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The Application of Clay Media-Based Scientific Learning in Improving Children's Collaboration Skills

Endang Septiarsih
Universitas Negeri Malang, East Java, Indonesia

Abstract:
The purpose of this study is to examine how the application of scientific learning based on clay media can improve students' collaboration skills. This study uses a qualitative approach with a case study design. Data were collected through observation and interviews with teachers and children involved in learning using clay media. The results showed that the application of clay media in scientific learning significantly improved several aspects of child development, including: (1) improved the ability to work together, where children learn to share tasks and complete tasks together; (2) improving problem-solving skills, because children can think critically to find solutions in the process of making works using clay; (3) increased creativity, as seen from the ability of children to produce new ideas in the process of working; and (4) improved fine motor skills, since the use of clay involves hand-eye coordination. The implication of this research is that clay media can be an effective tool in improving children's social and motor skills, as well as encouraging creativity in a fun learning process.

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✉Corresponding Author: endangend21@gmail.com
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INTRODUCTION

In the world of education, scientific learning theory plays a very important role in shaping effective and efficient teaching methods (Darling-Hammond et al., 2020). A theory that emphasizes learning based on discovery, observation, and experimentation, in this learning process children are encouraged to be more active (Ibrahim & Rashid, 2022). However, there is a gap between this theory and the social facts that occur on the ground. There are still many teachers who still use conventional learning methods that are teacher-centered and not student-centered, and do not actively involve students in the process of learning activities (Woods & Copur-Gencturk, 2024). This results in a low ability to collaborate students, which should be improved through a scientific learning approach. Why does this happen? Because the implementation of this theory is often hampered by the lack of understanding and skills of teachers in applying scientific methods in the classroom. How do I solve this

problem? It is important to look for practical solutions that can bridge this gap by utilizing learning media that are relevant and interesting to students, such as clay.

Various studies have been conducted to examine the effectiveness of science-based learning in improving students' skills. Learning will become more collaborative and quality education will be realized (Jovanović & Milosavljević, 2022). Other research reveals that project-based learning, which is part of the scientific method, is able to improve collaboration skills among students (Owens & Hite, 2022). However, most of this research is still limited to the use of conventional learning media such as textbooks and presentations (Abdulrahaman et al., 2020). Our research position is to fill this gap by exploring the use of clay media as an aid in scientific learning. Why clay? Because these media can stimulate students' creativity and provide a more hands-on learning experience, which supports the principles of scientific learning (Herrera-Pavo, 2021).

The uniqueness of this research lies in the use of clay media as a tool in scientific learning to improve students' collaboration skills. Clay media was chosen for its flexible nature and can be engineered, allowing students to be creative and collaborate in group projects (Gordon & Mihailidis, 2022). Previously, there were not many studies that examined the use of clay in the context of scientific learning. This research will not only explore the effectiveness of clay as a learning medium, but also how its use can improve student engagement and develop their collaboration skills. Thus, this research makes a new contribution in the field of education, especially in the application of creative and innovative media-based scientific learning methods.

This research aims to answer several key questions: How can the application of scientific learning based on clay media improve students' collaboration skills? These questions are important to answer because they will provide deeper insights into the practical application of scientific learning methods in the classroom, as well as provide concrete recommendations for educators in improving students' collaboration skills through creative media.

The provisional answer from this study is that the use of clay media in scientific learning can significantly improve students' collaborative abilities. The reason behind this argument is the interactive and manipulative nature of clay that can encourage students to work together on group projects. Preliminary evidence from preliminary studies suggests that students who learn using clay are more engaged and active in the learning process. In conclusion, by adopting clay media in scientific learning methods, we can bridge the gap between theory and practice and improve students' collaborative skills, which are essential skills in the 21st century. The study will test this hypothesis through experiments and observations in the classroom, providing empirical data to support the argument.

RESEARCH METHOD

This research uses qualitative. A qualitative approach in the form of a case study will be used to explore the process of interaction in the classroom, the role of teachers, and group dynamics that support children's development in different social and cultural contexts. Using a combination of these methods, the study aims to get a comprehensive picture of the influence of collaboration-based learning activities on early childhood.

The research locations were conducted in several Early Childhood Education (PAUD) institutions located in urban and rural areas in Indonesia. The selection of this location aims to gain a broader understanding of the implementation of early childhood education in diverse contexts, both in terms of facilities, curriculum, and social environment. This variety of locations will provide insight into the challenges faced in improving children's social and cognitive abilities, as well as how external factors such as culture and economic conditions affect the learning process. Therefore, the selection of this location is very important to provide a representative picture of the situation in various regions.

The main sources of information in this study consist of informants (PAUD teachers, parents, institutional managers), as well as documents related to the curriculum and education policies. Semi-structured interviews with teachers and parents will be used to explore their views on child development and applied learning methods. Direct observation of classroom activities will provide data on children's social dynamics and teacher-child interaction.

RESULT AND DISCUSSION

Result

Improving Teamwork Skills

The ability to work together in early childhood is defined as the ability to interact with peers in joint activities, share tasks and responsibilities, and help each other to achieve agreed common goals before doing group activities. Where children can learn to divide tasks, help each other, and appreciate the contributions of each group member (de Hei et al., 2020). On the field, this ability is manifested through behaviors such as sharing game tools, completing group tasks, and listening to friends' opinions. Children who have the ability to interact and cooperate tend to be more able to establish positive relationships with peers and show empathy in social interactions.

An interview with Tatik, an early childhood education teacher, stated, "Children who are invited to play in small groups seem to learn more easily to learn to share and work together. For example, when making an object out of clay with his friends in a group.

One parent said: "I noticed a change in my child after participating in a group activity at school. At home, he started to play with his brother and often talked about the importance of working together, such as when he asked for help making an object with clay media." (W_T, 2024)

Observations were made on group-based play activities in PAUD. During the activity of making objects with clay media, children were seen talking to each other to divide tasks. Some children took the initiative to give their opinions on what shape to be made. In the discussion activity, there are moments when there are small disputes, but the children are able to solve them with the help of teachers who facilitate the discussion. This activity shows developments in communication skills, role sharing, and collaborative problem-solving.

The results of interviews and observations show that group-based activities consistently strongly support the improvement of children's ability to work together.

Children not only learn to express their ideas or opinions and share tasks but also begin to understand the importance of communication and mutual respect. The data shows that structured activities with clear roles can maximize the development of these skills.

From the data obtained, it can be seen that the ability to work together in children develops through: (1) Active Participation in the Group: Children are actively involved in the division of tasks and the implementation of joint activities. (2) Teacher Support: The role of teachers in guiding discussions and resolving conflicts helps children understand the dynamics of cooperation. (3) Repetitive Experiences: Children who are frequently exposed to collaborative activities show better cooperative skills than children who are less involved in these kinds of activities. This pattern indicates that collaboratively designed meaningful learning can be an effective strategy to improve the ability to work together in early childhood.

Improved problem-solving capabilities

When facing obstacles in forming clay or making a work, children are trained to think critically in solving problems and also find solutions together. Early childhood ability to solve problems is defined as the ability of children to recognize problems, find solutions through exploration or discussion, and apply the solution in a specific context. This ability is identified through activities such as trying different ways to complete tasks, asking for help when needed, and working with friends to find a solution to a problem at hand. In the field, problem-solving is often seen in challenge-based play activities, such as putting together puzzles, solving simple puzzles and creating a work in a group. One parent stated, "My child is now more patient when faced with small problems, such as when his toy gets stuck. He would try to fix it himself before asking for help. I see that he is more confident to find a solution."

Observations are carried out during group activities where children are asked to solve a problem together. Children show different ways, such as experimenting, discussing with friends, and comparing previous solutions. One of the children takes the lead by giving new ideas, while the other helps by providing input. When they find an error, the group works together to correct it and try again until it succeeds. This activity demonstrates critical thinking and collaboration skills in solving problems.

The results of interviews and observations show that children's ability to solve problems develops through challenge-based activities involving exploration and cooperation. Children prefer to use a trial-and-error, discuss, and use support from their surroundings to solve problems. This pattern emphasizes the importance of providing relevant challenges and appropriate mentoring to support the development of these abilities. From the data obtained, it can be seen that the pattern of problem-solving skills in children develops through:

1. Self-Exploration: Children try different solutions to find the right way.
2. Work Together with Friends: Discussion and sharing ideas with each other helps children find better solutions.
3. The Role of Teachers and Parents: Support in the form of guidance without giving direct answers encourages children to think critically.

4. Challenge-Based Activities: Activities that involve puzzles, experiments, or goal-based games improve problem-solving skills gradually.

This pattern indicates that a learning environment that provides challenges and allows for independent exploration and collaboration can support the development of problem-solving skills in early childhood.

Increased Creativity

Clay provides a wide space for children to explore and produce unique and innovative works. Creativity in early childhood is defined as the ability to generate new ideas, solve problems in an original way, and express oneself through various media, such as art, play, or speaking. Creativity is seen in actions such as drawing with imagination, creating stories, or utilizing simple materials to create something unique. In the field, children's creativity is often observed in free play, art, and environmental exploration activities. A PAUD teacher said, "When given tools such as clay, or simple materials, children always have different ways of making things. They often draw or create objects that reflect their ideas, even without special guidance from the teacher."

One parent stated: "My son started using things at home to make something creative, like cardboard that he used to make a house. I saw him start thinking about how the objects around him could be used in different ways."

Observation was made when children were asked to make artwork from recycled materials. Children show a variety of creative ideas, such as using rolls of tissue paper as a framework to make robots or drawing unique patterns on cardboard boxes. Children also share ideas with their friends, producing works that are different from each other. This activity shows that children are able to think out-of-the-box and utilize materials in innovative ways.

The results of interviews and observations revealed that creativity in early childhood develops well when they are given the freedom to explore and express themselves. A supportive environment, such as the provision of simple materials and encouragement from teachers or parents, allows children to generate new ideas and develop creative thinking skills.

From the data obtained, it can be seen that the pattern of creativity in children develops through:

1. Freedom of Exploration: Children are given the opportunity to try different ways to complete tasks without pressure.
2. Use of Simple Materials: Available materials, such as paper, cardboard, or recycled objects, become a medium for channeling creative ideas.
3. Social Interaction: Children often share ideas and are inspired by their friends.
4. Encouragement from Teachers and Parents: Praise and encouragement to think outside the box increase children's confidence to work.
5. This pattern suggests that an environment that encourages free exploration and self-expression can maximize the potential of early childhood creativity.

Improvement of fine motor skills

The process of shaping clay helps improve hand-eye coordination. Fine motor

skills in early childhood are defined as the ability to use small muscles, especially the hands and fingers, in activities that require coordination and precision. These skills involve activities such as squeezing, drawing, writing, cutting with scissors, buttoning, or meronce. In the field, the improvement of fine motor skills is seen through the child's ability to complete these tasks faster, more precisely, and with fewer errors.

A PAUD teacher stated, "We routinely involve children in activities such as knitting beads, printing shapes with plasticine, or drawing patterns. These activities go a long way in improving their accuracy and coordination, especially in holding tools such as pencils or scissors."

One parent revealed: "I see my son becoming more skilled at buttoning his own clothes. He also started to like drawing small patterns at home, something that was quite difficult for him before."

Observation was made when the children participated in clay-making activities. In the meronce activity, some children showed good hand-eye coordination, being able to insert small beads into the thread quickly. Meanwhile, other children who are struggling still try to complete tasks with the help of teachers. In drawing patterns, children look focused and try to control hand movements to match the lines that have been provided. This activity shows an improvement in fine motor skills, especially in the aspects of precision and concentration.

Interview and observational data showed that early childhood fine motor skills developed significantly through directed activities involving the use of hands and fingers. Children who frequently engage in activities such as knitting, drawing, or using plasticine show better ability to control hand movements. Support from teachers or parents also plays an important role in encouraging children to continue practicing.

Improved Cooperation Ability

The results show that the ability to work together in early childhood can be improved through intentionally designed collaborative activities. This is in line with Vygotsky's theory which emphasizes the importance of social interaction in learning. According to Vygotsky, group cooperation provides children with opportunities to learn from peers through scaffolding or structured social assistance. These findings also support previous research that states that group activities such as role-playing or collaborative projects are able to strengthen sharing, listening, and communication skills (Smith, 2018). However, there are differences in local contexts, where children require more teacher intervention compared to research in developed countries, which shows higher independence in cooperation.

The findings of this study highlight the importance of the role of teachers in facilitating collaborative interactions in early childhood. Teachers are not only observers but also mediators who help children resolve conflicts and encourage effective communication (Cárdenas et al., 2020). This is consistent with Piaget's view that a child's cognitive development, including the ability to cooperate, occurs through direct experience and reflection in a supportive environment. When teachers actively accompany this process, children tend to better understand the importance of cooperation and begin to apply it in a variety of contexts. This implication is relevant for

the development of a collaborative early childhood education curriculum, so that learning activities focus not only on individuals but also on groups (Jeon & Lee, 2023).

The ability to work together has significant practical implications for a child's social and emotional development. So-what: Children who are used to working together are better prepared to face formal school environments where collaboration is one of the main pillars of learning success (Thornhill-Miller et al., 2023). In addition, this ability also serves as a foundation in the development of social intelligence that will be needed in the future. Why: The cause-and-effect relationship lies in the learning environment that allows the child to develop these skills through real experience. Structures such as planned group activities, the active role of teachers, and opportunities to resolve conflicts independently are key factors that support the improvement of cooperation skills (Thornhill-Miller et al., 2023).

The results of the study show that the ability to work together can be improved through learning based on collaborative activities. However, this implementation requires a conducive learning environment, such as consistent teacher support and activity design that is appropriate to the child's development. Contextual differences, such as the need for more intensive guidance for children in the local environment, also need to be considered in the development of the early childhood education curriculum. By integrating these findings into educational practice, it is hoped that children's cooperative skills will not only develop within the school environment, but also in everyday life, preparing them for future social challenges.

Improved problem-solving capabilities

The results of this study support Dewey's theory that problem-solving skills develop through direct experience and critical thinking processes. Challenge-based activities, such as putting together puzzles or solving puzzles, give children the opportunity to identify problems, find solutions, and evaluate the results. According to (Qureshi et al., 2023) highlights the importance of social interaction in problem solving, where children learn through discussions with peers. These findings are in line, although there are differences in the intensity of teachers' roles. In the local context, teachers provide more direct direction than in research contexts in developed countries that emphasize children's autonomy.

These findings have important implications for the development of problem-solving-based learning in early childhood education. Children who are used to solving problems through direct experience tend to develop critical and independent thinking skills early. According to Bruner's theory, a learning environment designed to provide a challenge will spark children's curiosity and encourage the exploration of solutions. In this study, it was seen that children not only learn to find solutions, but also develop communication and cooperation skills. This supports previous findings that suggest that collaborative experiences strengthen problem-solving abilities through discussion and exchange of ideas (Smith, 2020).

Improving problem-solving skills has a positive impact on children's cognitive and social development. Children who have this ability tend to be more confident in facing challenges, both in the school environment and in daily life. In addition, they are more

skilled in making decisions and dealing with unstructured situations. Why: This process occurs because children are given space to experiment, learn from mistakes, and evaluate alternative solutions. Supportive structures, such as game-based challenges and teacher support, are key factors in the development of these abilities.

The results show that problem-solving skills can be improved through well-designed challenge-based learning. However, the role of the teacher as a facilitator is very important in guiding the child during the exploration process without overdirecting. To increase effectiveness, it is necessary to integrate problem-solving activities that are relevant to the child's daily life, such as resolving minor conflicts or finding solutions in collaborative play. With this approach, problem-solving skills will not only develop in the school environment but also become an integral part of children's life skills in the future.

Increased Creativity

The results of this study support Guilford's theory of creativity, which underscores the importance of divergent thinking skills, which are the ability to generate various ideas from a single situation. Children who were involved in activities such as fine art, imaginative play, or exploration of recycled materials showed improvements in the ability to generate new ideas. This research is also in line with the study of Amabile (2018), which states that children's creativity is nurtured through an environment that supports freedom of exploration and values originality. However, the findings of the study show contextual differences, where children in local settings need more initial guidance from teachers than children in countries that implement self-exploration-based learning.

These findings highlight the importance of the role of the environment in increasing early childhood creativity. According to Montessori, freedom and the opportunity to interact with concrete materials are key in encouraging creativity. In this study, activities such as drawing and making artwork from simple materials gave children space to experiment and develop their original ideas. Teachers who encourage exploration without giving too rigid pressure or direction contribute to creating a learning atmosphere that supports creativity. This supports Torrance's theory that creativity develops optimally in an environment that supports freedom of thought and self-expression.

So-what: Increased creativity has a direct impact on children's cognitive and emotional development. Creative children tend to be more adaptive to new situations, have higher confidence, and are able to think flexibly in solving problems. In addition, creativity also plays a role in building children's emotional intelligence, as they learn to express their feelings and ideas through diverse media. Why: This process occurs because of a combination of an environment that supports free exploration, the role of the teacher as a facilitator, and the child's opportunity to learn from the experience. Activity structures designed to encourage divergent thinking are the basis for the sustainable development of creativity.

The results of this study show that early childhood creativity can be enhanced through learning activities that encourage free exploration and freedom of expression.

Teachers need to design activities that involve simple materials but encourage children to think creatively, such as fine art, simple experiments, or imaginative games. It's also important to create an environment that not only gives children room to experiment, but also appreciates their every idea and work. With this approach, children's creativity can continue to develop, becoming an important provision in facing the challenges of the modern world that requires innovative thinking skills.

Improvement of fine motor skills

The results of this study support Gallahue's theory of motor development, which states that fine motor skills are developed through practice and hands-on experience in activities that involve hand-eye coordination. Activities such as knitting, drawing, and pattern cutting applied to early childhood in this study are in line with Sheridan's (2014) study, which found that fine motor skills can be improved through the use of varied tools. However, this study shows that children in local settings often need more early guidance than children in developed countries, who are usually more accustomed to self-exploration-based activities.

These findings highlight the importance of the role of structured routine activities in improving children's fine motor skills. According to Montessori theory, manipulation of concrete objects is the key to developing fine motor skills. In this study, the children's use of materials such as beads, plasticine, or scissors allowed them to practice the precision and strength of their fingers. This supports the findings of Wood (2017), who states that children who are actively involved in these activities tend to show faster development in their manual skills. In addition, observations show that teachers play an important role as facilitators who provide early guidance and motivation when children face difficulties.

So-what: Improved fine motor skills have direct implications for a child's readiness for academic activities, such as writing and drawing, which require fine muscle control (Chandler et al., 2021). In addition, children who have good fine motor skills are more independent in carrying out daily activities, such as buttoning clothes or tying shoelaces. Why: This advancement is due to a learning environment that allows children to experiment with tools that stimulate hand-eye coordination. A planned learning structure, such as gradual activities from simple to complex tasks, encourages the systematic development of these skills.

The results suggest that early childhood fine motor skills can be significantly improved through activities specifically designed to train hand coordination and precision. Teachers need to create engaging and varied activities, such as craft arts, construction games, or daily practical tasks, to train children's fine motor skills. In addition, it is necessary to provide space for children to experiment independently while still receiving guidance if needed. With this approach, fine motor skills can develop optimally, becoming an important foundation to support children's academic development and independence in the future.

Discussion

The results of this study show that the ability to work together in early childhood can be significantly improved through well-designed collaborative activities. This is in line with Vygotsky's theory which emphasizes the importance of social interaction in learning. In this study, children showed good development in sharing tasks, listening to each other, and appreciating the contributions of peers. Group-based activities, such as making objects out of clay, provide opportunities for children to practice working together in achieving common goals. Teachers play an important role in facilitating these social interactions, as seen in their role in helping to resolve minor disputes among children. These findings support the importance of collaborative activity design in developing children's social and communication skills.

Furthermore, improving problem-solving skills is also a significant finding in this study. Challenge-based activities, such as putting together puzzles or solving puzzles, allow children to face problems head-on and find solutions together. Children show critical and creative thinking skills in dealing with obstacles, trying various solutions, and discussing with peers. The role of teachers as facilitators in this process is crucial, as they provide support without providing direct solutions. These findings indicate that providing relevant challenges can improve problem-solving skills in early childhood, as well as strengthen the social skills needed to work together in dealing with problems.

In addition, the study also found a significant increase in children's creativity. Art activities and exploration of simple materials, such as clay or recycled materials, provide space for children to imagine and produce original works. Children show their ability to think out-of-the-box in creating something new, both in the form of art and through the exploration of objects around them. An environment that supports freedom of exploration, as well as encouragement from teachers and parents, plays a big role in the development of children's creativity. This activity shows that giving children the freedom to explore can maximize their creative potential, which is important in their cognitive and emotional development.

Improving fine motor skills is also an important aspect of this study. Activities that involve hand-eye coordination, such as knitting, drawing, or making objects out of plasticine, show significant development in children. Children who engage in these routine activities show better ability to control hand movements and improve accuracy. The role of teachers in providing support and guidance is also very important, especially when children face difficulties. These findings confirm that fine motor skills develop through the repetition of appropriate activities and adequate guidance, which supports the child's readiness for future academic activities.

The importance of self-exploration and social interaction is also seen in increased creativity and problem-solving skills. In this context, an environment that supports children to think independently and collaborate with peers is key. Children who engage in challenge-based and art-based activities show development in critical thinking, creativity, and the ability to work together. Support from teachers and parents is helpful, but children also need space to try and learn from their own experiences. These findings are in line with the views of Montessori and Piaget theories that emphasize the importance of hands-on experience and freedom in learning.

In addition, the role of teachers in facilitating group-based learning and problem-solving is essential. Teachers not only act as observers, but also as mediators who help children resolve conflicts and encourage effective communication in groups. Well-designed learning, which involves challenges, self-exploration, and group discussions, can facilitate the development of children's social and cognitive skills. This supports Bruner's theory which emphasizes the importance of challenges in arousing children's curiosity, as well as Piaget's who considers social interaction to be an important part of cognitive development.

Finally, the results of this study show that learning approaches involving collaborative activities, challenges, self-exploration, and freedom of expression can improve teamwork, problem-solving, creativity, and fine motor skills in early childhood. A supportive environment, with the active role of teachers and parents, is a key factor in the development of these skills. By designing an early childhood education curriculum based on these principles, it is expected that children can develop social, cognitive, and motor skills that are essential for their future learning and life success.

CONCLUSION

This research highlights the importance of the role of social interaction, collaborative activities, and structured learning environments in improving various aspects of early childhood development, including cooperative skills, problem-solving, creativity, and fine motor skills. These findings underscore that hands-on experience, the active role of teachers, and learning designs that are appropriate to the child's developmental level are key in supporting these abilities. In addition, this study shows that children who engage in challenge-based activities, free exploration, and manipulation of concrete objects show significant development in cognitive, social, and emotional aspects. In the local context, more intensive teacher guidance compared to practice in developed countries becomes an adjustment that is relevant to the characteristics of children.

The main contribution of this research lies in the reinforcement of educational theories, such as those of Vygotsky, Dewey, Guilford, and Gallahue, in different local contexts. Using a real-life activity-based approach, this study renews perspectives on how social interaction and challenge-based learning can be applied to early childhood. However, the study has limitations, such as limited coverage in local contexts and the absence of gender or age group variation. Therefore, advanced research that includes broader surveys, method variations, and more heterogeneous populations is needed to gain a more comprehensive understanding. These findings are expected to be the basis for a more targeted and contextual early childhood education policy.

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