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The Effect of Causal Learning Model Integrated With Character Values On The Ability To Master Physics Concepts And Positive Attitudes Of High School Students

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Abstract— This study aims to analyze the effect of causal learning model integrated with character values on the ability to master physics concepts and positive attitudes of high school students. The background of the research is based on the low concept ability and positive attitude of students caused by the dominance of conventional learning methods and the lack of integration of character values in the learning process. This study used a quasi-experimental approach with a nonequivalent control group design. The research subjects were 11th grade students of SMA Negeri 4 Mataram in the 2024/2025 school year. The experimental class received treatment using an integrated causal model of character values, while the control class used direct learning. The research instrument consisted of a concept mastery description test and a positive attitude questionnaire for students. Data analysis was carried out by testing validity, reliability, normality, homogeneity, and Mann-Whitney test. The results showed that the application of the integrated causalytic model of character values significantly improved the ability to master physics concepts and positive attitudes of students compared to conventional learning. This model is effective in encouraging students to think causally and analytically, as well as internalizing character values such as responsibility, cooperation, and honesty. Thus, the causal learning model integrated with character values can be an innovative alternative in improving the quality of physics learning and shaping positive student character.

Keywords— Causalytic Model; Character Values; Concept Mastery; Positive Attitude; High School Physics

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1. Introduction

Physics education as part of the Natural Sciences (IPA) family plays a central role in shaping students' critical, logical and analytical thinking skills. Physics not only conveys conceptual knowledge about natural phenomena, but also provides provisions for students to be able to connect between theory and practice in everyday life. Unfortunately, the reality in the field shows that physics learning at the high school level is still dominated by conventional methods that are teacher-centered and emphasize memorization of formulas, not on deep understanding of scientific concepts [1]. This kind of learning model tends to inhibit the development of higher order thinking skills and limit the ability of students to solve problems based on real phenomena.

Preliminary data obtained from SMAN 4 Mataram corroborates this phenomenon, where the average score of the midterm exam of class XI students for physics subjects is far below the criteria for achieving learning objectives (KKTP). As many as 75% of students had to take remedials, with an average score of only 47.95 for class XI-IT-1 and 50.15 for class XI-IT-2 [2]. Interviews with physics teachers at the school also revealed that the low mastery of physics concepts is related to students' inability to analyze phenomenon-based problems, due to the lack of practice questions and the dominance of the memorization approach.

In addition to cognitive aspects, learning in schools also faces serious challenges in affective aspects, especially the character of students. Passivity in class, disrespectful behavior, and the increasing negative influence of social media are worrying phenomena. Teenagers often display behaviors that are not conducive to learning, such as lack of confidence, reluctance to participate, and involvement in deviant behaviors such as juvenile delinquency and violence [3]. This shows that character education has not been effectively internalized in the learning process.

In response to these conditions, the Merdeka Curriculum is designed with a flexible learning approach and is oriented towards the formation of the Pancasila learner profile. This curriculum emphasizes the holistic development of learner competencies, through the integration of knowledge, skills, and character values in project-based learning and reflection [4]. One model that is relevant to this spirit is the causalytic learning model integrated with character values, which combines causal and analytical thinking approaches with strengthening character values such as responsibility, honesty, cooperation, and empathy.

The causal learning model was developed by Rokhmat to equip students with the ability to map the cause-and-effect relationship of a phenomenon, as well as compose scientific arguments based on physics concepts and principles [5]. This model encourages learners to not only understand facts, but also investigate deeply why an event occurs and what the consequences are. When integrated with character values, this model is believed to be able to form learners who are not only academically intelligent, but also morally and socially mature [6].

Previous research shows that the causal approach assisted by learning tools such as LKPD can improve students' open thinking ability and mastery of physics concepts [6]. In this context, the integration of character values in learning is not just a complement, but an important part of pedagogical strategies that can improve the overall quality of learning.

Based on this background, this study aims to examine the effect of implementing an integrated causal learning model of character values on the ability to master physics concepts and positive attitudes of high school students. This research is expected to contribute to the development of innovative learning models that are in accordance with the demands of the curriculum and the needs of 21st century learners.

2. Literature Review

2.1. Causal Learning Model

The causal learning model is an innovative learning approach developed to foster the ability to think causally and analytically in students. This model is designed so that students not only remember information, but are able to understand, analyze, and explain phenomena based on the logical relationship between cause and effect [7].

In general, the causal thinking process consists of three main indicators, namely cause predicting, effect determining, and cause identifying [8]. Through this process, learners are invited to examine physics phenomena in depth by tracing the factors that cause an event and predicting various possible consequences. This ability is important in learning physics because it helps students understand the relationship between concepts and explain natural phenomena rationally.

This model was developed by Rokhmat and his colleagues since 2010 through constructivism approach, information processing theory, and social interaction in learning [9]. Causal learning places learners as active subjects who construct knowledge through concept-based inquiry and argumentation. In its implementation, this model consists of four learning phases, namely orientation, exploration and development of the concept of causality, preparation of arguments, and evaluation [10]. In the orientation phase, the teacher conveys the learning objectives and discusses the preliminary assignment. The exploration phase encourages learners to observe phenomena and identify causes and effects. The argumentation phase invites students to develop logical explanations based on physical theory, and the evaluation phase reflects on understanding and strengthening concepts.

Gopnik and Schulz also explained that there are several forms of causal thinking models, such as common-cause, causal-chain, and common-effect. In the context of physics learning, these models are the basis for structuring students' reasoning about natural phenomena [11]. The common-cause model, for example, teaches students that one cause can lead to two or more interrelated effects; this reflects the complexity of relationships in physical systems.

The application of the causal model in learning has been proven to improve students' analysis, synthesis, and scientific argumentation skills [12]. In addition, learners become more active in the learning process because they are directly involved in the exploration of phenomena, hypothesis generation, and decision making based on scientific concepts.

Thus, the causal learning model is one of the promising alternatives in 21st century physics learning because it is able to integrate high-level cognitive aspects with a scientific approach based on causal reasoning.

2.2. Character Values in Learning

Learner character building is an important aspect of education that cannot be separated from academic achievement. Character education aims to build learners' full personalities through internalizing moral, ethical, and social values into the learning process [13]. In the Indonesian context, character strengthening is part of the direction of national education policy, as stated in the Merdeka Curriculum which emphasizes competency-based learning and the noble values of Pancasila [14].

Character values are a set of values rooted in the nation's culture and believed to be able to shape the positive behavior of students in personal, social, and national life. The five main character values integrated in education according to the Ministry of Education and Culture are: religiosity, nationalism, integrity, independence, and mutual cooperation [15]. These values are not only a reference in learning religious or civic subjects, but can also be instilled in exact subjects such as physics, through contextual and reflective learning approaches.

In physics learning, the integration of character values can be done through various strategies, such as providing case studies of natural phenomena that emphasize social responsibility to the environment, group work to foster collaboration, and reflection on learning that fosters honesty and curiosity [16]. Character is not only shown from learning outcomes, but is reflected in the way students respond to the learning process: attendance in class, how they interact with teachers and friends, and how they respond to failure or challenges in understanding concepts.

Previous research shows that low internalization of character values in learners can have a negative impact on learning behaviour and social interaction. For example, increased passive behavior, lack of confidence, and social deviations such as skipping class, juvenile delinquency, and technology abuse [17]. This phenomenon demands a systematic and integrated educational intervention to shape positive attitudes and values.

An effective learning model in developing learners' character is a model that places students as active subjects in meaningful learning. One of them is value-based learning that allows students to experience, reflect, and internalize values through a contextual learning process [18]. In this case, character values are not taught as separate materials, but rather implicitly and explicitly instilled through learning approaches that touch on cognitive, affective, and psychomotor aspects.

Thus, learning that integrates character values not only aims to produce students who are intellectually intelligent, but also have high moral and social maturity. This integration becomes an important foundation in realizing humanist and transformative physics education.

2.3. Integrated Causalytic Model of Character Values

The integrated causal learning model of character values is a synthesis of two major concepts, namely causal learning based on cause-and-effect relationships and analytics, and the integration of character values in the learning process. This model aims to improve the understanding of physics concepts while forming positive attitudes and character of students, which are essential in facing the challenges of life outside the classroom.

Basically, the causal model is already known as an approach that prioritizes cause-and-effect-based reasoning, where students are trained to think critically in identifying the causes of a phenomenon and predicting possible consequences. This approach not only helps students understand physics concepts more deeply, but also hones their ability to think logically and analytically [9], [10]. The causal model itself consists of four learning phases which include orientation, concept exploration and development, argument building, and evaluation [10].

However, in the integrated causalytic model of character values, each phase is not only focused on mastering physics concepts, but also on student character building. Character values such as responsibility, cooperation, honesty, and curiosity are integrated through various learning activities, either explicitly through discussion and reflection, or implicitly through tasks that demand cooperation and responsibility [19]. This approach aims to make students not only understand physics concepts, but also internalize these values in everyday life.

The integration of character values in physics learning can be seen in the exploration phase, where students are not only invited to identify causal elements in a phenomenon, but also invited to consider the impact of their actions on the environment and society. For example, in studying the concept of Newton's law or the law of conservation of energy, students are encouraged to think about how the concept can be applied to solve relevant social or environmental problems, such as the use of renewable energy or efforts to reduce pollution [20].

The application of the integrated causal model of character values has a significant impact in shaping students who are not only cognitively superior, but also have positive attitudes and high integrity. For example, through group activities in causal learning, students can develop the ability to work together in solving common problems, while the value of responsibility is strengthened by giving individual assignments that demand timely and quality completion. Thus, this model offers a holistic approach that combines cognitive, affective and social aspects in a balanced manner [21].

Overall, the integrated causalytic model of character values has great potential to improve the quality of physics learning in senior high schools, while at the same time shaping the character of learners that can be applied in their future social and professional lives. Previous research shows that the use of this model is not only effective in improving concept mastery, but can also build positive attitudes such as curiosity, concern for the environment, and the ability to collaborate [22].

2.4. Mastery of Physics Concepts

Concept mastery is one of the important aspects of cognitive competence that students must have in physics learning. Physics concepts are not enough to be memorized, but need to be understood deeply so that they can be applied in solving problems related to real-life phenomena. According to Silaban (2014), concept mastery is the ability of students to record and transfer back information from certain subject matter to be used in solving problems, analyzing, and interpreting events in everyday life [23].

Furthermore, Anderson and Krathwohl (2001) compiled Bloom's revised taxonomy that describes the levels of concept mastery, namely remembering, understanding, applying, analyzing, evaluating, and creating [24]. This level shows that concept mastery is not only limited to the ability to remember, but includes higher-level thinking skills that must be developed in the learning process.

Sari (2016) states that concept mastery reflects the ability of students to use the basic elements of a concept to solve certain problems [25]. This ability is an important indicator in achieving learning outcomes, because learners not only remember concepts, but are also able to re-explain them in their own language without changing the essential meaning.

According to Pahrun (2023), concept mastery is part of the learning outcomes that show the extent to which students understand concepts after learning activities take place [26]. By understanding concepts, students will find it easier to solve phenomenon-based problems and relate them to relevant physics principles and laws.

To develop optimal mastery of concepts, a learning approach that emphasizes deep understanding is needed. One of them is the causal learning model, which leads learners to think causally and analytically about the phenomena presented. This model has been proven effective in improving the ability to analyze and compose arguments based on the concepts that have been learned [1], [7]. The causal approach also encourages students to not just look for answers, but to understand the process behind each physics event studied [5].

Thus, mastery of physics concepts is not only a learning objective, but also a foundation of scientific thinking and problem solving skills that are essential for students in facing academic challenges and real life.

2.5. Positive Learner Attitudes

The positive attitude of learners is an important element in supporting the success of the learning process. It reflects mental and emotional readiness in receiving, responding to, and internalizing learning materials. According to Hill (2008), a positive attitude is a confident, honest, and constructive mental state, which is formed and maintained through will power and individual motivation [27].

Attitude not only reflects external behavior, but is also the result of cognitive and affective processes that are internalized in learners. In the context of physics learning, a positive attitude is closely related to interest in learning, perseverance, curiosity, and the ability to cooperate with peers and teachers.

Positive attitude also includes active involvement in the learning process such as listening carefully, asking relevant questions, and showing responsibility in completing tasks [20]. According to Utami (1999), learners' attitudes can be shaped through a learning process that involves two-way communication and reinforcement of positive values [28].

In the digital era, the formation of positive attitudes faces its own challenges, especially due to the influence of social media and popular culture that is often not in line with educational values. Therefore, instilling character values such as responsibility, empathy, and cooperation is important in building a positive attitude in the school environment [15].

Merdeka Curriculum as a new approach in national education also emphasizes the importance of character development, including positive attitudes, as part of the core competencies that learners must have [14]. Positive attitudes not only contribute to academic success, but also to the personal development of learners as responsible and adaptive individuals in social life.

The causal learning model integrated with character values can be a strategic alternative to foster positive attitudes of learners. This model facilitates learners in examining phenomena, developing cause-and-effect-based arguments, and reflecting on relevant character values during the learning process [19]. With the integration of cognitive and affective dimensions, learners not only understand physics concepts, but also develop attitudes that support overall learning success.

2.6. Related Research

Several previous studies have examined the application of the causal learning model in improving physics concept mastery and learner attitude development. These studies become an important foundation that shows the effectiveness of the model in the context of physics learning in secondary schools.

Anshori, Rokhmat, and Gunada (2019) examined the application of the causal learning model in improving students' creativity. The results showed that the causalytic model was able to facilitate learners in developing creative ideas through a systematic cause-and-effect thinking process [1].

Faisal, Rokhmat, and Ardhuha (2020) also found that the cascaded causal thinking approach significantly improved students' problem solving skills. Learning with this approach makes students more involved in the process of exploring and analyzing complex physics phenomena [7], [10].

Research conducted by Abdani, Rokhmat, and Rahayu (2018) developed a type 2B scaffolding causal approach assisted by LKPD. The results showed that this model was able to improve students' ability to analyze the cause-and-effect relationship of physics phenomena presented contextually [5], [22].

In addition to improving cognitive aspects, the causalytic model also contributes to the formation of positive attitudes of learners. Rokhmat (2015) stated that the integration of character values into the physics learning process through the discussion of phenomena can foster attitudes of responsibility, cooperation, and empathy [12].

Research by Hung and Jonassen (2006) is also relevant to support the use of causal reasoning as a conceptual tool in physics learning. They found that the use of causal reasoning can help learners in understanding the relationship between physics concepts and develop a deeper conceptual understanding [29].

The findings above show that the causal approach, especially when combined with character values, has great potential to improve the quality of physics learning both in terms of concept mastery and attitudinal aspects of learners. Therefore, this research was conducted to strengthen previous results while applying the approach in the context of physics learning based on the Merdeka curriculum.

3. Methodology

This study uses a quasi-experimental approach, namely a quasi-experimental study that allows researchers to provide treatment to the experimental group without random assignment to the subjects. Quasi-experimental research is used when full control of the independent variables is difficult to do, but it is still possible to compare the results between the experimental and control groups [29]. In this study, the integrated causal learning model of character values was applied to the experimental group, while the control group used direct learning.

The variables in this study consist of independent variables, namely the integrated causal learning model of character values, and dependent variables, namely the ability to master physics concepts and positive attitudes of students. In addition, the control variables in this study include teaching materials, teachers who teach, instruments used, time allocation, and assessment methods that are consistent between the two groups.

The research design used is a nonequivalent control group design, consisting of two classes: one class as the experimental group and one class as the control group. Both groups were given a pretest to determine the initial conditions, then the experimental group received treatment in the form of an integrated causal learning model of character values, while the control group carried out learning with a conventional model. After that, a posttest was conducted to measure the differences in learning outcomes of the two groups. This design allows researchers to compare the effects of treatments on the dependent variable [29].

This study was conducted at SMAN 4 Mataram in March 2025. The population in this study were all grade XI students at the school. Sampling was carried out using purposive cluster sampling, considering the homogeneity of initial abilities and characteristics of students. The sample used consisted of class XI IT 1 as the control group and XI IT 2 as the experimental group.

The instruments used in this study included teaching modules, student worksheets (LKPD), question grids, concept mastery tests in the form of descriptions, and student positive attitude questionnaires. The validity of the instrument was tested using product moment correlation, while its reliability was analyzed using the Cronbach Alpha formula. In addition, tests of difficulty level and discriminatory power were also carried out to measure the quality of the questions. The difficulty level of the questions is classified into easy, medium, and difficult categories [30], while the discriminatory power is used to determine the extent to which the questions are able to distinguish between high and low-ability students [31].

The posttest data were analyzed using normality and homogeneity tests. Because the data distribution in the experimental group was not normal, the hypothesis analysis was carried out using the nonparametric Mann-Whitney U test [32]. This test is used to test the difference in medians between two independent groups, and is an alternative to the t-test if the data does not meet the normality assumption.

The results of the data analysis were used to draw conclusions regarding the effect of the integrated causal learning model of character values on the ability to master physics concepts and positive attitudes of students. This model not only encourages conceptual understanding through a causal and analytical thinking approach [1][5], but is also integrated with character values such as responsibility, cooperation, and honesty in the learning process [15].

4. Results and Discussion

This study aims to determine the effect of causal learning model integrated with character values on mastery of physics concepts and positive attitudes of students. The research was conducted in two classes, namely the experimental class which was treated using the causalytic model and the control class which was given conventional learning. The results were obtained through several stages of instrument testing, pretest and posttest data collection, homogeneity test, normality test, and hypothesis testing using the Mann-Whitney test.

4.1. Instrument Test Results

Before being used in research, the question of mastery of physics concepts was first tested to ensure validity, reliability, difficulty level, and differentiating power. The test was conducted on March 27, 2025 at SMAN 7 Mataram with 28 students as respondents.

Table 1. Summary of Concept Mastery Instrument Test Results

No	Validitas			Reliabilitas			Tingkat Kesukaran		Daya Pembeda	
soal	r_{tabel}	r_{xy}	Ket.	r_{tabel}	r_{11}	Ket.	TK	Ket.	DP	Ket.
1	0,367	0,750	Valid	0,367	0,767	Reliabel	0,72	Mudah	0,4	Cukup
2	0,367	0,688	Valid	0,367	0,767	Reliabel	0,47	Sedang	0,4	Baik
3	0,367	0,749	Valid	0,367	0,767	Reliabel	0,56	Sedang	0,3	Cukup
4	0,367	0,711	Valid	0,367	0,767	Reliabel	0,29	Sukar	0,4	Cukup
5	0,367	0,680	Valid	0,367	0,767	Reliabel	0,55	Sedang	0,4	Cukup

The validity test results show that the five items developed have a correlation coefficient value greater than r-table, which is 0.374, so that all questions are declared valid. This validity is important to ensure that the instrument really measures the intended concept mastery aspects.

The level of difficulty of the items can be seen that item number 1 is in the easy category, items number 2, 3, 5 are in the medium category, and item number 4 is in the difficult category. This variation in difficulty level is important to differentiate the ability of students from various levels.

In terms of differentiating power, three questions have good category differentiating power, one question is sufficient, and one question is lacking. These questions were retained because they provide diagnostic information on students' higher order thinking skills, which are the focus of the causal approach.

4.2. Pretest and Posttest Results

Pretest was conducted to determine the initial ability of students in both classes can be seen in Table 2 below.

Table 2. Initial Test Data of Concept Mastery Ability of Experimental and Control Learners

Class	N	Highest Score	Lowest Score	Average	S^2
Experiment	28	65	15	38,0357	202,48
Control	30	60	5	34,6667	206,78

The mean value of the experimental class pretest was 35.44 and the control class was 35.11, indicating that both groups were at a statistically equivalent level before treatment. This is important to ensure that differences in final results are not caused by initial differences between classes.

Table 3. Posttest Results of Students' Concept Mastery Ability

Class	N	Highest Score	Lowest Score	Average	S^2
Experiment	28	85	60	74,6429	66,53
Control	30	80	55	65,3333	46,44

After the treatment, the posttest results showed a significant increase in the experimental class which can be seen in Table 3 below. The average score was 66.53, compared to the control class which only reached 46.44 (Table 4.6). An increase of more than 31 points in the experimental class indicates that the application of the causal learning model integrated with character values has a real impact on students' concept mastery.

Comparison of pretest and posttest results in both classes provides an overview of the effectiveness of the learning model applied. The average value of the pretest in the experimental class was 35.44, while the control class was 35.11. This very small difference in value indicates that the initial ability of students in both classes was in a relatively equal condition before the treatment was given. This is a strong basis for concluding that the difference in posttest results can be attributed directly to the learning treatment provided.

After the treatment, there was a significant increase in the posttest scores of both classes, with the highest increase occurring in the experimental class. The average posttest score of the experimental class was 66.53, while the control class only reached 46.44. The difference in value of 20.09 points reflects the positive effect of the causal learning model integrated with character values on students' mastery of physics concepts.

The high score increase in the experimental class shows that the causal learning approach is able to direct students to think systematically, relate concepts to real phenomena, and develop understanding based on cause-and-effect relationships. In addition, the integration of character values in the learning process helped shape more positive learning dispositions, such as a sense of responsibility, perseverance, and focus in completing tasks.

Meanwhile, the improvement that occurred in the control class tended to be smaller. This can be caused by the conventional learning method that is more teacher-centered, with the dominance of lectures and passive activities, so it is less able to encourage deep cognitive engagement from students.

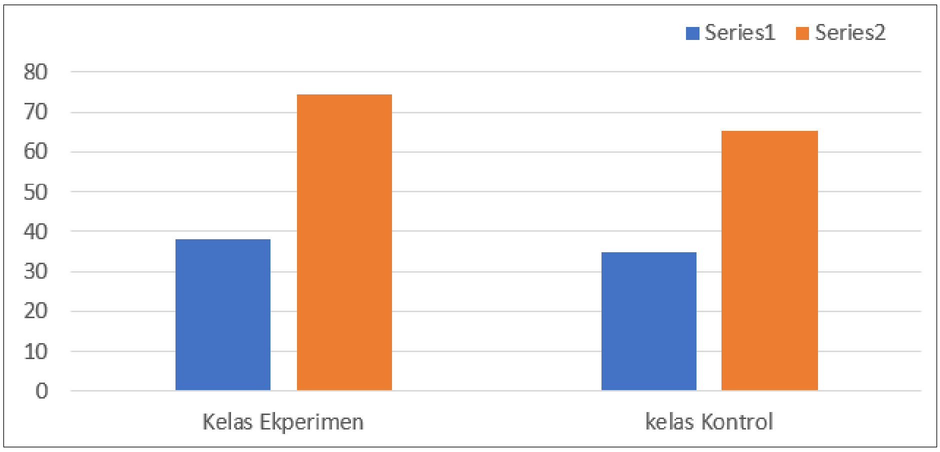

Fig 1. Comparison of pre-test and post-test

The comparison graph of pretest and posttest scores between the experimental and control classes shows a striking pattern of improvement in the experimental class. The steep increase curve indicates that the causal learning model not only succeeded in improving conceptual understanding, but also provided a meaningful and contextualized learning experience. Meanwhile, the graph for the control class only shows a relatively gentle increase.

Thus, this graph provides a strong visualization of the effectiveness of the character-integrated causalytic approach, which not only improves test scores, but also the quality of the learning process itself.

4.3. Homogeneity and Normality Tests

Homogeneity test is conducted to determine whether the data from both classes have the same variance. The results show a significance value of 0.862 (> 0.05), so it is concluded that the data is homogeneous. Data homogeneity is very important so that the statistical tests used provide valid results.

Table 4. Homogeneity Test Results of Initial Test of Concept Mastery Ability

Class	Number of samples	Variance	Significance Value	Conclusion
Experiment	28	202,48	0,862	Homogenous
Control	30	206,78		

Table 5. Normality Test of Posttest Data

Kelas	Data	Taraf Signifikan	Sig (2 tailed)	Kriteria
Eksperimen	Tes akhir	0,05	0,208	Terdistribusi Normal
Kontrol	Tes akhir		0,039	Tidak Terdistribusi Normal

The normality test using Shapiro-Wilk shows that the posttest data in the experimental class has a significance value of 0.208 (> 0.05) and is considered normally distributed. While the control class shows a significance value of 0.039 (<0.05), so it is not normally distributed. Because there is a mismatch of normal distribution in one of the classes, the Mann-Whitney non-parametric test is used in hypothesis testing.

4.4. Mann-Whitney Test

The Mann-Whitney test was used to test for significant differences between two independent groups, in this case the experimental and control classes, on the posttest results of concept mastery. The analysis results show the value of Asymp. Sig. (2-tailed) = 0.000, which is smaller than 0.05, so H_0 is rejected and H_a is accepted.

Table 6. Normality Test of Posttest Data

Ranks				
	Class	N	Mean Rank	Sum Of Ranks
Concept Mastery Ability Results	Experiment	28	38.48	1077.50
	Control	30	21.12	633.50
	Total	58		

Thus, it can be concluded that there is a significant difference between the class using the character value integrated causal learning model and the class using the conventional learning model. This strengthens previous findings that the causality-based approach is able to activate higher-order thinking processes and instill conceptual understanding more deeply [7][12].

Table 7. Normality Test of Posttest Data

	Hasil Kemampuan Penguasaan Konsep
Mann-Whitney U	168.500
Wilcoxon W	633.500
Z	-3.978
Asymp. Sig. (2-tailed)	.000

To determine whether there is a significant difference in mastery of physics concepts between the experimental class and the control class, hypothesis testing using Mann-Whitney U. This test was used because the data distribution in the control class did not meet the assumption of normality, based on the previous Shapiro-Wilk test ($p = 0.039 < 0.05$), while the experimental class data was normal ($p = 0.208 > 0.05$).

The Mann-Whitney test results show that the value of U = 168.500, with Z = -3.978 and a significance value (Asymp. Sig. 2-tailed) of 0.000 (Table 4.9). This value is far below the significance limit of 0.05, so it can be concluded that there is a significant difference between the experimental and control groups in terms of mastery of physics concepts.

The interpretation of this result is that the causal learning model integrated with character values has a significant positive effect on improving students' concept mastery. This is in line with the main objective of the causal model, which is to develop conceptual understanding through the process of cause-and-effect thinking, and support the process of internalizing knowledge in a meaningful way.

5. Discussion

This study aims to determine the effect of causal learning model integrated with character values on concept mastery and positive attitude of students of class XI SMAN 4 Mataram on harmonic vibration material. The results showed that this model was able to have a significant effect on improving both aspects, as supported by the difference in pretest and posttest results and the Mann-Whitney test which showed a significance value of 0.000 <0.05.

The increase in mastery of physics concepts in the experimental class is closely related to the syntax characteristics of the causal model which emphasizes the process of cause-and-effect thinking and the preparation of scientific arguments [7]. Learners are not only exposed to physics phenomena, but also trained to find relationships between variables through logical analysis. This is in accordance with the findings of Rokhmat (2015), who stated that the causal approach can strengthen critical thinking skills and improve students' conceptual understanding [12].

Furthermore, this approach also provides space for learners to collaborate, discuss and build meaning socially. These activities are consistent with constructivism theory which states that knowledge is actively constructed by learners through social interaction and reflection on their own learning experiences [24].

In addition to cognitive impact, this learning model also contributes to the improvement of learners' positive attitude. The questionnaire results showed that there was an increase in the attitude category from “good” to “very good” in the experimental class. This improvement cannot be separated from the integration of character values such as responsibility, cooperation, and honesty in learning activities [19]. These values are internalized through the stages of discussion, reflection, and problem solving, which makes students not only learn about concepts, but also form positive habits of thought and action.

The causal learning model integrated with character values also makes the teacher a facilitator who encourages students to actively explore information and build knowledge independently. This role is important in creating a participatory and meaningful learning atmosphere, in accordance with the active learning principles advocated in the Merdeka Curriculum [14].

This research also supports the views of Hung and Jonassen (2006), who state that causal reasoning is an important conceptual tool in science learning because it allows learners to understand phenomena in a deep and structured manner [28]. Thus, the causal approach not only improves academic outcomes, but also shapes learning characters that are process-oriented, collaborative, and reflective.

Overall, these findings suggest that physics learning that combines cognitive and affective dimensions through an integrated causalytic model of character values is an effective strategy to improve the quality of education. This approach can be a solution for 21st century learning that requires students to be not only intellectually intelligent, but also have character and be able to collaborate in a complex and dynamic environment.

6. Conclusion

Based on the results of the research conducted, it can be concluded that the causal learning model integrated with character values has a significant effect on improving mastery of physics concepts and forming positive attitudes of students. The application of a structured causal syntax, based on cause-and-effect reasoning, is able to encourage students to build a deeper, active, and reflective conceptual understanding of the material studied.

Statistical test results show that there is a significant difference between the experimental and control classes in both posttest results and attitude questionnaire scores, which indicates the effectiveness of the causalytic model in the cognitive and affective aspects of learning. The integration of character values in the learning process is also proven to support the development of students' attitudes of responsibility, cooperation, and honesty.

Thus, the causalytic learning model integrated with character values can be recommended as an alternative effective physics learning strategy, especially in the context of the Merdeka Curriculum. This approach not only improves academic achievement, but also shapes the character of students who are ready to face the challenges of 21st century learning.

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