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Enhancing Children's Interest and Understanding of Science through STEM Learning at Sekolah Kebangsaan Melayu Raya

(Meningkatkan Minat dan Pemahaman Sains Anak Melalui Pembelajaran STEM, di Sekolah Kebangsaan Melayu Raya)

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Abstract

This study evaluates the effectiveness of implementing STEM (Science, Technology, Engineering, and Mathematics) learning at the preschool level through the "Action of Yeast" and "Electrical Putty" experiments. Pretest and posttest results show a significant increase in children's understanding of the concepts of anaerobic respiration and electrical conductivity. Through an interactive approach, children were actively involved in scientific exploration, which fostered curiosity, courage to experiment, and critical thinking skills. This activity also strengthened social and collaborative skills, where children learned to work together in small groups, appreciate their friends' ideas, and take responsibility for completing experiments. In addition, this practical experience provided an opportunity for KKM-I student participants to apply educational theory in the field, strengthening their pedagogical abilities and understanding the importance of innovation in science learning. This research confirms that the application of STEM-based learning at the preschool level is a strategic step in building a strong foundation for a young generation that is adaptive, creative, and innovative. Thus, this activity not only improves children's scientific understanding but also prepares them to face the challenges of the Industrial Revolution 4.0 era and encourages their interest in science and technology.

Abstrak

Abstrak memuat tujuan utama penelitian, metode yang digunakan, temuan penelitian, dan kesimpulan. Abstrak ditulis dalam Bahasa Inggris dan Bahasa Indonesia menggunakan huruf Garamond 10pt, menggunakan single line spacing antar baris. Left indent 2.5 cm dan right indent 0 cm dan panjang abstrak ant Penelitian ini bertujuan untuk mengeksplorasi dan mengevaluasi efektivitas pembelajaran berbasis STEM melalui pendekatan praktis yang melibatkan eksperimen menggunakan lempung elektrik dan aksi ragi. Fokus utama dari penelitian ini adalah untuk meningkatkan pemahaman konsep ilmiah pada anak-anak prasekolah, terutama mengenai interaksi antara oksigen dan karbon dioksida, serta penerapan sains dalam kehidupan sehari-hari. Metode yang digunakan mencakup observasi dan kuesioner untuk menilai perubahan pemahaman siswa sebelum dan sesudah kegiatan. Hasil penelitian menunjukkan adanya peningkatan signifikan dalam kreativitas dan keterampilan berpikir kritis anak-anak, dengan skor rata-rata pemahaman konsep meningkat dari pra-tes ke pasca-tes. Kegiatan ini tidak hanya membuat pembelajaran menjadi lebih menyenangkan dan interaktif, tetapi juga membekali anak-anak dengan keterampilan penting untuk menghadapi

tantangan di era Revolusi Industri 4.0. Dengan demikian, penelitian ini menegaskan pentingnya integrasi STEM dalam pendidikan prasekolah sebagai langkah awal untuk menumbuhkan generasi yang kreatif dan inovatif.

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1. INTRODUCTION

Oxygen and carbon dioxide play a crucial role in the life of living things. According to Amilia (2022), oxygen is needed for respiration, allowing living things to obtain the energy they need to survive, while carbon dioxide serves as a by-product produced by living things and plays a role in photosynthesis. On the other hand, electric clay is an innovative material that can be used for various applications, including in science and art education (Zulirfan et al., 2021).

Combining the concept of gas with experiments using electric clay can stimulate creativity and problem-solving skills in children. This activity not only teaches children about the interaction between oxygen and carbon dioxide, but also how electric clay can be used to create simple electrical circuits. Through an interactive approach, children can be actively involved in understanding how these two elements work in the context of science and technology (Helga et al., 2024).

Research conducted by Triastuti (2021), highlights the importance of practice- based learning in the context of science education. In her study, Triastuti explains that interactive learning methods that involve direct experience can improve students' understanding of scientific concepts that may seem abstract if taught only in theory. By involving students in practical activities, they can more easily understand and internalize knowledge, which ultimately builds a strong foundation for critical and creative thinking skills this study shows that practice-based learning not only helps in scientific understanding but also in increasing students' motivation to learn.

Meanwhile, research conducted by Amarlita and Ningsih (2025) emphasizes the application of the STEM approach through the Project-Based Learning (PjBL) model in teaching voltaic cell material. They found that learning that integrates science, technology, engineering, and mathematics can significantly improve students' psychomotor skills. In the study by Triastuti (2021), students were asked to design and test voltaic cells using natural materials found in their surroundings. This activity not only trained technical skills but also encouraged students to think critically in designing experiments and finding solutions to the problems they faced (Nurwidodo et al., 2022).

STEM education at the preschool level is very important because early childhood development is a critical phase for building the foundations of critical and creative thinking skills. At this age, children have a high level of curiosity and strong exploratory abilities. In a study by Utomo et al. (2025) by introducing the concepts of science, technology, engineering, and mathematics through practical activities, children can learn to solve everyday problems in a fun way. This approach not only improves their scientific understanding but also helps them develop the social and collaborative skills that will be essential in the future (Indriyanti et al., 2021).

In addition, in the context of the Industrial Revolution 4.0 era, the ability to adapt quickly to technological advances is becoming increasingly important. According to (Nuraini, (2020) STEM-based learning can help children understand and utilize new technologies from an early age, preparing them for future challenges. By using innovative materials such as electric clay and conducting experiments involving gas interactions, children not only learn about scientific concepts but are also directly involved in the learning process. This will increase their confidence in facing challenges and encourage them to continue exploring and innovating in the fields of science and technology (Putri, 2025).

Much research has been conducted on STEM learning, but there are still shortcomings in the application of this method at the preschool level. In the study by Nurwidodo et al. (2022), most previous studies focused on students at the elementary and secondary levels, while preschool children were often neglected in the context of interactive science learning. This creates an urgent need to explore how scientific concepts, such as the interaction between oxygen and carbon dioxide, can be introduced to children through fun and creative hands-on experiences (Amarlita & Ningsih, 2025).

The urgency of this research lies in the potential of STEM-based learning to build a strong educational foundation from an early age. By integrating practical experiments involving innovative materials such as electric clay, children have the opportunity to learn firsthand and experience how scientific concepts work in everyday life (Bourguignon et al., 2014). This approach not only enhances their understanding of science, but also stimulates the interest and curiosity necessary to explore the world around them.

The purpose of this study is to evaluate the effectiveness of practical activities that integrate STEM concepts at the preschool level, with a focus on understanding the interaction between oxygen and carbon dioxide and the use of electric clay (Zulirfan et al., 2021). This study aims to improve students' understanding of basic science concepts through interactive learning experiences, develop 21st-century skills such as critical thinking and creativity, and encourage children's interest and curiosity in science and technology (Sumaya et al., 2021). By achieving these objectives, it is hoped that this research can make a positive contribution to science education at the preschool level and prepare the younger generation to face future challenges.

These practical activities help them develop observation, analysis, and creativity skills. For example, understanding how electric clay can conduct electricity opens up new insights for them about the properties of materials and their applications in everyday life (Zulirfan et al., 2021). Through fun and engaging learning, it is hoped that children can explore the world around them with a high level of curiosity, as well as develop critical and innovative thinking skills that will be useful throughout their lives. In addition, this experience can equip them with the skills necessary to face future challenges, both in science and in other aspects of life (Triastuti, 2021).

2. LITERATURE REVIEW

STEM, which stands for Science, Technology, Engineering, and Mathematics, is a field that plays an important role in the development of modern society (Triastuti, (2021). The main reason for the creation of STEM is to meet the global need for skilled and highly educated workers in an era of ever-evolving technology. With rapid advances in technology and science, today's world needs individuals who not only have theoretical knowledge but also practical skills to apply science in everyday life.(Bourguignon et al., 2014).

The importance of STEM cannot be separated from its contribution to innovation and economic growth. Sectors focused on STEM are often the main drivers in creating new products and services that can improve quality of life (Riawati et al., 2022). For example, discoveries in the fields of information technology, engineering, and health sciences not only create new jobs, but also contribute to increased efficiency and productivity in various industries (Bourguignon et al., 2014).

The results of a study by Novitasari (2022) show that children who are introduced to and stimulated with STEM concepts from an early age have a higher interest in science and technology as they grow up. In addition, they tend to perform better academically in science and mathematics-related subjects than children who do not receive similar stimulation (Motimona & Maryatun, 2023).

The main reason is that early STEM learning helps build a solid foundation of knowledge, critical thinking skills, and scientific exploration habits. This gives them an advantage in understanding more complex material at the next level of education (Riawati et al., 2022).

Therefore, according to Motimona & Maryatun (2023) investing in STEM education at an early age not only has a positive impact on current learning interests and achievements but also serves as an important long-term strategy for developing competitive human resources who are ready to meet the demands of a future workforce that increasingly relies on STEM skills.

Project-based learning is an approach that encourages children to actively engage in tasks or projects that have real and relevant goals. In the context of early childhood STEM education, this method encourages children to learn practically through direct experience, rather than just theory (Riawati et al., 2022).

When this method is applied in the form of group work, children learn together in small teams. This interaction helps them develop social skills such as sharing ideas, communicating effectively, listening to friends' opinions, and working together to achieve common goals. In addition, children also learn to resolve minor conflicts and build a sense of collective responsibility (Zulirfan et al., 2021).

At the same time, according to Bourguignon et al. (2014) the projects they worked on—such as designing simple electrical circuits or observing the yeast fermentation process—honed their STEM skills, such as understanding scientific concepts, developing basic technological skills, reasoning and problem-solving abilities, and experimental skills. Through project-based learning, children gain direct experience applying STEM theory in concrete situations, thereby deepening and enriching their understanding (Helga et al., 2024).

According to Nuraini (2020), learning about electricity and yeast action at the preschool and kindergarten levels can stimulate children's creative thinking skills in a fun and interactive way. In this

activity, children can be invited to experiment with simple electrical circuits using easily found materials, such as batteries, wires, and light bulbs. According to Amalia & Suprapti, through this exploration, children learn how to connect these components to produce light, which not only introduces them to basic electrical concepts but also encourages them to think critically about how each element works. By giving them the opportunity to try various combinations, children are trained to develop their imagination and find their own solutions, which is the essence of creative thinking.

In addition, according to Amalia and Suprapti (2018) yeast activities, in which children observe the fermentation process and gas formation, also provide opportunities for them to apply creative thinking. For example, they can discuss the materials used in the experiment and how the changes occur. Children are encouraged to ask questions, explain, and even design their own experiments to see how yeast works under various conditions (Wahyuningsih et al., 2019). Through these activities, they not only understand scientific concepts but also hone their creative thinking skills by exploring new ideas, collaborating with friends, and communicating their findings. The creative thinking skills developed in this activity will be invaluable to them when facing challenges in the future (Putri, 2025).

A voltaic cell is a device that generates electricity through a chemical reaction, usually involving two electrodes made of different materials and an electrolyte that functions as a conducting medium (Wahyuningsih et al., 2019). In learning activities, children can make a simple voltaic cell by mixing flour with water to form a dough. This process not only teaches the basic concepts of electrochemical reactions, but also provides children with practical experience.

Once the flour mixture is ready, children can connect the batteries to the LED lights using wires. However, in this situation, one of the wires is broken. According to Zulirfan et al. (2021) to solve this problem, children can use the flour mixture as a bridge or substitute between the broken wires. In this way, they learn about electrical conductivity and how current can flow even when there is a disruption in the circuit. According to Rafli et al. (2022) this activity teaches them problem-solving and creativity in finding solutions, as well as providing a better understanding of how electricity works in everyday life.

The yeast activity also provides an interesting and informative learning experience. In this experiment, children will use yeast, sugar, and warm water. First, yeast is added to a bottle containing a mixture of sugar and warm water. This process triggers fermentation, in which yeast converts sugar into alcohol and carbon dioxide gas. When this gas forms, it expands and fills a balloon placed over the mouth of the bottle (Pitaloka & Sinaga, 2023).

According to Pitaloka and Sinaga (2023) Children can directly observe how the gas produced causes the balloon to expand, which is a tangible visualization of the fermentation process. Through this activity, they learn about the interaction between yeast and sugar, as well as the basic scientific principles behind biological processes. Additionally, in the study by Wahyuningsih et al. (2019) this experiment encourages them to ask questions, explore, and discuss what is happening, thereby developing their critical and creative thinking skills. Both the voltaic cell and yeast action experiments are enjoyable and educational learning experiences, introducing basic scientific concepts in an interactive and relevant way for children (Utomo et al., 2025).

3. METHODS

This study employs a quantitative approach to evaluate the effectiveness of KKM-I student activities at Sekolah Kebangsaan Melayu Raya, particularly in the application of STEM concepts among kindergarten and preschool students. The quantitative method was chosen because it allows researchers to objectively measure students' understanding of the material presented through hands-on experiments and quizzes, as well as to assess their level of participation and skills during the activities.

3.1 Research Location and Subject

This research was conducted at Sekolah Kebangsaan Melayu Raya, which was first opened on January 6, 1957, under the name Sekolah Rakyat Kampong Melayu Raya. The students consisted of children of residents living in the Kampung Melayu Raya area and neighboring areas such as Kampung Genuang Baru, Kampung Sri Dagang, Ladang Labis Bahru, and Ladang New Pogoh. This school has early education levels, namely Tadika and Pratadika. This activity focuses on the application of the STEM (Science, Technology, Engineering, and Mathematics) concept (Bourguignon et al., 2014).

Through simple experiments such as Action of Yeast and Electrical Putty, which are designed to foster curiosity and understanding of science from an early age.

3.2 Population and Sample

The population of this study consisted of all Tadika and Pratadika students enrolled at Sekolah Kebangsaan Melayu Raya during the current academic year. The total population involved was 32 students, comprising 17 Tadika students and 15 Pratadika students. The Tadika students were divided into four groups, with each group consisting of four to five students. Pratadika students were also divided into 4 groups, with

3–4 students per group. The students' ages ranged from 4–6 years old, consisting of 17 girls and 15 boys. The research sample used total sampling, meaning that all students in the population were included as participants because the number was relatively small and it was possible for all students to be actively involved in the experiment and gain direct learning experiences.

3.3 Data Collection Techniques

Data collection was conducted using a quantitative approach through questionnaires and observation. The detailed techniques are as follows:

3.3.1.Questionnaire

The questionnaire is used to measure students' level of understanding of the material taught after the experiment. This instrument is designed in the form of STEM activity sheets, such as the Action of Yeast and Conducting Putty experiments. Through the pretest questionnaire, researchers can determine students' initial understanding of the concepts of respiration (action of yeast) and electrical conductivity (conductive putty). After the activity is completed, the questionnaire is given to assess changes or improvements in their understanding.

The questions in the questionnaire are designed to be simple and interactive so that they are easy for early childhood students to understand. For example, questions about the process that occurs in the experiment and the type of gas produced in the Action of Yeast experiment. This questionnaire can also provide an overview of students' curiosity and interest in science activities.

Research Questions:

1) Why does the balloon expand when the yeast undergoes fermentation?
2) What causes the light to turn on when using electrical putty?
3) What is the function of salt in the electrical putty mixture?
4) Observation

Observation techniques were carried out directly during the activity to record student activity, engagement, and skills based on group, gender, and age range. This observation was important to see the dynamics of interaction in each group, for example, how male and female students showed differences in how they experimented, worked together, or expressed their opinions.

These observations allow researchers to record the various strategies students use to complete tasks, as well as how they support each other. By observing differences in approach between different age groups, we can also evaluate the effectiveness of the learning methods used. For example, younger students may show a more exploratory approach, while older students tend to be more analytical and systematic in solving problems (Alwi et al., 2024).

With the data collected through observation, we can draw conclusions about the influence of these factors on the students' learning process. This also provides an opportunity to reflect on the teaching methods used, so that they can be adapted to meet the diverse learning needs in the classroom.

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3.4 Data Analysis

Data analysis was conducted using descriptive statistics, namely by calculating the mean, percentage, and frequency distribution of the observation results on student engagement and understanding. These descriptive statistics were used to describe the extent of the effectiveness of STEM activities on groups, gender, and age of Tadika and Pratadika students. To support data accuracy, researchers used simple software such as Microsoft Excel to manage and display results in tables and graphs to describe the results of questionnaires and observations, including the percentage of students who showed an increase in understanding of STEM concepts.

4. RESULTS AND DISCUSSION

Tabel 1. Descriptive Statistics by Respondents Group, Age, and Gender

	Group	Age	Gender
Mean	4.483870968	4.483870968	0.548387097
Standard Error	0.393142749	0.13812078	0.090858624
Median	4	4	1
Mode	4	4	1
Standard Deviation	2.188926186	0.769023959	0.505879411
Sample Variance	4.791397849	0.591397849	0.255913978
Kurtosis	-1.100478137	-0.073754835	-2.098149605
Skewness	0.023205679	1.232682508	-0.204491967
Range	7	2	1
Minimum	1	4	0
Maximum	8	6	1
Sum	139	139	17
Count	31	31	31

Analysis of age data shows that the mean age of respondents is approximately 4.48 years with a standard deviation of 0.77, indicating relatively low variation around the mean value. The median and mode are both 4, indicating that most respondents are 4 years old. This age distribution has positive skewness (1.23), indicating that there are more respondents below the average age, while the kurtosis, which is close to zero (- 0.07), indicates that the data distribution is relatively normal without significant outliers. The age range of respondents was from 4 to 6 years old, with two respondents aged 6 years old. Overall, the age data showed consistency and a clear tendency towards the median value.

The data on gender shows that the average gender value is 0.55, where 0 represents one gender and 1 represents the other gender. The standard deviation of 0.51 indicates that there is considerable variation among respondents. The median and mode are both 1, which shows that more than half of the respondents belong to one gender. With negative skewness (-0.20), the gender distribution shows that there are slightly more respondents of one gender than the other, although the difference is not significant. The highly negative kurtosis (-2.10) indicates a flatter distribution than a normal distribution, suggesting that most of the data is concentrated around the median value with few outliers.

The group data shows that the average group score is also 4.48, similar to the age data, with a higher standard deviation of 2.19. This indicates that there is greater variation within the group compared to age and gender. The median and mode are both 4, reflecting that many respondents are in the same group. The group value range is 7, with a minimum value of 1 and a maximum value of 8, indicating that there is quite a wide variation in the grouping of respondents. The skewness, which is close to zero (0.02), indicates that the distribution of group data is relatively symmetrical, while the kurtosis (-1.10) indicates a distribution that is slightly flatter than a normal distribution. This shows that despite the variation, the majority of respondents are well grouped around the mean value.

The International KKM activity with the theme Action of Yeast & Electrical Putty provides a concrete picture of the effectiveness of implementing STEM (Science, Technology, Engineering, and Mathematics) based learning at the preschool level. Based on the results of the pretest and posttest, there was a significant increase in the scientific understanding of the Tadika and Pratadika children at Sekolah Kebangsaan Melayu Raya. Before the activity took place, most of the students did not understand the basic concepts of gas formation in yeast or the simple principles of electricity in electrical putty. However, after the activity, the children showed a clear improvement in their understanding. They were able to explain that the gas formed came from a fermentation process that produced carbon dioxide, and that electrical putty could conduct electricity because it contained conductive materials such as salt or electrolytes. These results show that a practical, exploratory, and contextual learning approach is more effective than conventional learning, which focuses only on theoretical explanations.

This increase in understanding is in line with constructivist theory, which emphasizes that knowledge is built through direct experience. Preschoolers learn best when they can observe, touch, and try things for themselves, rather than just listening to the teacher's explanations. In this activity, children act as “little researchers” who conduct simple experiments, observe the results, and draw conclusions based on their observations. This approach makes science not something abstract, but part of the real world that they can understand through direct experience. These findings support Triastuti's (2021) research, which states that practice-based STEM learning can improve creative thinking skills and the ability to understand scientific concepts because students are actively involved in the process of discovering knowledge, not just receiving information.

Furthermore, the Action of Yeast & Electrical Putty activity also supports the findings of Helga et al. (2024), who discovered that applying STEM to electrical learning increases student participation and helps them better understand the relationship between theory and practice. In the electrical putty experiment,

children not only learn that electricity can turn on a light, but also understand how electric current can flow through different materials. They were invited to make their own dough, connect it to a simple circuit, and observe the effect of material changes on the LED light. This process made the concept of electrical conductivity tangible and easy to understand. Thus, the STEM approach not only introduces science but also hones children's logical and experimental thinking skills from an early age.

In addition to improving cognitive understanding, this activity also has a positive impact on the development of critical thinking and problem-solving skills. When children encounter a situation where the electrical circuit is not working, they are encouraged to find the cause and fix it themselves. Students try to reconnect the wires, adjust the moisture content of the dough, or replace the materials used. This activity fosters systematic, exploratory, and reflective thinking skills. This is in line with the findings of Zulirfan et al. (2021), which confirm that STEM-based projects can foster creativity and critical thinking skills through direct experience in finding solutions to problems encountered. In this activity, children not only learn "what" and "why," but also "how" something happens, which is at the heart of the scientific process.

The social and collaborative aspects were also one of the important findings of this activity. Children learned to work in small groups, communicate, share roles, and respect their friends' opinions. They showed a high spirit of cooperation when preparing experimental materials or when one of the group members encountered difficulties. These collaborative activities helped foster communication skills, empathy, and social responsibility. These findings reinforce the results of research by Indriyanti et al. (2021), which states that STEM activities can develop students' social and collaborative skills, while also strengthening their self-confidence. Group-based learning such as this also fosters a sense of togetherness and caring, which are important foundations in the character development of early childhood.

This activity also provides dual benefits, not only for students but also for KKM-I student participants. For students, the experience of designing, implementing, and evaluating STEM activities in the field is a direct application of the theory they have learned in college. They learn to adapt learning approaches to the characteristics of early childhood, observe student learning behaviors, and assess the effectiveness of the methods used. These results support the research by Nurwidodo et al. (2022), which highlights the importance of teaching skills in adapting STEM learning to be relevant to the context of the students. Thus, this activity not only improves children's learning capacity but also strengthens the pedagogical and professional skills of students.

In addition to improving cognitive and social aspects, this activity also contributes to the development of children's psychomotor skills. Activities such as mixing dough, holding wires, and observing changes in shape and color in experiments train their hand coordination and concentration. This is in line with the findings of Amarlita & Ningsih (2025), which confirm that project-based STEM activities can improve psychomotor skills because children are actively involved in the process of manipulating materials and observing results. Thus, this activity not only hones thinking skills early childhood.

This finding also reinforces Nuraini's (2020) view that STEM-based learning can enhance students' creativity in understanding energy and electricity concepts. Through electrical putty, children have the opportunity to develop their curiosity about various materials that can conduct electricity. They try using other materials and compare the results. This activity fosters scientific thinking, curiosity, courage to try, and a habit of experimenting. In addition, the yeast activity also introduces simple biological concepts through fermentation, which shows the relationship between living things and scientific processes. Children observe the formation of gas in balloons, which shows how yeast activity can produce carbon dioxide. This activity is not just a game, but an effective introduction to understanding life sciences in a fun way.

The results of this activity support the opinion of Bourguignon et al. (2014), who emphasize that introducing STEM from preschool age can shape a young generation that is adaptive to technological developments and ready to face future challenges. At an early age, children have a high level of curiosity and exploratory abilities. By providing appropriate learning experiences, such as these simple experiments, children can develop a strong foundation for scientific thinking. This type of learning also fosters an interest in science, which is expected to continue into the next level of education.

The findings from this activity also expand on the research by Utomo et al. (2025), which states that most STEM applications in Indonesia still focus on primary and secondary school levels, while preschool education has not been touched much. Through this KKM-I activity, it can be proven that the application of STEM at the preschool level is not only possible but also effective in improving children's scientific understanding and skills. This activity proves that with the right approach, complex scientific concepts can be conveyed in a simple and enjoyable way without losing their scientific meaning.

From the observations, it was evident that the children showed high enthusiasm during the activities. They actively asked questions, discussed, and tried various experiments. This condition shows that STEM-based learning is able to foster intrinsic learning motivation in children. Children learn not because of obligation, but because of a strong curiosity about the phenomena they observe. According to Sumaya et al.

(2021), learning that encourages active participation and independent exploration is key to developing 21st-century skills, including critical, creative, and collaborative thinking.

In terms of quantitative results, the data shows that the majority of students are between 4 and 6 years old, with a significant increase in understanding after the activities were carried out. Descriptive analysis shows that the level of participation and learning outcomes increased relatively evenly across age groups and genders. This shows that the STEM approach can be applied inclusively, regardless of children's initial abilities. Both boys and girls showed the ability to experiment and understand scientific concepts in their own way. These findings are in line with Wahyuningsih et al. (2019), who stated that the STEAM (Science, Technology, Engineering, Art, and Mathematics) approach can help children with different learning styles to understand science through interesting and visual activities.

Overall, the Action of Yeast & Electrical Putty activity proves that the application of STEM at the preschool level can provide a comprehensive learning experience, integrating cognitive, affective, and psychom otor aspects in a balanced manner. Children not only understand scientific concepts, but also learn to collaborate, communicate, think critically, and be creative.

This activity is a tangible example that interactive science education can be implemented from an early age, and that preschool is an important phase for building a strong foundation of scientific skills and learning character. The application of STEM in this activity is also relevant to the needs of the Industrial Revolution 4.0 era, where adaptive, creative, and collaborative thinking skills are key competencies that must be developed from an early age.

Thus, this activity not only has an impact on the children involved, but also has broader implications for the development of science education in Indonesia. STEM- based learning has been proven to be able to change the learning paradigm from mere memorization to understanding through direct experience. This model deserves to be applied more widely in early childhood education institutions to nurture a generation that is not only academically intelligent, but also creative, innovative, and ready to face global challenges.

5. CONCLUSION AND SUGGESTIONS/RECOMMENDATIONS

5.1 Conclusion

The International KKM activity themed Action of Yeast & Electrical Putty shows that the application of STEM (Science, Technology, Engineering, and Mathematics) based learning approaches at the preschool level can effectively improve children's conceptual understanding, critical thinking skills, and creativity. Based on the results of the pretest and posttest, there was a significant increase in children's understanding of the concept of anaerobic respiration in the yeast action experiment and electrical conductivity in the electrical putty experiment. Through direct experience and fun observation, children learned to relate scientific concepts to everyday phenomena, such as gas formation in fermentation or electric current in simple conductive materials.

This activity also succeeded in fostering scientific curiosity, courage to experiment, and an exploratory spirit in children. They did not just passively receive information, but actively sought knowledge, observed changes, and drew conclusions from their own observations. This proves that the STEM approach can be an effective means of building a foundation for scientific thinking from an early age. These findings support the results of research by Triastuti (2021), Helga et al. (2024), and Zulirfan et al. (2021), which state that project-based and experimental learning can increase students' motivation to learn, creativity, and problem-solving skills.

In addition to improving cognitive abilities, this activity also has a positive impact on children's social and emotional development. Through small group work, children learn to collaborate, appreciate their friends' ideas, and take responsibility for completing experiments. This type of interaction strengthens communication and cooperation skills, as emphasized by Indriyanti et al. (2021), who state that STEM- based learning can develop social skills relevant to the demands of 21st-century learning. Children not only gain scientific knowledge but also develop self-confidence and the ability to work in teams.

For KKM-I student participants, this activity provides valuable experience in designing and implementing STEM-based learning tailored to the characteristics of early childhood. Students learn to apply educational theory in field practice, hone their pedagogical skills, and understand the importance of innovation in science learning. Thus, this activity not only benefits students but also strengthens the professionalism of future educators.

Overall, this study confirms that the application of STEM at the preschool level is a strategic step toward shaping a young generation that is adaptive, creative, and innovative. Through simple yet meaningful activities such as Action of Yeast & Electrical Putty, children can understand the basics of science in a fun way while developing important 21st-century skills to face the challenges of the Fourth Industrial Revolution.

5.2 Suggestions/Recommendations

Based on the results of this study, schools are encouraged to apply STEM-based learning more consistently through simple and interactive experiments suitable for preschool children. Teachers should receive training to develop creative and student-centered STEM activities. Schools are also advised to provide adequate facilities and learning materials to support hands-on experiments.

In addition, collaboration between schools, universities, and parents is important to strengthen STEM education in early childhood learning. Future researchers are recommended to conduct broader studies involving larger samples and different educational settings to further examine the effectiveness of STEM learning.

Overall, STEM learning at the preschool level should continue to be developed to help children become creative, critical, collaborative, and ready to face future challenges in the Industrial Revolution 4.0 era.

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