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Minimizing Misconceptions: Designing an Electrical and Magnetic Syllabus for Prospective Elementary School Teachers Using Predict Observe Explain-Conceptual Change Text (POE-CCT)

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ABSTRACT

This study aims to 1) Obtain empirical data on the needs analysis for developing electrical and magnetic learning devices using the Predict-Observe-Explain (POE) approach assisted by Conceptual Change Text (CCT), and 2) Gather comprehensive information on designing a syllabus for electricity and magnetism using POE assisted by CCT. This qualitative research focuses on the define and design stages of the 4D model and involves 30 second-semester students from the Elementary School Teacher Education Study Program, including 6 men and 24 women, enrolled in the Basic Science Concepts course. Data collection methods included interviews to develop and validate a product based on needs analysis, such as graduate learning outcomes related to the course, relevant study materials, learning methods, time allocation, learning resources, references, learning media, and assessment criteria. The data was analyzed using content analysis techniques. The findings of this study confirm that 1) A learning tool using the POE-CCT approach is necessary to reduce misconceptions among prospective elementary school teachers, particularly in understanding the domains of electricity and magnetism, which are conceptually complex. The designed syllabus aims to address these misconceptions by incorporating POE learning tools assisted by CCT. This includes stages where students predict outcomes and reasons, observe and record their findings, and explain their observations followed by class discussions. 2) The syllabus development stage, based on needs analysis, results in POE learning tools with CCT assistance that promote independent prediction, observation, and explanation. This structured approach enhances active engagement, deeper understanding, and conceptual refinement through collaborative discourse, promising improved comprehension and retention of complex scientific concepts in the classroom.

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1. INTRODUCTION

Imagine a classroom where young minds light up with curiosity, eager to uncover the mysteries of electricity and magnetism. Yet, despite this enthusiasm, many aspiring elementary school teachers grapple with misconceptions surrounding these fundamental scientific principles. In our journey to demystify these concepts, we embark on a transformative exploration – one that seeks to not only minimize misconceptions but also empower future educators with a robust pedagogical toolkit. This study delves into the critical intersection of syllabus design and pedagogical methodology. By illuminating the path forward, we endeavours to shape a landscape where understanding flourishes and misconceptions dissipate, laying the groundwork for a generation of scientifically literate educators and learners alike. In the curriculum of the Elementary School teacher education study program, there are courses that focus on mastering science content and pedagogical debriefing. The quality of mastery of science material by prospective teacher students is influenced by the lecture method used by lecturers (Miranti et al., 2021; Sulman et al., 2022). Science content builds on the results of empirical research of scientists with scientific methods, which include scientific inquiry approaches or process skills (Abd-El-Khalick, 2014). Therefore, science learning should follow a scientific approach that facilitates the construction of conceptions by students (Fitriani et al., 2020) . However, observations in some universities show that most lecturers still use traditional teaching methods that are lecturer-centered and tend to be informative. This method is not effective in instilling mastery of the material to students, because it tends to produce understanding that is only rote and has limited retention power. Therefore, science learning should use a special approach that facilitates the development of learners' thinking and practical skills, as well as paying attention to the principles of constructivism.

Based on a number of literature on constructivism, (Wijayanti & Widodo, 2021), identified five important things related to learning and teaching. The five things are: (1) the learner already has initial knowledge, (2) learning is the process of constructing knowledge based on the knowledge already possessed, (3) learning is a change in the learner's conception, (4) the process of constructing knowledge takes place in a certain social context and (5) the learner is responsible for the learning process. Reinforcing the importance of considering learners' prior knowledge, promoting active engagement in the learning process, facilitating conceptual change, fostering collaborative learning environments, and empowering learners to take responsibility for their own learning. The key findings from the cited studies underscore the importance of considering learners' prior knowledge, promoting active engagement, facilitating conceptual change, fostering collaborative learning environments, and empowering learners to take responsibility for their own learning - all of which are central tenets reflected in current research approach aimed at minimizing misconceptions in electrical and magnetic concepts among prospective elementary school teachers.

The results of observations of the state of conception of several concepts of physical science among prospective elementary school teacher students at one of the universities in Tana Toraja Regency who contracted the Basic Science Concepts course in elementary schools showed that most elementary school teacher prospective students were in a state of misconception and lack of knowledge (did not have an initial conception), only a small part of them already had a scientific conception. Some of the identified misconceptions that most prospective teacher students have on the concepts of electricity and magnetism, including: 1) When there is an attractive force between two electrically charged objects, an object with a greater electric charge will exert a greater attractive force than an object with a small electric charge, 2) An object is understood to be electrically neutral, if the object does not contain an electric charge, 3) Electrically charged objects cannot attract neutral objects, 4) The battery is a source of electrons (source of electric current), 5) The electric potential difference between the ends of the open electric circuit is zero, 6) The strength of the electric current flowing in each branch of the parallel circuit the value always depends on the number of parallelized circuit branches, 7) The electric potential difference in a dead battery is zero, 8) The strength of the bar magnet depends on the size of the length, the longer the stronger, 9) When the bar magnet is cut, each piece of magnet has only one pole, namely the north or south pole, and 10) When

the metal bar is rubbed using a magnet, the metal bar will turn into a magnet because there are elementary magnets that move from the bar magnet to the metal rod.

Some misconceptions experienced by prospective students of physics teachers have also been found by several previous researchers, including (Kartal et al., 2011) who have found misconceptions in the concept of temperature and heat, (Djanette & Fouad, 2014) found misconceptions in the concept of light, and Ristanto et al. (2021) found misconceptions in the concept of excretory systems. Experts point out that misconceptions in learners can be influenced by a variety of factors, including prior knowledge, daily experience, language, culture, teachers, textbooks, and the learning process. Misconceptions tend to be resistant to new, more scientific ideas, and can even lead to rejection of accepted new concepts, hindering a thorough understanding of the material. It is important to immediately address misconceptions in prospective teacher students, because if left unchecked, these misconceptions can carry over until they become teachers and transmit them to their students. The process of reconstructing erroneous conceptions in learners is more difficult than building new conceptions, because often they are not aware of the misconceptions they have. Learning strategies such as Predict Observe Explain (POE) have been shown to be effective in improving students' understanding of concepts, including prospective teachers, and can improve their understanding and attitudes. POE stands for Predict, Observe, and Explain. POE is a strategy that actively engages students in demonstration by predicting what will happen before experimenting, observing, and ultimately trying to explain it, orally and/or in writing (Ajayi, 2019) (Mancuso, 2010). POE-based laboratory activities can also improve the understanding and attitudes of prospective teachers compared to traditional learning.

Concept change strategies, such as Conceptual Change Text (CCT), require the right approach. CCT, based on the process of changing concepts, identifies and rejects student misconceptions by asking for predictions, explicit misconceptions, and providing scientific explanations. By affirming student mistakes and providing concrete explanations, CCT helps teachers plan lessons more effectively (Naeem Sarwar et al., 2024a). CCT is used to identify and address students' misconceptions by introducing theories that clarify the reasons for their misunderstandings. The integration of CCT with the Predict Observe Explain (POE) technique allows students to forecast, observe, and explain scientific phenomena. In addition, cognitive conflict strategies, based on constructivism, are used in the conception alteration model (CCM) consisting of six stages. The conceptual change text is designed to satisfy the four essential conditions of Posner (1982) and follows the six stages of the CCM (Stepans, 2011). As a unit of language, CCT can be constructed from various types of text, such as explanatory, discussional, or procedural texts, aimed at minimizing misconceptions in students.

The development of learning tools to overcome misconceptions in prospective elementary school teacher students in the topic of electricity and magnetism has not been carried out thoroughly. Similarly, there has been no comprehensive investigation into the use of CCT-assisted POE strategies with the use of Four Tier Diagnostic Test (FTDT) on the understanding of prospective primary school students. In addition, data on the development of learning tools through Predict Observe Explain for prospective elementary school teacher students is not yet available. To respond to these shortcomings, this study aims to develop learning tools that can minimize misconceptions in prospective elementary school teacher students through the Predict Observe Explain approach. This research is based on the understanding that teachers' professional competence can only be developed through learning experiences that correspond to theoretical knowledge in a real context. Improvement of student learning outcomes requires changes in the way teachers teach, which requires a deep understanding of the material being taught and how students learn. Therefore, good learning tools must provide relevant and well-structured information, and pay attention to the needs of effective teaching. Based on this background, the objectives of this study are to: 1) Obtain empirical data on the analysis of needs for the development of electrical and magnetic learning devices through Predict Observe Explain (POE) assisted by Conceptual Change Text (CCT) and 2) Obtain comprehensive information about the design of electrical and magnetic learning devices through Predict Observe Explain (POE) assisted by Conceptual Change Text (CCT) so that can minimize misconceptions of understanding of prospective elementary school teachers.

2. METHODS

This research is a type of research and development. This method is a type of research that seeks to find, create, validate, and test a product from a series of needs analysis. This research uses a 4D model development design from (Thiagarajan, Semmel, and Semmel 1974). This model consists of four main stages, namely the define, design, develop, and disseminate stages. This research is limited to two stages of the 4 stages of the 4D model. The other two stages will be worked on in the next project. Therefore, the two stages that become the present study are define and design so that the research method used is qualitative. The data obtained from the define stage is to determine and define the needs in the learning process and try to collect some information related to the needs of developing this electrical and magnetic learning device. Following the design stage, the purpose of this stage is to produce a prototype of electrical and magnetic syllabus through *CCT-assisted POE* based on requirements analysis.

Qualitative methods were deemed most appropriate for the objectives of the study due to several key factors. Firstly, the research context, conducted at the Indonesian Christian University of Toraja (UKI Toraja), presented a nuanced understanding of the challenges faced by second-semester students in the Elementary School Teacher Education Study Program regarding their misconceptions in basic science concepts. Secondly, the qualitative approach allowed for in-depth exploration and interpretation of the students' perspectives, providing rich insights into their understanding and misconceptions regarding electrical and magnetic materials. Moreover, the choice of location for the study was informed by the researchers' prior experience and preliminary studies, indicating a specific need for qualitative inquiry to uncover the underlying issues. The use of interviews as a data collection method facilitated direct engagement with the participants, enabling a thorough examination of their beliefs and conceptual frameworks. Finally, the application of content analysis techniques, a widely accepted qualitative research methodology, ensured systematic data analysis and interpretation, enhancing the trustworthiness and validity of the study findings. By employing qualitative methods, the study upheld principles of scientific rigor, transparency, and replicability, thereby enhancing confidence in the credibility and generalizability of its outcomes. Data obtained through interviews was then analysed using qualitative methods. Qualitative method is a method that emphasizes research to examine the complex details of a subject, examine the relationship between social events, cultural phenomena &; society through life, experience, behaviour, perspective, point of view, emotions and feelings (Creswell, 2007) Furthermore,(Denzin & Lincoln, 2009) mentioned that qualitative methods as research methods that provide tools in understanding the meaning in depth related to complex phenomena and processes in social life.

This research was conducted at the Indonesian Christian University of Toraja (UKI Toraja), Makale, Tana Toraja Regency, South Sulawesi Province. The Indonesian Christian University of Toraja (UKI Toraja) in Makale, Tana Toraja Regency, South Sulawesi Province, presents several specific factors that make it particularly suitable for the study. Firstly, its focus on teacher education aligns directly with the research objectives, as the study involves second-semester students in the Elementary School Teacher Education Study Program. This specialization ensures that the participants possess a foundational understanding of educational principles and pedagogical techniques, providing valuable insights into their misconceptions regarding basic science concepts. Secondly, the university's location in Tana Toraja Regency offers a unique cultural and geographical context, potentially influencing the students' perspectives and conceptual frameworks regarding science education. Additionally, the researchers' prior experience and preliminary studies indicate a specific need within this academic environment, suggesting that the university serves as an ideal setting to investigate and address the identified challenges. The university's commitment to academic excellence and its willingness to participate in research endeavors further enhance its suitability for the study.

The subjects of the study were 30 second-semester students in the Elementary School Teacher Education Study Program, consisting of 6 men and 24 women who took the Basic Science Concepts course. In selecting participants for the study, several criteria were likely considered to ensure relevance

and representativeness. Firstly, the participants were second-semester students in the Elementary School Teacher Education Study Program, indicating a specific academic level and field of study. This criterion ensured that the participants had a foundational understanding of educational principles and were actively engaged in learning about basic science concepts, aligning with the research focus. Additionally, the choice of participants who were taking the Basic Science Concepts course further targeted individuals with direct exposure to the subject matter under investigation. Furthermore, the distribution of participants, consisting of 6 men and 24 women, might have been intentional in capturing potential gender differences or perspectives in understanding basic science concepts. The choice of location for this study was based on the experience of researchers who had conducted preliminary studies and it was found that many second-semester students still have incorrect concepts in understanding every material taught in the basic concepts of science courses, especially electrical and magnetic materials. Data that has been obtained through interviews is collected into a database. Furthermore, the database was analysed using content analysis techniques (Krippendorff, 2018, whichre often used in qualitative research (Miles & Huberman, 1994). By adhering to a transparent and replicable content analysis methodology, this study upholds the principles of scientific rigor and accountability, fostering confidence in the validity and generalizability of its findings.

3. FINDINGS AND DISCUSSION

3.1. The Needs for the Development of Electrical and Magnetic Learning Devices through Predict Observe Explain (POE) Assisted by Conceptual Change Text (CCT)

Activities at this stage are to determine and define needs in the learning process and try to collect some information related to the needs of developing electrical and magnetic learning devices. The results of activities in this stage can be described as follows:

Lecturers have tried to develop their own Semester Learning Plan Basic Concepts of Natural Sciences, but are constrained by the absence of a Semester Learning Plan that can be used as a reference or reference and there has been no structured effort to minimize misconceptions that occur in students, Based on the initial conditions that occur encourage the conducting of research and development ideas where it is necessary to redesign the Semester Learning Plan comprehensively To be more focused on instilling the right concepts during lectures so that students can understand the concept of electricity and magnetism.

Special lectures on electrical and magnetic materials have not been held. There are no textbooks or reading materials that specifically discuss electricity and magnetism. Available is Self-Study Material Basic Concepts of Natural Sciences which discusses the topic of magnetism and electricity. The textbooks used by lecturers seem to only be concerned with the aspect of completeness of information so that it amounts to thick pages. Similarly, the selection of material is not carried out so that it becomes unclear which parts should really be emphasized and which are only additional knowledge. From the existing syllabus, information is obtained that electricity and magnetism are part of the lecture material Basic Concepts of Natural Sciences. This topic is discussed in the sub-discussion of electricity and magnetism one meeting. This is an opportunity to develop Electrical and Magnetic Learning Tools instruments through Predict Observe Explain. So this finding indicates that the portion of electrical and magnetic learning in this course is very minimal. The majority of the discussion/material only discusses electrical and magnetic materials in theory without giving students the opportunity to do practicum to prove the theory they are learning. This condition certainly does not support developing a comprehensive understanding of student concepts because of the lack of electrical and magnetic material presented. In this study, the content of the textbook is realized in a Conceptual Change Text.

To determine the opportunity to develop electrical and magnetic learning devices to minimize misconceptions about understanding prospective elementary school teachers, researchers gave questionnaires to regular students of Elementary School Teacher Education in the Third Semester of 2019 (Class A.10 &; Class B.10) totalling 42 people. The questionnaire given is related to the lectures on

Basic Concepts of Natural Sciences that have been carried out in the study program in order to obtain data on process needs and understanding of electrical and magnetic topics that need to be developed. Related to the development needs questionnaire can be seen in detail in the Appendix. Data shows that lectures on science concepts so far tend to be carried out by lecture or expository methods (75.00%). The tendency to use lecture or expository methods causes students to be unfamiliar with learning through POE for prospective elementary school teachers on the topic of electricity and magnetism. This can be seen from the answer to point Number 15, only 5.00% stated 'rare'. Apart from the results of the questionnaire on the number, it was also reinforced by the results of the interview. In general, students do not understand or are still wrong about learning through POE.

Apart from the results of the questionnaire on the number, it was also reinforced by the results of the interview. In general, students do not understand or are still wrong about learning through *POE*. In addition to using questionnaires, interviews were conducted using interview guidelines for: (1) YK (student, male, 19 years old) said that he had difficulty in understanding the topic of electricity and magnetism, especially at the symbolic level. So lecture activities are needed that can explore students' ability to predict, observe and explain (interview, February 21, 2021). (2) LP (female student, 19 years old) said that she had difficulty understanding the concepts of electricity and magnetism because she only read/memorized the material without practicing or doing practicum activities in the laboratory. Based on the above, it is necessary to develop tools that can improve the quality of learning and can minimize student misconceptions.

Based on the results of interviews with two lecturers of Basic Concepts of Natural Sciences, it was illustrated that there was a need for a lecture activity carried out by lecturers in order to provide better knowledge (than before) related to electrical and magnetic materials to students. With these lectures, students can understand the material at various levels of understanding. Thus, the Electrical and Magnetic Learning Device through CCT-assisted POE (POECCT) developed by researchers is indeed in accordance with the needs of lecturers and students.

Based on the needs analysis phase, both through interviews, questionnaire distribution, and document analysis, it is known that lecturers are still find it difficult to develop learning tools independently, so the tools developed are still limited to Semester Learning Plans and learning outcome tests. The learning tools used are more adopting learning tools that are commonly used so far. For this reason, a learning tool that uses the POECCT approach is needed to minimize misconceptions about understanding prospective elementary school teachers.

The finding that lecturers face challenges in independently developing learning tools and tend to rely on commonly used materials such as Semester Learning Plans and learning outcome tests aligns with previous research in the field of education. Several studies have highlighted the difficulties educators encounter in creating innovative and effective teaching materials, often due to factors like time constraints, lack of training in instructional design, and limited access to resources. This reliance on traditional tools may lead to stagnant teaching methods and hinder the development of more student-centered approaches (Parker, 2018; Winslow, 2023). Introducing new teaching methodologies, such as the POECCT approach mentioned in the finding, corresponds to the ongoing discourse in educational research aimed at promoting active learning, critical thinking, and deeper understanding among students. Previous studies exploring the effectiveness of innovative teaching strategies, including the POECCT approach, have shown promising results in enhancing student engagement, improving conceptual understanding, and reducing misconceptions (Almusaed et al., 2023; Lee et al., 2018). Therefore, the suggestion to implement the POECCT approach to minimize misconceptions among prospective elementary school teachers is supported by existing literature, as it offers a pedagogical framework that emphasizes inquiry-based learning, hands-on activities, and formative assessment practices, which are essential components for addressing and correcting misconceptions effectively. The finding underscores the importance of continuous professional development for educators and the adoption of evidence-based instructional practices to enhance teaching and learning outcomes in the field of education.

3.2 The design of the Electrical and Magnetic syllabus through Predict Observe Explain (POE) Assisted by Conceptual Change Text (CCT)

The second stage after the define stage is the model design stage, the purpose of this stage is to produce a prototype of electrical and magnetic learning devices through CCT-assisted POE based on requirements analysis. In detail, the initial concept of developing this syllabus framework is outlined in the following presentation:

Course Title: Electrical and Magnetic Syllabus for Prospective Elementary School Teachers
Course Description: This course focuses on equipping prospective elementary school teachers with the knowledge and skills necessary to effectively teach electrical and magnetic concepts to young learners. Utilizing the Predict Observe Explain-Conceptual Change Text (POE-CCT) approach, students will engage in hands-on activities, collaborative learning experiences, and reflective exercises to deepen their understanding of fundamental principles in electricity and magnetism and develop strategies for facilitating conceptual change in their future students.
Course Objectives:

1. To develop a comprehensive understanding of foundational concepts in electricity and magnetism.
2. To explore effective instructional strategies for teaching electrical and magnetic concepts to elementary school students.
3. To apply the Predict Observe Explain-Conceptual Change Text (POE-CCT) approach in designing engaging and interactive lessons.
4. To cultivate skills in assessing student understanding and addressing misconceptions related to electrical and magnetic phenomena.
5. To reflect on personal teaching practices and pedagogical approaches for promoting conceptual change in elementary school classrooms.

Course Outline:

Week 1: Introduction to Electricity and Magnetism

1. Overview of basic electrical and magnetic concepts
2. Historical perspectives on the development of electricity and magnetism
3. Hands-on exploration of simple circuits and magnetic interactions

Week 2: Understanding Electric Circuits

1. Properties of electric charges and currents
2. Series and parallel circuits
3. Conductors and insulators

Week 3: Exploring Magnetic Fields

1. Properties of magnets
2. Magnetic fields and lines of force
3. Magnetic materials and their applications

Week 4: Electromagnetism

1. Relationship between electricity and magnetism
2. Electromagnetic induction
3. Applications of electromagnetism in everyday life

Week 5: Predict Observe Explain (POE) Strategy

1. Introduction to the Predict Observe Explain (POE) instructional strategy
2. Practice sessions on applying POE in teaching electrical and magnetic concepts

Week 6: Conceptual Change Text (CCT) Approach

1. Overview of the Conceptual Change Text (CCT) approach
2. Designing Conceptual Change Texts for elementary school students
3. Incorporating CCT into lesson planning

Week 7: Integrating POE-CCT Approach

1. Integration of POE and CCT strategies in lesson design
2. Creating hands-on activities and demonstrations to promote conceptual change
3. Peer feedback and collaborative lesson planning exercises

Week 8: Assessing Understanding and Addressing Misconceptions

1. Strategies for assessing student understanding of electrical and magnetic concepts
2. Identifying and addressing common misconceptions
3. Formative assessment techniques for promoting conceptual change

Week 9: Reflective Teaching Practices

1. Reflective journaling on personal teaching experiences and pedagogical beliefs
2. Peer discussion and feedback on teaching practices
3. Goal setting for promoting effective instruction in electricity and magnetism

Week 10: Culminating Project

1. Designing a comprehensive lesson plan integrating the POE-CCT approach
2. Presentations of lesson plans and peer evaluation
3. Reflection on the learning process and future implications for teaching practice

Assessment:

1. Participation in class discussions and activities
2. Completion of hands-on assignments and laboratory exercises
3. Design and presentation of lesson plans incorporating POE-CCT approach
4. Reflective journal entries on teaching experiences and pedagogical development

Required Texts:

1. Panofsky, W. K., & Phillips, M. (2005). *Classical electricity and magnetism*. Courier Corporation.
2. Contant, T. L., Tweed, A., Bass, J. E., & Carin, A. A. (2018). Teaching science through inquiry-based instruction.

Additional Resources:

1. Supplementary readings and articles on electricity and magnetism
2. Online simulations and interactive resources for teaching science concepts
3. Educational videos and documentaries on historical developments in electricity and magnetism

The syllabus is made in accordance with the Regulation of the Minister of Research, Technology Directorate General of Higher Education No 44/2015 concerning National Standards for Higher Education Chapter II part IV Article 12. The Semester Learning Plan is developed independently by researchers in accordance with the expertise in the field of science. The components that have been stated can be explained as follows:

3.2.1 Graduate learning outcomes charged to the course

The discussion of electricity and magnetism is not a course but a lecture material. In this research, a learning tool related to the material will be made. Thus, the formulation of graduate learning outcomes refers to the description of learning outcomes of graduates of the Indonesian National Qualifications Framework in the Elementary School Teacher Education Study Program.

Following the Regulation of the Minister of Research, Technology Directorate General of Higher Education No. 44/2015 concerning National Standards for Higher Education article 5 point 3, the formulation of graduate learning outcomes contains the qualifications of graduate abilities which include attitudes, knowledge, and skills. In formulating the learning outcomes of electrical and magnetic lecture graduates, the study of several materials discussed in each lecture can improve the attitudes, knowledge, and skills of prospective elementary school teacher students.

As explained in the earlier section, the representation of matter can be distinguished into the macroscopic level, the submicroscopic level (verbal and visual) and the symbolic level. Therefore,

through the study of several materials in lectures can increase student understanding maximally, sub microscopically (verbal and visual) and even symbolic, including: (1) static electricity, (2) electrical circuits, (3) magnetism, and (4) conducting investigations through experiments to explain electrical and magnetic events.

The result of lectures in this study is a change in behaviours. Behavior change based on the treatment of CCT-assisted POE Strategy in elementary school teacher candidates in a better direction than before. With a qualified understanding of the concept, students are able to teach it properly and correctly to elementary school students in the future. Therefore, prospective elementary school teacher students can understand knowledge (factual, conceptual, and procedural) about electricity and magnetism based on their curiosity about science and technology, art, culture related to phenomena and events in everyday life, declare it in accordance with scientific concepts and be able to teach it to elementary school students properly and correctly.

3.2.2 Study materials related to the capabilities to be achieved.

Study materials are used as material to achieve goals and abilities to be achieved in lectures. Thus, in preparing a learning plan must be determined material that is relevant to the goals and abilities to be achieved. Sub-sub-discussion of Basic Concepts of Natural Sciences courses that are relevant and related to the sub-discussion of electricity and magnetism.

Table 1. Lecture Topics

Week	Topics
1	Introduction to Electricity and Magnetism
2	Understanding Electric Circuits
3	Exploring Magnetic Fields
4	Electromagnetism
5	Predict Observe Explain (POE) Strategy
6	Conceptual Change Text (CCT) Approach
7	Integrating POE-CCT Approach
8	Assessing Understanding and Addressing Misconceptions
9	Reflective Teaching Practices
10	Culminating Project

3.2.3 Learning methods

In accordance with the Regulation of the Minister of Research, Technology, Directorate General of Higher Education, No. 44/2015 concerning National Standards for Higher Education article 14 point 3, learning methods that can be chosen for the implementation of course learning include: group discussions, simulations, case studies, collaborative learning, cooperative learning, project-based learning, problem-based learning, or other learning methods, which can effectively facilitate the fulfilment of learning outcomes Graduates. Furthermore, in point 5, each course can use one or a combination of several learning methods as referred to in paragraph (3) and be accommodated in a form of learning.

In this study, the implementation of lectures uses a combination of contextual and conceptual approaches. The lecture strategy used is the POE Strategy assisted by Conceptual Change Text (CCT). The learning methods and techniques used are a combination of question and answer, discovery / inquiry, experiment, and expository. Lectures are supported by practicum activities in the laboratory to strengthen understanding of concepts and skills of the science process. This is done to enrich the student learning experience.

3.2.4 Time

In this study, the allocation of time and the number of meetings made were adjusted to the Semester Credit Unit Basic Concepts of Natural Sciences. Generally, the Basic Concepts of Natural Sciences have 3 Semester Credit Units. Thus, the allocation of time and the number of meetings to be made is a maximum of ten meetings. With the time allocation each meeting is 150 minutes.

3.2.5 Learning resources, reference lists and learning media.

Learning resources can be in the form of textbooks, audio-visual objects, the surrounding environment, or anything that can be used by students to achieve predetermined abilities. In this study, learning resources in the form of main books and reference books as reliable sources of information. The main book and supporting books each have 5 titles, in Indonesian or English. To further enrich students' understanding, they can independently access reference book resources via the internet and so on.

Other aspects that need to be considered in developing the electrical and magnetic Semester Learning Plan are media and teaching aids, teaching practicum materials needed. In general, the media, teaching aids and practicum materials needed from the first meeting to the end, are relatively the same on each topic of discussion. Media and tools needed for electrical and magnetic subject matter include: whiteboard, textbooks, and LCD Projector. In addition, for the topic of electrical discussion, practicum tools are needed in the form of rulers, pieces of paper, several batteries, small bulbs, electrical conducting cables, voltmeters, while for the topic of magnetism, practicum tools are needed in the form of bar magnets, screws / iron, metal rods, paperclips etc.

3.2.6 Assessment criteria, indicators, and weights

In accordance with the Regulation of the Minister of Research, Technology, Directorate General of Higher Education No. 44/2015 concerning SNPT article 19, assessment in lectures includes assessment of the process and assessment of student learning outcomes. Article 21 explains that assessment techniques include observation, participation, performance, written tests, oral tests, and questionnaires. Next, the assessment of the process in the form of a rubric and the assessment of results in the form of a portfolio. In this study, student success in lectures Basic Concepts of Science is determined by the achievements concerned in various activities with their respective weights such as attendance and lecture participation given a weight of 10%; presentations and discussions weighted 20%; tasks weight 20%; test 1 (held at the beginning) weights 25%; Test 2 (held at the end) weights 25%. Total weight 100%.

The product development design stage, which is based on the results of needs analysis in the field, produces syllabus based on Predict Observe Explain (POE) assisted by Conceptual Change Text (CCT) which includes: (a) Predict, Lecturers ask students to independently write their predictions about what will happen and ask what they think and see and why this is so (b) Observe, distribute MFIs so that they can demonstrate, give students time to make observations, ask students to write down what they observe. (c) Explain, asking students to change or add to student explanations according to the results of their observations and after students have committed to their explanation, discuss ideas through class discussion.

The product development design stage described, incorporating the Predict Observe Explain (POE) approach assisted by Conceptual Change Text (CCT), aligns with previous research in educational psychology and science education. The use of POE as a pedagogical framework for teaching science concepts has been widely explored and supported in the literature. Research has shown that the POE approach engages students in active learning processes, promotes critical thinking skills, and enhances conceptual understanding by encouraging students to make predictions, observe phenomena, and revise their explanations based on evidence (Fitriani et al., 2020; Hong et al., 2021).

The incorporation of Conceptual Change Text (CCT) into the syllabus development further enriches the instructional design by providing students with structured text materials that facilitate conceptual change. Previous studies have demonstrated the effectiveness of CCT in addressing misconceptions and promoting conceptual change among students. By presenting scientific concepts in a way that challenges students' preconceptions and encourages reflection, CCT helps to bridge the gap between students' prior knowledge and scientific understanding (Naeem Sarwar et al., 2024b).

The specific instructional activities outlined in the syllabus development stage, such as predicting, observing, and explaining, reflect best practices in science education. These activities are designed to actively engage students in sense-making processes, encourage inquiry-based learning, and foster collaborative discussions among peers. Previous research has shown that such interactive and student-cantered approaches are effective in promoting deep learning and conceptual understanding in science (Lai, 2008; Patil et al., 2023).

The product development design stage described in the finding aligns with previous research emphasizing the importance of active learning strategies, conceptual change approaches, and inquiry-based instruction in science education. By integrating POE assisted by CCT into the syllabus, educators are likely to create a more effective learning environment that supports students' conceptual development and helps minimize misconceptions.

The study initiates with a comprehensive needs analysis phase, encompassing interviews, questionnaire distribution, and document analysis, to understand the challenges faced by lecturers in developing learning tools independently. It then introduces an innovative approach, the POECCT method, merging Predict Observe Explain (POE) tools with Conceptual Change Text (CCT), to mitigate misconceptions among prospective elementary school teachers. This approach is translated into practical applications such as textbooks, Semester Learning Plans, Student Activity Sheets, and conception diagnostic tests, ensuring direct benefits for educators and students in real-world educational settings. Embracing student-centered learning principles, the proposed tools foster active engagement and deeper comprehension, in alignment with contemporary pedagogical standards, thereby enhancing the efficacy of teaching and learning processes. While the study presents innovative learning tools and approaches, several key limitations need consideration. Firstly, its findings may lack generalizability beyond the specific context of the research due to potential cultural differences, institutional policies, and variations in educational systems across different regions. Secondly, implementing these tools effectively in diverse educational settings may encounter practical challenges such as time constraints, resource availability, and faculty training requirements. Additionally, the study lacks detailed elucidation on the evaluation methods employed to gauge the effectiveness of the developed learning tools, warranting a robust evaluation framework encompassing student learning outcomes and educator feedback. Moreover, the long-term sustainability and scalability of the proposed approach are not extensively addressed, necessitating considerations for ongoing support, material updates, and adaptability to evolving educational needs for sustained success.

4. CONCLUSION

The finding of this study confirms that based on the needs analysis phase, both through interviews, questionnaire distribution, and document analysis, it is known that lecturers are still difficult to develop learning tools independently, so the tools developed are still limited to Semester Learning Plans and learning outcome tests. The learning tools used are more adopting learning tools that are commonly used so far. For this reason, a learning tool that uses the *POECCT approach* is needed to minimize misconceptions about understanding prospective elementary school teachers. The product development design stage based on the results of needs analysis in the field, produces *Predict Observe Explain* (POE) learning tools assisted by Conceptual Change Text (CCT) which include: (a) Predict, Lecturers ask students to independently write their predictions about what will happen and ask what they think and what they see and why this is so (b) Observe, distribute Student Activity Sheets so that

they can demonstrate, give students time to make observations, ask students to write down what they observe. (c) Explain, asking students to change or add to students' explanations according to the results of their observations and after students have committed to their explanations, discuss ideas through class discussions. Some of the research products developed are textbooks, Semester Learning Plans, Student Activity Sheets and conception diagnostic tests.

Further research could explore the development and implementation of teacher training programs aimed at enhancing educators' ability to independently develop innovative learning tools, such as those utilizing the POECCT approach. These programs could provide educators with the necessary knowledge, skills, and resources to design and implement effective instructional materials that promote conceptual understanding and minimize misconceptions among students. By evaluating the effectiveness of such training programs through pre- and post-assessments, researchers can assess their impact on teacher practices and student learning outcomes.

Conflicts of Interest: "The authors declare no conflict of interest"

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