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Empowering Scientific Attitudes in Biology Students through the SIRI Learning Model

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Abstract: This study aimed to investigate the effect of SIRI learning model in empowering scientific attitudes in biology students. This experimental study was conducted with a nonequivalent pretest-posttest control group design and involved 95 biology students at Makassar State University, Indonesia. Data were collected using a scientific attitude questionnaire. The scientific attitude rubric was used to assess students' statements and the results were analyzed using ANCOVA at the 0.05 level of significance. The findings showed that there was an effect of SIRI learning model on scientific attitudes in biology students. The LSD test results also showed that the scientific attitude scores using the SIRI model were significantly different from the STAD learning model and the lecture model class. It is concluded that the SIRI learning model can improve scientific attitudes in biology students.

Keywords: Biology; Learning Model; Scientific Attitude; SIRI

Introduction

Education plays an important role in producing quality generations. Every level of education is obliged to provide opportunities for every learner to acquire knowledge, skills, and values to prepare them for the world competition that is getting tougher every day (Jamaluddin et al., 2022). Meaningful education is seen as an important educational goal and a necessity in facing the challenges of the 21st century (Sudjimat et al., 2020; Zain, 2017). According to Karakaya Ozyer & Altinsoy (2023), the results of meaningful learning have a great opportunity to produce a quality learning process, both from the cognitive, affective and psychomotor aspects.

One of the objectives of learning biology at the higher education level is to develop students' (Prachagool & Arsaiboon, 2021). Scientific attitude is an attitude that is directed to achieve an objective knowledge (Alkiş Küçükaydin, 2022; Saraç Yıldırım & Doğru, 2023). Learning science can help students to understand nature and its symptoms related to research and investigation so as to foster scientific attitudes (Erduğan, 2020). According to Kareem (2022), the level of reasoning towards objects and psychomotor skills also determines one's attitude towards their quality. Students who have a high scientific attitude will have fluency in thinking so that they will be motivated to always achieve and have a strong commitment to achieving success and excellence (Küçükaydın, 2021; Pascaeka et al., 2023). Fitriana et al (2020) states that scientific attitudes are very important in social life because they can shape human personality in making rational considerations when making a decision.

However, the facts in the field show that scientific attitudes in students are of concern. The results of observations show that the average score of scientific attitudes of biology students at Makassar State University, UIN Alauddin Makassar, and Muhammadiyah Makassar University is in the low category, namely 47. In addition, several studies have also shown that scientific attitudes in students at the

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lower and middle school levels also need special attention (Pascaeka et al., 2023; Sanudin & Aminatun, 2023).

The low scientific attitude of students is caused by several factors. Less learning in applying scientific attitude assessment to students is one of the factors (Adiansyah et al., 2021). Survey results show that 39% of biology educators have difficulty developing students' scientific attitudes due to habitual factors, interaction time with students, and generally practical thinking (Çalik & Özgür Karataş, 2019; Saraç Yıldırım & Doğru, 2023). In addition, empowering the attitude of curiosity, fostering the attitude of creativity, and the attitude of science is still not considered in the learning process (Hasmawati et al., 2023; Prachagool, 2021). Although all biology educators realize and state the importance of fostering scientific attitudes for students. According to Wildan et al (2019), expository science learning does not foster students' scientific attitudes because learning emphasizes more on providing definitions, concepts, or principles from educators. The application of scientific attitudes in biology learning is generally still limited to indicators that have never been measured in real terms on the competencies that have been obtained by students (Pattipeilohy et al., 2022).

Scientific attitudes formed in learning will provide experience for students to recognize and understand the nature of interaction in the learning process (Dewi et al., 2021). Scientific attitudes can help students to learn scientifically, structured, and independently (Sakin, 2016)). Therefore, empowering scientific attitudes is important to do. One way to empower students' scientific attitudes is by using problem-based and cultural learning models. SIRI is one of the learning models that uses the principles of problem solving and culture-based learning (Jamaluddin, Palennari, et al., 2023; Jamaluddin, Zubaidah, et al., 2023). The character of the SIRI model can provide more experience to students in the learning process. In addition, the SIRI learning model can also be an effective solution in shaping quality characters that have a positive impact on students' knowledge skills (Palennari et al., 2023). According to Akib (Akib, 2016), the problem-solving and culture-based learning model is one of the complete learning models in presenting cognitive, affective and psychomotor dimensions.

Based on the description above, the positive characteristics contained in the SIRI learning model are assumed to form scientific attitudes in biology students. Therefore, the effort made in overcoming the problem is to apply the SIRI model in shaping scientific attitudes in biology students. The hypothesis of this study is that the SIRI model can influence the formation of scientific attitudes in biology students.

Method

Type of the Study

This research used quasi-experiment with posttest-pretest non-equivalent control group design (Sugiyono, 2009). There were three treatment groups in this study, namely the class that used the SIRI learning model (experimental), STAD class (positive control) and lecture model class (negative control).

Population and Sample

The population of this study were all biology education students at Makassar State University (UNM) in the class of 2022. The research sample consisted of 33 students in the SIRI class, 31 students in the STAD class, and 31 students in the lecture model class. The sample is students who program the Animal Physiology course determined using purposive sampling technique. All class samples were equal in terms of knowledge based on grouping test data.

Instruments of the Study

The data for this study were collected using learning tools and scientific attitude instruments. The scientific attitude instrument uses a questionnaire, which is a non-test instrument in revealing scientific attitudes after studying animal physiology material for one semester. The scientific attitude questionnaire was developed by the researcher by modifying Harlen (1992) rubric which includes dimensions: 1) inquisitiveness, 2) respect for data/facts, 3) critical thinking, 4) discovery and creativity, 5) open-mindedness and cooperation, 6) perseverance. The instrument uses a Likert scale with the options strongly agree, agree, disagree, strongly disagree using a score of 1-4.

Prior to data collection, all instruments were expertly validated. Three lecturers validated the learning tools and research instruments. The results showed that the scientific attitude questionnaire consisting of 24 questions was valid with a validity value of 0.62-0.73 and reliable with a value of 0.75-0.81. The learning tools such as syllabus, lesson plan, student worksheet, were also valid with scores of: 4.23, 4.41, and 4.18.

Data Analysis

Students' scientific attitude data were analyzed using Analysis of Covariance (ANCOVA) and LSD (Least Significant Difference) tests with SPSS for windows version 21.0. Before ANCOVA analysis, normality and homogeneity tests were conducted. The normality test was conducted using the one-sample Kolmogorov-Smirnov Test, and the homogeneity test was conducted using Levene's Test. After that,

ANCOVA and LSD tests were run to investigate the effects of the SIRI learning model on scientific attitudes. The LSD test was conducted to investigate the significance level of the learning model.

Result and Discussion

Result

The Results of the Normality Test and Homogeneity Test of the Students'

Normality and homogeneity tests showed that the scientific attitudes of biology students before and after treatment were normally distributed and homogeneous as presented in Table 2.

Tabel 2. The Results of the Normality and Homogeneity Tests of the Students'

Treatment Group	N	Normality	Homogeneity
Scientific Attitudes -pretest	95	0.63	0.37
Scientific Attitudes -posttest	95	0.72	0.41

The average score of students' scientific attitudes on 6 indicators shows that open-mindedness and cooperation are the highest indicators of scientific attitudes. Curiosity is the lowest scientific attitude indicator obtained in the results of this study. The average value of scientific attitudes of biology students is presented in Figure 1.

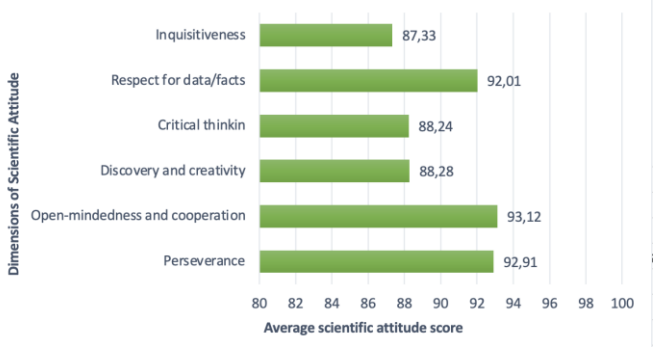

Figure 1. Average Scientific Attitude Score

The results of Anakova test on students' concept mastery in SIRI learning model, STAD and Lecture Model class are presented in Table 3. Based on the results of the ANOVA test in Table 3, it can be seen that the p-value = 0.001. p-value < α (α = 0.05). Thus, the hypothesis that there is an influence of the learning model on scientific attitudes in biology students is accepted. That is, there is an influence of the learning model on the formation of scientific attitudes.

Furthermore, to see how big the significance of the difference in the value of student attitudes in the three treatment classes, further tests were carried out using the LSD test. LSD test results can be seen in Table 4.

Table 3. Ancova Test Results of the Influence of Learning Models on Students'

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1832.639[a]	3	661.212	417.467	.000
Intercept	1811.192	1	19387.722	7992.292	.000
Tes Awal	619.937	1	622.271	354.024	.000
Model	711.108	2	324.415	271.006	.001
Error	203.911	92	1.862		
Total	550221.720	94			
Corrected Total	2513.072	95			

Table 4. Summary of LSD Test Results on the Effect of Learning Models

Models	Pre-	Post-	Devia-tion	Increase (%)	Mean score	LSD Notation
SIRI	43.82	91.02	47.20	107.71	90.32	a
STAD	45.21	73.85	28.64	63.35	74.03	b
Lecture model	41.01	60.19	19.18	46.77	60.93	c

The LSD test results in Table 4 show that the scientific attitude in the SIRI learning model is significantly different from the STAD and lecture learning models. There is a difference in notation between the three learning models. These results show that the corrected mean of students' scientific attitudes in the SIRI learning model of 90.32 is higher when compared to STAD of 74.03, and the class using the lecture model has the lowest corrected mean of 60.93. Further test results show that the SIRI learning model has better potential in empowering scientific attitudes in biology students.

Discussion

The results showed that the three classes given treatment had an influence on the formation of scientific attitudes of biology students. It can be seen that the SIRI learning model has a more effective value in presenting scientific attitudes during the learning process. This is due to the SIRI learning model which has a quality learning stage process, starting from the stages of stimulation, investigation, review, and inference.

Scientific attitude assessment consists of the dimensions of curiosity, respect for data/facts, critical thinking, discovery and creativity, open-mindedness and cooperation, and perseverance. In the curiosity attitude assessment, students have no obstacles in writing questions, looking for more reading sources related to the material, attention and enthusiasm in the learning process. The results of interviews with educators are in line with the results obtained, it was found that while using the SIRI model, students have been accustomed to writing questions and looking for many reference sources in learning. According to Camci (2015), the indicators that must be included in learning to measure this dimension are that students must ask questions or get used to looking for sources outside the textbook about material related to learning as deeply as possible.

In the dimension of respect for data/facts, there are five indicators such as being objective/honest, not manipulating data, making decisions according to facts, and mixing facts with opinions. Based on these indicators, the assessment of these attitudes has been applied to the SIRI learning model. Students become able to respect facts because they are used to it. In addition, several other factors that allow honest scientific attitudes to grow are due to the SIRI model which has honesty values so that an honest culture in students can emerge properly (Jamaluddin et al., 2022).

The dimension of critical thinking attitude has several indicators such as not mixing facts with opinions, doubting friends' findings, asking about any changes hings, repeating the activities carried out, and not ignoring data even though it is small. The results of the research on students' scientific attitudes are in line with what is desired. It can be seen that the questionnaire results provide satisfactory scores. The results are in line with the learning process in the classroom, in the process of discussion and presentation, students can provide questions, statements and critical attitudes during class. These results prove that SIRI can shape scientific attitudes, especially in critical thinking indicators.

Scientific attitudes in the dimension of discovery and creativity consist of several indicators, such as using facts for the basis of conclusions, showing different reports with classmates, changing opinions in response to facts, using practical tools properly, suggesting new experiments, and describing new conclusions from observations. The SIRI model provides an extraordinary experience in presenting the attitude of discovery and creativity of students, especially during the laboratory. The attitude of discovery and creativity of students will appear well if supported by the right learning model and facilities (Hadiati et al., 2019; Kayacan & Ektem, 2019).

In the dimension of open-mindedness and cooperation, indicators such as respect for other people's findings, willing to change opinions if data is lacking, accepting suggestions from friends, not feeling always right, considering every conclusion is tentative, and actively participating in the group. The SIRI model provides opportunities for students to work together and openly accept opinions or suggestions from other students. The implementation of the syntax of the problem-solving-based learning model can have an impact on students, in the form of self-confidence, the ability to work independently, learn to accept and give opinions, democracy, the ability to analyze, learn to share with others (Bachtiar et al., 2018; Jamaluddin, Palennari, et al., 2023).

In the last scientific attitude dimension, namely perseverance whose indicators consist of the attitude of continuing to research after the "novelty" is lost, repeating experiments even though they result in failure, completing an activity even though other friends' tasks are completed earlier. Related to the SIRI model, this scientific attitude of perseverance can be realized. The complex learning syntax directs students to think, trains students to be independent and diligent in completing tasks. Environmentally sensitive attitude consists of attention to surrounding events, participation in social activities, and keeping the environment clean. Problem solving and culture-based learning help students' metacognitive and affective and can improve relationships among students, self-esteem, social skills, and attitudes towards learning (Arsih et al., 2019, 2021; Hidayati et al., 2020).

This study also found interesting facts that the steps that educators should take in fostering scientific attitudes are trying to remind students to always try to improve the quality of themselves on scientific attitudes, and always focus on lecture material. Students who are well motivated in the learning process will have an impact on effective results. Thus, if this is done maximally, then fostering can fully occur and run smoothly (Eğmir & Ocak, 2020; Ocak et al., 2022; Rohaeti et al., 2020).

In general, improving scientific attitudes can occur well if science learning is presented by reducing the role of 'lecture' and increasing the role of 'facilitator' through

practical activities that encourage 'doing science' such as observation, testing, and research (Kırılmazkaya & Dal, 2022; Suryandai et al., 2022). Th changes in students' scientific attitudes after learning show that a person's attitude is not static but can undergo changes due to the learning process, and attitudes can change due to the conditions and influences given (Erduğan, 2020; Genç & Evran Acar, 2021; Maison et al., 2020).

Conclusion

The results showed that the SIRI learning model had an effect on the formation of scientific attitudes in biology students (p-value <0.005). In addition, the SIRI learning model contributes better in shaping students' scientific attitudes than other learning models. These findings indicate that SIRI as a learning model can be used in learning to improve scientific attitudes in biology students. This research is interesting to study and develop because it can provide important information for educators in implementing learning strategies that can foster students' scientific attitudes. The implementation of scientific attitude formation by educators is carried out by showing examples of scientific attitudes, positive reinforcement of scientific attitudes, and providing opportunities for the development of scientific attitudes. Scientific attitudes focus on the tendency, readiness, and willingness of students to respond or behave scientifically during the learning process.

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The authors declare no conflict of interest.

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