Preliminary Study Needs Analysis Developing a Relevant and Effective Learning Model Design of Genetics Course

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Abstract *: Learning genetics courses often faces challenges because the material studied is abstract and complex. A relevant learning model is needed that meets the needs of students to improve their competence in genetics courses. This study aims to identify the needs of students and lecturers through a needs analysis approach as a basis for developing a relevant genetics learning model. The study used a qualitative descriptive method. Data were collected through interviews, questionnaires, and document observations. The results of the analysis showed that students needed learning that was more integrated with the context of everyday life to understand the concept of genetics in depth and needed motivational learning because this course was considered a difficult course. The lecturer explained the need to develop a learning model that provides interactive activities, such as project-based learning, case studies, or other effective strategies to improve student competence. Based on these results, a prototype of a contextual genetics learning model will be developed to meet the needs of students and lecturers teaching the course. These findings are the basis for designing a more relevant and effective genetics learning model. The study provides initial insight into the needs of genetics learning and is the first step in developing an effective learning model according to the context of students. Further research is needed to test and implement the proposed model.*

Keywords: needs analysis, learning model, genetics

Introduction

In today's genomic era, the application of genetics has become part of everyday life, applied in the fields of health, agriculture, law, and technology. Genomic topics, which are part of genetics, not only advance genomic research but also provide a better learning experience, knowledge, and confidence for students (Whitley et al., 2020). Therefore, it is important for students studying genetics not to see genetic information as an abstract science but to understand the basic principles of genetics to make the right choices, as one of the solutions to life's problems faced (Machová & Ehler, 2023).

The Molecular Genetics course is one of the advanced courses in the Biology Education study program at Pelita Harapan University. The Genetics course equips students to have a deep understanding of reproduction patterns and inheritance of traits, molecular structure, replication, expression, and regulation of genetic material, which is a unique entity and capacity created by God in living things for their survival.

Facts found in the field: students of the Biology Education Study Program, Faculty of Education-UPH, have difficulty understanding the Molecular Genetics course studied in the

fifth semester. This is illustrated by the results of individual test scores from the Mid-Semester Exam course that have not reached the expected standard. The learning results of the UTS scores in the last three years were that for students in the 2019 intake, the average UTS score was 68.43 with a learning completion of 77.78%; for students in the 2020 intake, the average UTS learning results were 56.70 with a learning completion of 40.74%; and for students in the 2021 intake, the average UTS score was 46.8 with a completion of 33.33%. Based on the learning outcome data, especially for the last 2 years, which were low, it shows that the average learning outcome has not reached a score of 60 (minimum passing). Based on information from the lecturer, one of the difficulties for students is understanding abstract concept material, coupled with students' initial knowledge of the basic concepts of genetics when they were in high school being very weak.

A similar picture was found in a study conducted in the Biology Department of Malang State University on genetics learning. Data obtained from those students who had taken genetics courses stated that genetics was a difficult course because the material was complicated, abstract, and contained many terms. Genetics is known as one of the most challenging subjects in biology education because of its abstract concepts and processes (Angraini et al., 2022). According to Azzahra & Kartikawati (2023), genetics is still considered difficult for students so that there is a chance of an understanding of the concept of genetics that is different from the understanding put forward by experts. Other studies have found that students have difficulty visualizing certain genetic concepts, indicating that the abstract nature of genetics causes learning difficulties (Mussard & Reiss, 2022).

However, other studies have found that some students who have difficulty in certain genetic content knowledge, if overcome, allow them to successfully solve challenging genetic problems (Avena & Knight, 2019). Research conducted by Ayimbila & Akantagriwon (2021) explains concept mapping learning as one of the genetics teaching methods to improve academic achievement.

To achieve effective learning outcomes, a systematic and research-tested molecular genetics course learning model is needed. For this reason, it is necessary to design a learning model that is in accordance with student characteristics, course characteristics, and relevant learning for students. To achieve this, a preliminary study is the basis for developing the model to be carried out.

Research on model development has not been widely conducted; this can be seen from the search for articles via Vos viewer with the keywords *teaching model, genetics course.* 56 articles were selected with the source scopus.com, and the mapping results based on the Vos viewer application are as follows.
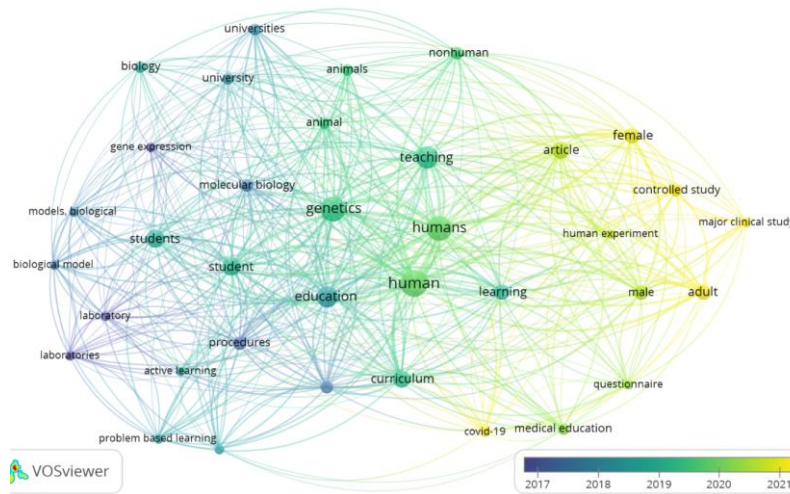
Figure 1. Results of searching for articles on learning Genetics with the vosviewer application

Based on the mapping of Vos viewer data, there has been no specific research on the genetic learning model; only the biology learning model is visible. This is a novelty of this study; therefore, this preliminary study is an important basis for developing genetics learning models. Thus, the purpose of the study is to identify student needs through a needs analysis approach as a basis for developing a relevant genetic learning model.

Method

This research method is descriptive-qualitative, which is rooted in naturalistic inquiry, allowing flexibility in theoretical approaches, sampling techniques, and data collection strategies. The strength of descriptive qualitative research is its straightforward approach, focusing on the perspective of the participants and staying close to the data (Hall & Liebenberg, 2024). Data were collected based on interviews and documentation related to the research topic, notes from in-depth interviews, and the results of document analysis. The subjects of the study were students of the Biology Education Study Program, Pelita Harapan University, who had taken genetics courses. The research instruments were interview sheets and documents. Then data analysis was carried out to describe the phenomenon of genetic learning being studied.

Table 1. Preliminary Research Steps

No	Stages	Activities carried out	Results/output
1	Identification of problems	Needs analysis by collecting data from lecturers, students and Genetics learning documents.	Problems and needs of learning Genetics
2	Literature study	search for literature on genetic learning strategies, identify learning models based on meaningful and motivational instructional design	References to theories, model strategies, and innovations in genetic learning.
3	Formulating research objectives	Formulate research objectives, determine the effectiveness of the Genetics learning model strategy.	Formulation of objectives that are relevant to the problem

No				
4	Designing Research Instruments	designing data collection instruments for interviews, document observation sheets	Valid and reliable instruments for data collection
5	Initial Data Collection	Interviews with lecturers and students about their experiences in learning genetics. Document observation	Initial data on genetics learning problems and needs.
6	Preliminary Data Analysis	Qualitative data analysis based on interviews and document observations	The results of the analysis show urgent areas for learning development.
7	Formulation of Development Plan	Based on the results of the analysis, the needs were determined, namely the development of learning models, learning modules, teaching guides by lecturers.	Development plan

Results and Discussion

Based on the results of interviews with students, students expressed concerns about their competence in the genetics course; this was confirmed when the student's conducted *microteaching* on the topic of genetics; students did not master the basic concepts of genetics. The following is a summary of the results of interviews with students.

Table 2. Results of interviews with students who have completed the Genetics course

No	Question	High score group students	Students in the medium value group	Low Score Group Students
1	What is your perception of the Genetics course?	I think this course is challenging because it is complex and there are many abstract concepts that must be studied diligently. If you don't understand the concept, you will be confused.	I find this course difficult, I find it difficult to differentiate one topic from another.	In my opinion, this course is the most difficult, because when I was in high school during the pandemic, the teacher did not explain this material, so when some of my friends knew about Mendel's laws, but I myself did not know, because I felt I did not have any initial knowledge so I felt this course was very difficult.
2	What material do you master the most and which material do you not master, why?	The material that I have mastered is Mendel's law 1 and Mendel's law 2, what I have not mastered is gene expression and gene regulation.	Now I'm not sure I still remember the material, at least I still remember Mendel's law a little.	I don't think I remember anything for sure, it seems like I really don't understand this course.
3	What obstacles do you face in studying Genetics?	One material is interrelated with another, if you don't know the concept, you will be confused and not understand the next topic.	There is a lot of abstract material so it is difficult for me to understand it, my initial knowledge of genetics is not strong	I feel that studying genetics is difficult, so even though I have passed this course, I feel like I haven't mastered it because I don't have a strong understanding of the concepts.

4	In your opinion, what learning media is suitable for learning genetics?	I am very helped by the videos from *YouTube* that the lecturer gave me and that I searched for myself, because it helped me understand abstract concepts. I also learned from the lecturer's PPT, textbooks and searching on the internet.	I can also be helped by videos from *YouTube* , but there are also language barriers because they are in English, so I still need videos in Indonesian.	I also tried to learn with videos, through lecturers' journals and PPTs and also textbooks, but still need help from someone more expert. When the lecturer provides a tutor for those of us with low grades, it helps us understand the concept because we can ask the tutor repeatedly if we still don't understand.
5	What kind of activities do you think can improve your mastery of the Genetics course?	activities that activate students, because when we participate in learning, we will remember more than just listening to the lecturer's explanation	Inviting students to be active, such as in discussions, *Jigsaw, problem-based learning,* helps us learn the materials taught by lecturers better.	It is better if the activity repeats the previous material before continuing to the next topic, so that it can be understood better. Activities carried out in learning such as discussions, jigsaws, discussions and *problem-based learning* help learn the materials taught by the lecturer, do not feel bored, we are encouraged to be active.
6	What is your input for this course?	Because this learning is complex, it would be good if we were provided with tutors to guide us in learning this material.	If possible, before starting the next lesson, we are always given the opportunity to repeat the previous material, even though we know the lecturer's time is limited, but it really helps me to remember the lesson.	There needs to be a tutor, the previous material must be mastered first before continuing to the next meeting.
7	In your opinion, are modules necessary to master Genetics learning?	I totally agree ma'am, if there is a module it will help us in learning, because it will be structured. We have standard sources that must be mastered. Sometimes if we look for the material ourselves or ask the tutor, it is sometimes different, so we are confused about which one is correct. If there is a module, we will stick to the contents of the material contained in the module	I think it is very necessary, ma'am, because it will make it easier for us to master the material, because the module is definitely well-structured so that it is easier to understand than reading a textbook. We are helped to understand important material.	I agree ma'am, because the module is more systematic and easier to understand. It is better than just PPT, because the explanation is more complete. So the module is very helpful ma'am.

Based on table 2, it can be concluded that the obstacles faced by students with middle and low academic levels are that they find it difficult to differentiate one topic of material from the next, they feel they lack basic knowledge about genetics at the high school level, and there is already a perception that this course is considered difficult. The results of interviews with lecturers stated that students have difficulty understanding material with abstract

concepts. The mastery of biology learning in high school about the basic concepts of genetics is very weak, thus affecting students' ability to learn genetics. Lecturers have applied various methods in lectures, including collaborative learning, jigsaw, *gallery walk,* inquiry, *problem-based learning,* and group investigation. The result is that students can only answer lecturers' questions during learning, meaning only as far as *short-term memory.* After completing the learning, students do not explore enough sources of material to enrich their understanding of the concept, whereas to master the concept of genetics, independent learning is needed by repeating the material independently. The following are the results of interviews with lecturers who teach the course.

Table 3. Results of interviews with lecturers teaching the Genetics course

No	Question	Explanation from the lecturer
1	What are the learning outcomes of the Genetics course obtained by students in the last 3 years in the UPH Biology Education study program?	In the last 3 years, student learning outcomes in the Genetics course have not shown significant progress. Every time a Genetics course exam is held, there are always students whose scores are below 55 (the passing standard). The number can vary in each class, but generally students who fail the Genetics course exam are around 10% to 35% of the total number of students per class.
2	Based on your experience, what obstacles do students face in the Genetics course?	There is an initial assumption that Genetics is a difficult course. Difficulty in understanding the concept, students tend to memorize the material so that it is difficult to answer questions related to understanding the concept.
3	In learning Genetics, what topic is considered the most difficult by students? Why is it considered difficult?	The process of gene expression regulation. This topic is an advanced stage of gene expression material. Students find it difficult to describe the complexity of regulation that occurs in gene expression. Various types of inheritance patterns (Mendelian, Mendelian extension and non-Mendelian). This topic is broad enough that students need to distinguish between these types of inheritance patterns.
4	What learning model is applied in the Genetics course, is it effective in helping students master the learning?	Collaborative Learning Model *: Jigsaw, Gallery Walk, Inquiry and problem-based learning* . Students conduct group investigations and interactive lectures and Q&A. The methods are quite varied but students lack independent learning.
5	What learning resources are used in the Genetics course? Is there a Genetics module that serves as a study guide for students?	Printed books PPT lecturer Scientific journals and related websites Learning video: *youtube* There is no module yet that can be used as a study guide for students.
6	In your opinion, what learning tools are needed so that students can be more effective in learning the Genetics course?	Students need modules or textbooks that can help them understand the concepts taught, and can repeat learning independently according to the guidance provided.

Based on the results of interviews with the lecturers, it can be concluded that the lecturers have used various learning methods, but students still have difficulty understanding

concepts, tend to memorize material, have short memories, only remember material during learning, but when the exam is obtained, the results are not satisfactory.

Based on research conducted by Rusmana et al. at the Indonesian Education University, it was found that American undergraduate students showed a better understanding of genetics than Indonesian students. The largest value gap was in the topics of inheritance mechanisms, protein synthesis, reproduction and expression of genetic material, and mutation (Rusmana, Ai Nurlaelasari; Rahmatullah, Arif; Nareni, Eni; Ha, 2021). In line with the research on learning genetics, the results of research in the Biology Department of the State University of Malang stated that students who had taken the genetics course stated that genetics was a difficult subject because the material was complicated, abstract, and contained many terms (Angraini et al., 2022). Genetics is known as one of the most challenging subjects in biology education because of its abstract concepts and processes; authentic learning is expected to improve understanding and provide experience for students (Mierdel, J., Bogner, 2021). However, it is highly expected that the knowledge gained from genetics should be used to improve the understanding of education professionals about the biological origins of differences in mental abilities, thus empowering them to adopt more respectful and flexible educational practices to achieve learning goals (Bueno, 2019).

With the challenging characteristics of the genetics course, an effective learning design is needed so that students can master the learning well. One of the instructional designs used in colleges to develop course learning devices is based on the instructional design "Significant Learning Integrated Course Design by Dee Fink in a book entitled Creating significant learning experiences. An integrated approach to designing college courses (Fink, 2003).

Instructional design according Fink's presents active and meaningful learning activities. According to Wibisono (2014), the active learning system is a strategy to bring learning closer to the material studied through the learning process in achieving the expected goals. Thus, Fink's instructional design known as Significant Learning Integrated Course Design can facilitate and help students learn actively. Research from Choden & Kijkuakul (2020) shows that active teaching and learning approaches are an effective pursuit for teaching basic genetics.

To be an active learner, a student must have strong motivation, especially for courses that are considered difficult. Active learning requires instructional design that is developed according to the needs of students so that it is effective. It is expected that students have a strong will to learn difficult material. The motivational learning model strategy is one of the choices that helps students achieve more meaningful learning. One of the motivational learning models is the ARCS model, which is an acronym for attention, relevance, confidence, and satisfaction. The ARCS model is a motivational learning model developed by Keller. This model is designed to influence learning motivation. The ARCS model can be applied to improve student learning motivation and bring about changes in specific motivational components such as increasing curiosity, developing self-efficacy, and overcoming feelings of anxiety and helplessness (Keller, 2010). The ARCS model in teaching includes elements that

can stimulate student curiosity and maintain interest; the teaching content has strong relevance to students' prior knowledge; and students have the confidence to achieve learning goals and feel satisfied after completing learning goals. The ARCS model can be used to design effective motivational instruction in various subjects by adapting different teaching methods (Fang et al., 2023).

Based on the problems in the field, there is a need to conduct research aimed at improving student competence in genetics courses by conducting research and development to produce effective genetics learning model strategies, helping students achieve learning goals, and being competent as prospective teachers to teach biology subjects in high school. In addition, it is expected to help lecturers carry out systematic teaching through learning designs that are arranged based on Designing Courses for Significant Learning, which is integrated with the ARCS model, thus producing an instructional design with a learning model strategy that suits student needs through proven research and development stages. The following is a table that illustrates the relationship between student needs in learning genetics and the ARCS model, which is expected to solve the problem.

Table 4. ARCS Model in facilitating learning of Genetics courses

No	Student needs in learning Genetics courses	ARCS Model Components	Instructional design
1	The perception of genetics students is that it is difficult, it requires interesting learning, so that they are motivated to learn with high student curiosity.	*Attention*	A learning design that stimulates and creates an interesting learning experience for learning Genetics. Capturing interest in learning, stimulating high curiosity to learn
2	Students consider genetics abstract and complex, students need relevant genetic knowledge, so that it is related to students' lives.	*Relevance*	Designing learning so that learning experiences are meaningful and valuable for students, meeting students' needs to achieve learning goals with a positive attitude.
3	Students feel less confident in their ability to master learning Genetics well	*Confidence*	Learning design that helps students be confident to succeed in mastering the Genetics course
4	Students are worried about achieving good learning outcomes in the Genetics course.	*Satisfaction*	Learning designs that strengthen student achievement

Based on preliminary study This research is directed to develop instructional design based on integrated course design Fink (2013) by integrating the ARCS model according to John Keller. It is expected that with this development, lecturers will be more effective in teaching genetics courses, and students can achieve the expected competencies. The results of the development are an example for the development of learning design in other courses according to the context of learner needs in higher education.

Conclusion

Based on the analysis of the needs of Genetics learning, it is necessary to develop a Genetics learning model that is relevant to active and motivating learning through the

integration of instructional design by Fink and ARCS by Keller. The development of teaching materials in the form of modules and lecturer guides also needs to be developed for effective learning. This study provides initial insight into the needs of genetics learning and is the first step in developing an effective learning model according to the context of students. Further research is needed to develop and test the implementation of the proposed model.

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