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NEED ANALYSIS IN THE DEVELOPMENT OF MINI RESEARCH-BASED GENERAL PHYSIOLOGY LEARNING SETS

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ABSTRACT

The general physiology course prepares prospective junior high school science teachers to master the content and science process skills. Skills used to acquire or apply science concepts, laws, theories including mental, physical and social skills are called science process skill. Science process skill is the basis for making rational and correct decisions about controversial issues. Science learning, including at the Junior High School level, should ideally not only be memorized knowledge but also a research process using science process skills, so that students are able to gain science knowledge from new phenomena in nature. To improve the students' science process skills, the learning sets used by lecturers should be implemented effectively, so it is necessary to analyze the needs of learning sets. The research aims to explain the need analysis in the development of mini research-based general physiology learning sets. The research method used is a qualitative study with the data analysis technique of the Miles & Huberman Model. This research was conducted in January 2022 at the Science Education Study Program, Faculty of Teacher Training and Education, University of Sultan Ageng Tirtayasa, Indonesia. Need analysis of learning sets includes needs in the aspects of students, concepts, assignments, and learning objectives. Needs analysis results are learning sets for general physiology based on mini-research suitable for improving the science process skills of prospective science teachers. Comprehensive and truly needs analysis can apply to the next stage of research and development. It can be concluded that the development of mini research-based general physiology learning sets should be conducted according to the findings of need analysis.

Keywords: ***Development, General Physiology, Learning Sets, Need Analysis, Mini-Research***

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Introduction

Natural Sciences consists of scientific disciplines such as biology, chemistry, physics, that explain natural phenomena using procedures called scientific methods (Schlagwein, 2021). Science, which consists of various scientific disciplines, shows that science produces products, while the use of scientific methods shows that science is a research process that requires certain skills (Murdani, 2020). Skills used to acquire or apply science concepts, laws, theories including mental, physical and social skills are called science process skills (Rustaman, 2010). Science learning, including at the Junior High School level, should ideally not only be memorized knowledge but also a research process using science process skills, so that students are able to gain science knowledge from new phenomena in nature.

Science learning in junior high schools that applies the scientific method and uses science process skills requires a relatively long time, only science teachers who master the material, structure and methodology and are committed can implement it (Verawati & Prayogi, 2016). Science teachers with these characteristics are also able to help students have science process skills to investigate scientific phenomena like scientists (Molefe & Aubin, 2021). Although not all students will become scientists in the future, science process skills is the basis for making rational and correct decisions about controversial issues(Ekici & Erdem, 2020). Science process skill is used as a basis for making rational decisions because it is seen as a problem-solving skill, which is realized through a systematic process to find a solution to the problem (Rauf et al., 2013).

The results of the analysis on professional teacher education provide information that junior high school science teachers who come from biology or physics study programs alone have a low science process skill profile, which has implications for low student science process skill, so the science education study program plays an important role in preparing prospective junior high school science teachers (Setiawan & Sugiyanto, 2020). This preparation is realized through a learning sets with the results of the learning plan and other learning materials (Agustiana et al., 2020). Learning sets needs to be carried out optimally by science education study programs or lecturers in order to produce learning materials that suit the demands of the profile of middle school science teachers.

General physiology is one of the scientific subjects in the Science Education Study Program, Faculty of Teacher Training and Education, Sultan Ageng Tirtayasa University, Indonesia. General physiology courses equip students with knowledge of the physiology of animal and plant bodies, as well as scientific phenomena in everyday life related to physiological concepts using scientific methods. From the observation results, it was obtained that learning information in general physiology courses mostly used the lecture method. The use of the lecture method is contrary to science as a research process on natural phenomena, because it places students as learners who only receive material without using science process skill. The situation of students who are not trained in science process skill shows that the learning sets are not optimal.

The science learning process is pedagogically implemented through two approaches, namely deductive and inductive (Khan et al., 2020). The deductive approach places students as passive learners because the presentation of concepts and examples of their application are carried out by the lecturer, whereas the inductive approach provides ample opportunities for students to carry out a series of processes such as experiments with the guidance of the lecturer (Constantinou et al., 2018). The approach through a series of processes is most suitable, because it develops students' science process skill and is used as a tool for learning science content (Baydere et al., 2020). Learning tools for general physiology courses that are not yet optimal can be overcome by developing learning sets based on a process approach so as to train students' science process skill.

Science process skill is arranged in a hierarchy starting from observation which then depends on the use of previous science process skill, and refers to the scientist's mindset in information production or information communication (Ekici & Erdem, 2020). Pedagogically, inquiry-based learning places students in activities similar to scientists to build their knowledge (Pedaste et al., 2015). Science process skill, which is arranged in a hierarchy and refers to the mindset of scientists, can be facilitated through inquiry-based learning, because it has the same focus, namely placing students who study science like scientists.

Several studies on inquiry-based learning have been proven to train and even increase the science process skill of students or prospective science teachers. Yakar & Baykara research results (2014) explained that the science process skill of pre-service science teachers has increased, especially in identifying variables, which is an important skill when designing investigations. This increase is because inquiry-based learning triggers high curiosity, thereby creating discussion about a problem and leading to finding a solution. Şen & Vekİİ research results (2016) explained that the science process skill of pre-service science teachers has increased, because inquiry-based learning allows pre-service science teachers to design investigations independently so that they are trained to gain knowledge like scientists.

Inquiry-based learning is very popular in the world of educational research and development, because its success increases in line with the latest technical developments (Pedaste et al., 2015). Inquiry small research or mini research is a development of inquiry-based learning that prioritizes independence in discovering knowledge. Mini research consists of a series of activities that mobilize all students' abilities to solve problems and require students to build their own knowledge (Yuhanna et al., 2017).

The characteristics of mini-research are in line with the demands of general physiology courses because it facilitates students to carry out investigations in order to master knowledge of the physiology of animal and plant bodies and their relationship to scientific phenomena in everyday life, while at the same time practicing science process skill. This suitability is the background for conducting research which aims to explain the need analysis in the development of mini research-based general physiology learning sets.

Research Methods

Qualitative research methods were used to analyze the need for general physiology learning tools based on mini-research to improve science process skill. This research was conducted in January 2022 at the Science Education Study Program, Faculty of Teacher Training and Education, University of Sultan Ageng Tirtayasa, Indonesia. The research data comes from observations during general physiology courses. The learning plan, textbooks and assessment instruments previously used were also documented as research data. This needs analysis is also accompanied by a literature review.

The data analysis technique used refers to the Miles & Huberman model (1984) consisting of; (1) data reduction is carried out by making an overview of the data obtained based on research concentration; (2) data display is carried out by presenting the results of data reduction in the form of tables or graphs; (3) conclusion drawing/verification is carried out by explaining the data findings in the discussion which includes student analysis, concept analysis, task analysis, and learning objective analysis. A comprehensive and real needs analysis is beneficial for lecturers because it produces accurate information, so that learning tools for general physiology courses based on mini-research can be developed to increase students' science process skills in line with field needs.

Results and Discussion

The results of the needs analysis include student analysis, concept analysis, task analysis, and learning objective analysis as important information that is used as a basis for designing learning tools and are presented in the following sub-chapters.

Student Analysis

Student analysis is about student characteristics which are aligned with the aim of developing learning tools for general physiology courses, as a solution to the science process skill problem of untrained students. Student characteristics analyzed according to Thiagarajan et al. (1974) namely previous knowledge, cognitive development, and student skills individually and in groups that correlate with teaching and learning activities, media, format, or language. The student analysis carried out in this research included student cognitive development, media, as well as the format of teaching and learning activities.

The theory of human cognitive nature and development according to Piaget (1952) consists of four stages, namely: (1) sensory motor stage at the age of 0-2 years; (2) pre-operational stage at 2-4 years of age; (3) concrete operational stage at the age of 7-11 years; (4) formal operational stage which begins at the age of 11-15 years. The formal operational stage is based on Piaget's theory of human cognitive development (1952). This is the final stage that begins at age 11 or 12 and continues into adulthood, meaning that most teenagers and young adults are at the formal operational stage (Decano, 2017). Students who teach general physiology courses in the sixth semester are classified as teenagers and young adults, so their cognitive development is at the formal operational stage.

Students whose cognitive development is at the formal operational stage according to Piaget (1952) able to think abstractly, create hypotheses and prove them through a systematic process to obtain solutions to problems. Further studies by Piaget (1961) explains why only half of adults and some are not even at the formal operational stage, are influenced by factors such as maturity, active experience and social interaction. The cognitive development of someone who is undergoing formal education according to the explanation of Ewing et al. (2011), is strongly influenced by educators who facilitate exploration activities so as to increase active experience and through social interaction. General physiology courses are designed through exploratory activities to be able to think abstractly and obtain solutions to problems using systematic processes, in accordance with students' cognitive development which is and should be at the formal operational stage.

The cognitive development of sixth semester students is at the formal operational stage so that it is suitable for learning that positions students individually and in groups to think abstractly and obtain solutions to problems using a systematic process, supported by the characteristics of students as Generation Z (Gen Z) or the generation born between 1996 – 2012. This support emerged from students' awareness of practical learning opportunities for career development, because practical learning can develop skills needed in the world of work such as problem solving, collaboration, oral and written communication (Schwieger & Ladwig, 2018).

The suitability of sixth semester students with learning that positions them to think abstractly and obtain solutions to problems using a systematic process is supported by their habit of using technology. Gen Z students are very familiar with the internet which provides information quickly in various fields, apart from that it allows students to study independently at their own pace because of the various forms of information available (Szymkowiak et al., 2021). Easily accessible internet also makes students prefer media that can be accessed by mobile devices as a source of university information which of course applies responsive design principles and can be presented well (Rue, 2018).

Concept Analysis

Concept analysis based on the explanation of Thiagarajan et al. (1974) aims to identify the main concepts to be studied, then sort them to form a hierarchy, and detail each concept so that concepts are formulated that are relevant to development goals. Concept analysis is important for constructing concepts that are used as a means of achieving the skills that students must have at the end of their learning experience.

Concept analysis was carried out by analyzing concepts in the General Physiology Course Learning Outcomes based on the Science Education Study Program Learning Outcomes. The concept analysis also adapts to the content of integrated junior high school science subjects listed in the Middle School Science Teacher's Guidebook by Hardanie et al. (2021), this is done because the general physiology course aims to equip students with knowledge as prospective junior high school science teachers.

Concept selection is carried out by paying attention to its relevance to everyday life to create learning that facilitates students carrying out a series of meaningful processes with the guidance of lecturers. Lago & Cruz (2021) explains that sn important element of contextual learning material that makes it meaningful is that it relates to experiences or phenomena in everyday life or pre-existing knowledge. This concept analysis will later be used in textbooks to train and even improve student science process skill.

The results of the competence analysis of general physiology courses and the content of integrated junior high school science subjects obtained concepts of the physiology of animal and plant bodies which will be used in textbooks to improve students' science process skill. Table 1 below provides a list of general Physiology concepts as a means of improving science process skill.

Table 1. List of General Physiology Concepts as a Means of Increasing Student Science Process Skill

No	Concept of Integrated Science Subjects for Students in Junior High School	The concept of the General Physiology Course based on competence		General Physiology Concepts to Improve Student Science Process Skills	
1	Human coordination system	1.1	Nervous system	1.1.1	The central nervous system controls reflex movements
2	Homeostasis	2.1	Excretory system	2.1.1	Test the urine content & observe the kidneys of cows and goats
2	Homeostasis	2.2	Thermoregulation & osmoregulation in animals	2.2.1	The effect of environmental temperature on animal temperature
3	Plant cell structure & function	3.1	Transport in plant cells	3.1.1	Diffusion & osmosis in plants
				3.1.2	Plasmolysis and imbibition in plants
4	Structure & function of the body of living	4.1	Dormancy & germination	4.1.1	Dormancy in seeds & seed germination

No	Concept of Integrated Science Subjects for Students in Junior High School	The concept of the General Physiology Course based on competence		General Physiology Concepts to Improve Student Science Process Skills	
	creatures-plants	4.2	Transport of plant tissue	4.2.1	Transport of water through xylem
		4.3	Photosynthesis-transpiration relationship	4.3.1	Respiration in plants and the distribution of molecules in water

Task Analysis

Task analysis based on the explanation of Thiagarajan et al. (1974) serves to identify the main and additional skills that are the focus of development. This analysis examines in detail the tasks that will be given to students through general physiological concepts that have been determined in the previous analysis. The task analysis carried out in this research is to determine learning indicators, so that they can train and even increase students' science process skills.

Determining learning indicators for general physiology courses refers to science process skills indicators according to Rustaman (2010) and adjusted to the results of previous student analysis, depth and breadth of concept scope. Table 2 below presents general physiology course learning indicators on one concept, namely plant diffusion derived from competences to increase student science process skills.

Table 2. Learning Indicators for General Physiology Courses

No	Indicators	Sub Indicators		General Physiological Learning Indicators
1	Asking question	1.1	Asking question	Students ask questions about what chemical and mechanical influences affect the diffusion process.
2	Hypothesize	2.1	Put forward a hypothesis	Students propose hypotheses about chemical and mechanical influences on the diffusion process.
3	Planning an experiment	3.1	Determine experimental tools and materials	Students determine tools and materials for diffusion experiments with chemical and mechanical influences.
		3.2	Determine the experimental work steps	Students determine the working steps of a diffusion experiment using chemical and mechanical influences.
		3.3	Determine what is being measured	Students determine the diffusion time interval as the object being measured.
4	Using tools and materials	4.1	Using tools	Students use a stopwatch to measure the diffusion time interval.
5	Carry out trials/experiments	5.1	Carrying out experiments	Students carry out diffusion experiments.
6	Observe	6.1	Carrying out observations	Students observe experiments carried out regarding the object being measured, namely the diffusion time interval.
7	Grouping/ Classification	7.1	Record each observation.	Students record the results of experiments, namely diffusion time intervals based on chemical and mechanical influences.
8	Communicate.	8.1	Create graphs or diagrams.	Students create graphs or diagrams that illustrate the relationship between diffusion time intervals and the effects of chemical and mechanical influences.

Analysis of Learning Objectives

Analysis of learning objectives refers to the explanation of Thiagarajan et al. (1974) which functions to draw conclusions based on concept analysis and task analysis in the form of goals that are expected to emerge after development. The objectives that are expected to emerge are used as a reference for developing learning tools, namely lesson plan, textbooks and evaluation instruments. Analysis of learning objectives carried out based on concept and task analysis, produces the formulation of learning objectives consisting of audience, behavior, condition and degree.

The learning objective to increase student science process skills is facilitated by the mini research learning stage. Mini research learning that facilitates increasing student science process skills is supported by the explanation of Yuhanna et al. (2017) namely mini research which consists of formulating problems, proposing hypotheses, conducting experiments, recording experimental results, processing data, analyzing and concluding according to the learning indicators contained in Table 2. Apart from that, mini research learning according to Yuhanna et al. (2017) which prioritizes independence, in accordance with the characteristics of students whose cognitive development is at the formal operational stage, namely being able individually and in groups to think abstractly and obtain solutions to problems using a systematic process.

The characteristics of students as Gen Z who are accustomed to using technological devices to search for various information also support mini-research learning which prioritizes independence. The results of the analysis of learning objectives for general physiology courses on one of the concepts, namely plant diffusion to increase student science process skills, are presented in Table 3.

Table 3. Learning Objectives for the General Physiology Course

No	Mini Research-based Learning Stages		General Physiology Learning Indicators	General Physiology Learning Objectives
1	Formulation of the problem.	1.1	Students ask questions about what chemical and mechanical influences affect the diffusion process.	Students ask specific questions such as what chemical and mechanical influences are on the diffusion process through the problem formulation stage.
2	Proposing a hypothesis.	2.1	Students propose hypotheses about chemical and mechanical influences on the diffusion process.	Students propose hypotheses that can be investigated using experiments such as the diffusion process being influenced by chemical and mechanical aspects through the hypothesis submission stage.
3	Experiment planning.	3.1	Students determine tools and materials for diffusion experiments with chemical and mechanical influences.	Students determine tools and materials along with their specifications in diffusion experiments with chemical and mechanical influences through the experimental planning stage.
		3.2	Students determine the working steps of a diffusion experiment using chemical and mechanical influences.	Students determine operational work steps in diffusion experiments with chemical and mechanical influences through the experimental planning stage.
		3.3	Students determine the diffusion time interval as the object being measured.	Students determine the diffusion time interval as an object to be measured precisely through the experimental planning stage.
4	Implementation of experiments	4.1	Students use a stopwatch to measure the diffusion time interval.	Students use a stopwatch appropriately to measure the diffusion time interval through the experiment implementation stages.
		4.2	Students carry out diffusion experiments.	Students carry out diffusion experiments in an orderly and timely manner through the experiment implementation stages.
		4.3	Students observe experiments carried out regarding the object being measured, namely the diffusion time interval.	Students observe the experiments carried out regarding the object being measured, namely the diffusion time interval, carefully through the stages of carrying out the experiment.
5	Recording of experimental results	5.1	Students record the results of experiments, namely diffusion time intervals based on chemical and mechanical influences.	Students record the results of the experiment, namely the diffusion time interval based on chemical and mechanical influences, carefully through the stages of carrying out the experiment.
6	Analyze and conclude experimental results	6.1	Students create graphs or diagrams that illustrate the relationship between diffusion time intervals and the effects of chemical and mechanical influences.	Students create graphs or diagrams that describe the relationship between diffusion time intervals and the effects of chemical and mechanical influences precisely through the analysis stage and conclude the experimental results.

Science process skill is arranged in a hierarchy starting from observation which then depends on the use of previous science process skill, and refers to the scientist's mindset in information production or information communication (Ekici & Erdem, 2020). Pedagogically, inquiry-based learning places students in activities similar to scientists to build their knowledge (Pedaste et al., 2015). Science process skill, which is arranged in a hierarchy and refers to the mindset of scientists, can be facilitated through inquiry-based learning, because it has the same focus, namely placing students who study science like scientists.

Conclusion

This study aims at explaining the need analysis in the development of mini research-based general physiology learning sets. The results and discussion of the analysis of needs for general physiology learning tools are that students are at the formal operational stage so that they are suitable for mini-research based learning. Mini research learning positions students to carry out investigations like scientists, thereby facilitating the improvement of science process skills. Increasing student science process skills is also facilitated by selecting general physiological concepts that are relevant to everyday life to trigger curiosity about a problem and guide the search for a solution. Mini-research-based learning that places students like scientists is supported by their status as Gen Z who are familiar with technology, making it easier to quickly search for information in various fields.

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