An Analysis and Design of Web-Based Learning *GoProfTeach* as Interactive Learning Tools

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**Abstract.** This study aims to analyze the need for: 1) analyzing resources availability 2) analysing the TPACK (Technological, Pedagogical, and Content Knowledge) profile of preservice biology teachers 3) designing GoProfTeach as a web-based learning tool for in-service and pre-service teachers. In doing so, it followed ADDIE development model. The instrument for data collection was a validated TPACK test. This article, in particular, discusses the results of the study in the first year of the analysis and design phase. The instrument for data collection included documents checking sheets, questions validation sheets and a Technological Pedagogical Content Knowledge (TPACK) test. The results of resources availability analysis and TPACK tests indicate that there is a need for the development of web-based learning resources as a means of increasing the ability of TPACK of pre-service and high school Biology teachers. The contents that have been designed include; 4 sets of practice exercises, 4 modules, and 2 virtual lab topics. Following the research findings, the website contents will be further developed to make sure that they be used as an independent and interactive learning source for undergraduate students and pre-service Biology teachers who will take the Teacher Professional Education Program (PPG) and PPG Student Competency Test.

1. Introduction

LPTK or teacher training institution is a tertiary educational institution that provides undergraduate and graduate degree programs as well as profession education, directed primarily at mastering the field of education in accordance with level 6 and 7 of KKNI (National Qualifications Framework). As one of programs of LPTK, undergraduate education degree program and Teacher Profession Education (commonly referred to as PPG) are designed to prepare students as prospective educators who can meet the needs of the schools in the 21st century. Thus, ICT plays an important role in the process of education in the 21st century and the Industrial Revolution 4.0 era. TPACK is a set of knowledge framework that shows the relationship between three aspects that prospective and in-service teachers need to have mastery over: technology, pedagogy, and content. This TPACK needs to be mastered by pre-service and in-service teachers so that later they can design effective learning programs [1]. Mastering these interrelated elements allows them to design effective learning programs. The TPACK framework was developed by Mishra et al from Sulman’s PCK (pedagogical content knowledge) framework. For the pre-service teachers, this ability will affect the quality of learning in the classroom as well as their self-efficacy in teaching [2]. According to Valtonen [3] workforce constantly demands changes in labor’s competence, thus increasing the significance of problem solving, critical thinking, and collaboration in the life of the 21st century. The regulation of Ministry of Research and Higher
Education (Menristekdikti) number 55 of 2017 article 4 section 3 states that teacher education is a national program with the aim to produce nationalist, professional educators with a global outlook and that meet local and national needs for the development of science and technology. To achieve this goal, students must embark on PPG after completing their undergraduate education degree program. At the end this program, they will have to face a competency test (UKMPPG). UKMPPG comprises knowledge Test (UP) and performance test (UK). The scope of UP includes four dimensions of professional teacher competency [4]. For uncertified teachers, they will need to take Teacher Profession Education and Training (PLPG. As the case of PPG program with competency test, participants of PLPG are also required to pass National Examination (UTN), local exams and performance exams after the completion of the program. In 2018, the Directorate General of Learning and Students (Belmawa Dikti) designed a number of programs related to the development of PPG learning systems for in-service teachers, which is known as Hybrid Learning Systems.

The initiatives are expected to produce competent, nationalistic graduates who have noble characters and that manage to stay relevant to the industrial era 4.0. The end goal of this initiative is definitely how universities can produce good quality students. The in-service PPG program implements hybrid learning where each instructor prepares a pedagogical competency module as an online teaching material for students [4]. In order for this Hybrid Learning to be well facilitated, the government (Kemenristekdikti) designed a web-based learning system called SPADA (Online Learning System) which was created using Brightspace software. The software is an e-learning platform that teachers can use to learn and do assignments online [5]. This program aims to encourage learning inovations based on education network among higher education institutions with the ultimate goal to achieve equality of access, relevance and quality of higher education [4]. Several previous studies have revealed the effects of providing e-learning on improving learning. A study by Safitri [6], for instance, found that the development of effective e-learning can improve students’ learning outcomes. Further research conducted by Jas [7] revealed that website-based media is able to create an atmosphere of active and fun learning as seen from the positive activities that arise in students. Firdaus and Arini [8] also explained that e-learning based media using the Content Management System on excretion material caused an increase in minimal learning completeness. These studies suggest that e-learning needs to be done and continuously developed so that learning improvement can occur. Based on the results of UTN test which were carried out simultaneously in 2016/2017, it was found that about 47.63% participants passed the national tests (22,745 out of 47,758 people). A total of 52.37% (25,013 participants) had to retake the UTN test [9]. The percentage suggests that most participants still have poor competency due to the lack of preparation before the exam. For this reason, independent learning facilities relying on ICT are necessary. This study will present analysis of the need for developing a web-based learning resource for prospective professional teachers.

2. Methodology

The entire research and development activities were carried out for two years by adopting ADDIE model. The present article, however, only encompasses the first two stages Analysing and Designing

**Analysing**

- Analysing the availability of resource (available content) from previous studies (2015-2018) and the resource to be developed (2019-2020)
- Analysis of TPACK profile of pre-service Biology teacher in Riau Province.

**Design**

At this stage, the product (content) was designed.

- Module design
- 4 question sets for test
- The initial design of the website was designed. The design is given in Figure 3.

Participants in this study were 146 pre-service Biology teachers enrolled in five LPTKs in Riau.
3. Results and Discussion

3.1. Results of Analysis Stage

The results of resources availability analysis indicate that there are no modules that really fit the essential indicators of the competence of high school Biology teachers yet. Most modules for teachers attached to the web-based learning platform currently tend to contain a basic summary of the material. In addition, previous research related to workbooks only discusses a small part of biological content. The available questions are not shown conformity with the indicators of the essence of high school teachers standardized by the Ministry of Education and Culture either. Therefore, the development of web-based teaching material such as "GoProfTeach" is very necessary. Following the analysis of resources availability, a mapping of web content is carried out based on the essential indicators of senior high school teachers. The results of the mapping can be seen in the following Table 1.

| Essential Indicators | Types of Web Content |
|----------------------|----------------------|
|                      | Question | Module | Virtual Lab |
| 1.1-1.6 TPK          | √        | √      |
| 1.7 TCK              | √        | √      |
| 1.8 CK               | √        | √      | √          |
| 1.9-1.14 TPACK       | √        | √      |

Overall, the results of the validated TPACK test show that the ability of the participants coming from 5 LPTKs in Riau province is in the low category, as shown in Figure 1 below. Figure 1 demonstrates that the test scores of students being sample in this study only classify as D or E. Students in University V were found to have the highest score (50.0) classified "D", while the lowest-performing group of students scored 24.6, classified "E". Numerous factors can be attributed to the low scores in the five LPTKs, including personal, institutional, technological availability, and professional development factors [10].

Figure 1. Results of TPACK test of pre-service Biology teachers

The data of TCK, TPK, and CK scores of the students in the five institutions:
Table 2. TPK, TCK, CK scores of pre-service Biology teachers

| Ability Score | University | V | W | X | Y |
|---------------|------------|---|---|---|---|
|               | B.Edu      | B.Sci | B.Edu | B.Edu | B. Edu |
| TPK           | 54.9       | 17.3  | 48.3  | 43.8  | 18.6  |
| TCK           | 33.6       | 21.7  | 26.5  | 27.7  | 19.0  |
| CK            | 47.1       | 28.7  | 39.6  | 37.0  | 26.3  |

The findings in Table 2 suggest the highest-performing students on the tests about technology and pedagogical aspects were those from Biology Education University V with the score 54.9. This score, however, is still classified low. On the contrary, the students of Biology FMIPA performed the worst in the tests with the score 17.3, which is tolerable given that the students did not learn pedagogic-related courses during undergraduate study. This result reinforces the need for web-based learning resources as an independent learning material for pre-service teachers from non-educational department. It is obvious from Table 2 that the average scores on the tests about technology and content aspects are in ‘very low’ category. Even students from Biology Education University V achieving the highest score among all samples only scored an average of 33.6.

Furthermore, from Table 2, it is also known that in general student Biological content knowledge is in the very low category with an E scale. This means that students have not been able to understand the biological content of various kinds of concepts correctly. Students generally can only answer the low to moderate criteria level thinking ability test.

The low scores of TPACK, TPK, TCK and CK tests from the pre-service teachers in Riau underlies the creation of a web-based learning resource called “GoProfTeach”. The resource is meant to form a helpful online learning material that can be accessed anywhere and anytime. The innovation is explained in the following sections.

3.2. Results of Design Stage
The name "GoProfTeach" is an acronym for ‘Go Professional Teachers”. This study was conducted in two stages. Firstly, the researchers registered a domain and a host address in Hostinger International, Ltd. Afterwards, the web display was designed by using Visual Studio Code software. The general view of the website can be seen in Figure 2 below:

![Figure 2. The initial design of GoProfTeach](image)

There are four main menus that serve as learning resources on the GoProfTeach website: Exercise Package, E-book, Useful Links, Audio visual lab (Virtual Lab).
The exercise package contains four sets of validated TPACK practice questions, and each set has a total of 80 questions with 5 answer choices. The exercise package was developed using the Plum model. Overall, the questions developed can already be used as a question exercise package because they have a reliability value of 0.963 which is classified as very reliable. In addition, expert validity showed that the questions were valid in terms of material, construction and language with a range of validity values ranging from 3.5-4.

The e-book listed on the website is a validated module and contains 4 sets of high school Biology SKG modules including:

- Module on the Nature of Biology Learning
- Module on the Application of Biotechnology in
- Module School Biology
- Module on the Utilization of Information Technology in the Development of Biology Learning Resources

Useful links contain helpful resources for teachers for developing teachers’ professionalism such as verified educational YouTube accounts which present animated learning videos learning animation and accredited journals.

This menu features a virtual lab that facilitates simulations in the development of psychomotor abilities of pre-service Biology teachers, even though they are not in the real laboratory. Figure 3 below shows the initial virtual lab design that was developed.

![Figure 3. Initial design of virtual lab](image)

3.3. Discussion

Based on the results of the availability of the resources analysis, it can be seen that this web-based learning resource needs to be developed given the unavailability of learning resources that can facilitate the improvement of the TPACK abilities of pre-service Biology teachers. Based on the results of the availability of the resources analysis, it can be seen that this web-based learning resource needs to be developed given the unavailability of learning resources that can facilitate the improvement of the TPACK abilities of pre-service Biology teachers. According to Hadjerrout [11] web-based learning resources are potentially good tools for improving teaching and learning in education. This web-based learning resource can serve users with a variety of interesting experiences that are not able in conventional classes. The research findings show that the TPACK score of pre-service Biology teachers is generally in the ‘very low’ category. A number of factors underlie these results, one of which is the unavailability of supporting instruments to develop teachers’ professionalism. [10] suggests several factors which contribute to teachers’ low TPACK scores; Professional Development Factors, Personal Factor and The Availability of Technology Factor.

This factor refers to the design of teacher training including the incorporation principal of learning, sequence of training material and relevance between job and training content [10,12]. The satisfaction level with the knowledge, skills and abilities developed in professional development programs has a strong influence on the interest of teachers to innovate while teaching [13]. For professional
development programs to be successful, teachers need to be involved in determining their own needs in learning and participate in school-based learning opportunities, contently supported, given as much information as possible, and facilitated to comprehend theoretical grounds and solve problems collaboratively [14,15,16]. Kafyulilo suggests that the continued use of technology by teachers in learning depends largely on how the professional development trainings are developed [10]. Teachers who regularly receive training are likely to continue employing technology to improve the quality of their teaching. Furthermore, the provision of integrated teacher professional development trainings will have a noticeable impact on the teaching quality and materials produced by the teachers [17]. In other words, those following integrated trainings performed better teaching than those provided separate development trainings. GoProfTeach is expected to provide integrated training for in-service and pre-service teachers in developing their professionalism.

Personal factors from individual teachers are the cause of the different levels of abilities in using technology. These factors include the knowledge, belief, previous skills and availability of learning time as well as teachers’ habit in using technology in teaching. If the teachers’ first time use the technology in working aligns with their experience and believes about the learning process, they will build confidence and be involved in using technology [18]. Based on Kafyulilo [10] that examines the relationship between the use of technology and personal motivations, teachers who did not integrate technology in their learning reasoned that they were not accustomed to using it and assumed their ability to utilize it was increasingly lost due to a long time of disengagement. Another study found that despite the provision of adequate technology, significant differences in the ability to use technology remained [19]. This is arguably attributed to the level of encouragement and motivation in integrating technology during the teaching process that differ among teachers.

Limited technological resources are one of the major hindrances to integration of technology in schools. In addition, environmental factors such as the availability of electricity and classrooms also determine whether teachers can successfully adopt technology into classroom [18]. GoProfTeach is e-learning with an outward system in the form of Massive Open Online Course (MOOCs) which is meant to expand access to learning. MOOC is an open, large-scale learning system with the aim of allowing unlimited participation accessible through the internet [19]. Online learning is an approach to learning that continues to grow with the evolution of technology. This approach provides free learning material on the internet for interested parties [20]. The MOOCs e-learning website provides convenience in terms of time and place, as well as quality contents provided by various well-known higher educational institutions that partner with MOOC service providers [21]. This web-based learning platform also offers varied contents, ranging from electronic books (e-books), learning videos, podcasts, to the use of interactive multimedia, and it has been proven to improve students’ mastery over a particular subject of study. The e-learning of physics using moodle software, for example, managed to improve critical thinking skills [22]. The GoProfTeach website developed contains four kinds of learning resources that are expected to improve the TPACK ability of pre-service teachers including the exercise package, modules, virtual lab, and useful links. The selection of these four learning resources is based on further studies on the improvement in learning outcomes from several research findings.

The practice package is one of the tools that serve as a diagnostic achievement in learning that has been done. This means that by working on evaluation questions, someone will know which part of the weaknesses they have so that in the future these weaknesses can continue to be improved [23]. This is expected to cause an increase in learning outcomes. Several previous studies have shown that giving practice questions can help improve student learning outcomes. A study conducted by Astuti [24] notes that the provision of authentic practice questions can improve learning outcomes. Research conducted by Dharmawati [25] revealed that the provision of written assessments in the form of multiple-choice tests and essays can improve students’ critical thinking skills. Modules added with the aim can be used as independent learning materials in understanding learning concepts. Besides, the module developed contains content that is following essential indicators so that users can focus more deeply on what they should, it is further expected to be able to improve the ability of TPACK prospective biology teachers. Also, the provision of modules is expected to increase user motivation in learning because the modules developed contain deeper and wider material. According to the statement Muldhofir [26] which states that the provision of modules can increase student motivation. This is also supported by research conducted by Setiidi [27] received positive responses from students and teachers. The students’ positive response to the learning module is due to clear instructions for using the learning module so that they are able to do the learning independently. The availability of the
instructions also enables them to clearly understand the procedures on the activity sheet as it is supported by clear language and instructions. The modules developed on this website also pay attention to the characteristics of the modules which consist of; self-instruction, self-contained, stand alone, adaptive, and user-friendly. The addition of useful links aims to make it easier for users to explore deeper and wider material that they want to master. As revealed by Suryawati [28], the addition of supporting sites in the book will make it easier for users to utilize information technology directly to have broader conceptual knowledge, to be able to know the problems that occur in the everyday environment.

The virtual lab can be used as one solution to answer challenges related to the procurement of lab facilities that have not been evenly distributed. In addition, there are studies which reveal that virtual labs can improve students' problem-solving skills and scientific literacy. Gunawan [29] shown that the use of virtual labs can improve students' abilities in problem-solving. In addition, research conducted by Ismail [30] found that virtual labs can increase students' science literacy. Therefore, it is hoped that this designed "GoProfTeach" learning resource will later be able to improve the TPACK ability of preservice biology teachers in high schools.

4. Conclusion
Findings from the analysis of the availability of resources and the TPACK ability of pre-service Biology teachers indicate there is a need for the development of web-based teaching materials that contain modules, practice questions, and virtual labs. Therefore, further research is needed regarding the means to improve TPACK abilities by developing a GoProfTeach web-based learning resource as introduced in this study.

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