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The effects of instructional design based web course on pre-service teachers' competencies

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ABSTRACT

Web Pedagogical Content Knowledge (WPACK) is an important competence for pre-service teachers in the educational technology course. However, novice pre-service teachers require the preparation stage to integrate the Web into instruction. The purpose of the study was to develop and to investigate the new instructional model for pre-service teachers in integrating the Web. The Preparation, Isolation, Transformation, Action, Reflection, and Revision (PINTARR) and two other models were implemented in three physics education technology groups with seventy-four participants. The instrument test was constructed to assess the pre-service teachers' competencies, namely Student analysis, Curriculum organization, Instructional strategy selection, Evaluation, Technological knowledge, and Physics knowledge. The result of MANOVA showed pre-service teachers in PINTARR group outperformed overall the pre-service teachers' competencies rather than the Multimedia and Web Design Learning group. The results indicated that the Preparation and the Isolation stage were the most important for novice pre-service teachers in improving the competencies.

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1. INTRODUCTION

The process of learning has been massively prevailed by the integration of pedagogy, content, and technology. Instructional-supported technology refines the paradigm of pre-service teacher competencies expected for the future teacher. Moreover, recently, the internet was a disruption information and communication technology (ICT) to infuse in the process of learning and teaching [1–3] including Web. It emerged technology that changes the way of communication [2], collaboration [4], tutorial, and information [5]. However, there was little explanation of pre-service teacher preparation before they integrated technology especially the Web in the ID process. This is required to prepare the pre-service teacher from "digital native students to digital native teachers" [6]. Furthermore, the preparation of the Web integration into the ID will be an important contribution to enhance the pre-service teacher competencies.

Technological Pedagogical Content Knowledge (TPACK) was a popular framework to integrate technology into the ID process. In this concept, Mishra and Koehler [7] described a learning technology by a design approach that TPACK framework can be a guiding design of curriculum and to be the assistance of a theoretical and epistemological learning environment like Web learning. Lee and Tsai [3] also expanded the framework to integrate the Web into a PCK known as TPACK-Web or WPACK [2]. Consequently, in the practice of specific Web course, the learning technology by design become the learning Web by a design approach that need to view the effective method in ID course like previous studies [8]. As Ugul, *et al.* [9] provided the specific of infusing the technology into the teaching and learning process. However, other studies showed that the pre-service teacher reached the lowest score of technological knowledge [10, 11]. Thus, there is a need to provide a model to include the preparing system and attitude. The recent study investigates the effective process of Web integration into lesson planning conducted by pre-service science teachers.

For this process based on the teachers' attitude toward ICT, the WPACK framework, and the learning Web by design approach, an ID model is constructed. The comparison of several models described to propose the effectiveness of the model in enhancing the pre-service teachers' competence through constructing the element of generic lesson planning and Web lesson design [12]. Therefore, the main purposes of this study were to develop the new model ID-based the teachers' attitude toward ICT, the WPACK framework, and the learning Web by design approach, and to identify the effects of the ID model compared with other ID models.

TPACK is the integration of three knowledge domains, namely technology, pedagogy, and content knowledge. This concept was expanded by Mishra and Koehler [1] from the Pedagogical Content Knowledge (PCK) framework that has been popularised by Shulman [13]. This framework then was derived by Lee and Tsai [6] into Web-Pedagogical Content Knowledge (WPACK). Lee and Tsai [6] also promoted WPACK as the teacher's competency needed to teach the Web knowledge. The construction of WPACK derivate into eight components: Web-Knowledge (WK), Content Knowledge (CK), Pedagogy Knowledge (PK), Pedagogical Content Knowledge (PCK), Web-Content Knowledge (WCK), Web-Pedagogical Knowledge (WPK), Web-Pedagogical Content Knowledge (WPACK), and teachers' attitude toward web. Generally, TPACK differs with WPACK especially on the substitution of Web into PCK [14] and adding the attitudes toward ICT. Consequently, the four of seven TPACK components change following Web formation, namely WK, WCK, WPK, WPACK, and attitudes toward Web. Although the original article of WPACK [3] has many citations, there is still few studies construct model-based WPACK. This shows that WPACK is a potential topic to develop the ID model for improving the pre-service teachers' competencies.

Analysis, design, development, implementation, and evaluation usually are used as the general model processes of instructional system development (ISD) [15] to design and implement the lesson plan. It is an ill-structured of the problem-solving process because pre-service teachers engaged the multiple parts of the ISD structure. There are few kinds of ID model for preparing pre-service teachers' TPACK as design guiding such as [16]. However, the implementation of the ISD model for instructional design-based Web was rarely studied. Therefore, a recent study, the ID-based Web was developed to enhance the pre-service teachers' competencies in designing a lesson plan.

The review of models generally describes the recommendation to the design model. It shows that the model should be the important guiding development as: 1) The model provides a stage to offer opportunity novice pre-service teachers to be experts before they transform the topic content into technology-rich pedagogy related learner characteristics; 2) ISD is the emerging stage to develop lesson planning that started from learner analysis, design, implementation, evaluation; 3) These stages are the cyclic process to attempt the refinement of the design product.

According to five recommendations for the developing model, this study proposes the Web-PINTARR model (Preparation, Isolation, Negotiation, Transformation, Reflection, and Revision). This model addresses to enhance the pre-service teacher competence in ID as shown in Figure 1. Web-PINTARR model offers the TPACK-practice to design lesson plan-based Web developed as guidelines for novice pre-services teachers in Web knowledge and skill to attempt as the expert adaptor of Web-based learning, especially Web-PINTARR can affect to enhance pre-service teachers' competencies.

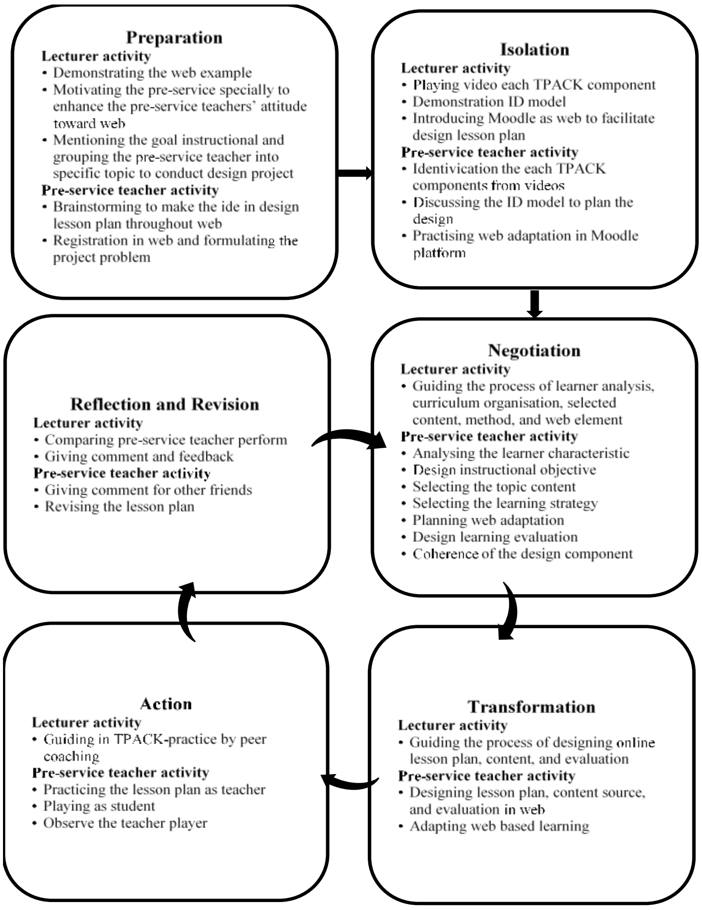

Figure 1. WPACK-PINTARR model

2. RESEARCH METHOD

2.1. Context and design of study

This study aimed to design the WPACK-PINTARR model and to measure the outcomes of pre-service teachers' TPACK through juxtaposing with the other models. To comparing the models, a quasi-experimental study design was conducted to determine the impact of a treatment on an outcome, while the randomize of pre-service teachers was not individually sufficient [17]. In this study, classes were formed before the study began. Consequently, the randomize only occurred when the classes of experiments were drawn, and this reason is the alternative design to ensure the observed effect [18].

Three class of two teacher educational institutions were randomized the multimedia group, the Web-learning design, and the Web-PINTARR (Figure 2). The stages of each class were different and had a function in this study. The Multimedia group was generally used by instructors to integrate the technology into learning in Indonesian teacher educational institutions. Therefore, this group covered as a control group and starting point in comparing others. The stage of the Multimedia model is similarly as the ID model, namely analysis, design, development, implementation, and evaluation. At the analysis stage, the pre-service teacher analyzed the student characteristics and subject matter analysis. Then, pre-service teachers conducted learning objectives designing, method of leaning selecting, and evalution designing in the design stage. At the development stage, pre-service teachers integrated the result of the analysis model into Web affordances. The last, Implement stage was a stage to practice the result of design in a classroom simulation. The second, Web-Learning Design group used the TPACK-setting, but the preparation and isolation were removed. The fuction of this group was to show the effect of pre-service teachers' TPACK without the pre-service teachers' attitudes toward Web. The last, Web-PINTARR group was conducted through implementing the stages as shown in Figure 1. This group was treated as an experimental group that received pre-service teachers' attitudes toward the Web in preparation and isolation stages.

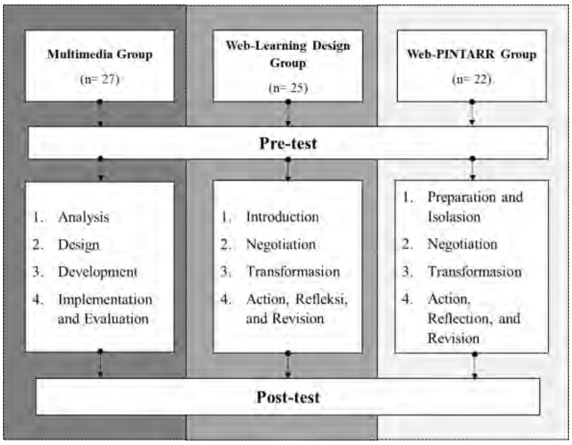

Figure 2. Quasi-experimental study design

2.2. Participants

The study involved 74 pre-service teachers that consist of 20 male and 54 female (n=54) from two higher teacher educations that have the same quality accreditation, namely 49 pre-service teachers from Universitas Negeri Yogyakarta (UNY) and 22 from Universitas Ahmad Dahlan (UAD). Their ages ranged from 18 to 21 years. The composition of experimental groups ware two classes as Multimedia Groups (n=27), Web-PINTARR (n=25), and Web-learning design (n=22). Those classes ware began at the fifth semesters in September 2018 until February 2019. Each group met one time per week for three hours. Although participants joined other subject-matter courses, the material obtained was not related to educational technology. They have joined the fundamental of pedagogical and physics content courses along the fifth semesters. The technology that has been taught including Word, Excel, Power-Point, dan Flash media, while Web was started to learn integrated into this course, namely educational technology in physics.

2.3. Instrument validity and reliability

Pre-service teachers were assessed to measuring the outcome after treatment for all groups. For this purpose, the instrument was constructed using a test from the Educational Testing Service [19–22]. This was categorized into six pre-service teachers' design indicators, namely student analysis, curriculum organization, instructional strategy selection, technological knowledge, evaluation design, and content knowledge [15]. For example, in Praxis's test [22]:

1. When scanning a drive for viruses, it is typically important to check files having which of the following extensions? (A) .jpg (B) .pdf (C) .wav (D) .exe

and designed in Web context:

2. When uploding a presentation slide file, it is typically important tool having which of the following names? (A) Page (B) Resources (C) SCROM Package (D) External tool

Multiple choice tests were designed five items for each indicators, and consultated to two experts in technology and physics education. The experts advised to revise items of the test including in word readible and mistake. After refining all items, the instrument was exemained to 50 pre-service physics teachers in other universities, and analysed item response indext with two caracteristic model using Quest program [23]. According to the difficulty threshold, person ability, and fit the model [23, 24], the rejected item of test contains five items: 1 item of student analysis, 2 items of instructional strategy selection, and 3 items of content knowledge. After the rejected items removed, Cronbach's alpha on indicators ranged from 0.90 to 0.76. Finally, the test items transformed into online test to fasibility data analysis.

2.4. Data analysis

Data from pre-service teachers' responses in Multimedia Groups, Web-PINTARR, and Web-learning design group were collected. The data were analyzed by IMB Statistical Package for the Social Sciences (SPSS) 25 version. The description statistic occurred to description pre-service teacher's achievement. The preliminary analysis was done to test the assumption of data, including normally, linearity, homogeneity, and multicollinearity test. The result showed that there were no serious violations. Then, the multivariate analysis of variance (MANOVA) was used to examine the difference among groups' mean data for the six-indicator.

3. RESULTS

The descriptive statistic was calculated in order to determine the comparative of pre-service teachers' competencies in three groups of the technological course as shown in Table 1. Overall, the score of pre-service teachers has increased. Most pre-service teachers for the Web-PINTARR group were higher mean scores in post-test than other groups, and they had the highest scores for Physics knowledge (M=8.33, SD=1.73). Whereas, the most pre-service teacher for Web-learning design group was higher than the Multimedia group. However, it was appeared that post-test mean score of Curriculum organisation (M=6.32; SD=2.53) for Web-learning design performed better than Web-PINTAR (M=6.15, SD=1.56) and Multimedia group (M=5.24, SD=1.98).

Table 1. Descritptive statistic of pre-service teachers' competencies among groups

Competencies	Groups	n	Pre test M (SD)	Post test M (SD)
Student analysis	Multimedia	27	4.04 (1.54)	5.88 (1.83)
	Web-learning design	22	3.82 (1.33)	3.90 (1.65)
	Web-PINTAR	25	4.26 (1.48)	7.22 (1.47)
Curriculum organisation	Multimedia	27	4.56 (1.76)	5.24 (1.98)
	Web-learning design	22	3.86 (1.28)	6.32 (2.53)
	Web-PINTARR	25	4.30 (1.59)	6.15 (1.56)
Instructional strategy selection	Multimedia	27	2.08 (.81)	2.20 (.87)
	Web-learning design	22	1.86 (.83)	2.95 (.65)
	Web-PINTARR	25	2.11 (.97)	3.15 (1.10)
Evaluation	Multimedia	27	2.36 (.99)	2.64 (1.19)
	Web-learning design	22	2.05 (1.05)	3.27 (.98)
	Web-PINTARR	25	2.26 (.86)	3.44 (.97)
Technological knowledge	Multimedia	27	2.08 (.95)	2.80 (1.47)
	Web-learning design	22	2.09 (1.06)	3.32 (1.24)
	Web-PINTARR	25	2.15 (.95)	3.81 (1.18)
Physics knowledge	Multimedia	27	4.96 (1.43)	4.68 (.85)
	Web-learning design	22	6.05 (1.29)	7.41 (1.40)
	Web-PINTARR	25	5.48 (1.50)	8.33 (1.73)

The test of MANOVA was performed to identify the different pre-service teachers' competence among Multimedia, Web-learning design, and Web-PINTARR group. For understanding the initial pre-service teachers' competencies, measured the pre-test data was used MANOVA. The result shows that there were no statistically significant for all groups in pre-test (Wilks' λ=.80, F(12, 132)=1.26, p=.25, η^2=.10). This indicated that pre-service teachers had the same ability before the treatment was applied. Consequently, the measurement of the group effectiveness was continued to the post-test, without joined pre-test data as covariate analysis.

In order to examine the difference among three groups, MANOVA also was applied. Overall, the result shows that the difference of pre-service teachers' competencies was a statistically significant among groups (Wilks' λ=.20, F(10,132)=13.71, p=.00, η^2=.56), showed effect size was large [25]. If this was determined sparatedly, Student analysis (F(2,71)=24.27, p=.00, η^2=.41), Instructional strategy selection (F(2,71)=7.75, p=.00, η^2=.18), Evaluation (F(2,71)=4.11, p=.02, η^2=.11), Technology knowledge (F(2,71)=3.93, p=.02, η^2=.10), and Content knowledge competence (F(2,71)=47.75, p=.00, η^2=.57) were significant difference among groups. However, Curriculum organisation (F(2,71)=1.99, p=.14, η^2=.10) was no significant defferentce of competence.

Moreover, post-hoc using Tukey's HSD was applied, to look for the effect of each variable between groups. Figure 3 shows the estimated mean of pre-service teachers' competencies. The result showed that pre-service teachers' competencies for the Web-PINTARR group were significantly different. For example, competence of Student analysis for the Web-PINTARR (M=7.22, SD=1.47) was significantly different from Web Design Learning (M=3.90, SD=1.65) and Multimedia (M=5.88, SD=1.83). Although, the competence of Curriculum organization for the Web Design Learning (6.32(2.53) was a higher score than the Web-PINTARR (M=6.15, SD=1.56) and Multimedia (M=5.24, SD=1.98), it was not significantly different.

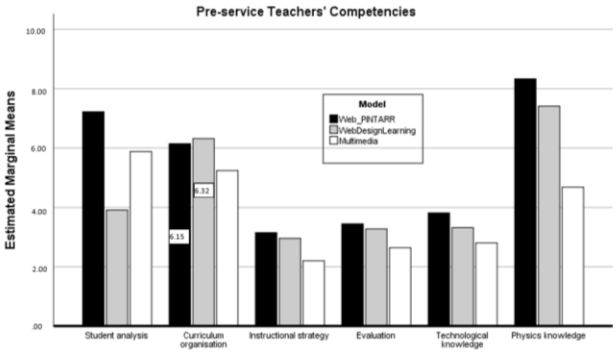

Figure 3. Mean pre-service teachers' competencies score for web PINTARR, web design learning, and multimedia group

4. DISCUSSION

The purpose of this study was to test the effectiveness of the Web-PINTARR model in improving the competency of pre-service teachers. According to the result, the Web-PINTARR group might be able to improve pre-service teachers' competencies. These results were consistent with previous studies that used technology related PCK as a fundamental of model design [16, 26, 27]. In addition, the Web-PINTARR group was more effective than the Multimedia group and Web-learning design group. The interesting note is the addition of introduction and isolation in stage at the beginning of the course, and comparison of multimedia and Web learning design. The result might show the reasons why the Web-PINTARR group was more effective than other groups to achieve the pre-service teachers' competencies. First, the finding indicated the effectiveness of the Web-PINTARR group because of the readiness of pre-service teachers to design technology. Specifically, pre-service teachers for the Web-PINTARR group had planned to design the Web in preparation and isolation stage, and they had directed on solving the problem in transforming technology, pedagogy, and content knowledge in the transformation stage. Meanwhile, in the multimedia group, introduction and Web design were carried out simultaneously at the transformation and design stage as previous research [26]. In addition, the finding was possible to facilitate the understanding of the TPACK component in the isolation stage. Thus, the study suggested using the preparation and isolation stages for novice pre-service teachers in technology integration before they designed the lesson plan.

The second, pre-service teachers in the preparation stage introduced the Web to adaptive the different content and motivated them to complete in the future stage. Because integrating technology into teaching and learning need complex activity [28, 29], pre-service teachers required the fundamental of Web design. Therefore, the instructor encouraged them to modify as a new experience in technological integration. Similarly previous research [30], the preparation stage might provide an epistemic activity that leads to involvement in efforts to integrate knowledge, build flexible knowledge, involve the inquiry assets, and become learners oriented to the complexity of Web integration. In addition, this might need pre-service teachers to master Web design. Although pre-service teachers for Web-learning design used the Web to transform technological knowledge into learning and teaching, they had the problem, especially in Web operating techniques. This might be the reason why pre-service teachers need to feel competent enough in using technology to instruction [31]. Thus, this study proposed to assure the attitude toward Web in design WPACK.

The limitation of this study was the number of participans only 74 pre-service physics teachers from two universities. Therefore, the generation of conclusion from the result analysis was limited. Larger participants migh make further research more credible. The result also was limited with data obtained from multiple choice questions which can be biased. Data support obtained from surveys and interviews will support the results of the study. Hence, data can be collected in depth through qualitative research and mix methods.

5. CONCLUSION

This study have developed the new model ID-based attitude toward ICT of pre-service teacher, the WPACK framework, and the learning web by design approach. The model could effectively increase the competence of pre-service teachers. The model may be used by lecturers to conduct instructional design courses. Future research should emphasize novice pre-service teachers' web knowledge in the preparation phase.

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