OPEN ACCESS

Nagri Pustaka: Jurnal Pendidikan, Ilmu Sejarah, dan Budaya
E-ISSN: 3032-0151 | Vol. 4 No. 4, 2026 | Pages 332-342
https://journal.yazri.com/index.php/nagripustaka

Development of Nature-Based Learning Module with Digital Assesment to Stimulate Science Skills in Children Aged 5-6 Years at Zainul Hasan Kindergarten

Lailatul Ismi[1]✉, Rabihatun Adawiyah[2], Rohyana Fitriani[3]
(1,2,3) Universitas Hamzanwadi, Lombok Timur, Indonesia

Received: 30-09-2026 | Revised: 12-10-2026 | Accepted: 18-10-2026

Corresponding Author:
Lailatul Ismi,
Universitas Hamzanwadi. Jalan. Cut Nyak Dien No.85, Pancor, Selong, Kabupaten Lombok Timur, Nusa Tenggara Barat. 83611
Email: lailatulismi@hamzanwadi.ac.id

ABSTRACT

Science skills in early childhood are an important aspect that needs to be stimulated during the golden age through concrete and meaningful learning activities. However, the implementation of Nature-Based Learning in early childhood education institutions tends to be recreational and has not yet been systematically structured to develop science process skills indicators. In addition, teachers' limitations in conducting rapid formative assessments result in suboptimal feedback for children. This study aims to develop a teacher-based digital evaluation Nature-Based Learning module that is valid, practical, and effective in stimulating science skills among children aged 5–6 years. The research employed a Research and Development (R&D) method using the ADDIE model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. The developed product is a nature-based learning activity module integrated with digital evaluation through QR Code technology. The results showed that the module obtained an 88.3% feasibility score from expert validation, categorized as highly feasible. The implementation of the module among children aged 5–6 years at TK Zainul Hasan demonstrated an improvement in science skills, with the average pretest score increasing from 47.2% to 82.5% in the posttest, achieving an N-Gain score of 0.67 in the moderate category. Therefore, the digital evaluation-based Nature-Based Learning module is effective in supporting the stimulation of early childhood science skills.

Kemampuan sains anak usia dini merupakan aspek penting yang perlu distimulasi sejak masa golden age melalui kegiatan pembelajaran yang konkret dan bermakna. Namun, pelaksanaan Nature-Based Learning di lembaga PAUD masih cenderung bersifat rekreatif dan belum terstruktur untuk mengembangkan indikator keterampilan sains. Selain itu, keterbatasan guru dalam melakukan asesmen formatif secara cepat menyebabkan pemberian umpan balik kepada anak belum optimal. Penelitian ini bertujuan mengembangkan Modul Nature-Based Learning berbasis evaluasi digital oleh guru yang valid, praktis, dan efektif dalam menstimulasi kemampuan sains anak usia 5–6 tahun. Penelitian menggunakan metode Research and Development (R&D) dengan model ADDIE yang meliputi tahap Analysis, Design, Development, Implementation, dan Evaluation. Produk yang dikembangkan berupa modul kegiatan berbasis alam yang terintegrasi dengan evaluasi digital melalui QR Code. Hasil penelitian menunjukkan modul memperoleh tingkat kelayakan sebesar 88,3% dari validasi ahli dengan kategori sangat layak. Implementasi modul pada anak usia 5–6 tahun di TK Zainul Hasan menunjukkan peningkatan kemampuan sains dari rata-rata pretest 47,2% menjadi 82,5% pada posttest dengan nilai N-Gain 0,67 kategori sedang. Dengan demikian, Modul Nature-Based Learning berbasis evaluasi digital efektif digunakan untuk mendukung stimulasi kemampuan sains anak usia dini.]

Keywords: digital learning module, early childhood education, nature-based learning, science skills

Introduction

Early Childhood Education (ECE) is an educational stage that plays a strategic role in building the foundation of children's cognitive, social, emotional, and scientific thinking development. During this period, children experience rapid developmental growth and

© 2026 The Author(s). Published by Yazri Aksara Nusantara, ID

This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0/).

therefore require stimulation through learning experiences that are concrete, contextual, and meaningful. One of the important aspects that needs to be developed is scientific ability, particularly science process skills, including the abilities to observe, classify, measure, question, predict, and conclude. These abilities serve as the foundation for children to understand environmental phenomena and develop scientific attitudes such as curiosity, critical thinking, and the ability to solve simple problems (Kemendikbud, 2014; Suryana, 2023).

Science learning in early childhood is not merely oriented toward conceptual mastery but emphasizes exploration processes and direct experiences. Young children construct their understanding through interactions with real objects in their surrounding environment. Therefore, the Nature-Based Learning approach is considered a relevant approach for stimulating children's science abilities. Nature-Based Learning is a learning approach that positions the natural environment as a source, medium, and learning context, enabling children to directly observe various natural phenomena (Fjørtoft, 2020). Through nature exploration activities, children can develop scientific skills such as observing changes, comparing object characteristics, discovering cause-and-effect relationships, and constructing understanding through multisensory experiences (Lestari & Prima, 2021).

Various studies have demonstrated that nature-based learning contributes positively to early childhood development. Research by Speldewinde and Campbell (2024) revealed that nature-based learning environments provide opportunities for children to apply science skills through play and exploration activities. Children not only acquire conceptual knowledge but also develop the abilities to observe, investigate, and interpret phenomena found in their surrounding environment. Other studies have also indicated that Nature-Based Learning can enhance children's problem-solving abilities and thinking skills through more meaningful direct experiences (Mufidah et al., 2026).

However, the implementation of Nature-Based Learning in early childhood education institutions still faces a gap between theoretical concepts and practical implementation. Conceptually, nature-based learning requires structured exploration activities that are integrated with children's developmental goals. Nevertheless, in practice, nature-based activities are still frequently perceived as additional activities or recreational experiences rather than as learning strategies specifically designed to systematically develop science skills. Initial observations at TK Zainul Hasan indicated that nature-based activities have not been fully directed toward achieving science ability indicators for children aged 5–6 years. Environmental exploration activities have not yet been supported by structured learning guidelines, resulting in the potential of nature as a learning resource not being optimally utilized.

In addition to learning implementation, another challenge is found in the assessment process of children's science development. Assessment in early childhood education should be authentic, continuous, and utilized as a basis for determining subsequent learning stimulation. However, previous studies have shown that early childhood teachers still experience difficulties in conducting authentic assessments due to limited time, the number of students, and high administrative workloads (Sumantri & Yetti, 2021). Consequently, assessment processes are often conducted manually and tend to be summative, making it difficult for teachers to obtain rapid information regarding children's development during ongoing learning activities.

The development of digital technology provides opportunities to address these challenges through the implementation of digital evaluation in early childhood education. Digital technology can assist teachers in documenting children's development, storing observation data, and providing feedback more effectively. However, previous studies indicate

that technology utilization in early childhood education has largely focused on learning media for children, while the use of technology as an assessment support tool for teachers remains relatively limited (Neumann et al., 2019). Furthermore, technology implementation in early childhood education needs to consider developmental principles that emphasize play activities, concrete experiences, and social interaction.

Based on previous research findings, it can be identified that studies on Nature-Based Learning generally focus on the benefits of natural environments for children's development, whereas studies on digital evaluation mainly discuss the effectiveness of technology in supporting documentation and assessment processes. These two fields have largely developed separately. Research integrating nature-based learning, digital evaluation instruments, and adaptive feedback systems into a single learning module that can be directly utilized by early childhood teachers remains limited. Nevertheless, the integration of these three components has the potential to address the need for contextual science learning while simultaneously supporting teachers in conducting effective formative assessments.

Based on this research gap, this study aims to develop a Nature-Based Learning Module Based on Digital Evaluation by Teachers as an innovative learning approach to improve science abilities among children aged 5–6 years. The novelty of this research lies in the integration of three main components: (1) a nature-based learning module designed according to early childhood science ability indicators, (2) a digital evaluation system that assists teachers in conducting practical and real-time assessments, and (3) a feedback system that supports the provision of stimulation according to children's developmental needs.

Therefore, this study aims to produce a valid, practical, and effective Nature-Based Learning module based on digital evaluation to stimulate science abilities among children aged 5–6 years at TK Zainul Hasan. This research is expected to contribute to the development of early childhood education, particularly by introducing a learning model that combines nature-based approaches and digital technology to support science learning that is more contextual, adaptive, and meaningful.

Methods

This study employed a Research and Development (R&D) approach using the ADDIE development model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected because it provides a systematic framework for developing educational products, beginning with needs analysis and continuing through product development, implementation, and evaluation (Branch, 2009). The product developed in this study was a Nature-Based Learning Module Integrated with Digital Evaluation by Teachers to Stimulate Science Skills of Children Aged 5–6 Years at TK Zainul Hasan.

The development of this module aimed to produce a learning product that was valid, practical, and effective in supporting science learning through direct experiences with the natural environment. This research was initiated based on the problems found in early childhood education settings, where Nature-Based Learning activities were still predominantly recreational and had not been systematically structured according to children's science indicators. In addition, teachers experienced difficulties in conducting rapid and continuous formative assessments due to the limitations of manual assessment processes.

The development process followed the five stages of the ADDIE model. The first stage, Analysis, involved identifying the needs of science learning for early childhood, children's characteristics, teachers' needs, and problems related to implementing nature-based learning

and child development assessment. The second stage, Design, involved designing the module structure, Nature-Based Learning activities, science skill indicators, digital evaluation system, and research instruments. The third stage, Development, involved developing the module and digital evaluation instruments, followed by validation by material and media experts. The fourth stage, Implementation, involved testing the developed product with teachers and children aged 5–6 years at TK Zainul Hasan. The final stage, Evaluation, was conducted to determine the validity, practicality, and effectiveness of the developed module. The developed product integrated three main components: (1) a structured Nature-Based Learning module based on early childhood science indicators, (2) digital evaluation tools in the form of checklists and documentation to support teachers' formative assessment, and (3) an adaptive feedback system that provides stimulation recommendations based on children's developmental levels.

The research participants were teachers and children aged 5–6 years at TK Zainul Hasan. Based on the research design, the initial trial involved three teachers and fifteen children aged 5–6 years, while the implementation stage involved eighteen children aged 5–6 years and two classroom teachers. The participants were selected using purposive sampling, in which participants were chosen based on specific criteria relevant to the research objectives. The teachers were selected because they acted as the primary users of the developed module and digital evaluation system, while children aged 5–6 years were selected because they were at an appropriate developmental stage for science skill stimulation through environmental exploration activities. The characteristics of the research participants are presented in Table 1.

Table 1. Research Participants

Participants	Number	Role in the Research
Kindergarten classroom teachers	2 teachers	Users of the module, implementers of learning activities, and respondents for practicality evaluation
Children aged 5–6 years	18 children	Subjects for measuring the effectiveness of the module through science skill assessment
Material experts	2 experts	Validators of module content and learning materials
Media expert	1 expert	Validator of module design and digital media components

In this development research, the researcher acted as the main instrument responsible for conducting needs analysis, designing and developing the module, collecting data, analyzing research findings, and evaluating the developed product. The research involved classroom teachers as product users and expert validators as evaluators of the module's feasibility. Product validation was conducted by two material experts and one media expert. The validation results showed an average score of 88.3%, categorized as "highly feasible."

Data were collected through several techniques, including expert validation, practicality questionnaires, observation, and science skill assessments. The expert validation sheet was used to evaluate the feasibility of the developed module based on content suitability, presentation, language, instructional design, and digital evaluation components. The teacher practicality questionnaire was used to determine the ease of use and applicability of the module during learning activities. Observation was conducted during implementation to examine teacher and children's activities while using the module. The effectiveness of the module was measured using a pretest-posttest design to assess children's science skills before and after implementation. The measured science indicators included observing, classifying, measuring, questioning, predicting, and concluding, which are aligned with early childhood science development indicators.

The research instruments and learning materials were developed based on early childhood science learning principles and environmental-based learning approaches. The main product consisted of a Nature-Based Learning module containing eight science themes related to flora, fauna, and environmental exploration activities. The module was equipped with a QR Code connected to a digital evaluation system consisting of observation rubrics and interactive quizzes.

Table 2. Research Tools and Materials Specifications

Component	Specification
Learning module	Printed Nature-Based Learning module integrated with digital evaluation
Digital device	Smartphone/tablet used by teachers to access digital evaluation
Digital evaluation system	QR Code connected to observation rubrics and interactive quizzes
Learning materials	Environmental exploration activities involving flora, fauna, and natural phenomena
Research instruments	Expert validation sheets, teacher questionnaires, observation sheets, and science skill tests

The collected data were analyzed using quantitative and qualitative approaches. Quantitative data obtained from expert validation scores, teacher practicality questionnaires, and pretest-posttest results were analyzed using percentage calculations and Normalized Gain (N-Gain) analysis. The effectiveness of the developed module was determined based on improvements in children's science skills after implementing the module. The results showed that children's average science skill scores increased from 47.2% in the pretest to 82.5% in the posttest, with an average N-Gain score of 0.67, categorized as moderate improvement.

Qualitative data were obtained from observations, field notes, and expert feedback, which were used as the basis for revising and improving the developed product. The research was conducted at TK Zainul Hasan from June to September 2026. The research stages included needs analysis, development of the Nature-Based Learning module integrated with digital evaluation, expert validation, limited trials, and product effectiveness evaluation.

The validity of the research data was ensured through expert judgment and triangulation of data collection techniques by comparing results from expert validation, observations, teacher questionnaires, and children's science skill assessments. The use of multiple data sources and techniques aimed to ensure that the developed product met scientific standards in terms of validity, practicality, and effectiveness.

Result

1. Development of *Nature-Based Learning* Module Based on Digital Evaluation

This development research produced the main product, namely the Nature-Based Learning Module Based on Digital Evaluation, which was designed to stimulate the science abilities of children aged 5–6 years at TK Zainul Hasan. The module development process followed the ADDIE model, consisting of five stages: analysis, design, development, implementation, and evaluation. The research was conducted from June to September 2026 involving 18 children aged 5–6 years and two classroom teachers as research subjects. The developed module contains eight science activity themes based on *Nature-Based Learning*, including exploration activities related to flora, fauna, and the surrounding environment. Each activity was designed based on six indicators of early childhood science abilities, namely observing, classifying, measuring, questioning, predicting, and concluding, in accordance with

the developmental indicators stated in Ministerial Regulation of Education and Culture No. 137 of 2014.

In addition to nature-based learning activities, the module integrates digital evaluation through QR Codes connected to observation instruments and interactive quizzes. This integration aims to assist teachers in conducting rapid formative assessments and systematically documenting children's science development. The product validation results conducted by two material experts and one media expert showed that the module obtained an average score of 88.3%, categorized as "Highly Feasible." These results indicate that the module meets the criteria of content feasibility, activity presentation, media design, and suitability with early childhood learning characteristics.

2. Effectiveness of the Module in Improving Science Abilities of Children Aged 5–6 Years

The effectiveness of the *Nature-Based Learning* Module Based on Digital Evaluation was examined by comparing children's science abilities before and after the implementation of the module (*pretest-posttest*). The assessment was conducted based on six science process skill aspects: observing, classifying, measuring, questioning, predicting, and concluding. The improvement in children's science abilities is presented in Table 1.

Table 3. Improvement of Science Abilities in Children Aged 5–6 Years After Module Implementation

Science Ability Aspect	Pretest (%)	Posttest (%)	Difference (%)	N-Gain	Category
Observing	52.7	86.1	33.4	0.71	High
Classifying	48.3	82.4	34.1	0.66	Medium
Measuring	45.6	80.5	34.9	0.64	Medium
Questioning	50.0	88.8	38.8	0.78	High
Predicting	44.4	79.6	35.2	0.63	Medium
Concluding	42.2	77.7	35.5	0.61	Medium
Average	**47.2**	**82.5**	**35.3**	**0.67**	**Medium**

Based on Table 3, children's science abilities improved after using the module. The average science ability score increased from 47.2% in the pretest stage to 82.5% in the posttest stage, with an average N-Gain score of 0.67, which was categorized as medium. These findings indicate that the implementation of the module was effective in improving science process skills among children aged 5–6 years. The highest improvement was found in the questioning ability aspect, with an N-Gain score of 0.78, categorized as high. This result indicates that environmental exploration activities provided strong stimulation for children's curiosity. Direct observation activities involving natural objects encouraged children to actively ask questions during the learning process. The observing ability aspect also showed significant improvement with an N-Gain score of 0.71, categorized as high. Activities such as observing plant growth and measuring objects using simple tools provided children with concrete experiences, enabling them to understand science concepts through direct interaction with the environment.

Meanwhile, the abilities of classifying, predicting, and concluding improved within the medium category. The concluding ability increased from 42.2% to 77.7%. Although improvement occurred, this ability still requires further stimulation because children aged 5–6 years are still in the pre-operational stage of cognitive development, where logical thinking skills have not yet fully developed.

3. Implementation of Digital Evaluation to Support Teachers' Formative Assessment

The implementation of digital evaluation through QR Codes in each learning theme facilitated teachers in documenting children's development and providing faster feedback. The

digital evaluation system assisted teachers in recording observation results during activities, allowing assessment to be conducted continuously rather than only at the end of learning activities. The implementation results showed that digital evaluation supported the formative assessment process, particularly in providing direct information regarding children's science development. Teachers were able to use the evaluation results as a basis for determining subsequent learning stimulation according to each child's developmental needs.

However, during the research implementation, an obstacle was found regarding unstable internet connections when activities were conducted in outdoor environments. To overcome this limitation, the evaluation system was designed to operate offline by downloading the evaluation materials before the activities began.

Discussion

1. The Effectiveness of Nature-Based Learning Module in Stimulating Early Childhood Science Abilities

The findings of this study demonstrate that the developed *Nature-Based Learning* (NBL) Module Based on Digital Evaluation effectively improved children's science abilities aged 5–6 years. The improvement was indicated by the increase in the average science ability score from 47.2% in the pretest to 82.5% in the posttest, with an average N-Gain score of 0.67, categorized as a medium level of improvement. These findings confirm the initial hypothesis that structured nature-based activities integrated with formative digital assessment can provide meaningful experiences to support children's scientific thinking development.

From a constructivist perspective, the effectiveness of this module can be explained through the theory of cognitive development proposed by Piaget (1972), which emphasizes that young children construct knowledge through direct interaction with concrete objects and their surrounding environment. In early childhood education, science concepts cannot be optimally developed through abstract explanations alone; instead, children require opportunities to observe, manipulate, compare, and explore real phenomena. The implementation of NBL activities in this study provided children with direct experiences involving plants, animals, and environmental phenomena, allowing them to construct scientific understanding through meaningful exploration.

This finding is consistent with previous studies showing that nature-based learning environments provide rich opportunities for young children to develop science process skills. Wulansari and Sugito (2016) found that nature-based learning models improved the quality of early childhood learning processes because they accommodated children's natural characteristics of learning through exploration and direct experiences. Similarly, recent research by Speldewinde and Campbell (2025) revealed that nature-based contexts enable young children to apply interconnected science skills through play, observation, and exploration activities.

The improvement in children's science abilities also supports Vygotsky's sociocultural theory, particularly the concept of the Zone of Proximal Development (ZPD). According to Vygotsky (1978), children's cognitive development occurs optimally when they receive appropriate scaffolding from adults and learning environments. In this study, teachers acted as facilitators by providing guidance, questioning prompts, and feedback during nature exploration activities. The module structure, which included activity instructions, teacher stimulation scripts, and digital feedback features, functioned as scaffolding that helped children move from initial understanding toward higher levels of scientific thinking.

2. Development of Science Process Skills through Nature-Based Exploration

The results showed that all six indicators of science abilities improved after the implementation of the module. The highest improvement occurred in the questioning ability aspect, with an N-Gain score of 0.78, followed by observing ability with an N-Gain score of 0.71. These findings indicate that nature-based exploration strongly stimulates children's curiosity and encourages them to actively engage in scientific inquiry.

The improvement in questioning ability can be explained by the characteristics of nature-based learning, where children encounter unpredictable and authentic phenomena. Natural environments provide various stimuli that encourage children to ask questions, make predictions, and seek explanations. According to Suryana (2023), early childhood science learning should emphasize curiosity development because questioning is an essential foundation for scientific thinking. Previous research supports this finding. Speldewinde and Campbell (2025) explained that children participating in nature-based kindergarten settings demonstrate science skills through spontaneous exploration and inquiry activities. Their study highlighted that natural environments provide meaningful contexts where children can develop observation, classification, prediction, and explanation skills.

Furthermore, the improvement in observing and measuring abilities indicates that children benefited from concrete scientific experiences. Activities such as observing plant growth and measuring natural objects allowed children to understand scientific concepts through sensory experiences. This finding aligns with Piaget's view that children aged 5–6 years are still within the pre-operational stage, where concrete experiences play an essential role in developing logical understanding (Piaget, 1972).

However, the results also showed that predicting and concluding abilities had lower improvement compared with questioning and observing skills. This finding is theoretically understandable because prediction and conclusion require more complex cognitive processes involving reasoning and logical connections. At the early childhood stage, children are still developing the ability to organize information systematically. Therefore, continuous stimulation and repeated scientific inquiry activities are required to strengthen these higher-order science skills.

3. Digital Evaluation as a Formative Assessment Innovation in Early Childhood Education

Another important finding of this study is that integrating digital evaluation into the NBL module supported teachers in conducting formative assessment more effectively. The QR Code-based evaluation system enabled teachers to document children's learning progress and provide immediate feedback during learning activities.

This finding supports the concept of formative assessment proposed by Black and Wiliam (1998), which emphasizes that assessment should not only function as a measurement tool but also as a process to improve learning through continuous feedback. In early childhood education, formative assessment is particularly important because children's development occurs dynamically through daily interactions and experiences. The integration of digital assessment in this study also addresses previous challenges experienced by early childhood teachers, particularly difficulties in conducting real-time observation and documentation. Previous studies have reported that teachers often rely on anecdotal notes and memory-based documentation when assessing children in nature-based settings, indicating the need for more systematic assessment models (Speldewinde & Campbell, 2024).

The digital evaluation component developed in this research provides a practical solution by combining learning activities, assessment instruments, and feedback mechanisms in one integrated system. Unlike conventional digital applications designed mainly for older learners, this system positions teachers as the primary users, which is appropriate with the characteristics of early childhood education where assessment requires professional interpretation from educators.

4. Theoretical and Practical Implications of the Research

The findings of this study contribute theoretically and practically to early childhood science education. Theoretically, this research strengthens the argument that effective science learning for young children requires integration between meaningful environmental experiences, teacher scaffolding, and continuous assessment. The combination of nature-based pedagogy and digital formative assessment provides a framework that connects constructivist learning theory with contemporary educational technology.

Practically, the developed module provides teachers with a structured guide for implementing nature-based science activities. The module reduces teachers' difficulties in designing science activities, observing children's development, and determining appropriate follow-up stimulation. Therefore, this innovation has potential to improve the quality of science learning practices in early childhood education institutions.

Nevertheless, several limitations should be acknowledged. The implementation was conducted with a limited number of participants from one kindergarten institution. Additionally, internet accessibility challenges were identified during outdoor activities, although this limitation was addressed through offline evaluation features. Future studies should involve broader samples across different educational contexts and examine the long-term effects of the module on children's scientific literacy development.

Future research may also explore the integration of more advanced technologies, such as artificial intelligence-based analysis, automated observation systems, and personalized learning recommendations. Such developments may strengthen the role of digital technology in supporting teachers' decision-making while maintaining the child-centered principles of early childhood education.

Authors should discuss the results and how they can be interpreted from the perspective of previous studies and the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

Conclusion

This study developed and evaluated a Nature-Based Learning Module Based on Digital Evaluation designed to stimulate science abilities among children aged 5–6 years at TK Zainul Hasan. The development was conducted using the ADDIE model, which resulted in an integrated learning framework combining nature-based activities, teacher-guided exploration, digital formative assessment, and adaptive feedback mechanisms. The findings indicate that the developed module was feasible and effective in supporting early childhood science learning.

The validation results demonstrated that the module obtained an average feasibility score of 88.3%, categorized as highly feasible based on expert evaluations. Furthermore, the effectiveness test showed a significant improvement in children's science abilities, with the average score increasing from 47.2% in the pretest to 82.5% in the posttest, and an average N-Gain score of 0.67, indicating a moderate level of improvement. The highest improvement was found in the questioning ability aspect (N-Gain = 0.78), followed by observing ability (N-Gain =

0.71). These findings confirm that structured nature-based learning experiences combined with digital formative assessment can effectively stimulate children's curiosity, observation skills, and scientific inquiry processes.

The main contribution of this research lies in the integration of three essential components: (1) structured Nature-Based Learning activities aligned with early childhood science indicators, (2) digital evaluation tools designed specifically for teachers to conduct real-time formative assessment, and (3) adaptive feedback mechanisms to support individualized learning stimulation. This framework provides an alternative approach for addressing common challenges in early childhood education, particularly the limited availability of structured science learning resources and teachers' difficulties in conducting continuous assessment during exploratory activities.

In practical implementation, the developed module can be applied by early childhood education teachers as a guideline for designing meaningful science activities based on children's direct interaction with natural environments. Teachers can utilize the digital evaluation feature to document children's developmental progress, identify learning needs, and determine appropriate follow-up stimulation. Therefore, this framework can support the transition from conventional assessment practices toward more authentic, continuous, and child-centered formative assessment.

However, this study has several limitations. The implementation was conducted within a limited research setting involving one kindergarten institution and a relatively small number of participants. In addition, outdoor digital implementation was influenced by internet accessibility challenges, although this issue was addressed through offline evaluation features. Therefore, further studies are recommended to involve larger and more diverse samples across different early childhood education contexts to examine the consistency and generalizability of the findings.

Future research should also explore the development of more advanced digital learning systems, including artificial intelligence-based assessment, automated analysis of children's scientific behaviors, and personalized learning recommendations for teachers. Such developments may strengthen the role of educational technology while maintaining the principles of play-based, experiential, and developmentally appropriate learning in early childhood education.

Overall, this study concludes that the Nature-Based Learning Module Based on Digital Evaluation represents a promising innovation for improving early childhood science education. By integrating environmental exploration, formative digital assessment, and teacher-supported feedback, the framework provides a practical and theoretically grounded approach to fostering scientific thinking among young learners.

The conclusion should summarise the main state of play at the point of writing and consider the next steps. Summarise and conclude, restating the main argument and presenting key conclusions and recommendations—state how your findings/new framework can be applied in practice. Explain what the implications are for further research.

References

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. https://doi.org/10.1080/0969595980050102

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.

Fjørtoft, I. (2020). The natural environment as a playground for children: The impact of outdoor play activities in pre-primary school children. *Early Childhood Education Journal*, *29*(2), 111–117.

Kemendikbud. (2014). *Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 137 Tahun 2014 tentang Standar Nasional Pendidikan Anak Usia Dini*. Kementerian Pendidikan dan Kebudayaan.

Lestari, P. I., & Prima, E. (2021). Pengaruh pembelajaran berbasis lingkungan alam terhadap keterampilan proses sains anak usia 5–6 tahun di TK Kota Semarang. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *5*(2), 1120–1130.

Mufidah, M., Jannah, F. R., Dhasni, S. M., & Hayati, N. (2026). Studi pustaka: *Nature Based Learning* sebagai sarana pengembangan problem solving anak usia dini. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *10*(1), 641–654.

Neumann, M. M., Hyde, M., Moore, D., & Hood, M. (2019). Assessment and technology: Mapping future directions in the early childhood classroom. *Frontiers in Education*, *4*, Article 116.

Piaget, J. (1972). *The psychology of the child*. Basic Books.

Speldewinde, C., & Campbell, C. (2024). Building a better wall: Assessing children's design technology learning in nature-based early childhood education. *Canadian Journal of Science, Mathematics and Technology Education*, *24*, 39–56. https://doi.org/10.1007/s42330-024-00320-6

Speldewinde, C., & Campbell, C. (2025). More than a cluster of sawflies: Understanding young children's application of science skills in nature-based learning. *Research in Science & Technological Education*, *43*(4), 1043–1064. https://doi.org/10.1080/02635143.2024.2435342

Sumantri, M. S., & Yetti, E. (2021). Kendala guru PAUD dalam pelaksanaan penilaian autentik Kurikulum 2013. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *5*(1), 233–243.

Suryana, D. (2023). *Pendidikan anak usia dini: Stimulasi dan aspek perkembangan anak*. Kencana.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Wulansari, B. Y., & Sugito. (2016). Pengembangan model pembelajaran berbasis alam untuk meningkatkan kualitas proses belajar anak usia dini. *Jurnal Pendidikan dan Pemberdayaan Masyarakat*, *3*(1), 16–27. https://doi.org/10.21831/jppm.v3i1.7919.