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RESEARCH ARTICLE

The Influence of Conceptual Change Model with Cognitive Conflict Approach Integrated with Mobile Learning on Science Literacy and Digital Literacy to Support SDGs Achievement among Students

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ABSTRACT

One of the biggest challenges in education today is equipping students with the skills needed to face complex problems, such as climate change, poverty, and social inequality, which are included in the Sustainable Development Goals (SDGs). One important factor in supporting SDG achievement is increasing science and digital literacy among students. However, to achieve this, it is necessary to innovate the learning process with alternative applications of CCM-CCA integrated with mobile learning. This study aimed to determine the effect of CCM-CCA integrated with mobile learning on students' science literacy and digital literacy to support the SDGs program. This type of research is a quasi-experimental study with a pretest-posttest control group design. The data collection technique used a test technique using science literacy and digital literacy tests. The data analysis technique used the Manova. The results of the study showed that there was an effect of CCM-CCA integrated with mobile learning on the science literacy and digital literacy of students. This is a supporter of achieving the SDGs goals, especially SDG 4. In the future, it is hoped that this learning model can become a solution and innovation for learning models used in the classroom so that the SDGs goals can be fully achieved.

1. INTRODUCTION

In the era of globalization and rapid technological development, education has a very important role in creating a generation that is not only academically competent but also able to adapt to changing times. One of the biggest challenges in education today is equipping students with the skills needed to face complex problems, such as climate change, poverty, and social inequality, which are included in the Sustainable Development Goals (SDGs). SDGs are a development program to improve economic and social welfare, one of which is through education which is seen as having an important role (Fitria & Hamdu, 2021; Purnamasari & Hanifah, 2021). Education can be used as a starting point for accelerating efforts to build a quality nation. Quality and appropriate education is one of the goals of SDGs (SDG 4) (Risyani et al., 2024). This emphasizes the importance of in-depth, inclusive, and technology-based learning that integrates SDGs into learning, especially science learning with various topics that follow the goals of achieving SDGs. In recent years, research related to SDGs has been increasingly directed at implementing SDGs in learning which is a form of Education for Sustainable Development (ESD) (Khusniati et al., 2024). However, SDGs in several schools have never been introduced to students during the learning process and there have never been any learning innovations that integrate SDGs (Junirianto et al., 2023).

One of the important factors in supporting the achievement of SDGs is increasing scientific literacy and digital literacy among students. Scientific literacy refers to the ability to understand scientific concepts and apply them in everyday life. There are three main competencies of scientific literacy, namely 1) describing facts that occur scientifically, 2) designing and testing hypotheses through investigations and 3) analyzing the results of investigations. Scientific literacy skills are important to practice so that students can have the ability to think scientifically in providing solutions to problems that occur around them (Hidayati & Rachmadiarti, 2024; Nuzula & Sudibyo, 2022). A society that is literate in science can be achieved through education, so education must be able to prepare and equip students with scientific literacy skills which are components of the 3 basic literacy skills that students need to have in 21st-century learning. However, the condition of student scientific literacy in Indonesia is very concerning. After almost 20 years of participating in scientific literacy measurement activities, the results show that Indonesian students' scientific literacy is still relatively low and is always in the top 10 countries with the lowest scientific literacy (Rohmaya, 2022). The low level of science literacy of students in Indonesia is influenced by various factors, including the curriculum and education system, the selection of learning methods and models by teachers, learning facilities, learning resources, and teaching materials (Pantiwati et al., 2024). This is an important concern so that every learning process is given innovation and learning variations that can hone students' science literacy.

Meanwhile, digital literacy is related to the ability to access, analyze, and use digital technology effectively. Digital literacy is the ability of individuals to search for, evaluate, and compile information in the form of writing and other media in various digital programs or platforms (Yunita & Watini, 2022). 4 pillars of digital literacy are important to understand and introduce regarding information and communication technology devices, namely digital skills, digital culture, digital ethics, and digital safety (Aida, 2022). This digital literacy is important to introduce early on in order to train children's cognitive abilities to understand digital technology slowly. Another contribution that can be made with digital literacy is to help society continue to move forward by becoming a fortress or vanguard in the use of better and more positive social media. People who have good digital literacy will find it difficult to be affected by hoaxes (Anggraini et al., 2021). Based on this, both skills (science literacy and digital literacy) are very important in supporting the achievement of SDGs goals, especially those related to environmental awareness (SDG 13), quality education (SDG 4), and health and well-being (SDG 3).

On the other hand, information technology is increasingly dominating the world of education, many students still have difficulty understanding basic concepts in science and developing digital literacy skills. This is often caused by misconceptions or wrong understandings related to the science concepts they are learning. To overcome this problem, a learning approach is needed that is not only effective in delivering material but also able to overcome misunderstandings that occur in students. The Conceptual Change Model with Cognitive Conflict Approach (CCM-CCA) is one alternative learning approach that has been proven effective in changing students' misunderstandings and improving their understanding of more complex concepts. CCM-CCA focuses on how students can change or improve their understanding through interaction with new concepts. On the other hand, this learning model utilizes cognitive conflict to challenge existing understandings and encourage students to review their knowledge. The combination of these two approaches provides an opportunity for students to overcome misconceptions and build better understanding (Makhrus et al., 2014).

The integration of CCM-CCA with mobile learning is believed to be able to further increase student involvement in the learning process and provide wider access to science-based learning materials and information related to SDGs. This is because CCM-CCA can provide confidence and understanding of a scientific concept through scientific evidence. The role of mobile learning as an aid to facilitate in explaining science concepts that seem abstract. The use of CCM-CCA assisted by mobile learning aims to make it easier for students to visualize concepts that are considered abstract so that conceptual changes in CCM-CCA learning can be maximized. Mobile learning is a learning medium that can help facilitate students' understanding of concepts and enable them to solve problems related to learning materials (Nyirahabimana et al., 2023). Mobile learning is also able to attract students' interest and motivation to learn. The use of learning media will be able to help convey abstract concepts so that the learning process becomes more effective. This will slowly attract students' interest in learning and will have an impact on better learning outcomes (Nuraini et al., 2024).

With this background, this study aims to test the effect of the Conceptual Change Model with Cognitive Conflict Approach integrated with Mobile Learning on science literacy and digital literacy. This study also focuses on how the application of this approach can support the achievement of SDGs among students, by improving their understanding of science issues and their ability to use technology effectively to access and share information relevant to sustainable development goals. This study is expected to find empirical evidence that supports the effectiveness of this learning approach in improving science literacy and digital literacy, as well as making a positive contribution to the achievement of SDGs goals, especially in the context of more inclusive and sustainable education.

2. METHOD

This study was conducted with a quantitative approach. This type of research is a quasi-experimental study with a pretest-posttest control group design (Table 1). This study used three sample groups, namely one experimental class and two control classes. In the experimental class, treatment was given in the form of implementing CCM-CCA learning integrated with mobile learning, while the first control class was given treatment with a problem-based learning model, and the second control class was given conventional learning. The three sample groups were given pretests and posttests on science literacy and digital literacy. Each sample group consisted of 30 students.

Table 1: Research design

SN	Class Type	*Pretest*	Treatment	*Posttest*
1	Experiment	O_1	X_1	O_4
2	Control 1	O_2	X_2	O_5
3	Control 2	O_3	X_3	O_6

Description: O_1: Score Pretest of experimental class, O_2: Score Pretest of control class 1, O_3: Score Pretest of control class 2; X_1: CCM-CCA learning integrated with mobile learning, X_2: PBL learning, X_3: Conventional learning, O_4: Score Posttest of experimental class, O_5: Score Posttest of control class 1, O_6: Score Posttest of control class 2.

The location of this research is the University of Mataram with data collection conducted on Physics Education students. The data collection technique in this study used the Test Technique providing two tests, namely the science literacy test and the digital literacy test. The indicators of science literacy used in the study are the ability to explain scientific phenomena, evaluate and design scientific investigations, and interpret data and evidence scientifically. The indicators of digital literacy are digital skills, digital culture, digital ethics, and digital safety. The data analysis technique for this study used the Manova test. The data processing of this study was carried out with the help of the software IBM SPSS 25.

3. RESULTS AND DISCUSSION

This study was conducted 5 times face-to-face learning. The first meeting was conducted by giving a pretest to the three sample groups to determine their initial abilities. Furthermore, three face-to-face meetings were used for learning with different treatments for each sample group according to the research design. In the final stage, the sample group was given a posttest to determine their final abilities after learning, especially those related to science literacy and digital literacy.

3.1. Result

This study was conducted in three face-to-face learning meetings. The experimental class was given learning using student discussion sheets and mobile learning containing physics material as a reference for student learning. Control class 1 was given problem-based learning with student discussion sheets containing physics problems. While control class 2 was given conventional learning where students paid attention to the lecturer's explanation. After three learning sessions, students were given a final test related to science literacy and digital literacy. The results of the analysis of the student's final tests are shown in the following table.

Table 2: Results of the analysis of the average post-test scores of students

Descriptive Statistics				
	Class Type	**Mean**	**Std. Deviation**	**N**
Science Literacy	Experiment	72.67	16.595	30

	Control 1	66.17	15.849	30
	Control 2	62.00	15.735	30
	Total	66.94	16.484	90
Digital Literacy	Experiment	84.67	11.885	30
	Control 1	65.33	9.185	30
	Control 2	80.67	10.063	30
	Total	76.89	13.294	90

Based on Table 2, it can be seen that students in the experimental class group have the highest average score with an average of 72.67 for science literacy and 84.67 for digital literacy. This shows that learning with CCM-CCA integrated with mobile learning can affect students' science literacy and digital literacy skills. This is because they are accustomed to using technology or integrating technology in their learning process so that learning becomes interesting and improves students' literacy skills. In contrast to the two control classes that only learn with the PBL model and the conventional model. Furthermore, the Box's M prerequisite test was carried out to determine the homogeneity of the variance-covariance of the sample group. The results are shown in the following table.

Table 3: Variance-covariance results with Box's M

Box's Test of Equality of Covariance Matrices[a]	
Box's M	2.356
F	0.380
df1	6
df2	188642.769
Sig.	0.892
Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.	

Based on the results of the Box's M test, it can be seen that the significance result is 0.892 or greater than 0.05. This shows that the variance-covariance matrix on both dependent variables is homogeneous so that it can be continued with the manova test. The results of the manova test on the two dependent variables (science literacy and digital literacy) can be seen in the following table.

Table 4: Manova test results

Multivariate Tests[a]						
Effect		**Value**	**F**	**Error df**	**Sig.**	**Observed Power[d]**
Intercept	Pillai's Trace	.986	2973.765[b]	86.000	.000	1.000
	Wilks' Lambda	.014	2973.765[b]	86.000	.000	1.000
	Hotelling's Trace	69.157	2973.765[b]	86.000	.000	1.000
	Roy's Largest Root	69.157	2973.765[b]	86.000	.000	1.000
Class_Type	Pillai's Trace	.463	13.096	174.000	.000	1.000
	Wilks' Lambda	.563	14.298[b]	172.000	.000	1.000
	Hotelling's Trace	.729	15.502	170.000	.000	1.000
	Roy's Largest Root	.660	28.691[c]	87.000	.000	1.000
a. Design: Intercept + Jenis_Kelas						
b. Exact statistic						
c. The statistic is an upper bound on F that yields a lower bound on the significance level.						
d. Computed using alpha = .05						

From the results of the Pillae Trace, Wilk Lambda, Hotelling Trace, and Roy's Largest Root tests which can be seen in Table 4, a significance of 0.000 was obtained in each test. If a significance of 0.05 is used, then 0.00 <0.05, so it is concluded that there is an influence of CCM-CCA integrated with mobile learning on students' scientific literacy and digital literacy. This is a guideline to support the achievement of SDGs 4 related to Education. Good scientific literacy and good technological literacy make it easier for students to face the challenges of the times, especially in an era that uses technology.

3.2. DISCUSSION

The implementation of CCM-CCA integrated with mobile learning can be seen in the learning devices used during the learning process. The implementation of CCM-CCA integrated with mobile learning is expected to provide a physics learning process that can influence students' scientific literacy and digital literacy. In the experimental class, the implementation of CCM-CCA integrated with mobile learning was carried out in 3 face-to-face meetings. Each meeting was given a student discussion sheet containing physics problems that had misconceptions so that conceptual changes were formed in students. The mobile learning used in learning was installed on students' smartphones which were useful as references and learning media that helped students solve problems on the discussion sheet. While in the control class, only face-to-face learning was carried out with problem-based discussion sheets in control class group 1, and using a conventional model in control class group 2. In the experimental class, students were seen actively discussing and using mobile learning for learning. This shows an increase in student enthusiasm and motivation to learn. After all the series of learning processes during 3 face-to-face meetings were completed, students in the three sample groups were given a posttest related to scientific literacy and digital literacy.

The results of the study showed that there was a significant influence on students' science literacy and digital literacy after implementing learning with CCM-CCA integrated with mobile learning. This was influenced by CCM-CCA which was able to cause cognitive conflict in students' minds after seeing the problems on the discussion sheet and trying to find solutions through mobile learning. Cognitive conflict is the most important thing in changing students' physics concepts. Cognitive conflict is based on constructivist learning theory which requires the process of assimilation and accommodation in students' cognition. Cognitive conflict is a state of learning that causes students to experience a mismatch between their preconceptions and the concepts being learned (Munawaroh et al., 2021). This cognitive conflict is important to connect students' initial concepts with new concepts being learned. Constructivist learning theory also states that to create balance in students' cognitive structures, an assimilation process is needed (Makhrus et al., 2014). The conceptual change model provides opportunities for students to construct new knowledge through assimilation and accommodation to achieve equilibration, so that students' understanding of concepts is more organized (Putra et al., 2014). Cognitive conflict also plays a role in the formation of students' concepts. cognitive conflict presented through data or example questions provides conflict in students' understanding. This has a positive impact on concept formation after they resolve conceptual differences through demonstrations, experiments, and discussions (Haryono, 2018). The use of CCM allows students to exchange ideas through discussions and presentations. Students find their views are wrong and sometimes contradict scientific views. This often results in dissatisfaction with old views and learners seek new ways that are acceptable, reasonable, and understandable (Tlala et al., 2014).

Learning activities with CCM-CCA help improve students' physics concepts so that they form a correct understanding of scientific concepts. This will have an impact on better learning outcomes. Learning activities that apply the conceptual change model can reduce students' misconceptions regarding their scientific literacy. With this learning, students become accustomed to expressing opinions and providing correct answers (Hajron et al., 2019). The use of mobile learning can also increase students' interest in learning and make them understand technology slowly. This mobile learning also functions as a medium and reference in learning to prove their concepts. Learning media, especially mobile learning, not only acts as a conveyor of information but also creates a learning environment that can be adjusted to the needs of individual students, thereby increasing their scientific literacy potential (Anditha et al., 2024). In addition to having an impact on scientific literacy, CCM-CCA integrated with mobile learning also has a significant impact on students' digital literacy skills. Moreover, the integration of mobile learning in learning can slowly provide an understanding of digital technology. Learning using technological devices is part of an effort to improve students' digital literacy. Mobile learning can provide teaching materials that can be accessed at any time and presented with attractive material visualizations for students. This can contribute to improving students' digital literacy. Through this digital module, students are given the convenience of using mobile learning-based learning media anywhere and anytime (Nurcahyo & Setyowati, 2021). The use of Android-based mobile learning effectively increases students' digital literacy. This is because Android-based mobile learning has been adjusted to the needs of students so that it can attract students' interest in using it (Wahyuni et al., 2022). Overall, it can be seen that CCM-CCA integrated with mobile learning has a significant impact on students' scientific literacy and digital literacy. This can be seen from the average score of scientific literacy and digital literacy in the experimental class which is much better than the score in the control class. Learning like this is a solution to achieve the SDGs goals, especially the fourth SDG related to quality education. Quality education can be seen from the learning process that is innovative and interesting and has good learning outcomes for students.

4. CONCLUSION

Based on the results and discussion, it can be seen that CCM-CCA integrated with mobile learning can be used to improve students' physics concepts so that it can have a significant impact on students' science literacy and digital literacy. Learning like this is an interesting learning innovation to achieve the SDGs goals, especially the fourth SDG on Quality Education. The limitation of this study is that some smartphones failed to install mobile learning which was developed as a learning media so that some students had to watch the material on their friends' smartphones. However, this is better when learning is designed in groups so that students become active in discussing to improve their concepts. Further research related to CCM-CCA based on mobile learning is directed at other abilities such as critical thinking and problem solving as well as on different materials or even on different subjects.

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