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## МОДЕЛІ НАВЧАННЯ ФІЗИКИ НА ОСНОВІ СИНЕКТИКИ ДЛЯ ВДОСКОНАЛЕННЯ НАВИЧОК ВИРІШЕННЯ ПРОБЛЕМ: АНАЛІЗ ПОТРЕБ

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## PHYSICS LEARNING MODELS BASED ON SYNETIC TO IMPROVE PROBLEM-SOLVING SKILLS: A NEED ANALYSIS

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### АНОТАЦІЯ

Дослідження присвячено обґрунтуванню доцільності розроблення моделей навчання фізики на засадах синектики для удосконалення навичок розв'язувати проблеми.

**Формулювання проблеми.** Моделі навчання фізики на засадах синектики розвивають уміння учнів застосовувати творче мислення, чим сприяють розвитку навичок мислення високого рівня, до яких відносять уміння розв'язувати проблеми. Реалізація синектичної моделі навчання передбачає використання аналогії та метафоричного мислення, які дають можливість зрозуміти абстрактні поняття у більш контекстуальний спосіб, чим полегшують розв'язування студентами проблем.

**Матеріали і методи.** Цей тип дослідження є дослідженням з поетапною розробкою ADDIE. Модель на початку дослідження потребувала аналізу і визначення розриву між реальними та бажаними умовами навчання фізики, особливо у коледжах. Дослідження проводилося на базі Університету Мухаммадія у Макасарі протягом трьох місяців у другому семестрі 2021/2022 н.р. В дослідженні брали участь два викладачі та 12 студентів. Збір даних для аналізу потреб базувався на інтерв'ю, огляді літератури та анкетах. Результати проаналізовані за допомогою якісних описових методів.

**Результати.** Наведено опис реальних та ідеальних умов навчання фізики, які базуються на результатах аналізу навчальних програм, характеристик студентів та здатності викладачів реалізувати навчання фізики в коледжі. Результати аналізу підтвердили розрив між реальними та бажаними умовами навчання фізики.

**Висновки.** Здатність вирішувати проблеми як затребувана сьогоденні навичка є одним із очікуваних результатів навчання, який базується на показниках успішності за освітньою програмою та когнітивних характеристиках студентів коледжу. Тому розроблена модель навчання фізики на засадах синектики є важливою, оскільки схильність до розв'язування фізичних задач є низькою. Це означає, що синергія творчого мислення між викладачем і студентом є необхідною основою для розвитку навичок вирішувати проблеми.

**КЛЮЧОВІ СЛОВА:** навчання фізики; синектика; навички вирішувати проблеми.

### ABSTRACT

This study aims to describe the development needs of physics learning models based on Synetic in improving problem-solving abilities.

**Formulation of the problem.** The design of physics learning models based on Synetic directs students in getting used to processing creative thinking to achieve higher-order thinking skills, one of which is problem-solving ability. The Synetic learning model implementations are identical to analogy and metaphoric thinking. Analogies and metaphor thinking will help students understand abstract concepts to become more contextual, making it easier for students to solve the problem.

**Materials and methods.** This research type is research and development with the ADDIE design. The learning model needs an analysis description performed during the analysis stage by determining the gap between the real conditions and the desired ideal conditions in learning physics, especially in college. The needs analysis research was carried out at the Muhammadiyah University of Makassar with two lecturers and twelve students as research respondents for three months in the even semester of the 2021/2022 academic year. The needs analysis data collection using interview guidelines, literature reviews, and questionnaires. The data collection results will be analyzed with a qualitative descriptive analysis.

**Results.** The reality and ideal conditions description obtained from the results of curriculum analysis, student characteristics, and lecturer abilities in implementing physics learning in college. The needs analysis results show a gap between reality and the desired ideal conditions in learning physics.

**Conclusions.** Even though the ability to solve problems is one of the expected learning outcomes based on curriculum achievement indicators and skills needed at this time based on a person's cognitive stage at the age of college students. Therefore, a physics learning model based on Synetic development is very needed and indicated by the student's tendency ability to solve physics problems to be low. It means synergizing between teachers and students for creative thinking is needed in learning physics as an important basis for improving problem-solving skills.

**KEYWORDS:** physics learning; synetic; problem-solving skills.

### INTRODUCTION

Learning physics is identical to problem-solving through a collaborative process of understanding a concept and formula or equality used to prove a physics phenomenon or theory previously through thought processes. Problem-solving skills based on thinking skills is one of *Higher Order Thinking Skills* (HOTS) or high-level skills considered height as a mindset and special

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talent because it is difficult to achieve. However, we can achieve the goals when lecturers apply the appropriate learning model. The Higher Order Thinking Skills has their characteristic because a person's ability level is assumed to be able to be at that stage to analyze, evaluate, and create. Someone is oriented to have the ability to apply knowledge and skills so that they can reason in solving problems, making decisions, and creating innovations. The result's initial observations show that the lecturer has tried to design the learning as well as possible so that students can achieve maximum learning outcomes appertain problem-solving. However, choosing the appropriate learning model following the demands of current needs is still ignored. Based on observations of 21 students, there were two students (9.52%) solved the problem with a good score category, twelve students (57.14%) solved the problem with a moderate score category, and seven students (33.33%) less able to solve problems in the process of learning physics. The data description shows any important problems with physics students related to how to solve problems in learning physics that involve thinking skills. Researchers seek to adopt analogy and metaphor thinking as the identity of a synectic learning model based on creativity theory and integrate it with cognitive and constructivist theories so that can direct the formation of analogy and metaphor thinking towards student-centered and lecturers only become facilitators of ideas that emerge later. Through synectic learning models, students are used to maximizing their brain thinking function so that learning-oriented is toward the higher-order thinking skills achievement through the analogy of thinking that is oriented on students and can activate themselves in the learning process. Educators are always required to innovate and even make learning inventions that can produce new learning experiences for their students to form meaningful knowledge (Joenaity, 2019)

In the 21st century, assessing the student's ability should not be done only by testing to answer the problem. Students must maximize the extent to which knowledge and skill are compiled in problem-solving, entrepreneurship, and creativity (Soh et al., 2010) Problem-solving is an action that involves mental processes and skills to obtain the correct conclusions about the problems that occur (Güneş et al., 2015). Problem-solving is a cognitive process performed by identifying problems stages, directing goals problem, and finding with implementing various alternative approaches to offering these goals (Lee & Lee, 2020). Because problem-solving is considered an almost complicated process, experts suggest dividing the process into several stages. Problem-solving is the student's ability to acquire knowledge, skills, and understanding to meet requests or an unusual situation. Students must synthesize their knowledge to apply it in new or different conditions (Posamentier, and Krulik, 2009). Someone who can solve problems has a well-organized knowledge structure because of the process of procedural problem-solving. Thus, someone can develop alternative problem-solving with appropriate procedures (Sani, 2019). Someone who has good problem-solving skills can streamline their knowledge and solve problems experienced easily (Özsoy-Güneş et al., 2015). A person's ability to think both convergent and divergent is needed as a thinking skill to solve a given problem (Shettar et al., 2020). The analysis process to build solutions based on questions or problem submissions can be resolved by the problem synthesis process. Thus, it makes sense that problem-solving begins with questions or phenomena associated with the basic agreement (Politsinsky et al., 2015). In addition, to solve problems, especially on scientific material, students need the least analytical skills characterized by the ability to identify known and asked variables and choose the proposed problem-solving strategy (Rufaida & Nurdiyanti, 2021). Someone who is still a beginner in solving problems starts solving problems by applying equations, substituting variables, then hiding other concealers that can help in solving problems (Çalışkan et al., 2010)

The synectic model is a strategy to combine various elements by using figures of speech in new view producing. The orientation of the synectic model is towards increasing the ability to solve problems, creative expression, empathy, and insight into social relations (Nurdin & Adriantoni, 2016). The synectic learning model is one of several information processing models that focuses on aspects of information processing to improve students' ability to develop creative thinking by building a novelty perspective (Priansa, 2017). Synectic is the best model for brainstorming and is more efficient than conventional learning models in developing creative thinking (Aiamy & Haghani, 2012). Synectics can increase activity and analytical problem-solving skills (Ariska et al., 2020). The synectic learning model can have an impact on itself in the form of instructional influences such as cohesion and productivity of small user groups, metaphorical thinking skills, and problem-solving capabilities, as well as having a driving effect in the form of self-esteem, adventure, and mastery of learning material (Huda, 2019). Metaphor is not only a new word for thought describing but also for thinking away and creating more deeply (Sunito et al., 2017). The synectic model provides an opportunity for students to develop thinking skills through metacognition so that there is a relationship between knowledge concepts from abstract to more concrete. The synectic models make difficult concepts can be easier to understand contextually (Nalini, 2012). The synectic learning model can facilitate the learning process by making abstract concepts more concrete. Thus, the synectic model can improve understanding of concepts and minimize misconceptions. Synectic can increase active learning. In addition, the synectic model is effectively increasing cognitive, affective, and psychomotor learning outcomes. The synectic model also touches on the metacognitive domain and is effective to improve creativity as one of the higher-order thinking skills (Rufaida et al., 2022). Based on the results of this presentation, a more in-depth study is needed to be related to the needs analysis for physics learning models based on synectics development towards improving problem-solving skills in physics learning

## METHOD

This research is a preliminary study in research and development. The development of this model is based on Gordon's theory of creativity, cognitive theory, information processing theory, and constructivist theory and implement through the development stages ADDIE consists of analysis, design, development, implementation, and evaluation stages. Preliminary studies are carried out through performance analysis and need analysis as guidelines for implementing research and development at a later stage. The analysis phase is carried out to see the current learning situations and whether there is a gap between what should have happened and the reality on the ground through a series of observations. The analysis phase is carried out through literature analysis in the form of an analysis of the curriculum, and performance analysis, observing things that cause low problem-solving skills and thinking of alternative solutions to improve the situation. This study involved 12 Department of Physics Education students at the University of Muhammadiyah Makassar as research subjects. The instruments used were observation sheets and interview guides, then analyzed descriptively qualitatively through a data reduction to analyze studied aspects during the needs analysis.

**FINDINGS**

The research results related to the needs analysis for the development illustrate *the gap* between the ideal and tangible description of learning physics in higher education which will lead to making recommendations for the most appropriate learning model to overcome the low problem-solving ability of students.

**Ideal Description of Physics Learning in Higher Education**

The ideal description of physics learning in higher education can be obtained through the results of curriculum analysis, student characteristics, and lecturer abilities to implement physics learning in college. Based on the higher education curriculum analysis, we have obtained information that graduates learning outcomes can present solutions to overcome various problems. In addition, students demanded to have the qualifications to be able to master scientific basics and skills in certain areas of expertise so that they can find, understand, explain, and formulate ways of solving problems that exist within their area of expertise. Thus, the students of the Department of Physics Education in higher education can hold theoretical concepts in certain areas of knowledge in general and specifically in physics education more in-depth and be able to formulate procedural problem-solving. The ideal description of physics learning in higher education is also shown by the student characteristics analysis related to the student expectations description achievement for the orientation of learning outcomes, the presentation of learning material, as well as the expected perceptions of students towards learning physics in higher education as shown in the following table.

Table 1.

**Needs Analysis Related to Student Characteristics**

No	Indicator	Percentage (%)
1	Learning Outcome Orientation	87,78
2	Material Learning Presentation	84,67
3	Learning Perception	96,25

The data distribution shows that 87,78% of students have the desire that physics learning outcomes are oriented towards problem-solving abilities by the applicable curriculum, 84,67% of students want the material learning presentation to be more contextual, and 96,25% of students think that learning physics perceptions are considered abstract and difficulty so that action is needed to overcome this slowly. Learning orientation has been carried out passably based on the Semester Learning Plan or RPS but has not been oriented maximally towards students' thinking abilities. Students agree that the learning physics orientation is problem-solving ability. So, learning physics evaluation should be directed to problem-solving ability to help students to develop thinking skills. The illustrations show the importance of applying the learning model that directs students to practice thinking skills in problem-solving as must be possessed competencies after implementing physics learning. The physics learning material presentation still needs improvement because there are still many students who find physics learning materials difficult to understand. Students have not been able to digest the lecturer's questions or statements regarding physics learning material as a result of students not being used to practicing their thinking skills so that they feel comfortable with the level of cognitive ability at the lower order thinking skill. The learning material presentation needs to pay attention to the processes that students go through and give rewards to have students learn comfort can maximize their thinking skills. As for students' perceptions of physics learning, it can use to develop an innovative learning model. Physics concepts feel abstract, so learning physics must be related to real-life examples or analogies with something easier to find so that the physics concept feels easy to understand. If a student has managed the basic physics concept, there can apply these concepts in the problem analysis process. The student's habit of using analogy thinking, will support his analytical skills and create various ideas for giving birth to alternative problem solutions. The students' characteristics are the basis for the urgency to develop a physics learning model based on synectic to improve problem-solving abilities.

An ideal description related to learning physics in higher education from the results of an analysis of the readiness and ability of lecturers regarding the learning outcomes orientation achieved based on the curriculum, the presentation of learning materials based on current innovations, and the perceptions that lecturers expect of students in responding to learning physics in higher education as presented in the following table.

Table 2.

**Needs Analysis Related to Lecturer Readiness and Capability**

No	Indicator	Percentage
1	Learning Outcome Orientation	93,33
2	Material Learning Presentation	86,67
3	Learning Perception	85,00

The data above shows that 93,33% of lecturers agree that the orientation of physics learning outcomes is toward the problem-solving ability according to the applicable curriculum, 86,67% of lecturers agree that the learning materials presentations are more contextually supported by learning technology, and 85,00% of lecturers agree that the physics learning perception is abstract and difficulty so that action is needed to overcome it slowly. Based on these data, the lecturer strongly agrees that the direction of learning orientation is to train students' thinking skills which is nothing but problem-solving ability. So, learning physics evaluation should be directed to problem-solving ability to help students to develop thinking skills. Lecturers also agree that an innovative learning model is needed to make it easier for students to understand the basic physics concepts in

physics learning materials presentation so that learning materials are more concrete and contextual. Lecturers' perceptions of physics learning are abstract. So learning physics must be presented closer to student life to create conceptual understanding as a basis for problem-solving.

#### **Tangible Description of Physics Learning in Higher Education**

Based on the results of the analysis of students' interviews in physics learning for higher education, students need initial knowledge to know the knowledge level and understanding possessed by students so that they can identify the material difficulty parts of learning students. The student's perspective on learning physics is basically in a critical condition. Physics is considered a scourge because of the inability of students to answer various problems related to physics concepts exactly. It is a strong reason because perceptions students that physics is identical with formulas or equations. It's making students look at physics as numbers and formulas without knowing the basic concepts and their application in everyday life and feel that physics is not beneficial to their life. Students' perception of physics is abstract thus requiring further explanation to achieve a conceptual understanding. However, if the material is presented only by giving problem-solving questions without being related to something concrete, the material will feel even more complicated. The desire of learning physics students is to train in what provides direct benefits in real-life. The making abstract concepts process make concrete in physics learning can be given by an analogy or a metaphor for the abstract concept becoming more real. The developing concept process with the implementation of an appropriate learning model takes time are needed, but the reality shows that lecturers have so far been more concerned with evaluating the final results and ignoring the learning process assessment and the learning convenience when learning implementation. Learning comfort is prioritized in every development of concept discovery by students as a student assessment of progress in a better direction. The orientation of physics learning is toward giving questions based on predetermined learning achievement indicators without being based on providing a strong conceptual basis. These questions make students more complicated to think. Some students solve problems in their way and are considered irrational by others. It's inappropriate because it is not by the existing steps. There are several ways students solve physics problems that directly refer to equations, but there are also those who understand the concept first. All of these conditions are the characteristics of each student in solving problems depending on the achievement of his thinking process.

#### **The Description of Physics Learning Needs in Higher Education**

Based on the ideal and tangible description, several gaps can be identified which are learning physics problems in higher education as a basis for the needs of users, lecturers and students in overcoming these problems, including: 1) Based on ideal conditions in the literature review of the higher education curriculum, information is obtained that the achievements learning physics in higher education is more focused on problem solving abilities through thinking skills, while the real conditions show that there is still a lack of students who have problem solving abilities; 2) Students and lecturers as users agree that the learning physics orientation is aimed at thinking skills as a basis for having problem solving abilities, but real conditions show that students feel that giving problem solving questions without being associated with something concrete in the process of building problem solving will increase feels complicated; 3) Users agree that the learning material presentation is delivered contextually so that there is a strong inculcation of learning physics concepts, while the real conditions state that students find it very difficult for physics to become something contextual because it is identical to a formula or equation which makes students only see physics as numbers and formula without knowing the basic concept of its application in everyday life and is considered not to have great benefits in his life; 4) Users want that physics is no longer something that is abstract and students can easily understand so that it is stored in long-term memory, but real conditions show that learning is using direct methods without getting used to students forming their own understanding through thinking skills; 5) Users hope that learning physics is presented in a more interesting and innovative way so that the implementation of learning is more enjoyable, but the real conditions show that physics is synonymous with thick books containing formulas and explanations that are difficult to understand so that it does not facilitate students who have a variety of learning styles. Thus, the physics learning model based on synectic is recommended to answer the need analysis to improve problem-solving skills which can achieve the goals expected by the currently developing curriculum.

#### **DISCUSSION**

Need assessment is the gap-determining process between current performance and the desired state. The gap indicates a needs assessment will culminate in making recommendations to research subjects regarding the products to overcome these gaps (Stefaniak, 2020). Physics is a subject that is considered difficult for students, identical with abstract concepts, and full of formulas and equations. Students want physics learning presentations to be contextual so that they feel alive in their minds and easy to conceptualize. Answering physics problems is difficult for students because they do not understand the basic concepts used to solve a problem, so they have no direction in starting problem-solving. Students are happy if they find concepts independently by expressing their thoughts as an activity and creativity. Creative problem-solving in physics can do with the analogy. If the analogy is appropriate, it can help students construct new knowledge and relate to past learning experiences. This can make students understand new problems easier (Aubusson et al., 2005). The analysis results show that students need help in contextualizing concepts in physics problem-solving. The results of the curriculum analysis show that the learning models application directs students to have thinking skills as the foundation for problem-solving. Building thinking skills can train students to produce ideas independently. Thus, teachers are required to activate students' brain functions with thinking activities, one of which is by thinking metaphors and analogies. The development of a physics learning model based on synectic is needed to build or overcome learning difficulties experienced by students due to their inability to contextualize physics concepts so that they do not have a basis for continuing thinking skills at the stages of analysis, evaluation, and creation. Synectic is applied to help someone develop a fresh way of thinking while empathetic to differences of opinion or not just justifying logical solutions but even accepting different views and showing correct and more creative possibilities (Nuridin & Adriantoni, 2016)

Synectic learning models train students to have metaphorical thinking skills and problem-solving capabilities to learn material hold (Huda, 2019). Synectic learning models can stimulate thinking skills, including metacognitive thinking skills and problem-solving (Suhana, 2019). The development of a synectic foundation physics learning model can collaborate with interesting learning materials presentation is expected to help in better physics concepts achievement and developing creative thinking as a basis for physics problem-solving. Synectics can be integrated into learning activities to develop metacognitive abilities as a foundation for thinking skills. Synectics can direct divergent thinking skills that allow a person to internalize the ideas into new ideas for problem-solving (Hargrove & Nietfeld, 2015).

Synectic proves that creative thinking can be trained and developed. Someone can solve problems through different perspectives and ways according to their creativity. Synectic is a method of metaphoric thinking or intellectual innovation through imagination and the use of analogy as a comparison to form a new idea. The synectic model is a learning pattern that trains logical thinking compared to conventional learning implementation (Abed et al., 2015). Synectic can be collaborated with learning technology by embedding synectic elements into learning simulations. The application of synectic elements to making something foreign or abstract into familiar or known. If synectics is packaged with a simulation, it can help teach abstract concepts in real life. So that besides helping to streamline learning, it also helps students achieve learning goals (Kallonis & Sampson, 2011). Thus, the physics learning model based on synectic can maximize learning outcomes that direct students to thinking skills, so it can be recommended to improve problem-solving skills.

## CONCLUSION

The development of a physics learning model based on synectic is urgently needed which is indicated by the tendency of students' ability to solve physics problems to be low and a creative way of synergizing between lecturers and students are needed in learning physics. Thus, the physics learning model based on synectic is recommended to improve problem-solving skills.

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