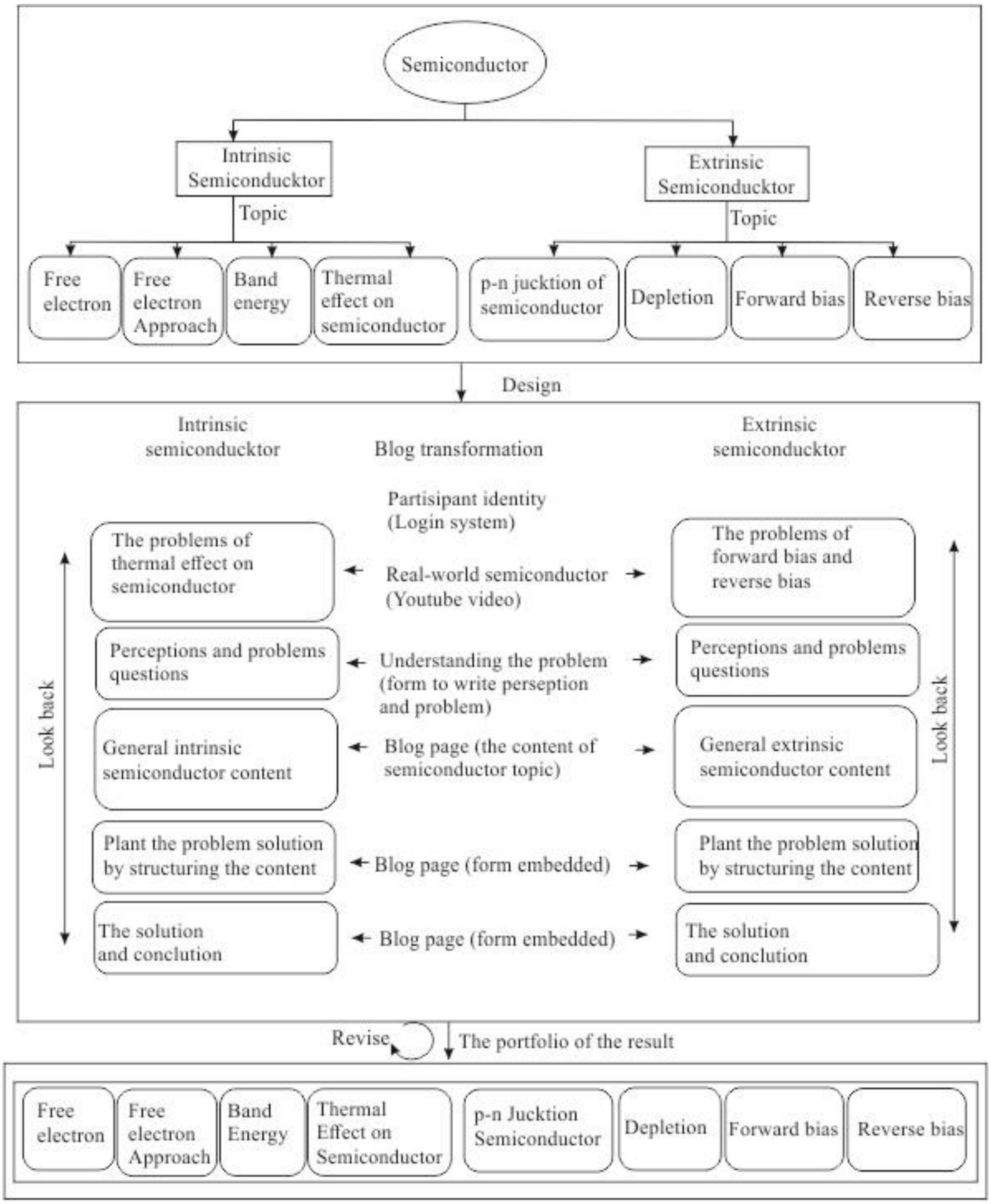

Figure 1. Blog development framework of instructional design (ID) model

METHODS

a) Participants, context, and learning processes

In this study, participants consisted of experts in the fields of blog design-based problem-solving approaches and upper-division students to solve the semiconductor problems. The blog design was validated by five experts as an estimating method (Hughes, 1996), coverage and conceptual accuracy (Jang & Chang, 2016). The anonymous composition of experts was one professor in physics education, one doctoral student in science education, and three physics lecturers in two universities. The implementation was conducted during the 5th semester with 40 students in the 2016-2017 academic year. Participants were 18 males (45%) and 22 females (55%). Their ages ranged from 21 to 24 years. All participating students took the material physics course but had not learned the semiconductor topic at the time of the study.

The context of the study was the semiconductor topic to transform into enriched blogs with appropriate technology. Semiconductor learning material was one of the most difficult and abstract topics in physics. The general semiconductor applications often discuss a microelectronic devices topic (Muscat, Allen, Green, & Vanasupa, 1998). Students need a prerequisite of the equations of quantum mechanics before learning the semiconductor topic (Bokstein, Mendelv, & Srolovtz, 2005; Chung, 2001; Irene, 2005; Razeghi, 2009). The content of semiconductors includes the Kronig-Penney model, energy band, electron drift, and depletion region in the semiconductor (Kronig, R. de L; Penney, 1931; Masir, Vasilopoulos, & Peeters, 2009). Therefore, the RWP was designed to uncover the specific topics by online videos. Blogs were designed with a form field system to facilitate. The blog system was created so that students could have their responses by writing down their problem-solving ideas. The real problem was expected to appear in the form field after seeing an embedded YouTube video. The form of the answer fields was predefined, consisting of two sessions. In section one, students watched a video about the heating of daily materials made by conductors, isolators, and semiconductors such as copper, glass, and silicon. These materials were connected to a power supply, connector, and light bulb to check electric current. In this section, students have to fill the intrinsic semiconductor topic to create a question like how current can flow in semiconductor material if it is heated. From this problem, students should distinguish the theory of free electrons and free electrons approach (Kronig-Penney's model). They categorized the concept of energy bands for metal conductors, semiconductors and insulators, and explained how electrons could move from valence band to conduction band so that there was a flow of electrons and holes. Although they did the tasks through blogs, students used the module as a reference to solve problems. In section II, extrinsic semiconductor participants filled out a form and addressed to blog resources as references. Those were five students' activities to be finished the task in the semiconductor course (see Figure 1). First, the blog was designed with a login system to record the identity of students. Second, there was a Youtube video about the thermal effect in semiconductors to respond by writing down the problem of the video. Third, students were expected to solve written problems before solving the problems in the blog according to the planning. In the last step, students were asked to read a text and view a video to enrich their knowledge in planning and executing the RWP solving. Students could proceed with steps in the order and return to the previous step to revise the issues. Figure 2 shows the appearance of the blog and its parts. The video stayed in the blog during the course period.

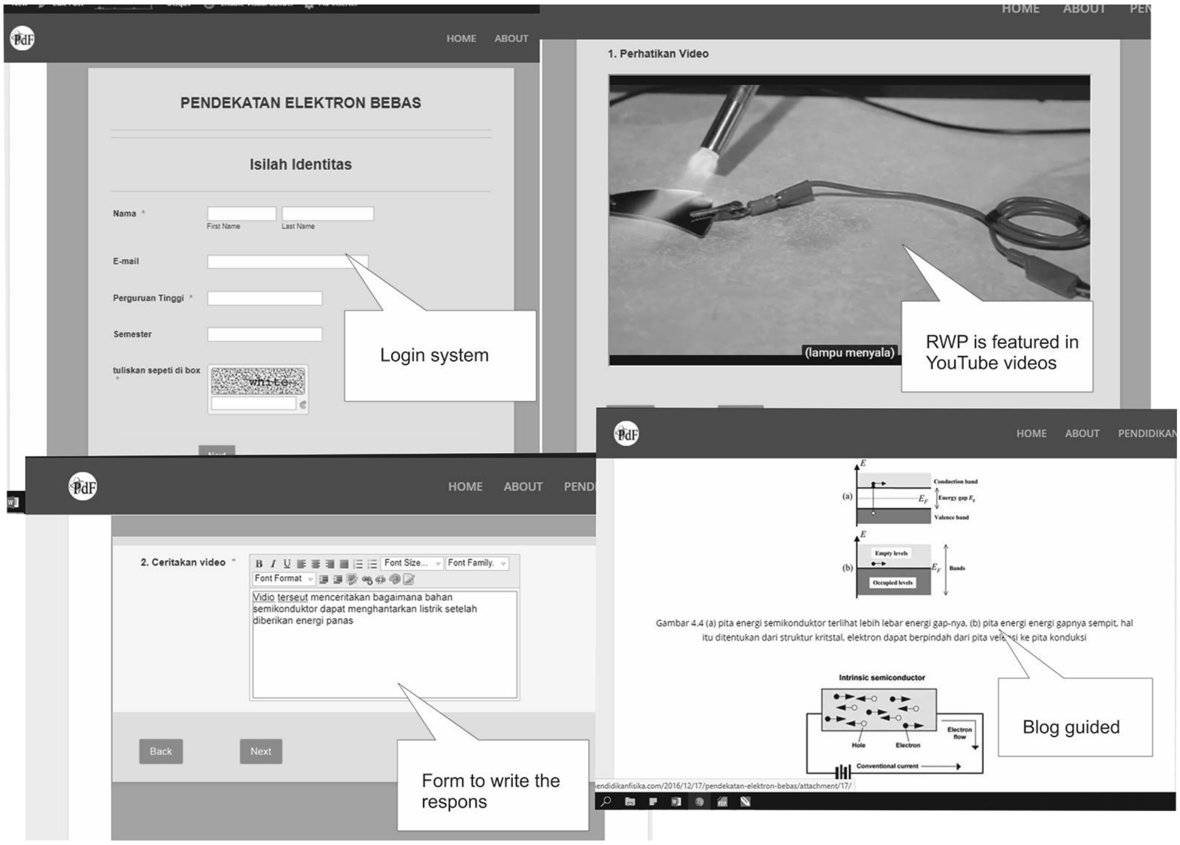

Figure 2. The appearance of the blog to solve RWP (www.pendidikanfisika.com)

b) Instrument

Data were obtained from the portfolio of participants by filling out the form in the blog. The portfolios of students' projects were analyzed via student performance-based criteria taxonomy, namely a New Taxonomy of Educational Objectives (NTEO), which are hierarchically sorted into four cognitive systems. This also was proposed to reveal students' performance in solving RWP. Indicators of four cognitive domains and scores are:

1. Retrieval is the recalling information basic knowledge of the recall, but not an understanding,
2. Comprehension is the combining information from its parts, but not a critical integration based on the problem solved
3. Analyze is the matching similarities and differences, classifying, analyzing errors, generalizing, and identifying specific information, and
4. Knowledge utilization is the utilization-making decisions, provide alternative solutions, test, and investigate information.

Indicators of four cognitive domains and scores are as follows expert validation results. The instrument validation was conducted by three experts using the content validity index (Aiken, 1980), in which good validity approaches show maximum probability. Each criterion was given a score on a Likert scale, ranging from strongly disagree (scale = 1) to strongly agree (scale = 5). The judges of students' answers were two physicists who showed a correlation of Spearman's rho over 6.78 in their scorings. Experts suggested looking at the important aspects of the NTEO. The validation was significantly high score validation, looking good appearance (0.95) based on Aiken's V.

c) Data Analysis

According to the cognitive level of NTEO, the portfolio was scored by two observers, and data were analyzed with descriptive and multivariate ANOVA (MANOVA). Table 1 shows the examples of students' answers to intrinsic semiconductor inputs selected on the NTEO cognitive domain with scores. The judges of students' answers were two physicists who showed a correlation of Pearson over 6.78 in their scorings.

Table 1. *Examples of students' responses in blog based NTEO classification*

Problem solving stage	Retrieval (Score =1)	Comprehension (Score =2)	Analysis (Score =3)	Knowledge utilization (Score =4)
Understanding the problem		Intrinsic semiconductor		
	What are the differences among conductors, insulators, and semiconductors?	Why can silicon be a conductor of current when heated?	How can semiconductor after heating turn on the light?	How can prove that a given semiconductor high temperatures electrons can flow?
		Extrinsic semiconductor		
	Can not diode drain current and vice versa?	Why does current not flow when the voltage poles reversed diode?	What the charge contained in n-type and p-type semiconductors, so it cannot flow of electric current?	How can diodes block external voltage, so it cannot drain current in the diode?
Planning the solution		Intrinsic semiconductor		
	Read the blog	Reading blog and several other references	Mapping the existing theories on blogs and other references	Using the material in the blog and then test it with other materials
		Extrinsic semiconductor		
	Reading from blog	Comparing on the blog with other sources	Analyzing on the blog with other sources	Test material in the blog with the actual conditions
Execute the plan		Intrinsic semiconductor		
	Their differences because of the energy gap	Because there is a transfer of electrons when it is heated from the valence band to the conduction band	Because when the semiconductor is heated, electrons present in the valence band to the conduction band move	Based on testing some of the material, the difference in the concentration of electrons and holes. The concentration change occurs to electrons in the conduction band and valence bands hole.
		Extrinsic semiconductor		
	If the p-type and n are connected, there is a depletion region which causes the current to do not flow back and forth	In the semiconductor p-n junction, there is a depletion area. Such areas may be energized if the same potential can be through the area	Concentration p-type, there are a lot of holes, while inside there are many electrons n-type, concentration difference this makes is formed depletion areas. Depletion voltage in the area have inhibited voltage the outside like the skating, will be able to pass one and cannot be crossing the other side	The difference in the concentration of p-type that contains a hole (+) and n containing many electrons (-). When applied forward bias positively met with a positive charge (p) and the negative pole to meet with a negative charge (n) will be able to make the depletion smaller area so that current can flow, and vice versa.

FINDINGS

a) Descriptives of students' problem-solving skills

Table 2 presents the number of students who responded by filling out the assignment in a blog. Most of the students completed the form (n = 34), four students completed a part of the form, and three students did not complete it. Intrinsic semiconductor topics were responded highly to 90% of students, greater than extrinsic semiconductor topic (77.5%), in the second session, 10% of students abstained from filling out the form. In addition, students also conducted revisions in both the intrinsic and extrinsic semiconductors. They revised the filling that indicated look back, the last stage of problem-solving, and those were few students (30%). It means that look back revisions of the portfolio went decreased. The student had the experience from the first section.

Table 2. *Number of students' completed responses in the form*

Component	Section I	Section II	Overall
Full completion	90 %	77.5%	84%
Part completion	7.5%	12.5%	10%
Abstain	2.5%	10%	6%
Revision of the artifact	35%	25%	30%
Avg. time of revision (min.)	23	20	21.5

Table 3. *Descriptive statistics of sequences of problem-solving stage*

Problem-solving stage	Section	N	M	SD
Understanding the problem	I	17	1.70	1.05
	II	21	2.29	1.04
Plan the solution	I	17	2.41	1.06
	II	21	2.90	.94
Execute the plan	I	17	1.88	1.11
	II	21	3.05	1.02

Table 3 consists of the descriptive statistics of students' problem-solving skills from filling the form in section I and section II. Overall, students in section II had a higher score of problem-solving skills than those in section I. The higher score was in the execute the planning stage (M = 3.05; SD = 1.02).

b) Students' problem-solving skills

From Table 1, the results were converted into problem-solving skills rating score by two independent judges. In order to determine possible differences in students' problem-solving scores of analyses, mean and variance were achieved. Before running analyses, normality tests were run and, data were found as normal distribution and homogenous variants ($p > .05$). MANOVA result showed that there was a significant difference between problem-solving stages (Wilks' Lambda = .24, $F (4,200) = 6.81$, $p < .01$), and the effect size was .87. However, the post hoc Turkey test showed that all comparisons of the problem-solving stages were not significantly different in section I and section II, except in the "Understanding the problem" and "Plan the solution" in the intrinsic semiconductor topic stage.

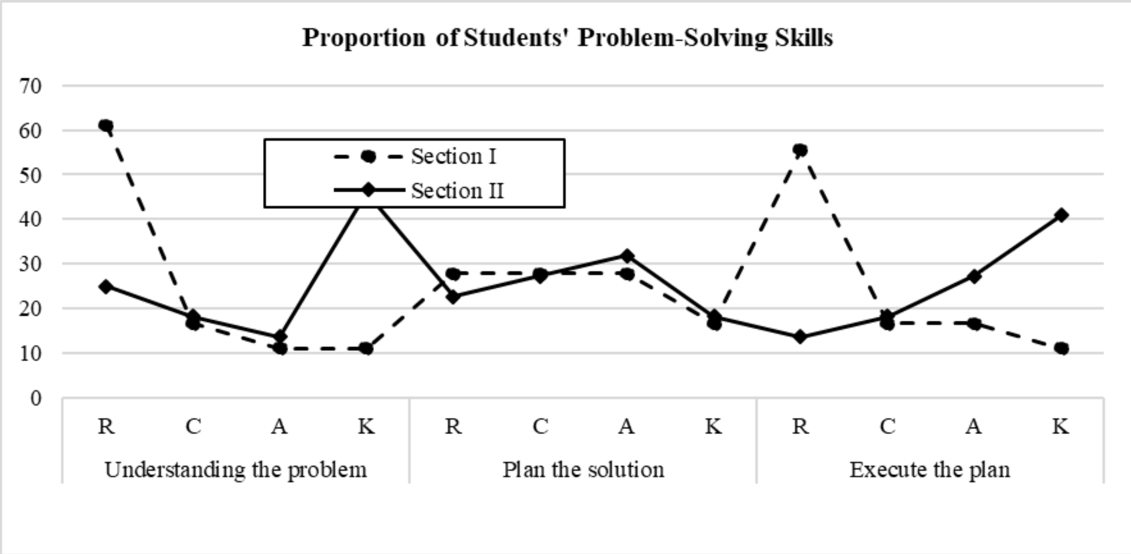

Figure 3. Distribution of students' responses in the field form. R indicates that the number of students is at the cognitive level of retrieval. C indicates that the number of students is at the cognitive level of comprehension. A indicates that the number of students is at the cognitive level of analysis. K indicates that the number of students is *at the cognitive level of knowledge utilization.*

In order to classify problem-solving skills, the students' answers were also grouped into retrieval, comprehension, analysis, and knowledge utilization in each step of problem-solving skills. Figure 2 shows the percentage of students based on the NTEO criteria. Overall, students in section II had high taxonomy for each step of the problem-solving skills, especially analysis and knowledge utilization in execute the plan stage. However, this did not occur in section I. This indicated that blogs as resources seemed to be able to increase students' cognitive levels.

DISCUSSION

The aim of this study was to describe students' responses in a transformative blog page and determine improvements of students' problem-solving skills in internal and external semiconductor topics. To collect students' responses, they were asked to complete forms in solving problems. We found that blogs had the advantage of being blog-based problem-solving. First, RWP motivated the students to fill out tasks in solving physics problems. Findings showed that the problem-solving stage of "Understanding the problem" showed a significant difference in section I and section II. This finding supported a significant autonomy to solve given motivation from RWP in the first stage, as indicated in the previous research (Virkkula, Esa; Nissilä, 2014).

Second, blogs drove creative problem-solving, similar to previous research on web-coated problem-solving (Y.-J. Lee, 2015; Ryan et al., 2016). This was possible because students explored alternative solutions in problem-solving more intuitively as suggested by Kuo et al. (2014). Providing various sources of readings in the blog might make students have new alternatives in solving problems. Even though it was only a qualitative solution, it was important because students need to do qualitative understanding before completing mathematical solutions (Gök, 2012).

Finally, although some students had the same planning in solving problems, they had the quality of executing the planning, especially when students had alternative resources to explore in solving problems. This indicates that the blog has an easy feature to explore ideas (Y. Lee, 2018). This achievement also was in line with previous research that developed students' problem-solving skills (Gök, 2012; Kuo et al., 2014). The complex tasks caused students hard-work to answer with a high level of problem-solving (Gikas & Grant, 2013). The blog facilitated revisions for students to give chances to improve their paper. This might drive students to enhance their meta-analytical thinking (Sawmiller, 2010).

The limitations of this study were seen from three aspects that we also recommended for further research. First, experts should communicate with each other. The meetings of experts facilitate the synchronization of different views (Mckenney & Voogt, 2017). In future research studies, the Delphi method can be used to complete learning integrated technology (Yeh, Hsu, Wu, Hwang, & Lin, 2014). Secondly, we were not able to evaluate the accuracy of students' writing via transformative blogs; hence, the results showed fewer students' reflective ability. For further research suggestions, smart systems can be inserted into blogs that can make students more reflective in collaborative problem-solving (Rosen, 2015). Finally, the explanations of students' initial understanding were not ready. Initial understanding is used to measure the effectiveness of the use of blogs before and after their responses. Future research needs to make an initial mapping of students' problem-solving skills to compare students' problem-solving abilities before and after the application of a transformative blog.

CONCLUSION

This study can provide insights for instructors and students in transforming technology to solve real-world semiconductor problems. In this study, technology transformation was carried out to facilitate specific topics considered traditionally difficult. This would bring benefits for students, especially in terms of motivation to do their assignments. In addition, transformation blogs could be a creative medium for students when there are alternative sources in the blog. Further research needs to emphasize more applicable blogs on improving students' problem-solving abilities in other difficult subjects.

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