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To cite this article: S Sukaesih *et al* 2019 *J. Phys.: Conf. Ser.* **1321** 032114

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Development of biology teaching management textbooks based on competency and conservation to maximize Pedagogical and Content Knowledge (PCK) the prospective teachers

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Abstract. The objectives of this research are: (1) to examine the feasibility of competences and conservation-based textbook of Biology teaching management, (2) to test the effectiveness of the developed textbooks in the small and large-scale test. This study is an Educational Research and Development (R & D) following the stages of potential and problems analysis, data collection, product design, product validation, trial usage, product revision, and mass production. The results of the feasibility assessment of the product by the expert, the textbook have content the very feasible criteria (77,88), and media experts gave very feasible criteria (83,35). In the small-scale test, the students responded that the book had met the criteria of excellent legibility, on 14 indicators of product legibility with an average legibility value of 90,07. The textbook legibility is excellent since the sentence is understandable and communicative, has illustration adequacy, easy to use, relevant to the competences achievement, as well as there is the integration of conservation character values and TPACK description. The large-scale test showed that the application of the developed textbook was effective in maximizing the ability of prospective teachers' PCK. It is found that competences and conservation-based Biology Teaching Management textbook are very feasible and powerful to maximize the PCK of prospective biology teachers.

1. Introduction

The study program curriculum needs to be compiled and adapted to the demands for the development of higher education goals. Learning devices in each course need to be adjusted. Biology Teaching Management (PP Bio) is a course in Biology Education Study Program. The achievement of this course learning is that students are expected to understand and be able to design the development of a biology learning system by utilizing media, libraries, and other learning resources in the form of Learning Implementation Plan of a biology course according to the curriculum that applies in secondary schools. PP Bio lectures provide basic provision to prospective teachers about how to design and implement effective learning. It is important for students to be trained problem solving skills, and students of pre service teacher are needed to face assignments and challenges in the working world [1]. As the agent of change teachers should continue to train prospective teachers in designing learning ability, one with understanding the PCK. PCK is an important knowledge in the process of developing teachers ability to transform knowledge into the learning process [2].

Teachers need to have teacher competencies, including pedagogical and professional competencies in teaching. Analyses of the data generated in final interviews, unit plans, and reflections that



participants wrote after completing the professional development course and testing the planning strategy in their classrooms yielded differences in several aspects of their instructional planning practices when compared with prior experiences and works [3]. In addition to competency in teaching, teachers must also have mastery of learning material well. The results of the study indicate that one of the possible factors to improve teachers can enrich PCK, which is a special blend of content knowledge and pedagogical knowledge built from time to time and experience, resulting in professional teachers [4]. Based on the observation results of students' teaching practice, there were several problems that were still faced by prospective teachers such as mastery of science material/concepts which is not yet deep, there were still misconceptions in formulating teaching materials, and prospective teachers had not been able to relate the material to the development of science and technology and life context. The next problem is that prospective teacher are still weak in understanding the curriculum and designing learning according to the demands of the 2013 curriculum. This indicates that the PCK capability of the UNNES Biology teacher candidates still needs to be maximized. The course PP Bio does not yet have a systematic textbook that can be used as a guide for students in understanding biology planning and learning, so teaching books need to be developed to support the learning process of students.

The results of PCK teacher candidate analysis are used as a basis for developing competency and conservation PP Bio teaching textbooks. Book development is seen as a solution/innovation alternative because of the unavailability of systematic and detailed learning resources to achieve learning goals. Competency-based learning and conservation are alternative strategies so that students can master science knowledge comprehensively and master pedagogical competencies well. The use of competency-based microteaching textbooks and conservation characters can develop the personal and professional competencies of prospective teachers [5]. Therefore, it is expected that through the development of competency and conservation PP Bio teaching textbooks, it can also maximize the pedagogical content knowledge (PCK) capabilities of biology teacher candidates.

This research is important and urgent because: (1) the UNNES curriculum develops into a Competency and Conservation Based Curriculum, so learning tools need to be adjusted; (2) there are no textbooks available for PP Bio course according to curriculum expectations; (3) it needs strategies and facilities so that prospective teacher students can maximize mastery of science knowledge and pedagogical knowledge in full version, so that prospective teachers have good PCK skills.

The purpose of this study was (1) to analyze the feasibility of competency and conservation-based PP Bio teaching books; (2) to describe the effectiveness of the application of books in PP Bio lectures to maximize the Pedagogical Content Knowledge (PCK) of Biology teacher candidates.

2. Methods

This research includes development research (Research and Development), ADDIE Models (Analyze, Design, Development, Implementation, Evaluate) [6]. Product validation was carried out by media experts and Biology Education material experts and Science Education experts. Small-scale product testing was carried out in one class consisting of 25 students. Small-scale test aims to obtain data about the readability of the product. Large-scale product testing was carried out on the PP Bio Course consisting of two classes. Large-scale tests are conducted to analyze the effectiveness of the product. Product effectiveness indicators, namely: if the results of the development of PP Bio-based teaching book products based on competency and conservation can maximize the ability of PCK of biology teacher candidates. Based on the results of small-scale product testing and large-scale testing, product repairs and improvements are carried out.

The development research data in the form of product feasibility were analyzed descriptively and qualitatively, while the product effectiveness test results were analyzed quantitatively and descriptively. Descriptive analysis was carried out on the data obtained during the formative test process; in the process of developing PP Bio-based teaching books on competency and conservation, while the quantitative test was carried out on summative test data, namely in testing the effectiveness of PP Bio books on PCK of the prospective teacher. PCK data of the teacher candidate is taken by analyzing Content Representation (Co-Re) and PaPeR (Pedagogical and Professional-experience Repertoire). PCK as a dependent variable

from research is an indicator to test the effectiveness of products. To date, no such study has specifically explored and reported on the specific and individual views of practising science teachers on the use of CoRes and PaP-eRs; and how they believe it might have influenced their practice [7].

3. Results and Discussion

In this study, the development of competency and conservation-based PP Bio teaching books was carried out. Product validation is carried out by learning media experts and material experts. The results of the media and material expert validation are presented in Table 1.

Table 1. Validation results of the feasibility of PP bio books

No	Validation	Assessment Aspect	Assessment Results	Criteria
1	Expert 1	Material (content)	84,61	Very Feasible
		Media (graphics)	80,00	Very Feasible
2	Expert 2	Material (content)	71,15	Feasible
		Media (graphics)	86,67	Very Feasible
	Mean P1 and P2	Material Aspects	77,88	Very Feasible
	Mean P1 and P2	Material Aspects	83,35	Very Feasible

Table 2. Expert's advice on improvements for material aspects

No	Component	Advice	Revision
1	Competence Formulation	Competencies formulated to meet high-level thinking achievement (planning, designing, creating)	Add/improve competency formula
2	Reference/reference source	Use new and up-to-date reference sources	Add new reference sources
3	Questions/questions in practice	Questions still measure low-level abilities, so questions can be made to measure high-level thinking skills.	Fix questions or questions in the training section
4	Attachment of the Lesson Plan	Adjust the lesson plan format, and check the formulation of learning objectives.	Revising Lesson Plan
5	TPACK Formulation	TPACK aspects should be illustrated in the material described in each chapter	Create TPACK formulas for each chapter description
6	Paparan material	There are still many theories, need to be added with more operational examples	Add with examples to make it easier to understand

Table 1 shows that competency and conservation-based PP Bio textbooks meet the criteria 'very feasible' according to the material expert validator and instructional media expert. Feasibility of material aspects with a value of 77.88, while the media aspect is 83.35. The expert validation test results obtained suggestions for product improvement. Suggestions and responses from material and media experts are presented in Table 2 and Table 3.

In the material aspect, the validator suggested improvements to several components, namely in the formulation of competencies, reference/reference sources used, questions or questions in the exercise, completing the RPP attachments, sharpening the TPACK formula, and adding examples to the material presented. Expert advice and responses are used as a basis for improving the product developed. Table 3 presents expert suggestions and improvements on aspects of the media.

Table 3. Expert's advice on improvements for media aspects

No	Component	Suggestion	Revision
1	Writing Technique of Table Number	The writing technique of table and figure number should be consistent	The writing technique of table and figure number has been consistent
2	Title of the course	Using the term " learning," not the term " teacing	Adapting the terms used in the department curriculum
3	Adding visual/figures	Add examples of learning media images Adding theG	Using the term "learning", not the term "teaching"

Improvements to the media aspects according to experts, the component of writing table-numbers must be consistent, rechecking the name of the course by looking at the Study Program Curriculum and adding images or visuals as examples to clarify information. Advice from experts has been accommodated and used as a basis for product improvement. The product improvement results in the feasibility test are used as the initial draft; then a small scale test will be carried out.

In this study, a small-scale product test was conducted on 25 students taking the PP Bio Course. A small scale test is conducted to assess the product, and the readability of the product developed. The following are the small-scale test results presented in Table 4.

Table 4. Results of product assessment in small scale tests

No	Aspects	Score
1.	The textbook cover design	86
2.	The overall textbook design	86
3.	The sentences are easy to understand and communicative	94
4.	The truth and the accuracy of the terms used	90
5.	The sentence does not cause double meaning	92
6.	The selection of font type and size	89
7.	The adequacy of images or illustrations to clarify information	84
8.	The ease of use	92
9.	The relevance of media (textbooks) with the material studied	92
10.	The relevance of the material presented with the achievement of learning objectives	95
11.	Textbooks are a source of learning for competency achievement in PP Bio course	93
12.	Textbooks provide innovative ideas for students in teaching	88
13.	The Integration between conservation character values	91
14.	Textbooks are a guide/guideline for students to design effective learning	89
	Mean	90,07

Students give positive responses to the developed textbooks, among others the PP Bio book helps students in completing assignments, facilitates students to achieve learning goals, helps the lecture process, and the contents of the book are very inspiring because students can understand how to teach and how to do learning. Suggestions for improvement are also delivered, among others, improvements to the cover design, adding illustrations used, reinforcing conservation values in each chapter, and adding applicable examples. Suggestions conveyed by students are the basis for consideration for product revisions.

Textbooks have very good readability based on the assessment of small-scale tests. Then the product effectiveness test is carried out. Based on the effectiveness test, the application of the PP Bio textbook to the ability of the PCK of teacher shows the following results:

1. Prospective teachers can make a plan for implementing learning (RPP) properly and can apply in teaching practice (microteaching).
2. In the teacher content representation, the teacher can formulate 2-5 big ideas for developing teaching material; prospective teachers are also able to identify difficulties experienced and determine efforts to overcome existing limitations.
3. Prospective teachers can choose teaching methods/techniques by applying the principles of active learning and using technology in learning.
4. Prospective teachers can realize their learning plan well, which can be identified through the Pedagogical and Professional-experience Representation (PaP-eR) sheet.

Competency and Conservation-Based PP Bio Textbooks are effective in maximizing the ability of PCK of prospective teacher because these products have the following characteristics and advantages namely: contain competencies, and integrate conservation character values; affirm the purpose of TPACK on each topic specifically; contain assignments and exercises to strengthen the prospective teacher's TPACK; attach operationally examples of learning devices that are close to ideal; use attractive features, with consistent subtitles; use language and easy-to-understand sentences; provide adequacy of illustrations to strengthen information.

Textbooks are developed based on competency and conservation, so the strategies in the learning process also refer to innovative learning strategies with a transformation approach. Students are given the opportunity to reflect critically by making a reflection journal. Students get the opportunity to express their ideas and creativity to develop their work in designing effective learning and developing high-level thinking skills. The application of innovative learning approaches and models can develop students' thinking skills and process skills. One application of the model in learning that can improve thinking skills is the application of the Conceptual Understanding Procedures (CUPs) model. CUPs learning model should be done step by step, and it automatically leads students to participate actively in the learning process. The first step is to make students work individually, so they require stating an opinion before they work in a group. Every task given in every step is similar, and students have to come out with an answer. Students insisted on thinking critically over and over again in one phase by using CUPs learning model so that they will get used to think critically and improve their critical thinking skills [8].

PP Bio teaching materials are a set of materials systematically arranged to create an environment or atmosphere that allows students to learn to understand material, solve problems, and complete project assignments given by lecturers. Textbooks can be a guide for students to answer and solve problems. The results of previous studies also reinforce the results of this study. The results of the development of Calculus Model textbooks supported by "GeoGebra" can improve mathematical problem-solving abilities and mathematical representations. The role of mathematical representation is important in learning mathematics because it can be a means for students to solve problems [9].

The PP Bio book was developed to maximize the content and pedagogical knowledge of prospective teachers. The textbook covers the scope of specific material according to the learning objectives, and learning outcomes contained in the Semester Learning Plan (RPS). Teachers' pedagogical abilities can develop because textbooks provide operational examples in developing learning devices. Research that applies "Asynchronous e-learning" can be used to improve pedagogical competencies in direct learning applied in the classroom. Direct learning provides reviews, explanations, schemes, and examples that can be used by students to select relevant resources on the e-learning portal. Pedagogical competence increases after students complete the task of identifying pedagogical aspects both from analyzing videos in e-learning courses or simulations in the classroom with direct feedback [10]. In PP Bio class, students are encouraged to work through a series of individual project-based work. Projects carried out by students are in the form of activities in creating or developing learning designs and objectives, teaching materials, learning media, lesson plans, and learning outcomes of assessment instruments. The product

of the work of each student will be a portfolio for students. Project-based learning makes acquired knowledge more meaningful and can develop students' critical and creative thinking skills. Relevant research also states that project-based learning using e-portfolios can improve analytical, evaluation and creating skills. Project-based learning using e-portfolio has a positive impact on the ability of students to analyze with moderate N-Gain (0.67), evaluate with moderate N-Gain (0.51), and create with moderate N-Gain (0.44) [11].

The results of the development of competency and conservation-based PP Bio textbooks are expected to contribute positively to the improvement of the learning process in the PP Bio Course and to increase the competency of prospective teachers. Textbooks can also be used more widely as reference books for teachers and readers to add insight and strengthen teacher competencies, both personal, social, professional, and pedagogical competencies.

4. Conclusion

The conclusions of this research are:

1. Competency and conservation-based textbooks of PP Bio course meet the criteria that are very feasible for material aspects with a value of 77.88 and are very feasible for the media aspect with a value of 83.35.
2. Competency and conservation-based textbooks of PP Bio to maximize Pedagogical and Content Knowledge (PCK) capabilities.

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