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Improving Children's Cognitive Skills Through Project-Based Science Hydroponic Planting

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Abstract

This research is motivated by the importance of developing early childhood cognitive abilities through engaging and meaningful learning experiences. The aim of this study is to enhance children's cognitive skills through science-based hydroponic planting projects at Handayani Kindergarten, Awang Bangkal Barat Village. The method used is Research and Development (R&D), consisting of the stages of design, validation, revision, and limited implementation. The research subjects are children aged 5–6 years. Data collection techniques include observation, interviews, and questionnaires, while data analysis employs both quantitative and qualitative descriptive analysis. The results show that the developed hydroponic learning media received a feasibility score of 100% from material and media experts, categorized as highly feasible, and a practicality score of 85% from teachers, categorized as very good. Furthermore, the use of this media is able to improve children's cognitive abilities, particularly in observation, logical thinking, and drawing simple conclusions. Therefore, science learning based on hydroponic planting projects is effective in enhancing the cognitive abilities of early childhood learners.

Keywords children's cognitive abilities; early childhood education; hydroponics; project-based learning; science.

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INTRODUCTION

Early childhood education is a crucial initial stage in individual development, especially in fostering children's cognitive abilities. According to Regulation of the Minister of Education and Culture (Permendikbud) Number 137 of 2014, early childhood education aims to provide educational stimulation to support children's physical and spiritual growth so that they are prepared to enter the next level of education. One of the developmental aspects requiring special attention is cognitive ability, which includes logical thinking, problem-solving, and

understanding various simple concepts in daily life. The cognitive development of young children is strongly influenced by the stimulation provided through learning activities. At the age of 5–6, children typically have a high sense of curiosity, are beginning to develop simple logical thinking, and are interested in exploring their surroundings. However, in practice, learning activities in early childhood education institutions still tend to be conventional, lacking variety, and not fully engaging children actively. As a result, children's cognitive abilities especially in observation, logical thinking, and drawing simple conclusions are not optimally developed (Sulaiman, Ardianti, & Selviana, 2019).

Observations at TK Handayani in Awang Bangkal Barat Village revealed that science learning activities are still limited and the use of educational play tools (APE) is not yet optimal. Additionally, some children show a lack of environmental awareness, such as littering and damaging plants around the school. This condition highlights the need for innovative forms of learning that can enhance cognitive abilities while also fostering environmental awareness. The role of cognitive abilities in early childhood education cannot be separated from the quality of learning experiences received by children. According to Piaget's theory of cognitive development, preschool children are in the pre-operational stage, during which they begin to build understanding through concrete experiences and interactions with their environment. Therefore, the stimulation provided must challenge children to think, solve problems, and find solutions independently through meaningful activities (Baiti, 2021).

However, the reality in the field shows that early childhood learning is often still teacher-centered, with routine activities and little innovation. Children mostly listen to teachers' explanations rather than being directly involved in exploration and simple experiments that can hone their thinking skills. In contrast, effective learning for young children should emphasize direct learning experiences (learning by doing), where children explore, ask questions, and try new things. One innovative approach that can be implemented is project-based science learning. This approach provides opportunities for children to learn through direct experience, exploration, and simple experimentation. Through these activities, children can develop their observation skills, logical thinking, and the ability to draw conclusions based on their experiences. Furthermore, project-based learning can also increase active involvement, independence, and a sense of responsibility in children (Baiti & Rahman, 2022).

Hydroponic planting activities are one form of project-based science learning that is relevant for early childhood education. Hydroponics is a method of cultivating plants without soil, using water as the main medium. This activity is well-suited for children because the process is simple, the materials are easy to obtain, and it can make use of recycled items such as plastic bottles. By engaging in hydroponic planting, children can directly observe plant growth from seeding, caring, to harvesting. In addition to learning basic science concepts, children are also taught values of environmental care, such as recycling plastic waste and taking care of plants around the school. Several previous studies have shown that science learning can improve early childhood cognitive abilities through various media and

approaches. However, the use of hydroponic media as project-based learning is still rarely implemented, especially at TK Handayani in Awang Bangkal Barat Village. Moreover, hydroponic planting activities have the potential to foster positive character traits in children, such as curiosity, responsibility, and environmental awareness. Therefore, this research is carried out as an innovative effort to develop learning media that can improve children's cognitive abilities while also building environmental awareness (Baiti & Zulkarnaen, 2022).

Based on the above explanation, the purpose of this study is to enhance children's cognitive abilities through project-based hydroponic science learning at TK Handayani in Awang Bangkal Barat Village. It is hoped that this research will make a real contribution to the development of innovative learning media in early childhood education and serve as a reference for teachers in designing enjoyable, meaningful, and effective learning activities to support young children's cognitive development (Nurhayati, 2024).

METHODS

This study employs the Research and Development (R&D) method, aiming to develop project-based hydroponic science learning media to enhance the cognitive abilities of early childhood learners. The R&D method was chosen because it allows researchers to systematically design, test, and evaluate learning media, resulting in a product that is feasible, effective, and relevant to the needs of early childhood education. The research consists of four main stages: design, validation, revision, and limited implementation.
In the design stage, the researcher identifies field needs through initial observation and discussions with teachers. Based on these findings, the researcher designs simple, safe, environmentally friendly, and easy-to-use hydroponic learning media. The media is made from used plastic bottles as containers, flannel fabric as wicks, rockwool as the planting medium, plant seeds such as mustard greens or spinach, and AB Mix nutrient solution. In addition, the researcher prepares project-based daily lesson plans that emphasize active involvement of children in every learning stage.

During the validation stage, the developed media and learning tools are validated by two experts: a subject matter expert and a media expert. Validation aims to ensure that the learning media and devices meet early childhood education standards, are safe to use, and are effective in improving children's cognitive abilities. The experts assess the media through validation forms, and the results are used as the basis for further refinement before implementation. The next stage is revision, where the researcher makes improvements and refinements to the media and learning tools based on the feedback and recommendations from the experts. The revision process is carried out carefully to ensure the media is truly feasible and suited to the needs of the children and school environment (Fardiah, Murwani, & Dhieni, 2019).

Once the revision process is complete, limited implementation takes place at Handayani Kindergarten in Awang Bangkal Barat Village. The implementation is carried out with a group of children aged 5–6 years, involving the classroom teacher as facilitator. The learning process

runs for several weeks, during which the children are directly involved in planting, caring for, and observing the growth of hydroponic plants. The teacher guides the children in recording their observations, discussing the changes that occur, and encouraging them to draw simple conclusions from their experiences.

Data collection utilizes three main techniques: observation, interviews, and questionnaires. Observation is used to monitor the development of children's cognitive abilities, such as observation skills, logical thinking, and drawing conclusions. Interviews are conducted to gather teachers' opinions on the ease of use, practicality, and children's responses to the hydroponic media. Questionnaires are provided to teachers and experts to assess the feasibility and practicality of the developed media. The research instruments include observation sheets for children's cognitive development, expert validation sheets (for both subject and media), and teacher response questionnaires. The observation sheets are developed based on early childhood cognitive ability indicators, while the validation forms and questionnaires are designed to measure the feasibility, ease of use, and practicality of the media.

Data obtained from observations, interviews, and questionnaires are analyzed using quantitative and qualitative descriptive analysis techniques. Quantitative analysis is conducted by calculating the percentage of media feasibility and practicality based on the scores given by teachers and experts. Meanwhile, qualitative analysis is used to describe the results of observations on children's cognitive development, teacher responses during implementation, and significant findings throughout the learning process. Through this R&D method, it is expected that the developed hydroponic learning media will provide meaningful learning experiences, improve cognitive abilities, and foster environmental awareness among early childhood learners at Handayani Kindergarten, Awang Bangkal Barat Village.

FINDINGS AND DISCUSSION

Media Feasibility and Validation

The results of this research indicate that the project-based hydroponic science learning media developed in this study achieved a very high level of feasibility. Validation by subject matter experts in the initial stage yielded a percentage score of 90%, categorized as excellent. After revisions were made according to validators' suggestions, the score increased to 100% in the second stage. These findings demonstrate that the developed media meets the requirements for content suitability with the developmental characteristics of early childhood and is well-aligned with the current curriculum. The expert validation process emphasized several important aspects, including the relevance of the hydroponic project to science learning objectives, the clarity of instructions, the appropriateness of the activities for the cognitive level of 5–6-year-old children, and how well the project fosters curiosity, logical thinking, and problem-solving skills. The increase to a perfect feasibility score after revision indicates that the suggestions provided by the experts—such as simplifying some of the

activity steps and adjusting the language to be more child-friendly—were effectively incorporated into the final product (Yaswinda, Putri, & Irsakinah, 2023).

In addition to the content expert validation, the media expert validation also indicated that the hydroponic media developed was rated as excellent. In the first stage, the percentage score was 91.7%, which increased to 97.9% in the second validation stage. This improvement reflects enhancements made to the visual appearance, safety features, and user-friendliness of the media for young children. The media was reviewed for factors such as sturdiness, absence of sharp edges, attractiveness of colors, and overall appeal to children. The experts' feedback included suggestions to make the bottle edges smoother, reinforce the stability of the structure, and incorporate more visual aids to guide children during the planting process. These improvements contributed to the overall quality and usability of the learning media.

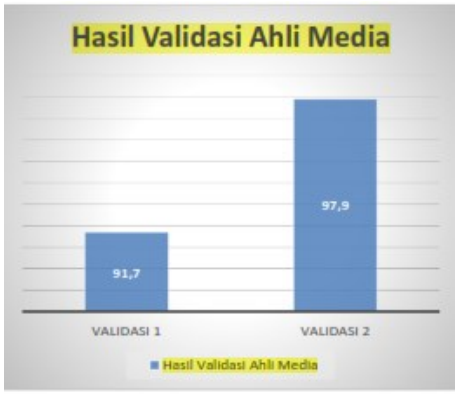

Figure 1. Media Expert Validation Results

Based on Figure 1, it is evident that there was a notable increase in validation scores from the first to the second stage, indicating substantial quality improvement following revisions in accordance with expert recommendations. These findings validate the effectiveness of the iterative development process and highlight the importance of expert involvement in educational media development.

Practicality and Usability

The practicality test conducted by teachers showed that the project-based hydroponic media achieved a score of 85%, falling into the excellent category. This indicates that the media is easy to use, the materials required are readily available, and the instructional guidelines are clear and comprehensible for teachers. During the implementation phase, teachers reported that the step-by-step instructions were straightforward, the materials could be prepared in advance with minimal cost, and the activities did not require specialized equipment or facilities. Teachers also observed that the hydroponic media facilitated increased student engagement and hands-on participation (Kamaruddin et al., 2023). Children showed a high level of enthusiasm during each stage of the project, from assembling the hydroponic system to planting seeds, daily watering, and observing plant growth. The media served not only as

a teaching tool, but also as an interactive centerpiece that promoted collaborative learning, critical thinking, and discussion among students.

Anecdotal records from classroom observations highlighted several instances where children initiated conversations about the changes they noticed in their plants, compared growth rates, asked questions about why some seeds sprouted faster than others, and hypothesized about the effects of sunlight and water on plant growth. Such moments of curiosity and inquiry are evidence of the cognitive stimulation provided by the project-based approach. Teachers further reported that the media was flexible and adaptable to different class sizes and learning conditions. For example, the hydroponic project could be conducted in small groups or as a whole-class activity, and teachers could easily adjust the duration and focus of the project based on student needs and interests.

Impact on Children's Cognitive Development

Implementation of the hydroponic media in the classroom led to significant improvements in children's cognitive abilities, particularly in observation, logical thinking, and drawing simple conclusions. Through direct involvement in the planting process, children learned to recognize the parts of a plant, understand the stages of plant growth, and appreciate the importance of environmental care. Classroom observations and teacher interviews revealed that children became increasingly attentive to detail, such as noting differences in leaf color, stem length, and root development over time. They also developed the ability to make predictions for example, anticipating how long it would take for seeds to sprout, or what might happen if a plant did not receive enough water or sunlight (Fransiska, Suarni, & Margunayasa, 2024).

During group discussions, children were encouraged to share their observations, compare their findings, and collectively draw conclusions about the plant growth process. This collaborative atmosphere fostered not only individual cognitive growth, but also the development of communication skills and social interaction. Moreover, the project cultivated a sense of responsibility among children. They took turns watering the plants, were careful not to damage the seedlings, and practiced cleaning up their workspace after each session. Teachers noted an improvement in children's attitudes towards their environment, as evidenced by fewer instances of littering and greater care for plants in the school area. This outcome aligns with the broader goal of instilling environmental awareness from an early age.

Qualitative Insights and Classroom Dynamics

The qualitative data further illuminate the positive impact of the hydroponic project on classroom dynamics. Teachers reported an increase in student motivation and sustained interest over the course of the project. Unlike conventional learning activities that often rely on passive listening, the hydroponic project required active participation, experimentation,

and ongoing observation. Children's questions and comments during the project demonstrated an evolving understanding of scientific concepts. For instance, students asked why roots grow downwards, why leaves are green, and what happens when a plant is not watered. Teachers used these questions as entry points to introduce basic scientific explanations, reinforcing the concept of cause and effect. The project also supported differentiated learning by allowing each child to progress at their own pace. Some children were quick to grasp the steps involved in setting up the hydroponic system, while others needed more time and guidance. The hands-on nature of the project made it accessible to all learners, regardless of their initial level of knowledge or skill (Nuraeni, 2024).

Comparison with Conventional Methods

Compared to more traditional, teacher-centered approaches, the project-based hydroponic activity offered a richer and more meaningful learning experience. Whereas conventional lessons might involve reading about plant growth or viewing pictures, the hydroponic project allowed children to witness the process firsthand, monitor daily changes, and take ownership of their learning. This concrete, experiential learning was particularly effective in promoting deeper understanding and retention of scientific concepts. It also provided opportunities for problem-solving when students encountered unexpected outcomes, such as a plant failing to sprout or leaves turning yellow. Through guided inquiry and reflection, teachers helped children explore possible reasons for these occurrences and brainstorm solutions.

Despite the overall success of the project, some challenges were encountered during implementation. For example, maintaining the hydroponic system required consistent attention, and some children initially needed reminders to care for their plants regularly. Additionally, unforeseen variables such as fluctuating classroom temperatures or limited sunlight occasionally affected plant growth. To address these challenges, it is recommended that future implementations include more structured routines for plant care, as well as contingency plans for environmental factors. Providing additional visual aids, such as growth charts or progress journals, may further enhance children's ability to track changes and reflect on their learning (Mulu et al., 2024).

Teachers also suggested expanding the project to include a wider variety of plants or incorporating related activities, such as composting or recycling, to reinforce environmental themes. Involving parents by sharing updates or inviting them to observe the project could further strengthen the impact of the learning experience. The findings from this study have important implications for early childhood education. The success of the project-based hydroponic media demonstrates the value of experiential, inquiry-based learning in fostering cognitive development and environmental awareness among young children. It also

highlights the role of teachers as facilitators who guide, encourage, and support children's learning through hands-on activities.

By adopting similar project-based approaches, early childhood educators can create more engaging and meaningful learning environments that promote curiosity, independence, and lifelong learning skills. The use of easily accessible materials and simple technology, as exemplified by the hydroponic project, makes such initiatives feasible and sustainable in a variety of educational settings.

CONCLUSION

Based on the research findings, it can be concluded that project-based science learning media using hydroponic planting activities is effective in improving the cognitive abilities of children aged 5–6 years at Handayani Kindergarten, Awang Bangkal Barat Village. This is evidenced by the content expert validation, which reached 100%, as well as the media expert validation scores in the excellent category, indicating that the media is suitable and feasible for classroom use. Furthermore, the practicality test by teachers showed a score of 85% (excellent category), confirming that the media is easy to implement in the learning process. Implementation of the hydroponic media not only enhanced children's cognitive abilities such as recognizing plant parts, making growth predictions, and drawing simple conclusions but also increased their active engagement and curiosity. The project fostered greater environmental awareness, responsibility, and collaborative learning among young learners. The positive outcomes of this research support the integration of project-based science activities into early childhood education curricula. Such approaches can enrich learning experiences, bridge theory and practice, and equip children with essential cognitive and social skills from an early age.

REFERENCES

BakhshBaloch, Q. A. (2017). Subjective health status and health-related indicators in home-dwelling elderly: A covariance structure analysis. *Journal Title*, 11(1), 92–105.

Baiti, N. (2021). *Perkembangan anak: Melejitkan potensi anak sejak dini*. Guepedia.

Baiti, N., & Rahman, M. A. (2022). Meningkatkan kemampuan motorik kasar anak melalui kegiatan senam irama. *PrimEarly: Jurnal Kajian Pendidikan Dasar dan Anak Usia Dini*, 5(2). https://doi.org/10.37567/prymerly.v5i2.1438

Baiti, N., & Zulkarnaen, M. (2022). Pelatihan stimulasi keterampilan literasi awal anak usia dini melalui media poster di masa pandemi. *AN-NAS: Jurnal Pengabdian Masyarakat*, 1(2), 25–32.

Baiti, Noor, dkk. 2024. Development of Serial Image Media in Character Building and Monotheistic Values in Early Childhood. Science get Journal. Vol. 2. No. 1. 9-20.

Fardiah, F., Murwani, S., & Dhieni, N. (2019). Meningkatkan kemampuan kognitif anak usia dini melalui pembelajaran sains. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 4(1), 133.

https://doi.org/10.31004/obsesi.v4i1.254

Fransiska, K. A. W., Suarni, N. K., & Margunayasa, I. G. (2024). Perkembangan kognitif siswa pada penggunaan media pembelajaran digital ditinjau dari teori Jean Piaget: Kajian literatur sistematis. *Ideguru: Jurnal Karya Ilmiah Guru*, 9(2). https://doi.org/10.51169/ideguru.v9i2.839

Hayati, Firdha. dkk. (2023). Meningkatkan Pemahaman Mitigasi Bencana pada Anak Usia Dini Melalui Kegiatan Sains, Video Edukasi dan Praktik Simulasi. Martabe: Jurnal Pengabdian kepada Masyarakat. Vol. 6. No. 5. 1533-1544. https://doi.org/10.31604/jpm.v6i5.1533-1544

Kamaruddin, I., Suarni, E., Rambe, S., Sakti, B. P., Rachman, R. S., & Kurniadi, P. (2023). Penerapan model pembelajaran dalam: Tinjauan literatur. *Jurnal Review Pendidikan dan Pengajaran*, 6(4).

Mulu, M., Liana, D., Wahyu, Y., & Jarut, Y. (2024). Peningkatan pengetahuan siswa tentang budidaya tanaman melalui teknologi hidroponik sederhana. *Jurnal Pengabdian kepada Masyarakat (JMM)*, 8(4). https://doi.org/10.31764/jmm.v8i4.24463

Nuraeni, S. (2024). Penerapan pembelajaran sains melalui permainan untuk meningkatkan perkembangan kognitif pada anak usia 5–6 tahun di PAUD Mathla'ul Anwar. *PELANGI: Jurnal Pemikiran dan Penelitian Islam Anak Usia Dini*, 5(2). https://doi.org/10.52266/pelangi.v5i2.943

Nurhayati, M. (2024). Jurnal pendidikan inovatif. *Jurnal Pendidikan Inovatif*, 6(April), 226–237.

Sulaiman, U., Ardianti, N., & Selviana, S. (2019). Tingkat pencapaian pada aspek perkembangan anak usia dini 5–6 tahun berdasarkan standar nasional pendidikan anak usia dini. *NANAEKE: Indonesian Journal of Early Childhood Education*, 2(1). https://doi.org/10.24252/nananeke.v2i1.9385

Tajqiyah, L., Dwijayanti, I., Nugroho, A. A., Marfuah, S., & Surya, A. D. (2024). Efektivitas model STEAM berbantuan media *loose parts* untuk meningkatkan kemampuan kognitif anak usia dini. *As-Sabiqun*, 6(1). https://doi.org/10.36088/assabiqun.v6i1.4388

Yaswinda, Y., Putri, D. M. E., & Irsakinah, I. (2023). Pembelajaran sains berbasis pemanfaatan lingkungan untuk peningkatan kognitif anak usia dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, 7(1). https://doi.org/10.31004/obsesi.v7i1.2842