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Developing Electrical Magnetic Textbook Based On Technological Pedagogical Content Knowledge (TPCK)

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Abstract – Electrical magnetic is a compulsory subject in the physics education program. One of the learning outcomes and graduates in the curriculum is to be able to analyze subject matter (pedagogical content knowledge). Researcher's observations during giving lectures on magnetic electricity showed that students paid less attention to the importance of understanding on the relationship between learning outcomes and teaching material during lectures. Thus, this phenomenon is appointed as one of the lecture evaluations in the study program. The lecture's evaluation results in a recommendation to develop textbooks that are adjusted in learning outcomes and graduates that refer to the curriculum of the physics education program. It is not enough to stop here, the problem findings continue for online learning related to Work From Home policies during the pandemic. This of course requires the availability of references that can be open accessed. Hence, the researchers then attempted to develop electrical magnetic textbook based on PCK (pedagogical content knowledge) which contained material content and material content analysis according to learning outcomes and graduates in the curriculum of the Physics Education. This study aims to : (1) determine the feasibility of electrical magnetic textbook based on PCK according to experts. (2) determine the responses of students after using electrical magnetic textbook based on PCK. The research method uses research and development design by gathering information stages and references, designing, developing, product, validating, and revising the product. The research was conducted in 2020 in the physics education study program IKIP PGRI Pontianak. Data collection techniques are in the form of indirect communication techniques. Overall, electrical magnetic textbook based on PCK have been produced. The validation results show that textbooks have an average validation score of 77.77% with Eligible criteria. The students' responses analysis show that textbooks developed have an average score of 78.52% with high criteria. After the revision, the textbook was presented with an online ISBN and open access on the online media.

Keywords: Development, Electrical magnetic, Textbook, TPCK,

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I. INTRODUCTION

Physics is a subject in the science family that can be developed inductively and deductively using analytical thinking skills in solving problems related to natural events both

qualitative and quantitative; it also can develop knowledge, skills and self-confidence. Electrical magnetic is a compulsory subject in the physics education study program curriculum at IKIP PGRI Pontianak. Learning

outcomes and graduates in the curriculum including being able to analyze subject matter (pedagogical content knowledge (PCK) in learning physics.

There is a need of this text book to be developed based on the preliminary observations conducted by the researcher. The researcher's observations during giving lectures on Electrical magnetic showed that students had not realized the importance of learning achievement targets in lectures so that learning outcomes were not optimal. This could be due to the absence of teaching materials that are integrated with learning outcomes according to the curriculum in the study program. If it is allowed to continue, it is feared to have an impact in the form of a decrease in lecture's learning outcomes. The results of the lecture evaluation provided a recommendations for developing textbooks according to the curriculum and adjusted to learning outcomes and graduates. The other problem that cannot be avoided is that recently learning is colored by online learning related to work from home during the pandemic. This of course requires the availability of appropriate references that can be open accessed. This is because the technology used in Indonesia is growing rapidly in all aspects of society. for example, the increasing use of social media activities and website (Das et al., 2016; McKemish et al., 2017; Poushter et al., 2018; Rizal et al., 2020).

There is a close relationship between the quality of textbooks with an understanding of

the nature of science, such as empirical, method, theoretical, creative, social and cultural dimensions (Ramnarain & Chanetsa, 2016). The teachers' ability to integrate technology determines how technology affects the learning environment (Valtonen et al., 2018; Sulisworo et al., 2019). Hence, researchers interested in developing Electrical magnetic textbooks based on the learning achievements and graduates contained in the 2019 curriculum revision document at the IKIP PGRI Pontianak physics education study program. Learning outcomes and graduates in this case are able to analyze subject matter (pedagogical content knowledge). Textbooks are handbooks for a course written and compiled by experts in related fields and meet the rules of textbooks and are officially published and distributed (Giyatmi, 2016). The textbook conducted to fulfill some specifications: it contains teaching material substance based on learning outcomes and graduates, it also presented systematically to achieve learning objectives, has an ISBN, at least 40 (forty) printed pages (according to UNESCO format), Size: standard, 15 x 23 cm, published by the publisher of the Scientific Agency / Organization / Higher Education, fulfills the rules of the textbook and the contents do not deviate from the philosophy of Pancasila and the 1945 Constitution.

Research and development aims to produce a new product or develop an old product to be better, complete, and effective. Similar research that has been conducted in the

form of development research in the field of physics education, has obtained results with good to very good criteria. (Sumarli et al., 2017; Boisandi & Anita, 2017; Rosdianto, 2018; Laos & Meti, 2020). Thus research and development is effective in producing a new product or developing an old product for the better.

Based on problem's finding and research urgency, the research aims to : (1) determine the feasibility of the PCK based on Magnetism Textbook according to the expert. And (2) determine the responses of student after using electrical magnetic textbook based on PCK.

Science education, especially physics, should involve technology, coordinate innovation in learning settings in schools, and accelerate technological innovation (Sotiriou et al., 2016). The technological pedagogical content knowledge (TPCK) in this research, the textbook based of PCK and integrated on ICT (Information communication and technology) literacy. Because of the PCK component have pedagogical and professional competence related to content mastery (Rehmat & Bailey, 2014; Yeh et al., 2015; Nofrion et al., 2018). PCK is also a potential indicator of the quality of learning. PCK will continue to develop in accordance with the teacher's teaching experience (Anwar et al., 2014; Widodo, 2017; Nasar et al., 2020). The textbooks then presented with online ISBN and open access olthrough online media.

Finally, the textbook produced is expected to be feasible according to validators from experts and can contribute as a complement to learning references on the electrical magnetic in physics education program of IKIP PGRI Pontianak. Hopefully it can be used by lecturers in IKIP PGRI Pontianak.

II. METHODS

The research was carried out in the academic year of 2020/2021 in the physics education study program of the Teacher Training and Education Institute (IKIP) PGRI Pontianak, West Kalimantan.

A. *Research and Development Design*

This study refers to the research and development design of (Bord & Gall, 1983) as presented in Figure 1.1. The electrical magnetic textbook based on PCK in this study is a magnetic electricity textbook that can constructed based on the concept of electrical magnetic through the analysis of material content relevant to learning outcomes according to the curriculum in the 2019 IKIP PGRI physics education study program. The development in Figure 1.1 is limited to the validation stage of material experts and media experts to produce electrical magnetic textbook based on PCK.

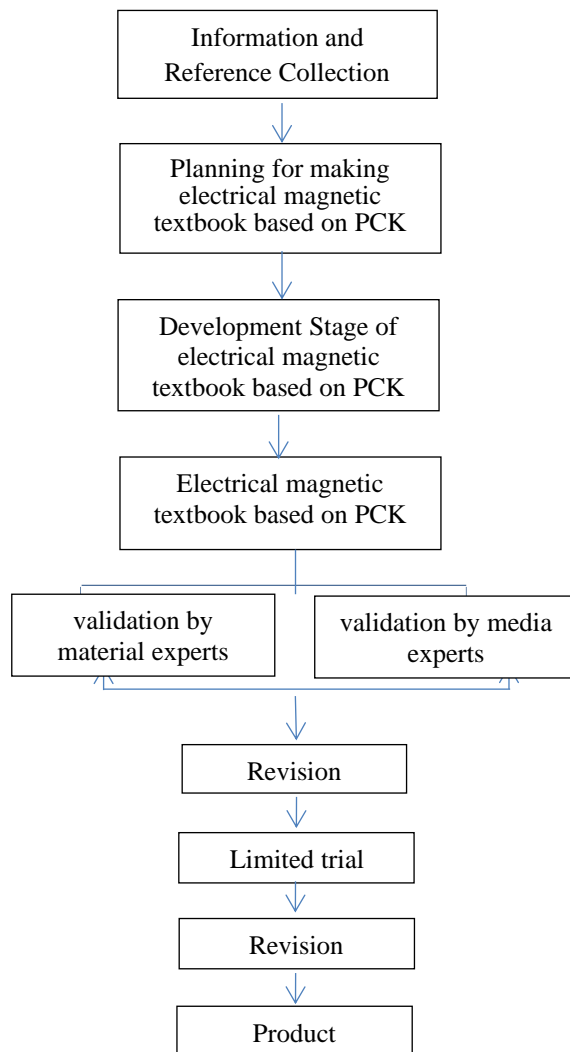


Figure 1. Research Design and Develop stages

The Research and Development Design from Figure 1.1 is described as follows:

1. Information and Reference Collection

At the stage of gathering information and references, it is done by analyzing problems, evaluating the results of magnetic electrification lectures, and recommending evaluation results after the lecturing process.

2. Planning for making electrical magnetic textbook based on PCK

Planning refers to the revision of the 2019 IKIP PGRI Pontianak physics education study program curriculum. At this stage, the

electrical magnetic textbook was planned based on PCK equipped with lecture learning outcomes, course relationship matrices and learning outcomes, as well as a syllabus for electrical magnetic courses.

3. Development Stage of electrical magnetic textbook based on PCK

At this stage, it covers the development of the electrical magnetic textbook based on PCK framework that was designed in the previous stage.

4. Electrical magnetic textbook based on PCK products are produced to be validated by experts.

5. Validation by experts

At this stage, validation is carried out by experts, namely validation by material experts and media experts.

6. Revision

Revisions were made after validation by a team of media experts and material experts.

7. The Limited trial

The textbook magnetic electricity based on PCK tested on 21 student of the physics education on the IKIP PGRI Pontianak.

8. Revision

The revisions was carried out after a limited trial.

9. Products

After the revision was made, an electrical magnetic textbook based on PCK was obtained. After the revision, this textbook was obtain an online ISBN and open access on the online media.

B. Data collection techniques and research instruments

The data collection technique used in this research is indirect communication techniques.

1. The data collection tools used were material expert validation questionnaires and media experts were used to collect experts' validation data related to the textbooks being developed.
2. The questionnaire of students' responses to the textbooks magnetic electricity based to PCK.

C. Data analysis technique

To answer the feasibility of an electrical magnetic textbook based on PCK by assessing media experts and material experts, the data were analyzed descriptively using the percentage feasibility technique using Equation (1).

$$K = \frac{F}{NIR} \times 100\% \quad (1)$$

Where K is the percentage of eligibility, F is the total number of respondents' answers, N is the highest score in the questionnaire, I is the number of questions in the questionnaire, and R is the number of respondents. The calculation results was then concluded by using the eligibility criteria based on Table 1.

Tabel 1. Validator's assessment interpretation criteria

Percent	Criteria
0 %- 20%	Not eligible
21%-40%	Less eligible
41%-60%	Enough
61%-80%	Eligible
81%-100%	Very eligible

(David & Cholik in Riduwan, 2014)

To analyze the students' response after using electrical magnetic textbook based on PCK, Equation (2) was used:

$$\%X_{in} = \frac{\sum S}{S_{max}} \times 100\% \quad (2)$$

where $\%X_{in}$ is the percentage of questionnaire, $\sum S$ k is the total score of respondent's answers, and S_{max} is the maximum number of score. The data is then concluded based on Table 2 below:

Table 2. Criteria response

Percent	Criteria
80,1 - 100	Very high
60,1 – 80	High
40,1 – 60	Enough
20,1 – 40	Low
0,0 – 20	Very low

III. RESULTS AND DISCUSSION

The result of the research that is going to be presented is the development stage of a PCK based on electrical magnetic textbook using Bord and Gall's research and development design. The stages in this development research consist of information collection and reference, and planning for Textbook Making, Textbook development, products, validation, and products in the form of electrical magnetic textbook based on PCK. The details of research activities for each stage of the model development are described as follows.

A. Information and reference collection

The stages of collecting information and references include problems analysis encountered during lecturing session,

evaluation results of magnetic electrification lectures, and recommendations for evaluation results after lecturing as described in the predecessor section, it is necessary to make teaching materials that are integrated with learning outcomes containing the learning outcomes of the study program (CPPs) mapping CPPs with the Constitutional Court, and course syllabus. At this stage, identification of things that are needed in the development of textbooks as well as the identification of the identity of the course were carried out. Magnetic electricity is one of the compulsory courses in semester 5. This course is included in the category of expertise courses (MKK) with the course code MKK 221519 with a weight of 3 credits.

After identifying the subject identities, the identification of the course indicators to be achieved was conducted. Referring to the learning outcomes according to the KKNi curriculum revision in the 2019 IKIP PGRI Pontianak physics education program, after attending lectures, it is hoped that students will be able to master concepts (P1) and special skills (KK) explained as follows: Mastering theoretical concepts of classical physics, modern, and applied physics in general; (KK1) able to make physics learning tools, analyze subject matter (pedagogical content knowledge), make assessment of learning processes and outcomes, carry out and evaluate secondary school physics learning, and use laboratories for learning Physics independently using scientific principles and

instructional design principles, scientific approaches, utilize science and technology, and the natural environment in accordance with the applicable curriculum, material characteristics and characteristics of students in order to be able to develop scientific thinking skills and attitudes. After determining the learning objectives, the next stage of the analysis is to identify the needs of the reference to support the design of magnetic electricity textbooks.

B. Planning for Making electrical magnetic textbook based on PCK

The design stages in this study were carried out to design the textbook framework to be compiled. Electrical magnetic textbooks are prepared based on PCK. Planning and designing the textbook design refers to the 2019 IKIP PGRI Pontianak physics education study program curriculum revision. At this stage, the electrical magnetic textbook based on PCK is integrated with course learning outcomes, subject relationship matrices and learning outcomes, as well as the syllabus for electrical magnetic courses.

The relationship between content (subject matter that must be studied and taught) and pedagogy (processes and practices or teaching and learning methods) is complex. Thus it may not be appropriate to view pedagogical knowledge and content as separate parts (Mishra & Koehler, 2006). Thus the design of textbook designs includes: cover page, foreword, table of contents, chapter 1 contains an introduction, chapter 2 coulomb law,

chapter 3 electric field, chapter 4 electric potential, chapter 5 capacitor, chapter 6 magnetism, bibliography, glossary, book index, appendix 1 contains CPPs (study program learning outcomes), appendix 2 contains cpps relationship matrices with courses, appendix 3 contains electromagnetic lecturing syllabus.

C. *Development and Product stage electrical magnetic textbook based on PCK*

At this stage, it covers the development activities of the electrical magnetic textbook based on PCK framework that has been designed to produce a product. The textbook conducted to fulfill some specifications: it contains material substance according to learning outcomes and graduates, it is presented systematically to achieve learning objectives, at least 181 (one hundred and eighty one) printed pages thick (including cover page), standard size, 15 x 23 cm, comply with the rules of textbooks and the contents do not deviate from the philosophy of Pancasila and the 1945 Constitution. Products that have been produced during the development stage are then tested for validity.

D. *Validation by experts*

At this stage, validation is carried out by experts, namely validation by two material experts and two media experts. Validity is done using a validity sheet. The assessment score of the validation of the electrical magnetic textbook based on PCK for each

aspect of each component uses the percentage feasibility technique using Equation (1.1).

Based on Figure 2, the results of the validation for each component are described as follows: The results of validity show that the feasibility component of the material coverage aspect has a validity score of 80%, 80% material accuracy, 70% relevance, 76.67% presentation, 80% grammar, and validation of media experts includes a validity component of 80%.

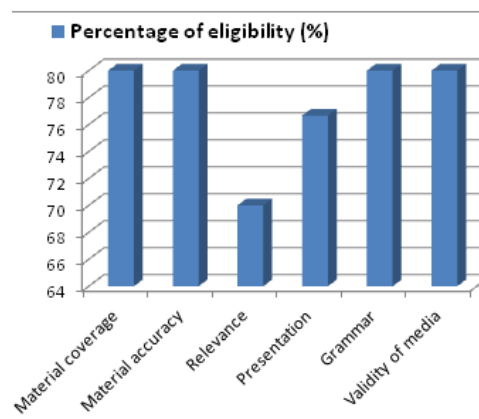


Figure 2. Percentage of eligibility (%)

The criticisms and suggestions given by experts are as follows: the textbook should be completed with SK and KD and contextual learning. The general conclusion from the validation results is that Electrical magnetic textbooks are prepared based on PCK and it can be used with revisions.

E. *The limited trial*

Trials were conducted on 21 students of the physics education IKIP PGRI Pontianak. Based on the results of limited trials, it is known that the magnetic electricity textbook based on PCK is eligible. Based on Figure 1.3, average response in all aspects is 78.52% with

high criteria. Then results of the response for each aspect are as follows: quality of content is 75.79% (high category), happiness is 81.35% (high category), evaluation is 77.38% (high category), validity is 78.96% (high category), and motivation is 79,16% (high category).

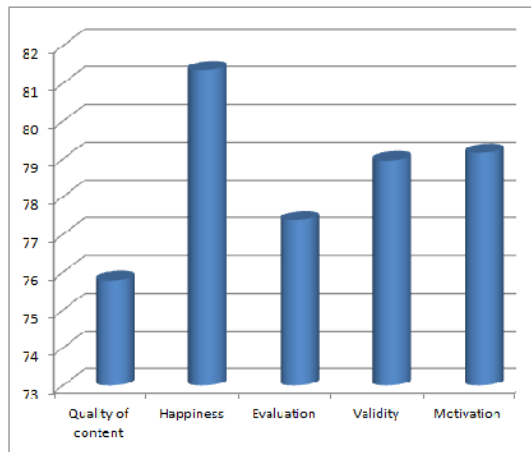


Figure 3. The eligible percentage student response

The limited trial results showed that there were no problems or questions related to the content of textbooks which deemed unclear by students. Thus, nothing was revised after testing.

F. Revision

Revisions were made after validation by a team of media experts and material experts. Overall there is no urgent part that must be revised, as for the validator's suggestions regarding the addition of standard competency (SK) and basic competency (KD) sections have been added to the textbook attachments, that is in the form of a learning syllabus. The syllabus contains CPPs and mapping CPPs with the courses on study program.

G. Products

After the revision was carried out, an electrical magnetic textbook based on PCK was obtained. TPACK is an integration of teaching materials, pedagogy and technology in the teaching and learning process (Mishra & Koehler, 2006; Swallow & Olofson, 2017). Technology has an important and positive role if it is well managed in science learning (Gupta & Fisher, 2012; Rehmet & Bailey, 2014). Paired components from TPACK are then presented in this study in "Developing Electrical Magnetic Textbook Based On TPACK". The textbooks which in fact can increase interaction between individuals directly, have an impact on the establishment of good communication between students through learning. Cooperation among students has also increased (Getuno et al., 2015; Deng et al., 2017; Akturk & Ozturk, 2019).

The final version of the textbook designs includes: cover page, foreword, table of contents, chapter 1 containing an introduction that consists of CPPs relationship and teaching material all chapter, chapter 2 Coulomb Law, chapter 3 Electric Field, chapter 4 Electric Potential, chapter 5 Capacitor, chapter 6 Magnetism, bibliography, glossary, book index, appendix 1 containing CPPs (study program learning outcomes), appendix 2 containing cpps relationship matrices with courses, appendix 3 contains electromagnetic lecturing syllabus.



Figure 4. The textbook cover

The textbook is completed with some specifications: it contains material substances according to learning outcomes and graduates, it is presented systematically to achieve learning objectives, has an online ISBN (registered with online ISBN number: 978-623-94667-2-5 (PDF)), book thickness 181 (one hundred eighty-one) printed pages (including cover pages), standard size, 15 x 23 cm, published by scientific / organizational / tertiary institutions that are registered with the IKAPI members of the Indonesian publisher association (No. 015 / Extraordinary Members / KLB/ 2018), comply with textbook principles and the content does not deviate from the philosophy of Pancasila and the 1945 Constitution. At final stage, the textbooks that have been produced received an online ISBN and open access, appeared on this research as TPCK.

H. Research of limitations

There are limitations to the development of magnetic electricity textbooks based on

PCK in the research that has been carried out, is : The Borg and Gall development steps used should be up to the mass product manufacturing stage due to time and cost limitations, yet the researcher only carries out this research and development until the limitation trial stage, so that the research only applies to limited research subjects, namely students of the physics education IKIP PGRI Pontianak.

IV. CONCLUSION AND SUGGESTION

A. Conclusion

The electrical magnetic textbook based on PCK was produced through the research and development design stage. Based on the results of data analysis that has been conducted, the validation results was an average of 77.77% or it has met the eligible criteria. The students' responses on the electrical magnetic textbook based on PCK reached 78.52% (high criteria).

B. Suggestion

Follow-up research is needed. The follow-up research that is meant to do is wider trial and mass product manufacturing stage research from the results of the development of textbooks that have been made.

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