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Enhancing Relevance and Authenticity in STEM: Exploring Biomimecry in a Frog – Inspired Robot Designs in Developing Pre- School Children's Manipulative Skills in STEM

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Abstract

This study explored biomimecry in a frog – inspired robot designs in developing pre-school children's manipulative skills in STEM in Mangu Local Government Area, Plateau State, Nigeria. The research aims to assess the impact of manipulating robot components on children's motor skills and engagement, comparing the outcomes in experimental and control groups. The methodology involves constructing a frog robot using accessible materials and measuring children's skill acquisition in various tasks, such as gumming, fixing, and operating the robot. Findings reveal significant differences between the experimental and control groups, indicating that the experimental group demonstrated higher proficiency in manipulative skills owing to hands-on interaction with the robot, whereas the control group exhibited limited skill acquisition. This underscores the potential of nature inspired educational robotics as a transformative tool in manipulative skills development in early childhood education level. It was recommended that pre service teachers trained on integrating play-based learning approaches to enhance children's problem solving and learning l outcomes.

Keywords: Relevance, Authenticity Biomimecry, Robot designs, STEM manipulative skills

Introduction

Relevance and authenticity are essential components of Science Technology Engineering and Mathematics (STEM) education and research. By ensuring that STEM content is relevant and authentic, educators can prepare learners for real-world challenges, foster critical thinking, inspire innovation, and bridge the gap between theory and practice. One problem that continues to inhibit progress in STEM worldwide and especially in Nigeria in particular is the lack of hands activities and use of relevant content linked to Nigeria problems and industry needs in the instructional process (Duguryil, et al. 2024; Katniyon, et al. 2023). A concept seems to have been ignored among others is the concept of biomimicry.

Biomimicry, also known as biomimetics, is the practice of drawing inspiration from nature and its biological systems to design and develop innovative engineering solutions for human challenges (Tomborini, 2024). Nature has long been a source of inspiration for human innovation, with biomimicry emerging as a powerful tool for solving complex engineering challenges. Biomimicry, the practice of emulating nature's strategies and processes, has led to ground breaking advancements in robotics, materials science, and energy harvesting. Among the diverse range of biomimetic inspirations, frog biology offers unique opportunities for robot design (Huang et al 2024). Frogs have remarkable jumping ability, agile locomotion, and adaptable skin have captivated scientists and engineers. By emulating these features, researchers aim to create robots that can: navigate challenging terrain, achieve efficient locomotion, and interact with environments in novel ways. Thus, successful biomimicry include velcro: inspired by burrs' hook-and-loop mechanism. Another example is seen in sharkskin surfaces which is used in reducing drag and improving fluid dynamics. Also, lotus effect surfaces: self-cleaning and water-repellent materials, whale fin wind turbines and efficient energy harvesting. Another example of successful use of biomimicry is in gecko inspired adhesives used in reversible and strong adhesion. biomimicry is applied to energy and environment medicine and healthcare, materials science, robotics and engineering, aerospace and transportation. Thus from the usefulness of bio mimicry studying the adaptations and abilities of living organisms, children can develop innovative solutions to real-world problems. Frogs, with their remarkable jumping ability, camouflage, and sensory capabilities, provide an ideal subject for biomimicry-inspired robotics. Robotics, in particular, has benefited significantly from biomimicry. By studying the remarkable adaptability and efficiency of living organisms such as jumping robots, researchers have developed innovative robot designs capable of navigating complex environments, interacting with humans, and performing tasks with precision (Huang et al 2024). Robotics education have become increasingly important in modern education, as they prepare children for careers in science, technology, and innovation. However, a gap existing in literature is that few research seems to have been done regarding children's engagement in bio mimicry inspired robotic designs. The integration of robotics education into STEM education provide a unique opportunity for children to engage in hands on, project-based learning experiences that foster creativity, problem-solving, and critical thinking (Katniyon et al. 2023). Research Duguryil et al. (2024) has shown that hands-on, project-based learning experiences in robotics and STEM education can: enhance children's interest and motivation in STEM subjects, develop problem-solving and critical thinking skills, improve collaboration and communication among team members, and foster creativity and innovation. However, there is a need for more research on bio mimicry-inspired robotics design, particularly in the context of children's manipulative skills development in STEM in Nigeria. This study aims to investigate how pre-school children design and build frog-inspired robots, exploring the development of STEM skills and creativity in this context.

Research Huang et al (2024) has shown that robotics for children can become a tool that aids in the understanding of abstract and complex concepts in science and technology courses as well as facilitate creative thinking. It can also serve as a great tool for building teamwork among children. The teacher or educator can come up with interesting programming and coding activities and conduct interactive team challenges with the help of customizable robots.

As a consequence, greater attention must be focused on how educational robots can be better integrated into the lives of young people. With the continuous advent of technology, it is worthwhile to understand the potential of robots as effective add-ons to learning. Robots can also be used in entertaining platform to learn about computers, electronics, mechanical engineering and languages. According Duguryil et al (2024) research has been shown that young children performed better on post-learning examinations and generated more interest when language learning took place with the help of a robot as compared to audiotapes and books. Educational robots are a subset of educational technology, where they are used to facilitate learning and improve educational performance of students.

Study by Peter (2013) reveals what these encounters are all about in different kinds of learning environments and it further develops a substantive theory regarding encounters in the dimensions of technological access and individually experienced ownership. Educational robotics refers to any robot technology that fulfils the technical requirements of robotics and which is applied to education in order to learn with, from and about it. Encounters include several aspects, such as technological and pedagogical design of the learning environment and children's individual interests. These are all relevant elements to the success of robotics for education. The success of educational robotics depends on elements that, on the one hand, promote children's engagement and, on the other hand, pushes toward indifference with it (Duguryil et al., 2024). Since children are the end users of educational robotics and their action with it indicates whether educational robotics can be used successfully as a learning tool, an understanding of these encounters is essential. In order to reveal the potential and overcome the barriers of educational robotics for education, a more detailed understanding regarding educational robotics in learning contexts is needed.

Children's learning of and through robotics can be assessed using various methods, such as multiple-choice questionnaires, design scenarios, artifact-based interviews, and project analyses (Katniyon, et al., 2023). There are benefits and limitations to each method. For example, questionnaires allow for standardization and measurement of discrete skills. Design scenarios and artifact-based interviews are subjective measures but allow for more nuanced assessment of children's conceptual understanding. Project analyses offer insight into the conceptual encounters a child may experience over the course of designing their project; however, encounters do not necessarily equate to mastery. However, quantity should be paralleled with quality. Assessments must be developmentally appropriate (in this case, for young children) and demonstrate purposeful value for research and practice.

Using robotics to support various applications has become considerably more prevalent during the past decade (Shinozawa et al., 2017). In particular, employing robotics in an educational context has become a widely researched topic. Most robots examined in previous studies involve using a tangible user interface and an anthropomorphic robotics body that attracts users' attention and facilitates socially meaningful interactions. Numerous studies have concluded that the actions of robots leave strong impressions on users. Shinozawa et al. (2017) asserted that a robot's motions and body gestures can provide strong motivators that affect user decision-making processes. Nishimura et al. (2018) compared audience impressions of an educational robot presentation with those of a computer animated agent presentation. Their results showed that the robot resulted in enhanced impressions on audiences. Thus, physical robots are expected to be useful as aids in many interactive fields as well as developing computational thinking, educational robots promote the development of other cognitive skills among children and young people: Learning from mistakes: discovering that errors are not final but a source of new conclusions is a valuable lesson for the future.

The design and application of model of frog robot is consistent with several contemporary learning theories. Some evidence is available that the use of model of frog robot in education has a positive impact on student behavior and development, especially in problem-solving and manipulative skills, collaboration, learning motivation, participation, and enjoyment and engagement in the classroom. These studies drew mixed conclusions about the effectiveness of robotics in education. Researchers have been actively exploring the use of model of frog robot in a wide range of courses. For example, Parks (2017) reported that the use of model of frog robot was beneficial for skill development in children. Earlier, Toh et al (2009) found that the use of robots helped improve the knowledge of concepts. Huang et al (2024) showed that model of frog robot could enhance students' interest in engineering and help them gain a better understanding of scientific processes in a biomimetic design. Furthermore, review of literature shows that model of frog robot are a constantly evolving field with the potential to be implemented in education at all levels from kindergarten to university. Chin et al. (2016) indicated that model of frog robot can provide primary school teachers with tools to increase student achievement. Previous systematic review studies have reported the potential contribution of model of frog robot in schools. However, there is a growing criticism from the robotics community in recent years over the lack of empirical research on how model of frog robot can be employed to improve pupil's manipulative skills and learning in general. Few of the empirical studies reviewed support the significance of using model of frog robot in classroom in Nigerian context. From literature most of these research are in China and the USA few research seems to have been carried on this area and thus creates a gap requiring this research. For this reason this research will be conducted to explore biomimicry in a frog – inspired robot designs in developing pre- school children's manipulative skills in STEM in Mangu LGA.

Objectives of the Study

The study is aimed at enhancing relevance and authenticity in STEM by exploring biomimicry in a frog – inspired robot designs in developing pre- school children's manipulative in Mangu L.G.A. Specifically, the study sought to:

1. Examine the extent to which pupils in the experimental and control group able to use manipulating skills of geometric shapes of the frog robot.

2. Examine the extent to which experimental and control differ in skills of gumming in frog model.
3. Examine the extent to which experimental and control differ in skills of gumming in frog model.
4. Examine the extent to which experimental and control differ in fixing of frog robot model.
5. Examine the extent to which experimental and control differ in frog robot hopping test.

Research Questions

For the purpose of the study, the following research questions were raised to guide the study thus:

1. To what extent are pupils in the experimental and control group able to use manipulating skills of geometric shapes of the frog robot?
2. What extent do experimental and control differ in skills of gumming in frog model?
3. What extent do experimental and control differ in skills of gumming in frog model?
4. What extent do experimental and control differ in fixing of frog robot model?
5. What extent do experimental and control differ in frog robot hopping test?

Methodology

The experimental design was used in various stages of construction of frog robot. Materials used include:

Carton

A carton is a box or container made of paperboard, or other materials, used to hold or store various products, such goods, or to package and distributing goods. Size of them carton we used. Length 5.5cm, the base is 5.5cm and the height triangle is 4cm.

D.C Motor

A DC motor is defined as a class of electrical motors that convert current electrical energy to mechanical energy.

Small Switch

A switch is an electrical component that can allowed you to control the flow of electricity or other signals by opening or closing a circuit. In the context of frog robot a switch could be turn the robot on or off control motors or movements (e.g trump, walk, or crawl).

Rubber Band

A rubber band is a loop of rubber used to hold things together or provide tension. In the context of frog robots, a rubber band could be used as a power source, for movement in a frog robot legs, arms, or other components.

Cutter

A cutter is a tool use to cut or remove materials from an object. In the context of frog robot a cutter could be used to shape or modify components.

Battery Connector

A battery connector is a gadget that combines electric circuits. Most battery packs require more than one connector. The primary battery connect is both the mechanical and electrical part that interfaces the battery to the P.D.A or other electronic gadget.

9v Battery

The nine-volt battery or 9-volt battery, is an electric battery that supplies a nominal's voltage of a volts.

Roller

A roller is a cylindrical or spherical object that rotate or moves freely, often used to reduce friction or facilitate movement. In the context of frog robots, a roller could be used as a wheel that facilitate movement.

Give Gum refers to a Type of Adhesive

Derived from natural or synthetic sources often used in industrials application. It could refer to natural gum, synthetic gum, gum Arabic and rubber based adhesive.

Stick

Stick is a straight branch or stick of wood typically used as a support or structured element in the context of frog robot, a stick could be used as a balance, beam or gripper to manipulate object.

Ruler

A standard ruler is a straightedge with equality spaced markings, used to measure distances or draw straight lines.

Manipulative skills used in Design and Testing process include:

Gumming

After gumming the floor with 2 triangular shape, the DC motor is placed on the center floor of the robot using glue to gum it. Glue is used to gum the materials to maintain firmness.

Connecting of Components

Cables and connector are used for connecting battery to DC motor firmly.

Safety Precautions Undertaken

- Using of hand gloves to avoid hand sticking to glue.
- Wearing of nose masks to avoid plastic dusts and chemical inhaling from glue.
- Wearing of goggle glass to protect your eyes during gumming and coupling.

Design and Test procedure

Design Procedure

The following are the procedures for designing and testing of frog robot:

Place the empty carton on the table. Measure it with a ruler with the required CM, Cut the rectangular shape and four triangular shapes Drilling of the shapes for arms coupling. , Gumming of two triangular shapes on the rectangular floor. Add DC motor, all battery on the rectangular floor. Then add battery connector on the battery to connect the battery and the DC motor. Add glue to gum both the battery, 9v battery DC motor switch and battery connector on the rectangular floor. Then passing the stick through the hold of the roller for coupling the arms. Inserting of rubber band on the roller to make it roll. Fixing of two triangular shapes besides the first two triangular shapes with the sticks. Gumming the edges of the stick to enable it not to remove. Testing of the frog robot by switching it on to see whether it will hop or jump.

Step 1: Cutting/Gumming

We used cutter for cutting the carton into shapes of four triangular and one rectangular for the floor in order to create a medium for pacing the DC motor, 9v battery and the switch.

Figure: 1 Gumming stage

Step 2: Connecting the 9v, DC motor

Figure 2: Connecting to DC motor

After gumming the floor with 2 triangular shape, the DC motor is placed on the centre floor of the robot using glue to gum it and wire connection to the battery for the purpose of hopping/ jumping.

Step 3: Fixing of parts

Figure 3: Fixing of parts

Coupling of frog arms and fixing it at the correct angles.

Step 4: Jumping/ Hopping Test

Figure 4: Hoping test

After all the components are fixed, we then switch on the robot to see whether it can jump or hop.

Step 5: Rear view of finished model

Figure: 5 Rear view of model

Step 6: Side view of finished model

Figure 6: Completed Model

After testing with the battery apart, showing proper hoping and jumping. The battery is then fixed firmly and the final test is done with proper jumping or hopping.

Results

RQ1: To what extent are pupils in the experimental and control group able to use manipulating skills of geometric shapes of the frog robot?

Table 1: Mean Responses of experimental and control group on the use manipulating geometric shapes of the frog robot design

Skills Usage							
Group	Excellent	Good	Fair	Poor	Total	$\bar{X}$	Decision
Experimental Group	3	7	2	3	15	2.67	Accept
Control Group	0	3	3	9	15	1.6	Reject

The data presented in Table 1 evaluates the proficiency of pupils in both the experimental and control groups in utilizing manipulating skills associated with geometric shapes of a frog robot, providing insights into their capabilities based on their self-assessments. In the experimental group, the distribution of responses shows that 3 pupils rated their skills as 'Excellent,' 7 as 'Good,' 2 as 'Fair,' and 3 as 'Poor,' which culminates in a mean score of 2.67. This relatively high average suggests that the experimental group possesses a notable level of proficiency and confidence in their ability to manipulate the geometric shapes effectively, indicating a positive outcome likely influenced by the instructional techniques or tools utilized during their learning process. Conversely, the control group exhibited a starkly different performance, with no pupils rating their skills as 'Excellent,' only 3 indicating 'Good,' 3 as 'Fair,' and a significant 9 categorizing themselves as 'Poor.' This resulted in a mean score of 1.6, reflecting a much lower level of skill proficiency and suggesting that these pupils either struggled with or did not engage effectively with the geometric manipulation tasks. The comparative results illustrate a clear distinction between the two groups, validating the effectiveness of the experimental approach in fostering skill development, while the control group's lower ratings reflect a rejection of their capacity in this domain. Overall, the data suggests that the experimental group was substantially more effective in acquiring and demonstrating manipulating skills with the frog robot, highlighting the critical role of targeted educational strategies in enhancing learning outcomes.

RQ2: What extent do experimental and control differ in skills of gumming in frog model?

Table 2: Mean Responses of experimental and control differ in skills of gumming in frog model.

Skills Usage							
Group	Excellent	Good	Fair	Poor	Total	$\bar{X}$	Decision
Experimental Group	5	7	2	1	15	3.07	Accepted
Control Group	1	4	3	7	15	1.93	Rejected

Table 2 provides a comparative analysis of the abilities of pupils in both the experimental and control groups concerning their skills in "gumming" with a frog model, measuring how these skills differ between the two groups. The experimental group demonstrates a noteworthy level of proficiency, with 5 pupils rating their skills as 'Excellent,' 7 as 'Good,' 2 as 'Fair,' and only 1 as 'Poor.' This distribution results in an impressive mean score of 3.07, which signifies a strong grasp and effective application of gumming skills among the participants, reflecting positively on the educational strategies employed in this group. In contrast, the control group showcases a lower skill attainment, with only 1 participant marking their ability as 'Excellent,' 4 as 'Good,' 3 as 'Fair,' and 7 indicating 'Poor.' This leads to a mean response of 1.93, revealing a significant deficit in skill levels compared to the experimental group. The stark contrast between the two groups underscores the effectiveness of the instructional methods used in the experimental setup, highlighting a successful engagement in developing gumming skills with the frog model. Collectively, these findings depict a clear differentiation wherein the experimental group not only exhibits greater confidence in their gumming abilities but also reinforces the impact of targeted intervention on skill acquisition, as evidenced by the acceptance of their higher-level competencies, while the control group's results reflect a rejection of their comparative capabilities in this area.

RQ3: What extent do experimental and control differ in skills of gumming in frog model?

Table 3: Mean Responses of experimental and control on skills in connecting DC motor skills in frog Robot

Skills Usage							
Group	Excellent	Good	Fair	Poor	Total	$\bar{X}$	Decision
Experimental Group	6	5	2	2	15	3.0	Accepted
Control Group	2	3	2	8	15	1.93	Rejected

Table 3 presents an assessment of the differences in skills related to connecting DC motor functionalities using the frog model between the experimental and control groups. The responses indicate that the experimental group demonstrates a commendable level of competence, with 6 participants rating their skills as 'Excellent,' 5 as 'Good,' 2 as 'Fair,' and only 2 as 'Poor.' This results in a mean score of 3.0, suggesting that the majority of students in this group possess a solid understanding and ability to effectively connect DC motors within the context of the frog model, likely a reflection of the educational strategies or hands-on experiences provided to them. On the other hand, the control group shows considerable struggle, as evidenced by their distribution of ratings: only 2 pupils assess themselves as 'Excellent,' 3 as 'Good,' 2 as 'Fair,' and a significant 8 marking their abilities as 'Poor.' This leads to a mean score of 1.93, indicating a stark proficiency gap compared to their experimental counterparts and highlighting challenges in grasping the required skills. The data clearly illustrates the effectiveness of the targeted learning interventions implemented in the experimental group, leading to a significant enhancement in their ability to connect DC motors using the frog model, while simultaneously underscoring the deficiencies in the control group's capabilities, thus validating the rejection of their skill level in this domain. Overall, the findings emphasize the crucial impact of instructional methods on skill acquisition and confidence in practical applications.

RQ4: What extent do experimental and control differ in fixing of frog robot model?

Table 4: Mean Responses of experimental and control in fixing of frog robot parts

Skills Usage							
Group	Excellent	Good	Fair	Poor	Total	$\bar{X}$	Decision
Experimental Group	9	3	3	0	15	3.40	Accepted
Control Group	4	0	4	3	15	1.80	Rejected

Table 4 illustrates the comparative proficiency levels in fixing a frog robot model between the experimental and control groups, revealing significant disparities in their skill sets. For the experimental group, an impressive 9 participants rated their skills as 'Excellent,' 3 as 'Good,' and 3 as 'Fair,' with none indicating 'Poor' skills. This distribution affords them a mean score of 3.40, underscoring a strong mastery of the skills required to fix the frog robot model, likely attributable to effective instructional methods and hands-on experience provided during the learning process, which appears to have instilled a high degree of competence and confidence among the participants. In stark contrast, the control group fares poorly in this assessment, with only 4 students rating their skills as 'Excellent,' none categorizing their abilities as 'Good,' while 4 rated themselves as 'Fair' and 3 as 'Poor.' This results in a significantly lower mean score of 1.80, indicating considerable difficulties in the required skill set and suggesting that the control group lacked the necessary exposure or training that would allow them to effectively acquire the fixing skills pertaining to the frog robot model. The marked difference between the two groups reinforces the effectiveness of the instructional approaches employed with the experimental group, ultimately validating the conclusion that the skills necessary to fix the frog robot model are considerably more developed in that group compared to their control counterparts, as seen in the acceptance of their higher skill levels versus the rejection of those in the control group.

RQ5: What extent do experimental and control differ in frog robot hopping test?

Table 4: Mean Responses of Experimental and control on Frog Robot Hopping Test

Skills Usage

Group	Excellent	Good	Fair	Poor	Total	$\bar{X}$	Decision
Experimental Group	3	4	3	5	15	2.33	Rejected
Control Group	1	1	7	6	15	1.80	Rejected

In evaluating the differences between the experimental and control groups in a frog robot hopping test, the data presented in Table 4 indicates a significant distinction in skills usage between the two groups, as demonstrated by their mean responses. The experimental group shows a higher number of respondents rating their skills as "Excellent" (3) and "Good" (4), while the control group has only one respondent rating their skills as "Excellent" and one as "Good," with a substantially larger number of respondents (7) rating their skills as "Fair" and another 6 categorizing their performance as "Poor." This disparity reflects a mean score of 2.33 for the experimental group compared to a mean of 1.80 for the control group, suggesting that the experimental group not only performed better overall but ultimately outperformed the control group in the frog robot hopping test. Both groups received a "Rejected" designation in their performance evaluation, indicating that while the experimental group displayed superior skills usage, neither group achieved an acceptable standard of performance. The findings indicate a clear advantage of the experimental group over the control, highlighting the effectiveness of the interventions or conditions applied to the experimental group as opposed to the standard conditions experienced by the control group.

Discussion

The findings from the research investigation highlight a compelling narrative regarding the skill acquisition and performance of pupils in the experimental and control groups when working with the frog robot model.

Regarding skills in geometric shapes manipulation in robot design data indicated a clear advantage for the experimental group in their manipulating skills with geometric shapes of frog robots, as demonstrated by a higher mean score of 2.67 compared to 1.6 for the control group. This disparity underscores the effectiveness of innovative educational strategies and suggests that the experimental group benefitted greatly from tailored instructional techniques that enhanced their understanding and proficiency with geometric shapes design skills. The ability to self-assess their skills positively is indicative of this group's confidence and engagement, which were likely cultivated through the hands-on approaches used in their learning. This finding aggress with Katniyon et al. (2023) who discovered that participants show marginal gains when exposed to design skills in robots design. This implies that STEM teachers should expose pre - scholars' to more design activities to enable gain skills for problem solving such as in biomimicry.

Findings from research on participants design skills of robot parts gumming skills, with the experimental group achieving an impressive mean score of 3.07 against the control group's mere 1.93. The substantial difference in ratings, particularly where the experimental group demonstrated higher proficiency levels with more pupils classifying their skills as 'Excellent' and 'Good,' illustrates the significant impact of targeted intervention. The experimental group's results strongly affirm the hypothesis that a structured learning model can facilitate better skill acquisition in practical applications, whereas the control group's lower ratings suggest they remained disengaged or inadequately prepared, leading to their rejection in terms of skill proficiency. Similar study Abdullahi (2014) on sixth graders indicates that participants show gains when exposed to design skills in robots design. This implies that STEM teachers should integrate more design activities in their lessons to enable gain skills for creativity and problem solving such as in areas such as biomimicry.

Another skills assessed was the skills of connecting DC motor skills, the experimental group scored a mean of 3.0 compared to the control's 1.93, once again highlighting a clear proficiency gap. The overwhelming majority of the experimental group rated their skills positively, revealing that they not only grasped the concepts but also applied them effectively in practice. This contrasts with the control group's distribution of ratings, indicating substantial challenges with the task. The findings and relation to Katniyon et al (2023); Duguryil et al (2024) strengthen the argument that effective instructional methodologies enhance understanding and practical application of complex skills, leading to differentiated outcomes in student performance.

On ability and skills of fixing of the frog robot parts, the findings presented an even more pronounced disparity with a remarkably high mean of 3.40 for the experimental group against only 1.80 for the control group. The near absence of 'Poor' ratings among the experimental participants suggests a comprehensive grasp of the material, which likely stemmed from engaging instructional practices. This marked improvement correlates with findings of Duguryil, et al (2024); Abdullahi (2014) that hands-on experiences provided to the experimental group, establishing a strong foundation for their technical skills, unlike the control group that lacked similar experiences and showcased inadequate skill levels. This further validates the notion that immersive and participatory learning experiences are crucial for effective skill acquisition in practical fields.

Finally, regarding hoping test both groups in the frog robot hopping test, the results still revealed a substantial advantage for the experimental group with a mean score of 2.33 against 1.80 for the control group. This outcome suggests that, despite not achieving acceptable performance levels overall, the experimental group was still capable of better self-assessment and demonstrated a higher degree of skill usage. Duguryil et al (2024)and Huang et al. (2024) had found advantages with participants in an experimental design with brush robots. The consistent pattern across all research questions suggests that the experimental interventions implemented resulted in a more effective learning environment, reinforcing the assertion that dedicated instructional strategies significantly enhance skill acquisition in technical domain tasks. Collectively, the findings from this research present a compelling case for refining educational approaches to foster greater engagement in robot design to improve skill proficiency in students working with robotic systems, ultimately laying the groundwork for future research and practical applications in similar educational contexts aimed at addressing global and national challenges.

Conclusion

Having achieved the purpose of the project though there was initial delay in the execution of the project due to inability of frog to jump or hop, however refocusing of materials and weight related issues provided desired hopping of prototype. The design and testing of the robot ourselves participating from beginning to the end having a proper understanding for participants and future classroom applications in design activities.

Recommendation

Considering the positive impact of the project on the pupils and the department of early childhood care and education, entirely, the following recommendation should be taken into consideration;

1. The school should provide some materials and tools that will be used during the practical and project execution, for examples; DC motor, battery, battery connector and also to help the pupils know how to use some equipment involve in design and testing.

2. The pupils should perform practical involve in the practice to acquire knowledge and skill in any project given.

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