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The Effectiveness of a Collaborative Participatory Training Management Model to Improve the Digital Literacy Skills of Kindergarten Teachers

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Abstract
The success of digital learning relatively improves learning performance; this is greatly influenced by kindergarten teachers who can utilize good teaching strategies for students and are willing to use digital learning. This study aims to analyze the effectiveness of a collaborative participatory training management model to improve the digital literacy skills of kindergarten teachers. A prospective cross-sectional interventional study with baseline and re-survey was conducted to evaluate the effect of collaborative participatory-based training management model. Training and Education were conducted for 5 days, with 70 participants selected by simple random sampling. Competence was measured using a questionnaire and analyzed using an independent t-test using SPSS software. Statistical tests show that collaborative participatory -based training management model is efficacious in improving the competence of kindergarten teachers ($p = 0.001$). The management of e-learning-based training can assist in developing more targeted and quantifiable training goals. This model serves as an alternative approach to enhancing the competencies of kindergarten teachers. The Digital Literacy Training Management Model can improve the pedagogical Competence of kindergarten teachers and can be used as an alternative choice of training that is carried out online so that it dramatically helps kindergarten teachers improve their competence.

Keywords
e-learning, management, model, teacher, training

1. Introduction
Information technology can be utilized in various sectors, one of which is Education. The hallmark of 21st-century learning is the digital dissemination of information and increased connectivity between individuals in society. This condition is often associated with the industrial revolution, particularly in the information sector. Therefore, Education in this era is required to equip Indonesia's younger generation to be ready to face the development of information and communication technology in social life. The concept of 21st-century learning is a result of the dynamics of societal development over time. History records the shift in society from the primitive era to the agrarian era, then the industrial era, and now entering the information society era (Khahro and Javed, 2022; Hermawan, Darmawan and Bestari, 2024).

Early Childhood Education is an initiative aimed at nurturing children from birth to six years of age, implemented through the provision of educational stimulation to facilitate their physical and spiritual growth and development, thereby preparing them for subsequent educational endeavors (Law Number 20 of 2003). Early childhood education is a pedagogical approach that prioritizes establishing a foundation for physical growth and development (coordination of gross and fine motor skills), cognitive abilities (intellectual capacity, creativity, emotional intelligence, spiritual

intelligence), socio-emotional aspects (behavioral attitudes and religious beliefs), as well as language and communication, tailored to the distinct stages of early childhood development (Aman and Saragi, 2020; Rahmatullah *et al.*, 2021; Harmi *et al.*, 2022; Armita, Hajazi and Zaitun, 2024; Li, 2024).

In the digital age, educators must stay abreast of technology advancements; hence, beyond fundamental teaching competencies, additional abilities must be cultivated in teachers to fulfill their roles successfully as learning facilitators (Karakose, Polat and Papadakis, 2021; Sanusi, Oyelere and Omidiora, 2022). The findings of the study by (Lin, Chen and Liu, 2017) substantiate this assertion, indicating that the efficacy of digital learning enhances academic performance, significantly influenced by educators who employ effective teaching strategies and are amenable to utilizing digital learning tools. Educators must possess competence in didactic media, media ethics, media education, and media-related school developments throughout implementation (Küsel, Martin and Markic, 2020). Educators must develop competence in the field of general media in order to plan, implement, and reflect on the use of safe and adequate digital media for early childhood (Gjelaj *et al.*, 2020; Novella-García and Cloquell-Lozano, 2021; Mattar, Santos and Cuque, 2022).

One type of literacy that utilizes digital technology is digital literacy. According to the World Economic Forum 2018, teachers must have the ability to understand three keys to educational progress, namely competence, character, and literacy, which are currently needed (Ministry of Education and Culture, 2018) (Kebudayaan and INDONESIA, 2018). In line with that, the CEO of Microsoft Indonesia (2018) stated that in this digital era, teachers must be able to respond to the increasing sophistication of current technology, where teachers must be wise as the vanguard in implementing technology in the world of Education. Starting from teachers designing teaching materials more interestingly and creatively, the learning process follows developments and progress in the current era.

The problem is the unpreparedness of teachers to face technological changes, including the low ability of teachers to master technology, which is one of the challenges faced in the world of Education today, This is revealed from the research results (Galindo-Domínguez and Bezanilla, 2021; Wiwin and Widiati, 2022). In Permendikbud no. 137 of 2014 concerning PAUD Standards, one of the indicators of teacher pedagogical competence is the utilization of ICT to organise educational development activities. The incapacity of educators to use ICT in education hinders schools from modernizing **instructional** resources. Technology may enhance the efficacy, efficiency, and enjoyment of teaching and learning activities for students (Permendikbud, 2014). This condition aligns with the research findings of (Hutagalung and Purbani, 2021; Pratolo and Solikhati, 2021), which state that teachers' digital literacy levels in Indonesia are still limited. (Redecker and Punie, 2017), in their research on the influence of digital literacy in the education system in Europe, found that although many teachers have recognised the importance of digital literacy, its adoption in learning is still limited. Then (Valverde-Berrocoso *et al.*, 2021), in their research on digital training for teachers in developing countries, stated in their research results that they found a gap between the expected digital skills and those possessed by teachers. The mapping findings from the United Nations Educational, Scientific and Cultural Organization (UNESCO) indicate that just 14% of educators can proficiently use and implement information technology. This situation is alarming and indicates a lack of proficiency among educators in Indonesia.

Teachers in most regions of Indonesia also experience this digital divide. A survey by the Central Statistics Agency (BPS) of 4,014 schools spread across 34 provinces found that the proportion of teachers with ICT qualifications for all levels of Education was only 10.10 per cent (BPS, 2018). Meanwhile, the percentage of students who access the Internet in schools for all levels of Education was recorded at 33.67 per cent. Differences in data criteria and the proportion of information technology users cannot cover the gap in skills in using and accessing information technology owned by teachers and students.

Technological developments also impact Education. Various digital teaching resources, known as e-resources, are abundantly available online. The digital era provides various online information, both verified and unverified (Diputra, Tristiantari and Jayanta, 2020). Therefore, a strategy is needed to trace information sources so that the information obtained is appropriate to needs, valid, and can be accounted for. The problem is that teachers use this information as a reference for developing learning resources or compiling their learning tools without further investigating whether the information has been verified. This is because teachers do not have the technical ability to search for information sources on the Internet and do not have adequate digital literacy Furthermore, the results of (Muharmi, 2022; Nurhayati *et al.*, 2024) show that the use of digital-based media in learning is minimal due to teachers' limited ability to create digital-based learning media

Based on the results of an exploratory study conducted in several kindergarten units (Kindergartens) in Medan City, it is known that computers/laptops have not been used to create digital learning media that can be used in the learning process. This is because teachers have never participated in training to improve their competence in creating digital learning media. Then, there are still teachers who are less creative in providing learning media, which are the work of teachers that can be used in the learning process. The learning media used are only photocopies of images. In addition, teachers also use the Internet to search for sources of information and increase their knowledge about learning in kindergarten. However, when getting information regarding learning media, teachers cannot yet imitate and modify, which is correlated with the characteristics or learning needs they will implement. This is because teachers have never participated in training in creating digital learning media.

Training is a planned activity carried out by the community to impart knowledge, values, attitudes, and skills to professionals in their fields. It aims to enhance and develop individual potential, bringing about change in people (King *et*

al., 2021). Specific organizations offer training as a means to encourage and enhance work skills (Alenezi, 2023). According to (Alenezi, 2023), training is the process of teaching new and existing employees the fundamental skills necessary to perform their jobs effectively.

Similarly, (Romero-Tena *et al.*, 2020; Wiwin and Widiati, 2022; Madsen *et al.*, 2023) found that teachers' pedagogical Competence in designing or creating digital learning media and using digital learning media in early childhood education (PAUD) remains low. Consequently, PAUD teachers must be taught to continuously improve their Competence. Based on previous research findings, PAUD teachers require training or competency-enhancing activities that cater to their needs, aiming to improve their pedagogical Competence in developing and utilizing digital technology in learning, and ultimately become competent and adaptive educators in the digital era.

This study examines the evolution of policies and strategies for large-scale teacher training in China. Initially, the training was highly centralized, with the government determining all aspects. Over time, the approach shifted to become more professional, collaborative, and responsive to local needs. The training strategies combined formal and informal methods, technology, and outreach to remote areas, while maintaining a balance between national standards and local flexibility. Overall, the training aimed not only to improve teachers' professional competencies but also to support national educational development (Li, Yang and Wang, 2023).

The integration of technology in the educational process may provide advantages in fostering overall child development as well as enhancing specific cognitive skills. According to research by (Hsin, Li and Tsai, 2014), children engaged in technology-mediated learning generally exhibit positive effects on cognitive, social, emotional, and physical development. Out of 94 participants, only two children experienced negative cognitive impacts, and one child faced a negative social impact. The research indicated significant favorable effects on children's cognitive capacities in language, reading, mathematics, science, digital literacy, and other domains. Research by (Bulut, Samur and Cömert, 2022; Xiong, Liu and Huang, 2022) indicates that the use of digital educational games as an instructional tool may enhance cognitive skills, namely the thinking capacities and creativity of early childhood learners in an engaging manner.

This study aims to evaluate the efficacy of the integrated digital literacy training management in enhancing the pedagogical competence of kindergarten educators, based on the findings from the exploratory and literature reviews conducted above. This study's novelty lies in the implementation of a digital literacy training management paradigm inside kindergarten teacher education and training. The results of this research are anticipated to serve as a digital literacy training model to enhance kindergarten teachers' competence in delivering services to preschool children.

2. Research Methods

Research Design

We conducted a cross-sectional, prospective intervention study with baseline and follow-up surveys to analyze the effectiveness of a participatory, collaborative-based training management model in improving the pedagogical Competence of kindergarten teachers. The training interventions employed a training management model that incorporated collaborative and participatory approaches. The five-day training program consisted of lectures, participation, practice sessions, and discussions. Prior to the intervention, researchers developed a curriculum, syllabus, and training modules that were pretested.

Population and Sample

The population in this study was all kindergarten teachers working in kindergarten educational units in Medan City. From this population, a sample of 70 teachers was selected from 33 kindergarten educational units representing various districts in Medan City. The sample selection took into account the representation of various school conditions, ensuring that the tested model reflects the diversity of kindergarten educational contexts in Medan City and that the results can be generalised to similar situations.

Data Collection Instruments

Data collection was conducted using several instruments designed to obtain comprehensive, in-depth, and relevant data. First, interviews were used to gather detailed information regarding the implementation of digital literacy training, including planning, curriculum, methods, and challenges encountered. Interviews were conducted with the training implementation team, the principal, and kindergarten teachers. Second, observations were used to monitor the implementation of the training and participant interactions during the training, particularly regarding how participants applied digital learning media in teaching and learning activities. Third, questionnaires were used at various stages of the research: to identify training needs in the preliminary study, to obtain expert and practitioner feedback in the validation phase, and to gather participant responses regarding the practicality and effectiveness of the model in the pilot phase. Additionally, pretests and posttests were administered to measure teachers' digital literacy skills before and after the training, allowing for an objective assessment of changes in participant skills.

Table 1. Grid of Questions for Kindergarten Teacher Digital Literacy Ability Test

Variables	Indicator
Technical Literacy Skills	1. Understand appropriate digital media to create interactive learning media 2. Explain the use of applications to create presentations. 3. Explain the importance of using interesting visual and audio media. 4. Explain the importance of narrative or explanatory text in each scene. 5. Identify the size of the digital design according to the needs of the learning media.
Information Literacy Skill	1. Understand that the media chosen supports meaningful and enjoyable learning. 2. Explain the importance of validity and relevance of digital information in the learning process. 3. Explain that visualisation helps simplify abstract concepts. 4. Explain that storyboards help plan video content systematically. 5. Explain that the storyboard is the initial guide in the video production process. 6. Explain that choosing the right template helps the readability and attractiveness of the teaching material. 7. Demonstrate that the information used is appropriate to the context, curriculum, and developmental level of the students.
Communication Literacy Skill	1. Understand that delivering age-appropriate messages will increase children's understanding and interest in learning. 2. Explain that early childhood children find it easier to understand information through pictures and sound than long texts. 3. Explain that interactive stories through video and audio encourage children's active participation in the learning process. 4. Explain that the Kahoot application allows direct interaction between teachers and students through digital devices. 5. Explain that messages in digital media must be clear, engaging and easy for students to understand. 6. Explain the importance of text clarity in the development of students' early literacy.
Reproduction Literacy Skill	1. Understand that digital work results in a format that can be used and redistributed. 2. Explain the transformation of digital media into relevant printed learning products. 3. Know how to rearrange information in a design format according to learning needs. 4. Know how to adapt visual design to align with content and learning objectives. 5. Select and arrange appropriate visual elements to strengthen the meaning of the material. 6. Explain how to present information in a new form (video) with appropriate visual and sound elements.

Source: Researcher (2022)

Data Validity and Reliability

To ensure the reliability of the test data, validity and reliability tests were conducted on the test instrument. The item validity test was conducted using SPSS on a sample of kindergarten teachers who were not part of the main research sample. The validity test revealed that 25 of the 30 items were valid, as their correlation coefficient (r-count) was greater than the r-table value at a 5% significance level. Invalid items were then eliminated from the test instrument. Furthermore, the reliability of the valid items was tested using Cronbach's Alpha coefficient. The calculation yielded an alpha value of 0.732, which exceeds the minimum standard of 0.6, indicating that the test instrument is reliable. Therefore, the instrument can be relied upon to consistently measure teachers' digital literacy skills.

Data Analysis

The data obtained from various instruments were then analysed qualitatively and quantitatively. Data from interviews and observations were analysed qualitatively to gain a deeper understanding of the existing problems, participant responses, and the context of the training implementation. Meanwhile, the quantitative data obtained were analysed using IBM SPSS software version 25. Descriptive statistics were used to analyse participant characteristics, with results presented as means ± standard deviations. The effectiveness of the Participatory Collaborative-based training management model was analysed using the Paired Test method to compare pretest and posttest scores, with a significance level set at P-value <0.05.(Manfei *et al.*, 2017; Kim and Park, 2019). In addition, training evaluation also considers four aspects: reactions, learning, behaviour, and outcomes, to assess the overall impact of the intervention.

3. Results

Research result

1. Digital literacy development paradigm for kindergarten teachers

The training that kindergarten teachers have attended, in general, is the Graduated Training for PAUD Teachers, and kindergarten teachers have never attended training themed on the use of ICT in learning. This was expressed by the Chairperson of the Indonesian Kindergarten Teachers Association, who is also the Principal of a Kindergarten in Medan City, as follows:

So far, the Training Organizing Institutions have generally held Leveled Training for PAUD Teachers and Curriculum Preparation Training. Therefore, many kindergarten teachers have participated in levelled training for PAUD teachers. However, training aimed at improving teachers' ability to use ICT or digital learning media in schools has never been implemented by LPD, be it HIMPAUDI, IGTKI, the Education Office, or BBGP North Sumatra.

One of the Principals of Medan City Kindergarten: My teacher usually uses a laptop/computer to make RPPH and syllabus or to compile various reports or documents such as learning outcome reports, student attendance lists, and individual child development reports. The teacher has also used a laptop/computer to make learning videos, PowerPoint presentations, or online games. Usually, teachers only use laptops to play videos of healthy and happy children's gymnastics and regional dance videos to introduce children to regional dances.

Kindergarten teachers usually use computers/laptops to create RPPH and syllabus or to compile various learning reports. Using laptops/computers to create digital learning media has never been done. This was expressed by the Principal of a Kindergarten in Medan City as follows:

My teacher usually uses a laptop/computer to create the RPPH syllabus or to compile various reports or documents such as learning outcome reports, student attendance lists, and individual child development reports. The teacher has never used a laptop/computer to create PowerPoint presentations, so PowerPoint points only use laptops to play videos of healthy and happy children's gymnastics and regional dance videos to introduce children to regional dances.

Kindergarten teachers cannot produce innovative and interactive learning media such as interactive games, engaging presentations with PowerPoint presentations, and learning videos perper the learning theme. In general, teachers use Worksheets containing pictures and numbers or letters to be worked on by students as a learning medium to recognize and recognize numbers and letters. This was expressed by a Kindergarten Teacher in Medan City as follows:

Every morning, I usually ask children to memorize letters and numbers. At the beginning of the lesson, I invite children to count numbers 1-50 or read the letters I write on the board. Then, I distribute worksheets to the children to do activities such as connecting numbers with letters, counting the number of pictures in the worksheet, and colouring pictures. I have never compiled interactive learning media myself because I have not been able to use PowerPoint or Canva to create learning media for kindergarten children.

Kindergarten teachers can operate Microsoft Office programs because they have taken computer courses during college. Therefore, teachers use laptops/computers for daily child development reports, attendance lists, RPPH, and syllabi. Use the Internet to search for sources of information related to learning in kindergarten. If there is an interesting YouTube video about children's learning in kindergarten, for example, introducing numbers and letters with learning videos, teachers use it for classroom learning. This was expressed by one of the kindergarten teachers in Medan as follows:

I once took a computer course for Microsoft Office programs in college. I usually do it myself for administration at school, and I usually do the RPPH, syllabus, and child development reports. I often use the Internet to get information related to learning in kindergarten, for example, activities to form various objects from origami paper and various kinds of beading and batik activities for kindergarten children's play activities. I also often use videos on YouTube to learn in my class. Usually, children are enthusiastic when learning using videos; they recognize numbers and letters faster by using learning videos because the appearance of YouTube videos is fascinating.

The forms of training that have been held by BBGP North Sumatra Province, as conveyed by Kindergarten teachers who have participated in the training, are as follows:

The training that I have attended as a participant invited by BBGP North Sumatra Province is the same as training in general carried out by the Medan City Education Office; my Principal assigned me to be able to attend the training through an invitation sent to the Principal by BBGP North Sumatra. The invitation explains the day/date of the training, training location, training schedule, materials, and participant requirements. Usually, participants are not allowed to bring family members when attending the training even though the training time is long; it can be up to 5 days. So I have to leave my family and also my students; usually, if there is a training activity that is quite long, my fellow teacher and the children who replace me in my class are put together in one class by a fellow teacher because our kindergarten lacks teachers.

Training activities have been carried out so far without an analysis of the needs of the training participants. Training participants are determined directly by the organizer's organizers by inviting training participants to come to the training location and leaving their duties with the programmed training materials is also a complaint from other kindergarten teacher respondents; here is an excerpt from the interview:

Before the training activity, the organizers never asked us about our learning problems. I was happy to be able to attend the training organized by BBGP North Sumatra because I could meet other kindergarten teacher friends and share new experiences and knowledge. However, I also wanted to develop more innovative learning in my class. I often see kindergarten teachers in Java on my social media who have become celebrities using learning media, such as interesting learning videos for kindergarten children. I want to attend training specifically for making learning videos so I can use them for my children at our school.

From the information above, it can be concluded that learning in kindergartens still follows traditional methods, with technology limited to administration and playing learning videos. Teachers' ability to utilize ICT to create digital learning media is still relatively low, even though they have an interest in learning. The training attended by teachers is more related to tiered training without considering the specific needs of digital literacy. Kindergarten teachers expect more effective training in utilizing time so that they do not leave their duties as teachers for long; in addition, participants also hope to receive training to improve their ability to compile learning videos to present in classroom learning with students. Teachers also expect a training model that aims to solve their problems in learning related to presenting more interesting and innovative learning in kindergartens.

2. The Influence of Training Management e-learning-based to improve the pedagogical Competence of kindergarten teachers

The influence of e-learning-based training management was carried out with 70 training participants. The following explains the pretest and post-test results:

Table 2. Effectiveness of training for Kindergarten Teachers based on e-learning

Variables	Average± SD	Max Score	Min Score	p-value
Competence				
Before	44.00± 8,952	30	70	0.001
After	79.36± 5,379	60	90	
Difference	35.35± 9,220			

Referring to the table above, the average pre-test score for teacher competency was 44, with the lowest score recorded at 30 and the highest at 60. In contrast, the post-test results showed an increase, with an average score of 79.36, a minimum score of 70, and a maximum of 90.

Furthermore, Tables 3 and 4 present the analysis results of the N-Gain Score test conducted on training participants. The N-Gain Score, or normalized gain test, is used to assess the effectiveness of the e-learning-based training management model in enhancing the pedagogical competence of kindergarten teachers in Medan. For a clearer illustration, the distribution of the average N-Gain is presented descriptively in the following table.

Table 3. N-Gain Distribution

Interval	Limited Trial		
	F	**Percentage (%)**	**Percentage Cumulative (%)**
< 40	0	0	0
40-55	0	0	0
56-75	30	42.86	43
> 75	40	57.14	100
Total	**70**	**100**	

Source: Pretest and Post-Test Data Processing Results

Based on the table above, it is known that the number of respondents was 70 people. No teachers obtained an N-Gain Score <40 and an N-Gain Score between 40-55. There were 30 teachers, or 42.86%, who obtained an N-Gain Score between 56-75. Moreover, 40 teachers, or 57.14%, obtained an N-Gain Score> 75. It can be concluded that the e-learning-based training management model effectively improves the pedagogical Competence of kindergarten teachers.

Table 4. Distribution of N-Gain Score

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain Score	70	0.56	1.00	0.7680	0.11485
N-Gain Percent	70	55.56	100.00	76.6391	11.55415
Valid N (listwise)	70				

Source: Pretest and Post-Test Data Processing Results

The N-Gain Score test results obtained 0.77 ≤ g ≤0.7, so the N-gain value is included in the high category (Hake, 1999). Furthermore, the N-gain category in the form of a percentage obtained a value of 76.64%, which means that the training management model effectively improves the pedagogical Competence of kindergarten teachers.

3. Results of Observations of Teaching Practices

The following is a recapitulation of the results of observations of teaching practices carried out by training participants using e-learning-based media in the form of learning videos:

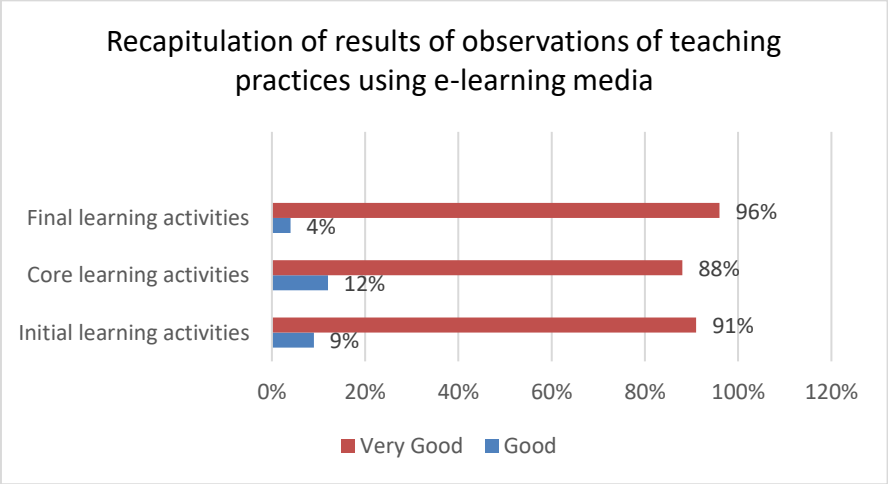

Figure 1. Recapitulation of the results of observations of teaching practices using digital learning media.
Source: Data Processing Results

In the picture above, it is known that 9% of training participants carry out initial learning activities with a suitable category, and 91% of training participants carry out initial learning activities with an outstanding category. In the core learning activities, 12% of training participants use learning videos well, and 88% carry out core learning using learning videos very well. While in the final learning activities, 4% of training participants carry out final learning activities well, and as many as 96% of training participants carry out final learning activities very well.

The table above shows the results of the post-test obtained by the training participants. The average score of the teacher competency post-test was 79.36, with a minimum score of 70 and a maximum score of 90. Based on the observations of training participants who have learned to use learning videos well, digital literacy training certificates can be given to 70 participants because the training participants have increased their pedagogical Competence.

Evaluation of Digital Literacy Training Management Model for Kindergarten Teachers

When reviewing the teaching practice activities by training participants after attending the training, the results were that 91% of training participants carried out the initial learning activities with a very good category, and 88% of training participants carried out the core learning using learning videos very well. In the final learning activities, 96% of training participants carried out the final learning activities very well.

The data from the training model assessment results by the training participants are used to determine the participants' responses to the developed training model. The following are the results of the training model effectiveness assessment:

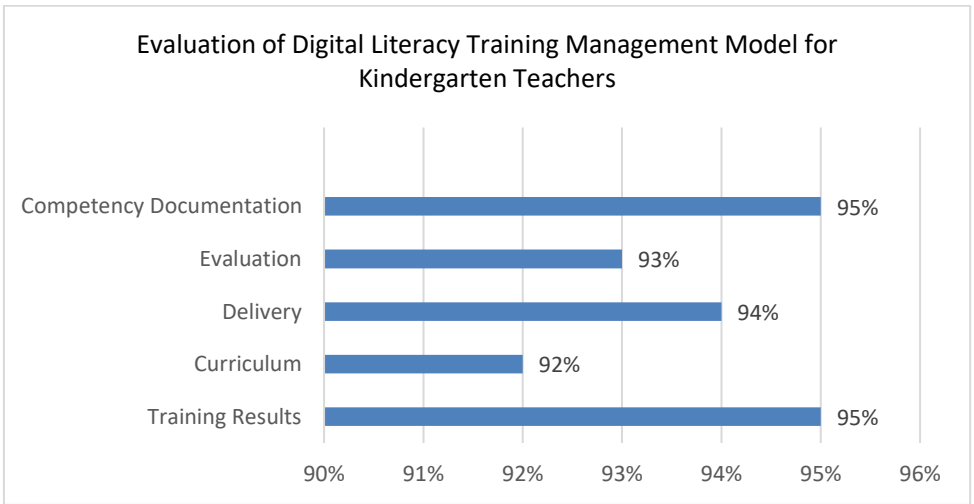

Figure 2. Assessment of the Effectiveness of the Digital Literacy Training Management Model

Based on the picture above, it can be seen that the assessment of the training results aspect obtained a score of 95% with an outstanding category. In the curriculum aspect, it obtained a score of 92%, with an outstanding category. In the delivery aspect, it scored 94%, with an outstanding category. In the assessment aspect, the score was 93%, with an outstanding category. The competency documentation aspect scored 95%, with an outstanding category. The average score for the training model assessment was 93%, with an outstanding category.

Thus, it can be concluded that the training model developed received a very good response from training participants. Next, the questionnaire was distributed to the training participants to determine the effectiveness of implementing the digital literacy training program according to the perceptions of the training participants. The following are the results of the assessment of the effectiveness of the digital literacy training program:

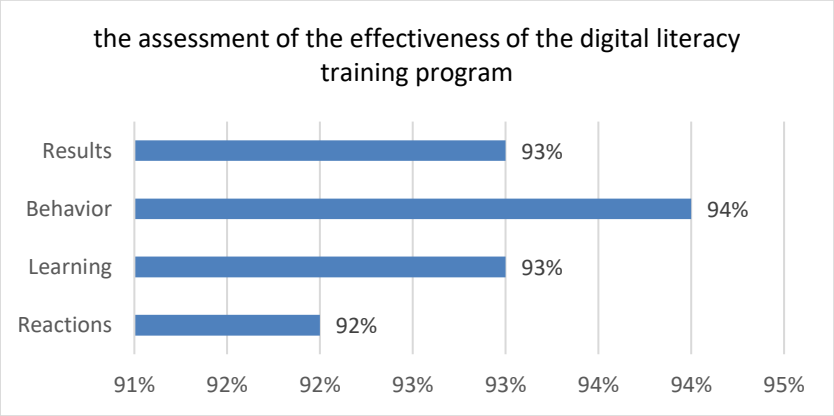

Figure 3. Assessment of the Effectiveness of the Digital Literacy Training Program

Based on the image above, it can be seen that the assessment of the reactions aspect obtained 92% with an outstanding category. In the learning aspect, it obtained an average score of 93% with an outstanding category. In the behaviour aspect, it obtained an average score of 94% with an outstanding category. In the results aspect, it obtained an average score of 93% with an outstanding category. The average score of the training evaluation was 93, with an outstanding category. Thus, based on the assessment results, it can be said that the digital literacy training program, according to the perception of training participants, is very effective.

4. Discussion

1. Digital literacy development program paradigm for kindergarten teachers

Currently, learning in kindergarten still adopts conventional methods, where technology is limited to administrative purposes and learning videos are played. Meanwhile, the ability of teachers to utilize information and communication technology (ICT) to create digital learning media is still relatively low. Many teachers have shown interest in improving their skills in this field. However, the training they attend tends to focus on tiered training and does not explicitly discuss digital literacy according to their needs. In addition, the training program organized by BBGP North Sumatra has not fully considered actual conditions in the field. In terms of material and format, the training is still not flexible enough and is not in line with the needs of the participants. Hence, its effectiveness in improving the Competence of kindergarten teachers in digital literacy is still limited.

Researchers created characteristics of a digital literacy training management model to improve the pedagogical Competence of kindergarten teachers, namely: (1) This model aims to improve the pedagogical Competence of kindergarten teachers in utilizing digital technology, especially in compiling and using digital learning media, namely digital-based learning videos; (2) The Digital Literacy Training Management Model adopts five stages of the training model developed by (Goad, 1982), namely analysis, design, development, implementation, and evaluation. Then, this model is integrated with the approach of online training teachers and teaching practice teachers, where teachers take part in digital literacy training and then implement the knowledge gained into classroom learning. (3) This Digital Literacy Training Management Model also uses the flipped classroom approach (Bergmann and Sams, 2014) in implementing its training, where training participants study the material independently before the class session (pre-class). The class session (in-class) focuses on discussion and problem-solving through Zoom meetings and practice making learning videos guided by a facilitator. This approach was chosen because it increases participant engagement in online training sessions and the effectiveness of time use (Rotellar and Cain, 2016; Hew and Lo, 2018). (4) The Digital Literacy Training Management Model has good quality training inputs including Participants are kindergarten teachers who have fundamental laptop skills and a high commitment to completing the training, facilitators have a minimum education of S1 Informatics/Informatics Engineering, have experience teaching digital literacy, and master the training materials, training materials are adjusted to the pedagogical competencies of PAUD teachers as stated in Permendikbud No. 137 of 2014 concerning PAUD Standards, validated training devices consist of training modules, training guidelines and digital literacy training model books.

Practical training depends not only on the method used but also on the quality of training input. This is according to the theory put forward by (Nadler, 1982), which states that training based on quality input will produce a more effective learning process and increase participant competence. In line with Nadler's theory, the research results from (Kirkpatrick, 1998) also stated that high-quality training increases participant satisfaction, understanding, and application of material in work. (Celis-Morales *et al.*, 2012) stated that quality input training will improve participant skills and performance more effectively. (6) The Digital Literacy Training Management Model improves competence ienting torientedeal products where the. This model aims to improve the pedagogical competence garten teachers using digital media, not just theory. With training output, teachers can make their learning videos using the Canva application, and after that, teachers can apply learning videos in the classroom to improve teaching effectiveness. This is in line with what was conveyed by experts (McClelland, 1998), (Gagne, 1970), and (Spencer and Spencer, 2008), who stated that training must be competency-based so that participants indeed master skills that can be applied in the workplace. Digital Literacy Training is also oriented towards Real Products, and this is according to the opinions of experts (Stewart *et al.*, 2013), Kolb (1984), and Trowler (2003), who stated that training that produces real products is more effective because participants can apply their skills directly in the workplace or everyday life.

2. Effectiveness of Digital Literacy Training Management Model to Improve Pedagogical Competence of Kindergarten Teachers

The effectiveness of the digital literacy training management model in enhancing teachers' cognitive competence is evaluated based on four key aspects: (1) The average N-Gain Score for the field trial was 76.64%. Since the g-value > 55% falls into the practical category, it indicates that the digital literacy training management model is effective in improving the pedagogical competence of kindergarten teachers in developing and utilizing digital learning media. (2) The Wilcoxon test results showed an Asymp. Sig (2-tailed) value of 0.001 and a Z value of 7.07 in a broad field trial. This suggests a significant improvement in the pedagogical competence of participants in designing and implementing digital learning media in kindergarten. (3) Participant feedback on the training model's effectiveness showed an average assessment score of 94%, categorizing it as outstanding. This indicates that the developed training model was well-received by the participants. (4) Regarding the implementation of the digital literacy training program, participants rated it highly, with an average evaluation score of 93, also in the outstanding category. This suggests that, based on participant perceptions, the training program was highly effective.

The findings of this study strengthen the theory that a model can be considered effective if the average value of n gain reaches at least≥ 70 (Hake, 1999; Hussin and Hamdan, 2016). In the context of training management effectiveness, a training program is considered adequate when the results of the training implementation are in accordance with its objectives (Pratomo and Shofwan, 2022; Blanchard and Thacker, 2023). This study's improvement of teachers' pedagogical Competence strongly supports (Avalos, 2011; Choi and Kang, 2019). The theory states that implementing training programs is integral to school human resource management.

This study is also supported by research from (Zhang, 2023). This article evaluates the digital literacy of English as a Foreign Language (EFL) teachers and examines the differences in digital literacy based on factors such as gender, education level, and teaching experience. The findings indicate that contextual factors play a significant role in the development of teachers' digital literacy, which in turn affects their teaching effectiveness. The findings of (Temirkhanova, Abildinova and Karaca, 2024) further support this study. Their research explores the development and impact of digital literacy skills among teachers at Astana International School, Kazakhstan, and how these skills influence the teaching of Computer Science and Design to high school students. The results show that teachers trained in digital literacy can create a more interactive and engaging learning environment, enhancing students' technical skills and creative capacity. Additionally, research by (Dewanto *et al.*, 2024) investigates the influence of digital literacy, innovative attitudes, and interpersonal communication on teachers' performance. The findings suggest that digital literacy and innovative attitudes directly affect teachers' performance, highlighting the importance of digital literacy training in improving teaching effectiveness. Research results from (Sudarti *et al.*, 2022) showed that the average pretest score was 46.27, while the average posttest score increased to 88.91. These findings indicate that digital literacy training has improved teacher competence. The availability of adequate facilities and infrastructure and support from each educational institution supports the success of this training. In line with the research results above(Marnita, Nurdin and Prihatin, 2023), research shows that teachers' digital Competence plays an important role in increasing the effectiveness and efficiency of learning management. The digital literacy skills teachers possess can build student enthusiasm and create harmonious interactions between teachers and students in the classroom. This significantly impacts thematic learning, especially in science subjects, which are often considered more challenging for students. Research from(Záhorec, Hašková and Munk, 2019)This study evaluates the importance of utilizing digital media and various interactive educational activities in the teaching process to improve educational efficiency. The significance of using this technology is analyzed from various aspects of the learning process. The evaluation is carried out by reviewing certain aspects of the teaching process based on the contribution of digital media, which are obtained through collecting opinions from teachers. This analysis also considers the segmentation factor of educators' subcategories and the length of their teaching experience.

Online Learning Teacher: Participants take part in training to improve their pedagogical Competence without having to leave their place of duty and with a training implementation time that is not long if classically carried out for 8 hours in a day, but if with online training, it is carried out for 1 hour 45 minutes online/synchronously, and for asynchronous it is carried out with time given freedom to training participants to study the material that has been given first. Then, after completing the online training, there is a follow-up to the participants' training results, and they are asked to apply the training results in kindergarten learning. In this Teaching Practice Teacher activity, training participants use the products they produce during the training, namely Learning Videos, to be used during learning together with their students. 2) Places that have never been studied before, namely, the research was carried out in kindergarten schools where research on the development of kindergarten teacher competence in compiling and using learning videos has never been studied before.

5. Conclusion

The positive response given by participants to the effectiveness of the Digital Literacy Training Management Model and to the evaluation of the implementation of the digital literacy training program, namely the average score for the training model assessment of 94 and the average score for the training evaluation obtained a score of 93 with an outstanding category. The pedagogical Competence of training participants in compiling and using learning videos that have increased can be reviewed from: First: the N-Gain acquisition of participants at the end of 76.64% in the practical category and the Asymp. The sig value (2-tailed) is 0.000, and the Z value is 7.07. It can be interpreted as a result of digital literacy training participants increasing their pedagogical competence in compiling and using digital learning media in kindergarten.

Implications: The Digital Literacy Training Management Model can improve the pedagogical Competence of kindergarten teachers and can be used as an alternative choice of training that is carried out online so that it dramatically helps kindergarten teachers improve their Competence without having to leave their jobs as teachers. Suggestion: To train managers and resource persons who are trying to improve teachers' abilities in using the Canva application to create learning videos in order to present enjoyable learning in kindergartens according to the material that the teacher has prepared in the learning design, the digital literacy training model to improve the pedagogical Competence of kindergarten teachers can be used as an answer to this problem.

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Conflicts of Interest

The authors have declared that no Conflicts of Interest

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Author contributions

DM: Conceptualized the study, designed the research methodology, and coordinated the overall research process. AS: Collected and analyzed the data, and contributed to the results and discussion sections. DW: Conducted the literature review, edited and revised the manuscript, and handled the journal submission process.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study

References

1. Alenezi, M. (2023) 'Digital learning and digital institution in higher education', *Education Sciences*, 13(1), p. 88. Available at: https://doi.org/10.3390/educsci13010088.
2. Aman, N.A. and Saragi, D. (2020) 'The Influence of Children Playing Method and Self-Concept of Social Ability in Children Aged 5-6 Years in TK An-Nisa Medan', in *The 5th Annual International Seminar on Transformative Education and Educational Leadership (AISTEEL 2020)*. Atlantis Press, pp. 9–15. Available at: https://doi.org/10.2991/assehr.k.201124.003.
3. Armita, P., Hajazi, M.Z. and Zaitun, Z. (2024) 'Methods of Memorizing the Qur'an for Early Childhood: Analysis of Direct Method, Affection, and Repetition as Parents' Strategies', *AlBanna: Jurnal Pendidikan Islam Anak Usia Dini*, 4(1), pp. 13–30. Available at: https://doi.org/10.24260/albanna.v4i1.1919.
4. Avalos, B. (2011) 'Teacher professional development in teaching and teacher education over ten years', *Teaching and teacher education*, 27(1), pp. 10–20. Available at: https://doi.org/10.1016/j.tate.2010.08.007.

5. Bergmann, J. and Sams, A. (2014) *Flipped learning: Gateway to student engagement*. International Society for Technology in Education.
6. Blanchard, P.N. and Thacker, J.W. (2023) *Effective training: Systems, strategies, and practices*. SAGE Publications.
7. Bulut, D., Samur, Y. and Cömert, Z. (2022) 'The effect of educational game design process on students' creativity', *Smart Learning Environments*, 9(1), p. 8. Available at: https://doi.org/10.1186/s40561-022-00188-9.
8. Celis-Morales, C.A. *et al.* (2012) 'Objective vs. self-reported physical activity and sedentary time: effects of measurement method on relationships with risk biomarkers', *PloS one*, 7(5), p. e36345. Available at: https://doi.org/10.1371/journal.pone.0036345.
9. Choi, J. and Kang, W. (2019) 'Sustainability of cooperative professional development: Focused on teachers' efficacy', *Sustainability*, 11(3), p. 585. Available at: https://doi.org/10.3390/su11030585.
10. Dewanto, W. *et al.* (2024) 'The effect of digital literacy, innovative attitudes, and interpersonal communication on teacher performance', *IJORER: International Journal of Recent Educational Research*, 5(2), pp. 477–489. Available at: https://doi.org/0.46245/ijorer.v5i2.583.
11. Diputra, K.S., Tristiantari, N.K.D. and Jayanta, I.N.L. (2020) 'Gerakan literasi digital bagi guru-guru sekolah dasar', *JCES (Journal of Character Education Society)*, 3(1), pp. 118–128. Available at: https://doi.org/10.31764/jces.v3i1.1483.
12. Gagne, R.M. (1970) *The conditions of learning*. Holt, Rinehart and Winston,.
13. Galindo-Domínguez, H. and Bezanilla, M.J. (2021) 'Digital competence in the training of pre-service teachers: Perceptions of students in the degrees of early childhood education and primary education', *Journal of Digital Learning in Teacher Education*, 37(4), pp. 262–278. Available at: https://doi.org/10.1080/21532974.2021.1934757.
14. Gjelaj, M. *et al.* (2020) 'Digital Technologies in Early Childhood: Attitudes and Practices of Parents and Teachers in Kosovo.', *International Journal of Instruction*, 13(1), pp. 165–184. Available at: https://doi.org/10.29333/iji.2020.13111a.
15. Goad, T.W. (1982) *Delivering effective training*. University Associates.
16. Hake, R.R. (1999) 'Analyzing change/gain scores'.
17. Harmi, H. *et al.* (2022) 'Analysis of multicultural understanding and moderation of religion of PAUD teachers in Bengkulu province', *Pegem Journal of education and instruction*, 12(4), pp. 128–136. Available at: https://doi.org/10.47750/pegegog.12.04.13.
18. Hermawan, D., Darmawan, C. and Bestari, P. (2024) 'Transforming Citizenship Education in the Digital Era: Challenges and Opportunities for the Indonesian Millennial Generation', *Unnes Political Science Journal*, 8(1), pp. 39–43. Available at: https://doi.org/10.15294/upsj.v8i1.9256.
19. Hew, K.F. and Lo, C.K. (2018) 'Flipped classroom improves student learning in health professions education: a meta-analysis', *BMC medical education*, 18, pp. 1–12. Available at: https://doi.org/10.1186/s12909-018-1144-z.
20. Hsin, C.-T., Li, M.-C. and Tsai, C.-C. (2014) 'The influence of young children's use of technology on their learning: A review', *Journal of Educational Technology & Society*, 17(4), pp. 85–99.
21. Hussin, M.K.A. Bin and Hamdan, A.R. Bin (2016) 'Effect of Knowledge, Readiness and Teaching Technique in Inclusive Practices Among Mainstream Teachers in Malaysia.', *International Journal of early childhood special education*, 8(1). Available at: https://doi.org/10.20489/intjecse.239573.
22. Hutagalung, B. and Purbani, W. (2021) 'The ability of digital literacy for elementary school teachers', *JPI (Jurnal Pendidikan Indonesia)*, 10(4), pp. 710–721. Available at: https://doi.org/10.23887/jpi-undiksha.v10i4.32938.
23. Karakose, T., Polat, H. and Papadakis, S. (2021) 'Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID-19 pandemic', *Sustainability*, 13(23), p. 13448. Available at: https://doi.org/10.3390/su132313448.
24. Kebudayaan, K.P.D. and INDONESIA, R. (2018) 'Seni Budaya'. Jakarta: Kementerian Pendidikan dan Kebudayaan.
25. Khahro, S.H. and Javed, Y. (2022) 'Key challenges in 21st century learning: a way forward towards sustainable higher educational institutions', *Sustainability*, 14(23), p. 16080. Available at: https://doi.org/10.3390/su142316080.
26. Kim, T.K. and Park, J.H. (2019) 'More about the basic assumptions of t-test: normality and sample size', *Korean journal of anesthesiology*, 72(4), pp. 331–335. Available at: https://doi.org/10.4097/kja.d.18.00292.
27. King, R. *et al.* (2021) 'Factors that optimise the impact of continuing professional development in nursing: A rapid evidence review', *Nurse education today*, 98, p. 104652. Available at: https://doi.org/10.1016/j.nedt.2020.104652.
28. Kirkpatrick, D.L. (1998) 'The four levels of evaluation', *Evaluating corporate training: Models and issues*, pp. 95–112.

29. Küsel, J., Martin, F. and Markic, S. (2020) 'University students' readiness for using digital media and online learning—Comparison between Germany and the USA', *Education sciences*, 10(11), p. 313. Available at: https://doi.org/10.3390/educsci10110313.
30. Li, B., Yang, F. and Wang, Q. (2023) 'Policies, strategies, and the evolutionary logic of large-scale teacher training in China', *ECNU Review of Education*, 6(3), pp. 451–468. Available at: https://doi.org/10.1177/20965311231167195.
31. Li, Y. (2024) 'Nurturing Tomorrow's Minds: The Impact of Family Education on Holistic Child Development', *Communications in Humanities Research*, 32, pp. 190–195. Available at: https://doi.org/10.54254/2753-7064/32/20240074.
32. Lin, M.-H., Chen, H.-C. and Liu, K.-S. (2017) 'A study of the effects of digital learning on learning motivation and learning outcome', *Eurasia journal of mathematics, science and technology education*, 13(7), pp. 3553–3564. Available at: https://doi.org/10.12973/eurasia.2017.00744a.
33. Madsen, S.S. *et al.* (2023) 'International perspectives on the dynamics of pre-service early childhood teachers' digital competences', *Education Sciences*, 13(7), p. 633. Available at: https://doi.org/10.3390/educsci13070633.
34. Manfei, X.U. *et al.* (2017) 'The differences and similarities between two-sample t-test and paired t-test', *Shanghai archives of psychiatry*, 29(3), p. 184. Available at: https://doi.org/10.11919/j.issn.1002-0829.217070.
35. Marnita, M., Nurdin, D. and Prihatin, E. (2023) 'The effectiveness of elementary teacher digital literacy competence on teacher learning management', *Journal of Innovation in Educational and Cultural Research*, 4(1), pp. 35–43. Available at: https://doi.org/10.46843/jiecr.v4i1.444.
36. Mattar, J., Santos, C.C. and Cuque, L.M. (2022) 'Analysis and comparison of international digital competence frameworks for education', *Education Sciences*, 12(12), p. 932. Available at: https://doi.org/10.3390/educsci12120932.
37. McClelland, D.C. (1998) 'Identifying competencies with behavioral-event interviews', *Psychological science*, 9(5), pp. 331–339.
38. Muharmi, T. (2022) 'Constraints of Virtually Using Digital-Based Learning Media for Early Childhood Education Teachers', *International Journal Reglement & Society (IJRS)*, 3(2), pp. 154–158. Available at: https://doi.org/10.55357/ijrs.v3i2.233.
39. Nadler, L. (1982) 'Designing Training Programs The Critical Model'. Philipina: Addison-Wesley Publihing Company.
40. Novella-García, C. and Cloquell-Lozano, A. (2021) 'The ethical dimension of digital competence in teacher training', *Education and Information Technologies*, 26(3), pp. 3529–3541. Available at: https://doi.org/10.1007/s10639-021-10436-z.
41. Nurhayati, S. *et al.* (2024) 'Analysis of the implementation of training on digital-based learning media to enhance teachers' digital literacy', *AL-ISHLAH: Jurnal Pendidikan*, 16(1), pp. 545–557. Available at: https://doi.org/10.35445/alishlah.v16i1.4029.
42. Permendikbud, R.I. (2014) 'Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 137 Tahun 2014 Tentang Standar Nasional Pendidikan Anak Usia Dini', *Jakarta: Mendiknas*, 72.
43. Pratolo, B.W. and Solikhati, H.A. (2021) 'Investigating teachers' attitude toward digital literacy in EFL classroom', *Journal of Education and Learning (EduLearn)*, 15(1), pp. 97–103. Available at: https://doi.org/10.11591/edulearn.v15i1.15747.
44. Pratomo, R.Y. and Shofwan, I. (2022) 'Implementation of education and training program evaluation', *Edukasi*, 16(2), pp. 63–77. Available at: https://doi.org/10.15294/edukasi.v16i2.39863.
45. Rahmatullah, B. *et al.* (2021) 'Overview of early childhood care and education in Malaysia', *Hungarian Educational Research Journal*, 11(4), pp. 396–412. Available at: https://doi.org/10.1556/063.2021.00074.
46. Redecker, C. and Punie, Y. (2017) 'Digital competence of educators', *Edited by Yves Punie* [Preprint].
47. Romero-Tena, R. *et al.* (2020) 'The challenge of initial training for early childhood teachers. A cross sectional study of their digital competences', *Sustainability*, 12(11), p. 4782. Available at: https://doi.org/10.3390/su12114782.
48. Rotellar, C. and Cain, J. (2016) 'Research, perspectives, and recommendations on implementing the flipped classroom', *American journal of pharmaceutical education*, 80(2), p. 34. Available at: https://doi.org/10.5688/ajpe80234.
49. Sanusi, I.T., Oyelere, S.S. and Omidiora, J.O. (2022) 'Exploring teachers' preconceptions of teaching machine learning in high school: A preliminary insight from Africa', *Computers and Education Open*, 3, p. 100072. Available at: https://doi.org/10.1016/j.caeo.2021.100072.
50. Spencer, L.M. and Spencer, P.S.M. (2008) *Competence at Work models for superior performance*. John Wiley & Sons.
51. Stewart, C.P. *et al.* (2013) 'Contextualising complementary feeding in a broader framework for stunting prevention', *Maternal & child nutrition*, 9, pp. 27–45. Available at: https://doi.org/10.1111/mcn.12088.
52. Sudarti, S. *et al.* (2022) 'Effectiveness of digital literacy training to improve early childhood education teacher's competence', *European Online Journal of Natural and Social Sciences*, 11(3), p. pp-553.

53. Temirkhanova, M., Abildinova, G. and Karaca, C. (2024) 'Enhancing digital literacy skills among teachers for effective integration of computer science and design education: a case study at Astana International School, Kazakhstan', in *Frontiers in Education*. Frontiers Media SA, p. 1408512. Available at: https://doi.org/10.3389/feduc.2024.1408512.
54. Valverde-Berrocoso, J. *et al.* (2021) 'The educational integration of digital technologies preCovid-19: Lessons for teacher education', *PloS one*, 16(8), p. e0256283. Available at: https://doi.org/10.1371/journal.pone.0256283.
55. Wiwin, D. and Widiati, U. (2022) 'Digital Media and Its Implication in Promoting Students' Autonomous Learning.', *Journal of English Teaching*, 8(1), pp. 97–106. Available at: https://doi.org/10.33541/jet.v8i1.3284.
56. Xiong, Z., Liu, Q. and Huang, X. (2022) 'The influence of digital educational games on preschool Children's creative thinking', *Computers & Education*, 189, p. 104578. Available at: https://doi.org/10.1016/j.compedu.2022.104578.
57. Záhorec, J., Hašková, A. and Munk, M. (2019) 'Teachers' Professional Digital Literacy Skills and Their Upgrade.', *European Journal of Contemporary Education*, 8(2), pp. 378–393. Available at: https://doi.org/10.13187/ejced.2019.2.378.
58. Zhang, J. (2023) 'EFL teachers' digital literacy: the role of contextual factors in their literacy development', *Frontiers in psychology*, 14, p. 1153339. Available at: https://doi.org/10.3389/fpsyg.2023.1153339.