The development of ICT-based learning curriculum for pre-service physics teacher

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Abstract. Information and Communication Technology (ICT)-based learning course aims to produce professional teachers who proficient in utilizing ICT in each learning component and processes. For pre-service physics teachers, the skills of integrating ICT into the learning process become the primary requirement, since ICT gives the advantages and convenience to explain the concept and the phenomena of physics. It can achieve by design an appropriate curriculum for ICT-based learning courses, specifically for pre-service physics teachers. This research uses the ADDIE approach with stages: analyze, design, develop, implement, and evaluate. Product results give a curriculum of ICT-based physics learning by applying the project-based learning method. The resulting product has passed the validation test and field trials to one class of pre-service physics teacher. The results obtained based on expert validation are excellent categorized curriculum, and it is highly recommended to revise the contents regularly to face the ICT progress is so rapidly. The implementation stage shows that this curriculum design makes pre-service physics teachers have portfolios and can support the learning process in the classroom. With this developed curriculum, pre-service physics teachers are expected to be ready to become professional physics teachers in the digital age.

1. Introduction
The digital era encourages the new technologies that make various fields must adjust professional competence, including education. The orientation of achievements in education should include technology mastery skills for students to face future challenges. As a teacher, submission of these skills becomes the main task. Teachers must continue to be active in training of professional development in order capable to delivery this competence in the learning process. This professional development can improve self-efficacy and teaching skills using ICT [1,2]. However, ICT integration requires a lot of modifications to school management, especially in budgeting for teacher-training, facilities, and other structural training. Therefore, the development of these skills begins when they are still pre-service teachers across the teacher education curriculum in university. The design of ICT-based learning curriculum is believed can bring more professional in-service teachers [3-4].

The main point in designing the ICT-based learning curriculum is the ability of pre-service teachers to create learning models and strategies that are innovative, creative, and able to bring high participation in the classroom [5]. So that the pre-service teacher has this ability, we as teacher education need to create condition the appropriate learning environment [6]. Pre-service teachers are now mostly aware and confident in mastering technology [7]. Assuming this belief, what remains is only a matter of how to design curriculum and learning environment that supports the professional development of
sustainable ICT fields. The curriculum design must still consider the current trends and the direction of future trends and more broadly involving policy makers, curriculum developers, teachers and teacher researchers at the university [8].

Science Subject, especially Physics, ICT provides an important role in explaining the concept and the phenomenon of physics. This role can improve students' understanding because it can present conducive learning conditions. These improvements come from the combination of hardware devices and modeling tools that improve laboratory activities in high school [9-11], simulation software and smartphone virtual lab for students understanding [12,13] or utilize e-learning platform [14,15]. This paper proposes the design of ICT-based learning curriculum for pre-service physics teacher with combined the trend of the industrial and technological developments and educational research so that university can produce the professional physics teachers in the digital age.

2. Methods
This research adopts the ADDIE approach for instructional development [16]. These steps consist of 1) Curriculum Analysis, 2) Material Design, 3) Validation and revision, 4) Implement in Classroom, and 5) Evaluate. Curriculum analysis includes identification of topics and material to be chosen. These topics and materials then become the basis for developing teaching materials. The design stage is to prepare a syllabus, classroom teaching planning, media, and other teaching materials. The developing step to validate and revise the design results. Then, next step implemented the final version in the classroom and evaluated it.

3. Results and discussion
The result of curriculum analysis is the selection of topics and content. This analysis based on the identification of competencies that must be owned by every pre-service physics teacher. The topics chosen shown as in table 1.

| Topics | Content and Materials |
|--------|-----------------------|
| How to Develop ICT-based Physics Learning course | Research and Development using ADDIE Models.  
Materials:  
1. Identify Required Resources  
2. Determine Potential Delivery System  
3. Compose Performance Objectives  
4. Generate Content and Develop Media  
5. Generate Content  
6. An Implementation Strategy  
7. Determine Evaluation Criteria |
| Electronic Book | Project to develop Physics Book in electronic format using 3D Pageflip-Professional Software.  
Materials:  
1. Adobe Acrobat DC  
2. Office Word  
3. Office PowerPoint  
4. Flash Animation  
5. Short Video |
| Simulation and Animation | Project to create simulation and animation for Physics Teaching Using I-Spring Software.  
Materials:  
1. Office PowerPoint  
2. I-Spring |
Table 1. Cont.

| Project Title                        | Description                                                                                     | Materials                                                                 |
|--------------------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------|
| The video for Motion Analysis        | Project to record various motion based on kinematic topic using tracker software for analyze motion and then create a worksheet for motion analysis. | 1. Smartphone  
2. Windows Movie Maker                                                   |
| The video for Learning Purpose       | Project to make YouTube Channel as learning media. Preservice Physics teacher create a YouTube channel, and they are recording a learning video, then they are upload and share. | 1. Handy-Cam  
2. Adobe Premiere Pro                                                  |
| Assessment Tools                     | Project to create assessment based-on ICT                                                       | 1. QuizMaker  
2. Kahoot! Software                                                      |
| Augmented Reality                    | Project to create Augmented Reality for Physics Teaching                                        | 1. Unity Pro  
2. Sample Project  
3. Android Smartphone                                                      |
| Scholar Profile                      | Create report and linking the scholar profile based on project using Google Scholar and Researchgate. |                                                                           |

The topic starts with the ADDIE approach which is an instructional development approach. This topic was chosen because when pre-service becomes an in-service teacher, it is not only limited to creating media but also implementing it in class. The next six topics are obtained from the search results through the trend of education and learning research using ICT. The last topic is the scholar profile. Scholar profile shows the portfolio which is the work result and the means of publication of their works. Each selected topic must report and uploaded in the Researchgate database and link with the Profile Scholar. This report is also a form of responsibility in scientific activities.

The syllabus and learning design are arranged according to the chosen topic. After completing the design phase, the complete learning tool then assessed by peers. The results of the assessment are suggestions for improvement to revise the learning device as shown in table 2.

Table 2. Peer-review assessment.

| Comments                                                                 | Revisions                                                                                      |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| The syntax of learning made should be adjusted to implementation so that the syntax does not only refer to one method but rather a combination of several methods by the strategies used in the syllabus developed. | Several modifications of syntax according to the implementation of the test on the course. |
| In the learning section of the project, it should be equipped with a complete guide to the project to be carried out. | Adding project guides.                                                                         |
| Presentation slides should add videos to make it more interesting.       | Adding videos.                                                                                 |
| Provide some variance software for every project.                        | Give some variance of software.                                                                |

Based on table 2, the final syntax using step from combination of problem based learning, project based learning, research based learning, and joyful learning. The guides provided for every project, not as
general guides since each project have different task. Further, for classroom lecture, we add some videos and present any variance of software. The results obtained based on expert validation are excellent categorized curriculum, and it is highly recommended to revise the contents regularly to face the ICT progress is so rapidly. The implementation stage shows that this curriculum design makes pre-service physics teachers have portfolios and can support the learning process in the classroom. With this developed curriculum, pre-service physics teachers are expected to be ready to become professional physics teachers in the digital age. At the end of the lecture, every pre-service physics teacher has been able to make: an electronic book, simulation, animation, motion worksheet, YouTube channel, Kahoot! Account and create a quiz, design for the augmented reality marker, and scholar profile.

4. Conclusion
This learning design for pre-service physics teacher can be used to improve understanding of how to develop ICT-based teaching materials and improve their portfolio work and scholar profiles. This portfolio work and scholar profiles show pre-service physics teacher as educator and researcher. Future work is how to implement ICT-based curriculum for in-service physics teacher and the continuation of curriculum from the pre-service teacher.

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