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Development of a Productive, Digital Literacy-Based Project-Based Learning Model to Enhance Community Competencies

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ABSTRACT

Digital transformation has reshaped community learning, requiring learning models that integrate digital literacy with meaningful productive activities. This study aims to develop a Productive Project-Based Learning model grounded in digital literacy to strengthen community competence. The study was based on the principles of Project-Based Learning, experiential learning, and digital literacy, emphasizing authentic projects, active participation, collaboration, and the application of digital skills to real-world needs. A Research and Development approach using the ADDIE framework was employed, encompassing analysis, design, development, implementation, and evaluation. The study involved community learners, facilitators, and relevant experts in the model validation and implementation processes. Findings indicated that the developed model demonstrated strong validity, practicality, and effectiveness. Its implementation enhanced participants' ability to identify problems, plan and execute productive projects, utilize digital technologies, collaborate, and evaluate project outcomes. The study concludes that Productive Project-Based Learning integrated with digital literacy provides a contextual and participatory learning framework for strengthening community competence and supporting sustainable learning practices within community education settings.

Article Information

Kata Kunci:
Pembelajaran Berbasis Proyek; Literasi Digital; Pendidikan Masyarakat; Pendidikan Nonformal; Kompetensi Masyarakat

ABSTRAK

Transformasi digital telah mengubah wajah pembelajaran masyarakat, sehingga menuntut adanya model pembelajaran yang mengintegrasikan literasi digital dengan kegiatan produktif yang bermakna. Penelitian ini bertujuan untuk mengembangkan model Pembelajaran Berbasis Proyek yang Produktif (*Productive Project-Based Learning*) yang berlandaskan literasi digital guna memperkuat kompetensi masyarakat. Penelitian ini didasarkan pada prinsip-prinsip Pembelajaran Berbasis Proyek, pembelajaran berbasis pengalaman (*experiential learning*), dan literasi digital, dengan menekankan pada proyek autentik, partisipasi aktif, kolaborasi, serta penerapan keterampilan digital untuk menjawab kebutuhan dunia nyata. Pendekatan Penelitian dan Pengembangan (*Research and Development*) dengan kerangka kerja ADDIE yang mencakup tahap analisis, desain, pengembangan, implementasi, dan evaluasi, digunakan dalam penelitian ini. Proses validasi dan implementasi model melibatkan peserta didik dari kalangan masyarakat, fasilitator, dan para ahli terkait. Hasil penelitian menunjukkan bahwa model yang dikembangkan memiliki tingkat validitas, kepraktisan, dan efektivitas yang tinggi. Implementasi model ini terbukti meningkatkan kemampuan peserta dalam mengidentifikasi masalah, merencanakan dan melaksanakan proyek produktif, memanfaatkan teknologi digital, berkolaborasi, serta mengevaluasi hasil proyek. Penelitian ini menyimpulkan bahwa Pembelajaran Berbasis Proyek yang Produktif dan terintegrasi dengan literasi digital menyediakan kerangka kerja pembelajaran yang kontekstual dan partisipatif untuk memperkuat kompetensi masyarakat serta mendukung praktik pembelajaran berkelanjutan dalam lingkup pendidikan masyarakat..

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1. Introduction

Digital transformation has changed the characteristics of community learning from a pattern that was originally centered on the delivery of knowledge to a learning process that demands the ability to access, evaluate, produce, and utilize information critically and productively.[1]This change makes digital literacy one of the fundamental competencies in lifelong education.[2]Digital literacy can no longer be understood as simply the ability to operate devices or use applications, but includes the ability to search for and manage information, communicate and collaborate through technology, create digital content, maintain digital security, and utilize technology to solve life's problems.[3]The Digital Competence Framework for Citizens (DigComp 2.2) positions these five areas as the main components of citizens' digital competence and emphasizes the integration of knowledge, skills, and attitudes in the critical, confident, and safe use of technology (Vuorikari et al., 2022).[4].

From a Community Education perspective, these needs have significant pedagogical consequences. Community education is oriented toward providing learning opportunities relevant to citizens' needs, life contexts, local potential, and social change.[5]PKBM, as a non-formal educational institution, not only functions to provide access to equivalency education, but also serves as a learning space that enables the community to develop life skills, productive skills, social abilities, and adaptive capacity to environmental changes.[6]. Studies on the management of PKBM in Indonesia show that the existence of PKBM is closely related to the principles of lifelong education, community-based education, and program management based on community needs.[7]. Thus, learning in PKBM ideally does not stop at academic achievement, but is able to connect the learning process to real-world problems and community capacity development.

This issue becomes increasingly relevant in the context of Cimahi City and West Bandung Regency. Research by Takariani et al. (2023)[8]A study on digital literacy in West Bandung Regency shows that the community's digital literacy level still faces inequality. The study found a relationship between education level and type of employment with the community's digital literacy. These findings indicate that access to technology does not automatically result in adequate digital competence. Differences in educational background, employment, and social characteristics of the community are factors that need to be considered when designing digital education interventions. This condition is important for PKBM because students in non-formal education have heterogeneous characteristics in terms of age, learning experience, employment, motivation, and experience using technology.[7].

The context of West Bandung Regency also shows that technology-based learning in PKBM has begun to develop, but there is still room to expand its orientation. Research by Nurhadi et al. (2023) at PKBM Ash-Shoddiq, Lembang, showed that digital technology-based financial literacy training was implemented through planning, outreach, needs identification, andragogical and participatory strategies, and the use of Microsoft Excel.[9]The program improved students' understanding and knowledge of financial literacy. The findings demonstrate that a digital approach to community education has been beneficial and demonstrate the importance of learning design that connects digital skills to students' practical needs.

On the other hand, the development of learning at the Cimahi City Community Learning Center (PKBM) demonstrates the need for program management that is responsive to the conditions and needs of residents. Komar et al. (2022) demonstrate the importance of managing needs-based PKBM manager training, particularly through the stages of needs analysis, planning, implementation, and evaluation.[10]This indicates that strengthening the quality of PKBM learning requires a systematic and contextual approach. Learning designed uniformly without considering the needs of the learners has the potential to result in less relevant learning experiences.[11]Therefore, learning models in community education need to provide space for learners to identify problems, determine needs, make decisions, collaborate, and generate solutions that can be used in real life.

These needs can theoretically be answered through Project-Based Learning (PjBL). PjBL is a learning approach that organizes the learning process through authentic projects that enable participants to investigate problems, build knowledge, use technology, work collaboratively, and produce artifacts or products. Krajcik and Shin (2014) identified important characteristics of PjBL, including prompting questions, learning objectives, investigative practices, collaboration, use of technology, and artifact creation.[12]Markula and Aksela's (2022) study shows that authentic projects are generally characterized by problem-centeredness, collaboration, technology use, artifact creation, presentation of results, and reflection. Thus, PjBL conceptually aligns with the characteristics of Community Education because the learning process can be built on the real problems and experiences of citizens.[13].

The relevance of Project-Based Learning (PjBL) is further strengthened when learning is directed toward the development of productive digital literacy. Technology in Project-Based Learning (PjBL) is not merely a tool for delivering material, but also an instrument for seeking information, conducting investigations, communicating, collaborating, producing content, and creating products. Zhang et al.'s (2024) meta-analysis of 31 experimental and quasi-experimental studies shows that Project-Based Learning (PjBL) positively contributes to computational thinking skills, primarily because project-based learning enables participants to confront authentic problems and develop problem-solving strategies.[14]The study strengthens the argument that PjBL has the potential to be developed as a learning approach that connects digital skills with thinking processes and real-world problem solving.

In Indonesian non-formal education, this relevance is beginning to gain empirical support. Sari et al. (2024), for example, developed a TPACK-Based Team-Based Project Learning design to improve digital literacy in equivalency education and community education.[15]The study shows that a project-based learning approach can be used to integrate technology, pedagogy, and the learning needs of learners. More specifically, Firdaus et al.'s (2026) research on the Project-Based Learning Model in Productive Digital Literacy Training at PKBM shows that learners' productive digital literacy skills are initially low, particularly in content evaluation, knowledge construction, and digital content creation.[16]The developed PjBL model achieved a high level of feasibility, demonstrated good syntax implementation, received positive responses from students and tutors, and resulted in increased digital literacy skills.

These findings also demonstrate that research on PjBL and digital literacy in community education has moved from the conceptual stage to model development. Therefore, this research

gap should not be attributed to the claim that there is no digital literacy-based PjBL model in PKBM. Instead, the research gap lies in the need to clarify and strengthen the productive dimension of PjBL, namely how the digital learning process is systematically directed from identifying needs and problems, project planning, utilizing digital resources, creating products, implementing them, to reflecting on and evaluating the product's usefulness for community members' lives. This gap is crucial because consumptive digital literacy, such as simply searching for information or using applications, does not fully reflect the community's ability to use technology as a means of producing work, solving problems, and increasing productive capacity.

Based on these arguments, this study develops a Productive Project-Based Learning Model Based on Digital Literacy in the context of community education. This model positions learners as learning subjects who actively identify problems and opportunities, design projects based on needs, utilize digital technology in the production process, produce useful products or artifacts, and evaluate and reflect on project results. With this construction, digital literacy is not positioned as a stand-alone competency, but as a capacity integrated with the process of experiential learning and problem-solving.

The novelty of this research lies in the reconstruction of PjBL into a productive orientation that explicitly integrates digital literacy competencies with the needs, experiences, and life contexts of PKBM learners. The model not only directs learners to complete project tasks, but also connects digital activities with product creation, competency strengthening, collaboration, problem-solving, and social benefits. This position contributes to the development of Community Education science because it expands the application of PjBL from the formal educational context to non-formal educational ecosystems that have different participant characteristics, goals, and needs.

Practically, the developed model can serve as a pedagogical alternative for PKBM managers and tutors in designing contextual, participatory, and responsive learning to digital transformation. Theoretically, this research enriches the discourse on Community Education by bringing together the perspectives of lifelong education, experiential learning, digital literacy, and project-based learning within a single productive learning framework. Thus, learning success is measured not only by increased knowledge acquisition but also by the learners' ability to use technology to produce work, solve problems, build collaborations, and develop productive capacities relevant to community life.

2. Method

This study used a Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. The R&D approach was chosen because the research objective was not only to identify community learning problems but also to produce a learning model that could be validated and implemented in the context of PKBM. The selection of ADDIE is relevant because this model provides a systematic and cyclical procedure for analyzing needs, designing learning solutions, developing products, implementing them, and evaluating them. Methodological studies have shown that ADDIE has a flexible structure for developing learning interventions, including in technology-based learning environments (Saeidnia et al., 2022).[17]. Educational development research that applies ADDIE also shows that these stages can be used to integrate expert validation, user trials, and evaluation of development outcomes.

The research was conducted from March to May 2026 at the Bina Mandiri Cipageran Community Learning Center (PKBM), Cimahi City, and the Bina Swakarya Batujajar Community Learning Center (PKBM), West Bandung Regency. The research involved 35 respondents, consisting of 30 learners and 5 tutors, while two experts served as instrument validators. Respondents were selected purposively, considering their involvement in the PKBM learning program and their willingness to participate in the entire research process. Learners were the primary subjects of the model implementation, while tutors served as facilitators and informants regarding the learning process. The use of diverse data sources was deemed relevant because complex educational research requires the selection of methods based on the research objectives and the characteristics of the phenomena being studied (Foster, 2023).[18].

The analysis phase was conducted through observation, interviews, and document review to identify learning needs, student characteristics, technology use experiences, and problems in productive learning. The design phase resulted in a draft of a Digital Literacy-Based Productive Project-Based Learning Model with six syntaxes, namely identification of problems and opportunities, project planning, exploration and development of ideas, digital-based production, presentation and product utilization, and reflection and evaluation. The development phase resulted in a prototype model and research tools which were then validated by two validators. The implementation phase was carried out through a learning media creation project using recycled materials from household waste. The evaluation phase was used to assess the feasibility, practicality, and effectiveness of the model.

The research instruments included interview guidelines, model implementation observation sheets, digital literacy competency instruments, student and tutor response questionnaires, and a product assessment rubric. The digital literacy instruments were developed based on five DigComp 2.2 competency areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Vuorikari et al., 2022).[4]Expert validation is used to ensure the suitability of the content, clarity of indicators, readability, and relevance of the instrument to the characteristics of the learners. The content validation approach through expert assessment is an important procedure in development research to ensure that the instrument represents the construct it is intended to measure (Setiawan et al., 2024).[19]. The validation results show that the instrument is suitable for use after considering the validator's input.

Data analysis was conducted quantitatively and qualitatively in a complementary manner. Qualitative data from observations, interviews, and documentation were analyzed through data reduction, categorization, presentation, interpretation, and drawing conclusions. Quantitative data from validation, questionnaires, competency tests, and product assessments were analyzed using descriptive statistics to determine the level of feasibility, practicality, and quality of the product. Changes in learner competencies were analyzed by comparing pretest and posttest scores. Because the number of respondents was relatively limited and data characteristics need to be considered before determining statistical tests, the Wilcoxon Signed-Rank Test was used when parametric assumptions were not met to examine changes in scores before and after implementation. Interpretation of effectiveness was strengthened by measurement of change and analysis of product quality.

The validity of the findings was strengthened through triangulation of sources and techniques, by comparing information from students and tutors and integrating the results of observations, interviews, questionnaires, competency measurements, product assessments, and documentation. Triangulation enabled researchers to gain a more comprehensive understanding and increased confidence in the findings compared to using a single source or data collection technique.[20]. Thus, the combination of quantitative and qualitative data is used not only to increase the amount of data, but to explain the relationship between the model implementation process, the experiences of the learners, and the resulting changes in competency.

3. Results

Initial Condition Analysis Results

The research was conducted at two community learning centers (PKBM): PKBM Bina Mandiri Cipageran in Cimahi City and PKBM Bina Swakarya Batujajar in West Bandung Regency. Thirty students were involved as the primary subjects in the implementation of the Productive Digital Literacy-Based Project-Based Learning (PjBL) model. The learning focused on creating learning media using recycled materials from household waste.

Initial analysis results indicate that learners' abilities before implementing the model were still relatively limited. Based on initial measurements of 20 instrument items, pretest scores ranged from 35 to 60. This indicates variation in learners' initial abilities in understanding and applying competencies related to digital literacy. Individual data for R01–R30 shows that no participants had initial scores above 60.

Table 1. Descriptive Statistics of Student Competencies

Indicator	Pretest	Posttest	Change
N	30	30	30
Minimum score	35	70	35
Maximum score	60	90	30
Mean	47.50	81.50	34.00
Median	47.50	82.50	35.00
Relative increase	–	–	71.58%

Source: Research data, processed 2026.

Table 1 shows an increase in competency achievement after the model's implementation. The average score increased from 47.50 in the pretest to 81.50 in the posttest, representing an absolute increase of 34.00 points. Relatively speaking, this increase represents approximately 71.58% of the initial score. The median also increased from 47.50 to 82.50.

Changes were seen across the entire range of participants' abilities. The minimum score increased from 35 to 70, while the maximum score increased from 60 to 90. Thus, improvements occurred not only among participants with relatively high initial abilities, but also among those with lower initial abilities. Individual data showed that all R01–R30 groups achieved higher posttest scores than their pretest scores.

Competency Improvement Level Based on N-Gain

N-Gain analysis was used to assess the level of competency improvement by considering the available room for improvement based on each student's initial score. The calculation results showed an average N-Gain of 0.652, while the median N-Gain was 0.667.

Table 2.N-Gain Distribution of Student Competence

Category	N-Gain Range	Frequency	Percentage
Low	< 0.30	0	0.00%
Currently	0.30–<0.70	22	73.33%
Tall	≥ 0.70	8	26.67%
Total		30	100%

Source: Research data, processed 2026

The results in Table 2 show that the majority of students, 22 (73.33%), were in the moderate improvement category, while 8 (26.67%) were in the high improvement category. No students were in the low improvement category.

The average N-Gain value of 0.652 indicates that overall competency improvement is in the moderate category and approaching the high category. This finding demonstrates that model implementation provides substantial improvement compared to baseline. Individual data also shows that participants' N-Gain values range from approximately 0.54 to 0.80.

Results of the Pretest and Posttest Difference Test

To test changes in competence inferentially, the Wilcoxon Signed-Rank Test was used because the data came from paired measurements of the same subject and the sample size was relatively limited.

Table 3. Wilcoxon Signed-Rank Test Results

Parameter	Results
N	30
Positive Ranks	30
Negative Ranks	0
Ties	0
Wilcoxon W	0.00
Z (approximation)	-4.79
Asymp. Sig. (2-tailed)	< 0.001

Source: Research data, processed 2026

The analysis results showed that all 30 students experienced an increase in their scores, indicated by 30 positive ranks, without negative ranks or ties. The Wilcoxon value was W = 0.00 with a Z of around -4.79 and a significance value of $p < 0.001$. Thus, there was a significant difference between the competencies of students before and after participating in learning using the Digital Literacy-Based Productive PjBL Model.

These results reinforce the descriptive findings that model implementation not only resulted in an increase in average scores but also a consistent pattern of improvement across all learners. The 34.00-point difference between the pretest and posttest averages indicates that the change in achievement has significant practical significance in the context of the learning process.

Implementation of Project-Based Learning

The model was implemented through a project to create learning media using recycled materials from household waste. Learning activities followed the model's six stages: problem and opportunity identification, project planning, idea exploration and development, digital-based production, product presentation and utilization, and reflection and evaluation.

In the identification stage, learners are guided to identify

learning media needs and the potential of materials available in their local environment. The next stage involves guiding learners to develop a product design, determine materials, assign tasks, and identify necessary information. The information search process utilizes digital sources relevant to the design and function of the media to be created.

The production stage is a key part of the learning process, as students integrate the results of their research with recycled materials from household waste. This activity encourages students to explore, make decisions, solve technical problems, make modifications, and produce usable learning media.

Thus, digital technology is used not only to access information but also as part of the design process, idea development, documentation, communication, and problem-solving. This pattern demonstrates that learning has shifted the learner's position from being a recipient of information to an active participant in the process of producing knowledge and learning products.

Learning Product Results

The implementation of the model resulted in learning media made using recycled materials from household waste. These products represent an artifact that represents the integration of learning, creativity, local resource utilization, and digital skills.

The media creation process involves several activities, from selecting materials and searching for digital references, developing a design, creating the product, testing, refining, and presenting the results. Therefore, the product is positioned not only as the final learning outcome but also as an instrument that enables learners to apply competencies throughout the learning process.

These characteristics strengthen the productive dimension of the developed model. Productivity in this research does not solely refer to the ability to produce objects, but also encompasses the ability to transform information, experience, creativity, technology, and environmental resources into products with educational functions.

Instrument Validation Results

Prior to implementation, the research instrument was validated by two validators. Validation was conducted to ensure the suitability of the indicators, clarity of instructions, item relevance, readability, and the instrument's suitability to the characteristics of community education learners.

Validation results indicated that the instrument was suitable for use in the study. Input from the validators was used as a basis for refining the instrument before it was implemented with the participants. Therefore, the pretest and posttest data analyzed in the study were obtained using an instrument that had undergone expert validation.

Overall, the research results indicate that the Digital Literacy-Based Productive PjBL Model can be implemented in a community education context through a project to create learning media using recycled materials. Implementation of the model resulted in improved student competency, as evidenced by an increase in the average score from 47.50 to 81.50.

This improvement was reinforced by an average N-Gain value of 0.652, with 73.33% of students in the medium category and 26.67% in the high category. Furthermore, the Wilcoxon test showed $p < 0.001$, indicating a significant difference between achievement before and after model implementation.

The findings demonstrate that the model's primary strength lies in its integration of project-based learning, digital literacy, and productive activities based on environmental potential. Learners are given the opportunity to use digital technology in authentic processes, produce tangible products, work collaboratively, solve problems, and reflect on their learning experiences. Therefore, the research findings provide an empirical basis for the model developed to be a potential alternative for productive learning in strengthening community competencies in non-formal education settings.

4. Discussion

Competency Enhancement through the Integration of Project-Based Learning and Digital Literacy

The results of the study indicate that the implementation of the Productive Project-Based Learning (PjBL) Model Based on Digital Literacy provides substantial changes to the competency of learners. The average score increased from 47.50 in the pretest to 81.50 in the posttest, with an increase of 34.00 points. All 30 learners showed an increase in scores, while the Wilcoxon Signed-Rank Test results in a p-value <0.001. The average N-Gain value of 0.652 also indicates that the increase in competency is in the moderate category and approaching the high category. These findings indicate that the developed model has strong pedagogical potential to improve the competency of learners in the context of community education.

This improvement can be understood from the characteristics of PjBL, which positions students as active actors in solving authentic problems and producing specific artifacts or products. Zhang and Ma's (2023) meta-analysis, which included 66 experimental or quasi-experimental studies with 190 effect sizes, found that PjBL had a positive impact on learning outcomes compared to conventional learning. This influence was not only related to academic achievement but also to thinking skills and affective aspects. The findings of this study extend this argument because the improvement occurred in the context of non-formal education, when learning activities were linked to the practical needs of students and their daily lives.

The educational context of the community is a crucial factor in explaining these results. PKBM learners do not always learn through a homogeneous learning structure like those in formal education. Therefore, authentic projects allow learners' experiences, prior knowledge, practical needs, and social environment to be incorporated into the learning process. The project of creating learning media from household waste presents a concrete problem to be solved, while also producing a product that can be observed and utilized. Thus, the learning process does not stop at mastering concepts but moves toward applying knowledge in real-world situations.

These findings align more specifically with Santhosh et al.'s (2023) meta-analysis on informal project-based learning. Based on 26 studies involving 3,202 participants from eight countries, the study found a positive effect of informal project-based learning (PjBL) on learning gains with an effect size of $d = 0.248$. Interestingly, effectiveness was influenced by the teaching model, assessment method, group size, and learning duration. These results are relevant to this study because learning is carried out in a non-formal educational environment and places productive activities at the core of learning. This means that the success of PjBL in community education is not solely determined by the use of the label "project," but by how the project is

designed to be relevant to the context, carried out collaboratively, and produce meaningful learning experiences.

Digital Literacy as a Competency Built through Authentic Activities

Improving the competency of learners also needs to be understood through the position of digital literacy in the developed model. In this study, digital literacy is not treated as a stand-alone subject. Digital competence is integrated into the stages of information seeking, source evaluation, communication, collaboration, idea development, production, documentation, and problem solving. This approach is consistent with the DigComp 2.2 framework, which views digital competence as a combination of knowledge, skills, and attitudes that enable individuals to use technology confidently, critically, and safely. The framework covers five main areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem solving.

Research findings show that project activities provide a context that allows these five dimensions to emerge more naturally. When learners research learning media designs, for example, they not only engage in information-seeking activities but also need to determine the relevance of the information and select appropriate sources. When they discuss product designs, communication and collaboration competencies develop. When they develop designs and document the results, these activities intersect with digital content creation. Meanwhile, when obstacles arise during the production process, learners are required to use their problem-solving skills.

This interpretation is supported by research by Chaw (2024), who used DigComp 2.2 to examine the relationship between digital competency and learning performance. The study showed that information and data literacy, communication and collaboration, digital content creation, and problem-solving were significantly related to learning performance, while the safety dimension showed a different pattern. Therefore, the improvements found in this study can be understood not only as an increase in the ability to use digital devices, but also as a development in the ability to utilize technology to achieve learning goals and produce products.

This is important because digital literacy in education is often reduced to the operational ability to use devices. However, a systematic review by Claro et al. (2024) shows that research on digital competence in education still varies in the operationalization of the construct and that greater attention is often paid to the use of technology as a tool rather than the ability to use technology to develop students' activities and skills. The model developed in this study provides an alternative to this problem by positioning technology as part of the learning process, not merely as a learning tool.

Household Waste-Based Projects as a Productive Learning Context

One of the important contributions of this research lies in the project selection, which involved creating learning media from recycled household waste. This project selection provides a contextual and productive dimension that distinguishes it from PjBL implementations that are solely focused on completing academic tasks.

In this model, the surrounding environment serves as a learning resource. Household waste, previously viewed as unusable, is transformed into materials for producing learning media. This process creates a connection between learning, creativity, local resource utilization, and ecological awareness. Students not only gain experience in creating products but also learn to identify opportunities arising from environmental problems.

These characteristics reinforce the concept of productive PjBL developed in this research. Productiveness does not simply mean producing an object, but refers to the ability of learners to transform information, knowledge, experience, local materials, and technology into functional products. In the context of community education, these characteristics are crucial because learning success can be assessed not only by knowledge acquisition but also by learners' ability to apply that knowledge to produce something of value to their environment and lives.

These findings also relate to empirical evidence on PjBL in informal learning environments. Santhosh et al. (2023) showed that the effectiveness of informal PjBL is influenced by instructional design, assessment methods, group size, and learning duration. In this study, concrete projects, activity allocation, tutor support, and product evaluation processes were mechanisms that enabled learners to maintain engagement throughout the learning process.

Shifting Roles of Tutors and Learners

Improved learning outcomes can also be explained by changes in learning interaction patterns. In the developed model, tutors are not positioned as the sole source of knowledge, but rather as facilitators who help learners identify problems, develop designs, seek information, resolve obstacles, and reflect on project outcomes. Conversely, learners are given greater space to make decisions and take responsibility for the process and products they develop.

This pattern is an important characteristic of PjBL because the learning process occurs through investigation, decision-making, collaboration, and production. A recent meta-analysis by Zhang and Ma (2023) showed that the effectiveness of PjBL can be influenced by various moderators, including group size, learning duration, subject characteristics, and learning type. This suggests that PjBL is not a self-evident intervention; the quality of the learning design and implementation conditions also influence outcomes.

In the context of PKBM (Center for Community Service) learning, these findings have specific implications. Tutors need to have the capacity to provide scaffolding without taking over the problem-solving process for learners. Mentoring is especially necessary when participants encounter difficulties finding digital information, determining the validity of sources, using technology, or transforming ideas into products. Thus, tutors' digital competence is a key factor in the model's success.

The Relationship between Digital Literacy, PjBL, and Community Competence

Research findings demonstrate that the strength of the model lies not in PjBL or digital literacy in isolation, but rather in its integration of both within productive activities. PjBL provides a pedagogical structure consisting of problems, projects, collaboration, production, presentation, and reflection; while digital literacy provides the competencies that enable learners to access, process, create, communicate, and evaluate information in the process.

This relationship can be explained as a three-layered learning mechanism. First, contextual problems provide a reason for

students to learn. Second, projects provide a space for them to apply their knowledge through action. Third, digital literacy expands the resources available to complete the project. These three elements create a more authentic learning experience than learning that simply delivers material directly.

Recent literature increasingly positions digital literacy as a pedagogical capacity, rather than simply a technical skill. Systematic studies of digital literacy show that digital competencies provide greater benefits when integrated with instructional design, interaction, collaboration, and the development of critical thinking skills. Therefore, the improvement in scores in this study is theoretically more appropriately understood as a result of integrating digital activities with problem-solving and production processes, rather than as a result of technology use alone.

The Meaning of Wilcoxon and N-Gain Results on Model Effectiveness

The statistical results provide empirical support for competency changes. All 30 students achieved higher posttest scores than their pretest scores, with the Wilcoxon test showing $p < 0.001$. Statistically, these results indicate that the distribution of scores after implementation differed significantly from the pre-learning condition.

The average N-Gain value of 0.652 reinforces the interpretation that the changes were not simply small differences in scores. Twenty-two students were in the moderate improvement category, and eight were in the high improvement category. This finding suggests that the model provides relatively consistent benefits, although the level of improvement varies across individuals.

However, these results should be interpreted with caution. The study design used pretest–posttest measurements without a control group, so the score increases cannot be fully attributed causally to the model without considering external factors, such as learning experiences during the study period, interactions between participants, or exposure to other learning resources. Therefore, the term "effective" in this study is more appropriately interpreted as empirical evidence of increased competency after the model's implementation, rather than as causal evidence equivalent to a controlled experiment.

This careful approach actually strengthens the article's scientific argument. The research evidence is more convincing because it relies not only on statistical significance but also demonstrates an average improvement of 34 points, an N-Gain of 0.652, improvement across all participants, and the project's implementation, resulting in a tangible product.

Contribution to Public Education Science

This research's primary contribution to community education lies in developing a model that connects digital competencies with productive learning based on local contexts. Most PjBL research still focuses on formal education, specific subjects, or academic achievement. Meanwhile, research on informal PjBL shows that non-formal contexts have their own characteristics, and their effectiveness is influenced by learning design and implementation conditions. This research contributes by integrating PjBL into the context of PKBM and directing it toward the production of learning media based on local materials.

The second contribution is conceptual. This research broadens the meaning of digital literacy in public education from the ability to use technology to the ability to use technology to learn, solve problems, collaborate, and produce products. This definition aligns with DigComp 2.2, which places digital competency within a broader spectrum of capabilities than technical skills.

The third contribution is practical. The model provides an alternative for PKBM tutors to develop relatively inexpensive and contextual learning by utilizing locally available materials. Reliance on expensive digital devices and learning resources can be reduced by combining digital technology with local materials. This approach also allows environmental issues to be incorporated into the learning process without diminishing the primary focus on developing community competencies.

Overall, the research results indicate that the Digital Literacy-Based Productive PjBL Model has pedagogical mechanisms relevant for community education. The score increased from 47.50 to 81.50, the N-Gain was 0.652, and the Wilcoxon $p < 0.001$ result indicated an increase in competency after implementation. These findings are consistent with meta-analytic evidence showing a positive direction of PjBL on learning outcomes, including in informal learning environments.

However, the primary contribution of this research goes beyond simply demonstrating that PjBL can improve learning outcomes. The research's novelty lies in how PjBL, digital literacy, and environmental-based productivity are integrated within the context of PKBM. The project to create learning media from household waste utilizes the environment as a learning resource, digital technology as a means of investigation and production, and the product as concrete evidence of developing competencies.

Thus, the developed model offers the perspective that digital transformation in community education does not have to occur through the use of complex technology. This transformation can be built through learning designs that position learners as actors capable of seeking information, assessing sources, collaborating, creating, solving problems, and producing products relevant to community needs. This position makes the Digital Literacy-Based Productive PjBL Model potentially suitable for further development as a contextual, inclusive learning approach oriented toward strengthening community capacity.

5. Conclusion

This study concludes that the development and implementation of the Productive Project-Based Learning Model Based on Digital Literacy provides a relevant instructional alternative for strengthening community learners' competencies in non-formal education settings. Implemented through a contextual project involving the development of learning media from recycled household waste, the integrated digital literacy model with problem identification, project planning, information exploration, product development, presentation, and reflection. The empirical findings demonstrate a substantial improvement in learners' competencies, as reflected in the increase in the mean score from 47.50 in the pretest to 81.50 in the posttest. The mean normalized gain of 0.652 further indicated a moderate level of improvement, while the Wilcoxon Signed-Rank Test confirmed a statistically significant difference between pre- and post-intervention scores ($p < .001$). Importantly, all 30 learners demonstrated improved scores following implementation. These findings suggest that integrating project-based learning with digital literacy can create authentic learning experiences that

connect technology use, problem solving, collaboration, creativity, and productive activities. The model also demonstrates potential for strengthening community education by using locally available resources and environmental issues as learning contexts. Nevertheless, further research involving larger samples, control groups, and longitudinal evaluation is required to establish broader generalizability and more robust causal evidence regarding the model's effectiveness.

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