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Implementation of Problem-Based Learning Based on Caring Community in Mathematics Material for Students of Ibrahimy 2 High School, Sukorejo

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Abstract

This study aims to examine the implementation of a Problem-Based Learning (PBL) model integrated with Caring Community in mathematics teaching materials on vectors at SMA Ibrahimy 2 Sukorejo, addressing students' persistent difficulties in mathematical problem-solving due to conventional approaches that neglect affective dimensions. Using a sequential explanatory mixed methods design, the study involved 30 students in the experimental class and 31 in the control class. Data were collected through learning achievement tests and observation, then analyzed quantitatively (normality test, homogeneity test, t-test, and normalized gain) and qualitatively (thematic analysis). Results show the experimental class's mean post-test score (82.40) was significantly higher than the control class (68.50) ($p = 0.000$). Qualitative findings reveal that Caring Community fostered an empathetic, collaborative classroom climate that enhanced active participation and reduced math anxiety. The study concludes that the PBL Caring Community model effectively improves students' mathematical abilities and aligns with the pesantren-based cultural context emphasizing solidarity and care.

Abstrak

Penelitian ini bertujuan untuk mengkaji implementasi model pembelajaran Problem Based Learning (PBL) berbasis Caring Community pada bahan ajar matematika materi vektor di SMA Ibrahimy 2 Sukorejo, mengingat masih tingginya kesulitan siswa dalam pemecahan masalah matematis yang bersumber pada pendekatan pembelajaran konvensional yang kurang memperhatikan dimensi afektif. Penelitian menggunakan pendekatan mixed methods dengan desain eksplanatoris sekuensial, melibatkan 30 siswa kelas eksperimen dan 31 siswa kelas kontrol. Data dikumpulkan melalui tes hasil belajar dan observasi, lalu dianalisis secara kuantitatif (uji normalitas, homogenitas, uji-t, dan normalized gain) dan kualitatif (analisis tematik). Hasil menunjukkan bahwa rata-rata post-test kelas eksperimen (82,40) secara signifikan lebih tinggi daripada kelas kontrol (68,50) dengan nilai sig. = 0,000 (<0,05). Temuan kualitatif mengungkap bahwa integrasi Caring Community menciptakan iklim kelas yang empatik dan kolaboratif, mendorong partisipasi aktif dan pengurangan kecemasan belajar. Simpulan penelitian menyatakan bahwa model PBL berbasis Caring Community efektif meningkatkan kemampuan matematis siswa dan relevan dengan konteks budaya pesantren yang menekankan nilai kebersamaan dan kepedulian.

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Introduction

Education is one of the main pillars in human life which not only functions as a means of transferring knowledge, but also as a vehicle for passing on values, culture and character from one generation to the next (Fitri, 2021; Nisa et al., 2020) . Every individual has the right to receive a decent, equitable and quality education, as mandated in various national and international conventions (Atikurrahman et al., 2019a). Education is realized through a learning process that is consciously designed to develop the potential of students holistically - covering spiritual, emotional, social, intellectual and practical skills aspects, so that they are able to contribute positively to themselves and the wider community (Harsya et al., 2024). In this context, senior secondary education, particularly in the field of mathematics, plays a strategic role in forming the foundations of logical, analytical and critical thinking required in academic and professional life (Hapsari & Manggalou, 2025).

Mathematics as one of the basic disciplines, is often a challenge for most students (Bruno et al., 2021). Various studies show that difficulties in learning mathematics do not only stem from the complexity of the material, but also from learning approaches that are less suited to students' cognitive and affective needs (Bhary, 2023; Irma et al., 2021). One topic that often causes obstacles is vectors, which require a strong conceptual understanding and the ability to integrate various previous mathematical principles. Based on empirical findings, students' difficulties in solving mathematical problems related to vectors can be categorized into five main aspects: (1) inability to transform word problems into mathematical models (30%), (2) difficulty in planning steps to solve (30%), (3) inability to apply previously learned mathematical concepts (10%), (4) reluctance or negligence in verifying the final results (20%), and (5) boredom due to excessive learning activities (10%). This phenomenon indicates the need for transformation in learning approaches that not only focus on cognitive aspects, but also pay attention to students' social and emotional dimensions. (Wahyuddin et al., 2022).

In an effort to overcome these problems, various innovative learning models have been developed, one of which is Problem Based Learning (PBL) (Irma et al., 2021; Masliah et al., 2023). This model positions students as active subjects in the learning process through exploration and solving authentic problems relevant to real-life contexts. PBL encourages students to think critically, collaborate, and develop metacognitive skills in designing problem-solving strategies. However, the effectiveness of PBL can be enhanced when combined with approaches that strengthen the classroom's social climate, such as the Caring Community concept (Radiusman, 2020; Tohir et al., 2020). The Caring Community approach emphasizes the importance of building an empathetic, respectful, and collaborative learning environment, where every member of the community feels safe to participate, express ideas, and support each other in the learning process (Anggraini et al., 2020; Nursing, 2023).

The integration of these two approaches is expected to create a learning ecosystem that is not only cognitively effective, but also fosters humanitarian values and social responsibility.

Several previous studies have shown the positive impact of implementing PBL in mathematics learning, especially in increasing motivation, conceptual understanding, and problem-solving skills (Salsabila & Cahya Mulyaning Asih, 2024; Suwartini et al., 2022). On the other hand, studies on Caring Community in the context of formal education are still relatively limited, especially in the high school environment in Indonesia (Ekowati et al., n.d.). In fact, the values of community care and solidarity are very relevant to local culture which emphasizes mutual cooperation and togetherness (Tohir et al., 2020). Thus, combining PBL and Caring Community in mathematics learning, especially in vector material, is a strategic step that has not been explored empirically, but has great potential to answer contemporary learning challenges (Atikurrahman et al., 2019a).

This study aims to explore the impact of implementing a Problem-Based Learning model integrated with the Caring Community principle on the understanding of vector concepts and the dynamics of social interaction within learning communities in senior high schools. The main focus of this study is Ibrahimy 2 High School, Sukorejo, as a representative of an educational institution actively developing a values- and character-based learning approach. Through this study, it is hoped that an empirical picture of the effectiveness of this hybrid learning model can be obtained, while also providing theoretical and practical contributions to the development of humanistic, inclusive, and sustainable mathematics education.

The novelty of this research lies in the application of the Problem-Based Learning (PBL) model integrated with the Caring Community approach in mathematics learning at the high school level. Unlike previous studies that generally only emphasize cognitive aspects and problem-solving skills, this study adds the affective aspect of the social-emotional dimension through the reinforcement of empathetic, collaborative, and mutually supportive learning. Furthermore, this research specifically applies to vector material, which is known to be complex and challenging for students. Thus, this research provides a new contribution to the development of mathematics learning that not only improves conceptual understanding but also builds a humanistic and character-based learning community.

Methods

This study uses a mixed methods approach with an explanatory sequential design, which combines quantitative and qualitative methods in stages. The first stage is carried out with a quantitative approach to measure the results of the implementation of the Problem Based Learning (PBL) model based on Caring Community on students' mathematical abilities, while the second stage uses a qualitative approach to explain the process and dynamics of the model's implementation in the classroom. The quantitative design refers to a quasi-experimental design with a nonequivalent control group design. The subjects used in this study include: For the control class, the researcher used 31

students of Class X_b SMA Ibrahimy 2 Sukorejo. Meanwhile, for the experimental class, the researcher used 30 students of Class X_a SMA Ibrahimy 2 Sukorejo.

Before the treatment was administered, both groups first took a pretest, then were given a posttest after the treatment was completed. This study did not use randomization due to limited field conditions. Data collection instruments included a mathematics learning achievement test as quantitative data and a structured observation sheet during the learning process as qualitative data. Quantitative data analysis was carried out through descriptive and inferential statistics, which included normality tests, homogeneity tests, and t-tests. Prerequisite tests for normality and homogeneity were conducted first. If the data met the assumptions of normality and homogeneity, the analysis was continued with a t-test to determine whether there was a significant difference between students' mathematical abilities in the experimental and control classes. Improvements in student learning outcomes were also analyzed using the normalized gain (N-gain) calculation.

This test is based on the research hypothesis, namely the null hypothesis (H_0) which states that the implementation of the Caring Community based Problem Based Learning (PBL) model does not cause a significant difference in students' mathematical abilities compared to conventional learning. Conversely, the alternative hypothesis (H_1) states that there is a significant difference in mathematical abilities between students who learn using Caring Community-based PBL and students who learn using conventional methods. Meanwhile, qualitative data were analyzed thematically through the stages of data reduction, data presentation, and drawing conclusions. Data integration was carried out by utilizing qualitative findings to explain quantitative results, thus producing a holistic understanding of the effectiveness and implementation process of the learning model.

Data collection techniques were structured according to the research design stages. In the quantitative phase, data were collected through objective, multiple-choice tests, validated for validity and reliability, administered as pretests and posttests. In the qualitative phase, data were collected through participant observation during the learning process, using a structured observation sheet containing indicators for the implementation of the Caring Community Based Problem-Based Learning model. Observations were conducted to determine student interactions, participation, teacher roles, and classroom atmospheres that reflected the values of a caring community.

The research design can be described as follows:

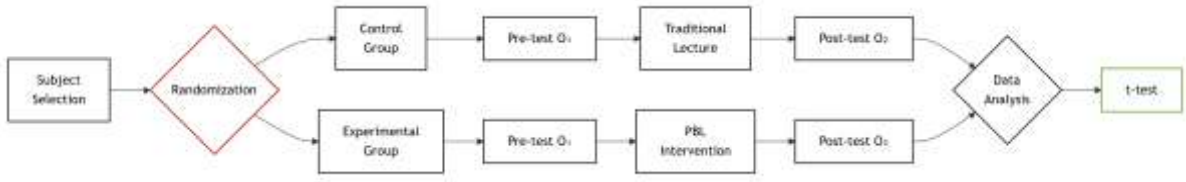

Figure 1. Research Flow

Results and Discussion

Based on the research that has been conducted, the following presents the research results and discussion regarding the Implementation of the Problem Based Learning Model Based on Caring Community in Mathematics Teaching Materials for SMA Ibrahimy 2 Sukorejo Students.

Results

Before conducting the homogeneity test, a normality test was first performed as part of the prerequisite tests for parametric statistical analysis. The normality test aims to determine whether the mathematics learning outcomes data for students in the experimental and control classes come from a normally distributed population. This is important because parametric statistical tests, such as the t-test, require data to have a normal distribution for the results to be valid and interpretable correctly.

The normality test in this study was analyzed using the SPSS program with the Shapiro-Wilk method, because the sample size in each class was less than 50 students. If the significance value (Sig.) obtained is greater than 0.05, then the data is declared normally distributed. Conversely, if the significance value is less than 0.05, then the data is considered not normally distributed, so it is necessary to consider the use of nonparametric statistical tests.

Based on the test results, the significance value (Sig.) for both groups was greater than 0.05. This indicates that the mathematics learning outcomes of students in both the experimental and control classes were normally distributed. Thus, the assumption of normality as a requirement for using parametric statistical analysis has been met, as presented in Table 1 below.

Table 1 Normality Test Results

		Kolmogorof-Smirnov			Shapiro-Wilk		
	Kelas	Statistic	df	Sig.	Statistic	df	Sig.
Learning outcomes	Ekspremen	,076	30	,200	,960	30	,307
	Kontrol	,079	31	,200	,974	31	,645

After the data met the assumption of normality, the analysis continued with a homogeneity test for students' mathematics learning outcomes in both classes based on their mid-term exam scores. The results of this homogeneity test, analyzed using SPSS, are presented in Table 2.

. **Table 2**. Results of Homogeneity Test

		Levene Statistic	df1	df2	Sig.
Learning outcomes	Based on Mean	,421	1	59	,519
	Based on Median	,254	1	59	,616
	Based on Median and with adjusted df	,254	1	42,922	,617
	Based on trimmed mean	,259	1	59	,613

The next stage is the implementation of learning, where class X_a as the experimental class applies the Problem Based Learning model based on Caring Community, while the control class uses direct learning in class X_b, with the same material. The learning process is carried out through three main stages, namely introduction, core activities, and closing. The learning steps include: (1) preparing a plan to solve the given problem, (2) solving the problem according to the plan that has been designed from the start, (3) utilizing all the information contained in the problem, (4) providing the correct answer, and (5) rechecking the answer by applying the correct steps or methods. like the following picture

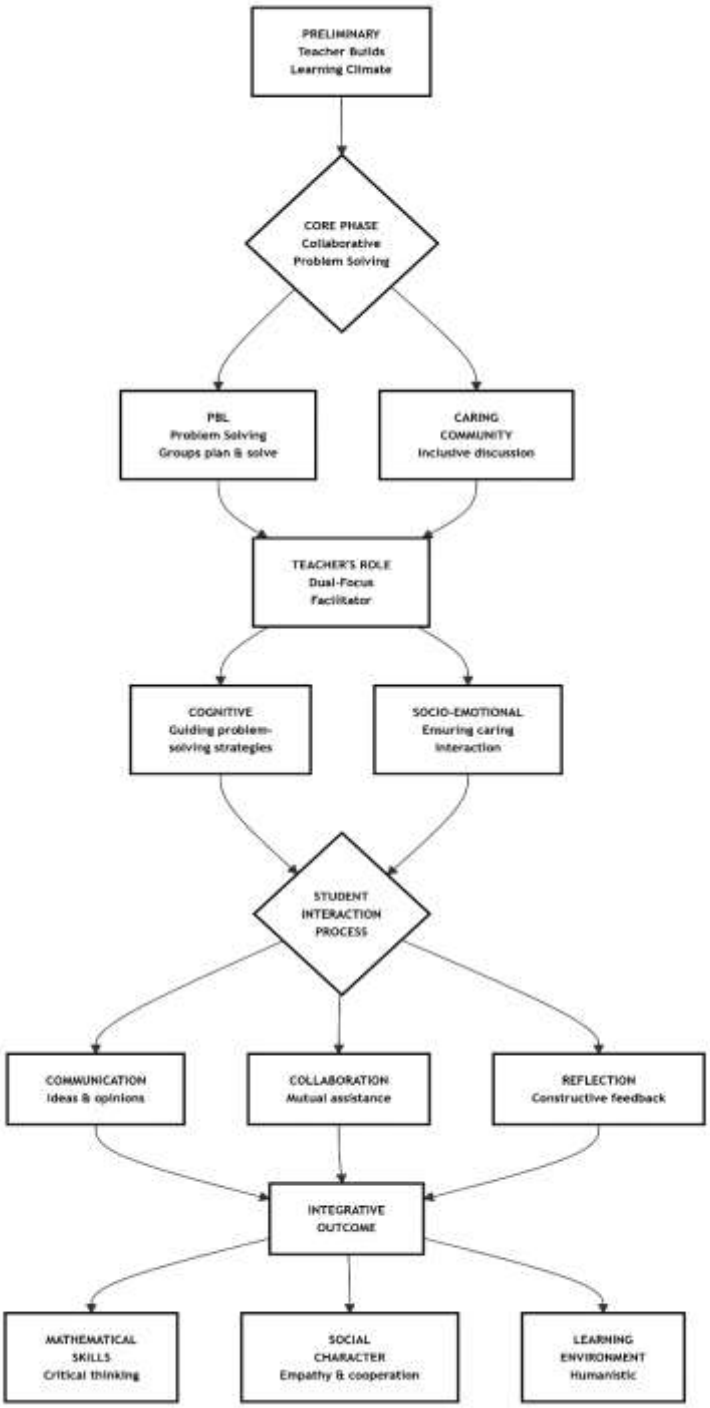

Figure 2. Integrating PBL with Caring Community in the Classroom

Figure 2. Shows the Process of Integrating the Problem Based Learning (PBL) model with the Caring Community approach in mathematics learning, carried out through the transformation of problem-solving activities by strengthening an empathetic and collaborative social climate in the classroom. In the introductory stage, the teacher not only conveys the learning objectives and contextual problems to be solved, but also builds a supportive classroom atmosphere by emphasizing the importance of mutual respect, listening to friends' opinions, and working together positively.

In the core activity, students are directed to develop problem-solving plans in groups. In this process, the Caring Community principle is applied through inclusive discussion habits, where each group member is given the opportunity to participate, share ideas, and help peers experiencing difficulties. The teacher acts as a facilitator, not only guiding problem-solving strategies but also ensuring that social interactions are conducted with a sense of caring, mutual support, and appreciation for each student's contribution.

Furthermore, as students complete the problem according to plan, utilize the available information, and review their answers, they are encouraged to reflect together and provide constructive feedback. This activity strengthens the Caring Community character as students learn to take responsibility not only for their own work but also for the success of their group and the learning community as a whole.

Thus, the integration of PBL based on Caring Community is reflected in learning that not only emphasizes critical thinking and mathematical problem-solving skills but also fosters a humanistic, collaborative, and caring learning environment. The next step was to conduct an independent samples t-test, the results of which are presented in Table 3.

Table 3. t-Test Results

		F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Post-test scores	Equal variances assumed	1,374	,246	29,287	59	,000	13,89366	,47440	12,94439	14,84292
	Equalvariances not assumed			29,215	57,119	,000	13,89366	,47557	12,94138	14,84593

Table 3. Shows that the t-test results in the row, obtained a t value = 29.287 with degrees of freedom (df = 59) and a significance value of Sig. (2-tailed) = 0.000. This significance value is smaller than 0.05, which indicates that there is a significant difference in the average post-test score between the experimental class and the control class. The average difference (Mean Difference) of 13.89366 indicates that the post-test score of the experimental class is higher than the control class. In addition, the 95% confidence interval is in the range of 12.94439 to 14.84292, all of which are positive, thus further strengthening that the difference is real.

Thus, the results of this test show that the application of the Problem Based Learning model based on Caring Community has a significant influence on improving students' mathematical abilities compared to conventional learning.

Discussion

Research findings indicate that the implementation of the Caring Community Based Problem Based Learning (PBL) model significantly improves students' mathematical abilities, particularly in vector material. This is inseparable from the characteristics of the PBL model, which places students at the center of learning through the exploration of authentic problems, as stated by (Pamungkas et al., 2025) Problem Based Learning encourages the development of higher-order thinking skills, including analysis, synthesis, and evaluation. However, the strength of this model in the context of this study is strengthened by the integration of the Caring Community principle, which creates an empathetic, inclusive, and collaborative classroom climate. This approach aligns with the view (Aziiz & Kurnia, 2024) on the *ethic of care*, which emphasizes that meaningful learning can only occur in relationships based on caring, trust, and mutual respect. Thus, the combination of these two approaches not only meets students' cognitive needs but also addresses the affective dimension that is often neglected in conventional mathematics learning.

The integration of Caring Community values into the PBL process has been shown to reduce common psychological barriers experienced by students in learning mathematics, such as anxiety, fear of making mistakes, or reluctance to participate. This is in line with findings (Tohir et al., 2021) which states that affective skills such as a sense of security, intrinsic motivation, and social support have a significant positive correlation with mathematics learning outcomes. In this study, a classroom atmosphere built on the principle of mutual care enabled students to feel comfortable expressing ideas, asking questions, and even making mistakes as part of the learning process. This kind of environment encourages the active participation of all class members, including students who are usually passive, thus expanding access to meaningful learning opportunities.

The significant difference between the experimental class and the control class can also be explained through *Vygotsky's theory* of social constructivism in (Tamrin et al., 2011) which emphasizes that knowledge is built through social interaction. In the Caring Community Based PBL model, interactions are not only cognitive (discussions on problem solving) but also affective (mutual support, positive feedback, and respect for differences). The collaboration that occurs is not simply a division of tasks, but rather an intellectual dialogue based on mutual trust. This distinguishes this research from conventional PBL applications, which often focus only on cognitive aspects and pay less attention to the quality of social relations within the group. This finding strengthens the argument (Atikurrahman et al., 2019b) The local cultural context, especially the values of mutual cooperation and togetherness in Indonesian society, can be a strong foundation for building an effective learning community.

Although most previous studies, such as those conducted by (Salsabila & Cahya Mulyaning Asih, 2024) also reported the positive impact of PBL on mathematical problem-solving abilities, this study offers a new contribution by integrating the caring dimension as a social-emotional foundation in the implementation of PBL. The main difference lies in the model design: while previous studies tend

to treat PBL as a pedagogical strategy alone, this study views PBL as part of a holistic learning environment, where human values and social connectedness are prerequisites for cognitive success.

Contextually, the relevance of this model at Ibrahimy 2 High School, Sukorejo, as an institution rooted in Islamic boarding school values, is a strengthening factor in the effectiveness of its implementation. Values such as *tawadhu'* (humility), *ta'awun* (mutual assistance), and *ukhuwah* (brotherhood), which are already embedded in the school culture, facilitate students' acceptance and internalization of the Caring Community principles. This indicates that the success of learning innovation is determined not only by the theoretical validity of the model but also by its suitability to the socio-cultural context in which it is implemented. Thus, this study not only provides empirical evidence of the effectiveness of the PBL Caring Community model but also emphasizes the importance of a contextual approach in developing humanistic and sustainable mathematics learning practices.

Conclusion

This study shows that the implementation of the Problem Based Learning model based on Caring Community has a significant influence on improving students' mathematical abilities, especially in understanding the concept of vectors at SMA Ibrahimy 2 Sukorejo. Quantitative findings revealed a significant difference between the experimental class and the control class, with the average post-test of the experimental class (82.40) being much higher than the control class (68.50). More than just cognitive improvement, the integration of the Caring Community principle has been proven to create an empathetic, inclusive, and collaborative classroom climate-an atmosphere that allows students to feel safe to participate, express ideas, and learn from mistakes without fear of being judged.

The success of this model is inseparable from the alignment between the pedagogical approach and the school's socio-cultural context. As an institution rooted in Islamic boarding school values, SMA Ibrahimy 2 Sukorejo has a strong cultural foundation of *ta'awun* (mutual assistance), *tawadhu'* (humility), and *ukhuwah* (brotherhood), which naturally support the implementation of the Caring Community principle. Thus, this model is not only academically effective but also culturally relevant. The integration of the affective dimension into mathematics learning, which has tended to be technical and cognitive, turns out to be key in overcoming psychological barriers such as math anxiety and reluctance to participate. Therefore, this study confirms that humanistic, holistic, and contextual mathematics learning is not only possible but also indispensable to address the challenges of 21st-century education.

Recommendation

Based on the findings and limitations of this study, several development directions can be used as a basis for further research in exploring the integration of the Caring Community Based Problem-Based Learning model into mathematics learning. First, further research could expand the scope of

mathematics material beyond vector topics, such as analytical geometry, calculus, or statistics, to test the transferability of this model to content that differs in structure and level of abstraction. Second, the research design could be enriched with a longitudinal approach to observe the sustainability of the model's impact on students' cognitive and affective development over the long term, not just within a single short learning cycle.

Third, considering the unique cultural context of Islamic boarding schools at Ibrahimy 2 High School in Sukorejo, which also strengthens the acceptance of the Caring Community principle, comparative research between different types of schools, such as religious-based schools and public schools, can provide deeper insights into the influence of socio-cultural context on the effectiveness of this hybrid model. Fourth, the integration of digital technologies, such as online collaborative platforms or learning analytics-based applications, can be developed to strengthen the caring community dimension in online or hybrid learning environments, especially in the post-pandemic era that demands flexible learning modes.

Finally, future research could also develop a more comprehensive instrument to measure affective dimensions such as empathy, psychological safety, and group cohesion as mediators between the implementation of Caring Community and improved mathematics learning outcomes. This way, not only will the model's effectiveness be measurable, but also the psychosocial mechanisms behind it can be more fully revealed. Such development will enrich the theoretical foundation and expand the practical application of a humanistic and sustainable learning approach in mathematics education.

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