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Development of GEBI: "game edukasi berbasis IoTs" for fashion students at vocational senior high school

Yusrin Nasrillah[1*)], Evania Yavie[1], Nurul Aini[2], Thiessa Krisnanda[1], Yunita Asfia[1], Siti Ubaidiah[1]
[1] PPG Universitas Negeri Malang, Indonesia
[2] Sekolah Menengah Kejuruan Negeri 7 Malang, Indonesia

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ABSTRACT

Research sought create and authenticate educational game GEBI (Game Edukasi Berbasis IoTs) targeted numeracy literacy enhancement in Pattern Making for Grade 10 students at SMKN 7 Malang studying Fashion Design and Production as part Phase E of Merdeka Curriculum. The game development followed the ADDIE model with validation as primary focus. The educational game GEBI developed through Liveworksheet platform which includes features such as login access, level-based contextual questions, multiple-choice tasks, instant feedback and progress tracking. This approach used constructivist pedagogy to develop essential numeracy skills including unit conversion and measurement interpretation to enable effective problem-solving for basic pattern drafting. Validation included participation from 30 students alongside two educational media experts and two subject matter experts. Questionnaire with 4-points Likert scale evaluated visual design together with pedagogy, content accuracy, examined interactivity and usability. Researchers applied quantitative analysis through percentage-based feasibility measures which required scores of 61% or higher. The feasibility study revealed GEBI's high feasibility after achieving total score of 93% which included 88% from media experts and 98% subject matter experts. The brief academic calendar created a limited development time which presented a major challenge. This research advances digital learning innovations in vocational education and recommends further studies evaluating success.

Corresponding Author:

Yusrin Nasrillah,
PPG Universitas Negeri Malang
Email: yusrin.nasrillah.2431519@students.um.ac.id

Introduction

In Indonesia, 18% of students reached a minimum of Level 2 proficiency in mathematics, which is considerably lower than the OECD countries' average (OECD average: 69%). Hardly any students in Indonesia excelled in mathematics, signifying that they reached Level 5 or 6 on the PISA mathematics assessment (OECD average: 9%). These learners can understand extended texts, handle concepts that are abstract or counterintuitive, and differentiate between fact and opinion by using implicit signals related to the content or origin of the information (PISA, 2022). The low numeracy literacy skills among vocational high school (SMK) students present a concerning issue in the demands of the industry 5.0 era, largely due to students' lack of proficiency in accurately interpreting data (Aristawati, 2022). Moreover, Marinič and Pecina (2023) emphasize that vocational education needs to address the challenges presented by Industry 5.0, prioritizing the enhancement of professional

knowledge and skills with significant applicability in the practical production process. These research findings emphasize the importance of incorporating numeracy skills in vocational training to equip students for the changing requirements of the industry. Numeracy literacy serves as a crucial skill in vocational education, especially in the Pattern Making course within the Fashion Design and Production field, enhancing understanding of the subject and providing students with relevant abilities needed to fulfill the requirements of today's job. This skill also allows students to obtain, comprehend, and assess intricate information linked to pattern-making abilities, encompassing fundamental arithmetic functions like addition, subtraction, multiplication, and division. These abilities are vital because they not only enhance comprehension of the subject but also equip students to tackle the difficulties of today's job market (Hafid & Kamaludin, 2024). These skills are essential as they not only support understanding of the subject matter but also prepare students to face the challenges of the contemporary job market.

However, despite the clear importance of these skills, Vocational High School students often focus primarily on mastering technical abilities within their chosen fields, sometimes overlooking the crucial role of literacy in their overall development. They believe that upon graduation, they will quickly find employment and possess skills in their area of expertise or major they choose that they believe will be applicable in daily life. While Lamada et al. Puspaningtyas & Ulfa (2020) emphasize that literacy development is crucial to recognize, because literacy is a fundamental skill that every person must have to navigate life in the future. Nonetheless, the existing circumstances involve several issues that emerge in learning mathematics such as the disparity in numeracy abilities among various students (Suciyati et al., 2022). During the first teaching practicum (PPL 1) of the 2024 Pre-service Teacher Professional Education (PPG) program at SMKN 7 Malang, a diagnostic test was administered to 30 tenth-grade students in the Pattern Making course, part of the Fashion Design and Production program. The test included 10 questions assessing basic numeracy skills, such as performing arithmetic operations, understanding scales, and reading measuring tools. The results revealed that 75% of the students scored below the minimum mastery threshold (KKM 70). Most students struggled particularly with decimal calculations and interpreting measurements accurately. These findings highlight a significant gap in numeracy skills, which are foundational to mastering pattern-making concepts and essential for students' future readiness in vocational contexts. Numeracy literacy is a critical prerequisite competency in the pattern-making process, involving operations with whole numbers and decimals as well as skills in reading measurement tools.

Building on this urgency, the subject of patternmaking demands factual knowledge, practical application, and creativity from students to apply basic numeracy literacy skills, including arithmetic operations based on pattern formulas and precise measurement tool reading. According to the decree of the Education Standards, Curriculum, and Assessment Agency (BSKAP) Number 32 of 2024, learning outcomes include students' ability to perform body measurements, construct basic pattern techniques, and follow material-cutting procedures. In response to this challenge, the lack of numeracy literacy among students particularly in vocational contexts demands a pedagogical shift that addresses not only the content but also the method of instruction. One promising direction is the development of varied and technologically integrated learning media that can contextualize numeracy within real world vocational practices. Vocational High Schools, particularly those specializing in Fashion Design and Production, are an appropriate target for the integration of IoT technology knowledge (Ritonga, Wahyu & Purnomo, 2020) which can be implemented using wireless connectivity to support interactive learning. The creation of learning media combined with IoT in the Pattern Making subject is strongly suggested as an educational resource due to its provision of interactive, instantaneous feedback and data-informed insights absent in traditional media. In contrast to conventional approaches that depend on fixed demonstrations or printed materials, IoT-driven media can emulate real measurement processes, offer automated error detection, and adjust to student input in real time. This improves student involvement, encourages self-directed learning, and connects theoretical concepts with real-world use crucial components in vocational training (Purwandari, Astuti & Handhika, 2021). Such media are deemed capable of creating a more enjoyable, interactive, and meaningful learning environment, thereby enhancing conceptual understanding (Trujillo, Chamberlin, Wiburg & Armstrong, 2016 as cited in Legowo, 2022). Conventional Pattern Making instruction without technological support tends to create a monotonous learning atmosphere (Listyaningrum, 2020).

Students' preference for using gadgets technology, particularly gaming applications that actively engage them, has driven the emergence of educational game-based learning media aimed at attracting students and improving their numeracy literacy skills. This theory suggests that learners build knowledge actively through experiences and interactions, rendering game-based learning a powerful method to boost motivation, engagement, and conceptual comprehension. Recent research has shown the effectiveness of game-based learning in enhancing students' literacy and math skills. For example, Cahyana et al. (2023) discovered that augmented reality in mobile game-based learning significantly improved students' literacy and numeracy in chemistry and biology areas. In a similar vein, Syamsir Adam (2023) found that a game-centered learning

approach significantly enhanced the mathematical problem-solving skills of vocational high school students. These results highlight the promise of incorporating game-based learning methods to enhance critical abilities in educational environments.

Previous research has shown that the implementation of gamification led to an improvement in learning completeness by 70.11%, indicating increased student skills compared to conventional learning media (Wardana & Sagaro, 2019). Utilizing Liveworksheet enables traditional learning materials to convert into easily accessible digital formats online, providing automatic responses and adaptability in question creation, time-saving benefits, and more engaging presentations tailored to learning requirements (Sofi'atun, et al., 2024). From an educational perspective, Liveworksheet upholds the tenets of constructivist learning theory, focusing on active student involvement and immediate interaction via self-directed tasks and prompt feedback. These characteristics promote learner independence and enhance cognitive links. In GEBI (Game Edukasi Berbasis IoTs), Liveworksheet functions as the interactive platform, and the IoT elements are emulated via dynamic tasks that mirror real-world metrics, numerical approximations, and activities based on digital inputs. This blend improves numerical literacy by placing mathematical ideas within the Pattern Making area, aligning with vocational education objectives.

The interactive design of educational games through Liveworksheet creates a dynamic and productive environment for students and teachers, enhancing student engagement and academic understanding (Firtsanianta & Khofifah, 2022). This research employs Liveworksheet as a digital resource to tackle the deficiency of interactive, engaging media in Pattern Making teaching, particularly to improve numeracy skills. Although research on gamification and digital tools exists, limited studies emphasize merging vocational subjects such as pattern drafting with interactive platforms that enhance mathematical comprehension. Current media frequently miss contextual significance and prompt responses necessary for enhancing numeracy in vocational areas. To address this gap, this study creates and evaluates GEBI (Game Edukasi Berbasis IoTs), an interactive educational tool utilizing Liveworksheet to enhance the numeracy abilities of tenth-grade vocational students in Fashion Design and Production, particularly in Pattern Making (Grade X Phase E). While GEBI lacks physical IoT devices, it replicates IoT concepts via tasks that include digital measurement data, data-oriented decisions, and immediate feedback. Liveworksheet replicates the interconnectivity of IoT by facilitating online tasks and automated adaptive evaluations, establishing a vibrant learning atmosphere that reflects the processes of digital fashion production. Consequently, the research puts forward two hypotheses: firstly, experts will assign GEBI a validity score of ≥ 4.0; secondly, a positive relationship exists between numeracy literacy and success in Pattern Making.

Method

This research uses quantitative Research and Development (R&D) methodology by modifying the ADDIE framework. The ADDIE framework offers a structured approach for creating impactful and adaptive learning materials, promoting significant and contextualized lessons suited to the requirements of students (Annas, 2013, in Safitri & Aziz, 2022; Syahid, Istiqomah & Azwary, 2024). This method was selected as it facilitates the organized development of creative educational solutions that target learning issues (Quantitative, 2016). The ADDIE framework includes five phases which is (1) Analysis by recognizing and evaluating students' difficulties with numeracy skills in the Pattern Making course; (2) Design by crafting and developing the educational game (GEBI) via the Liveworksheet platform, tailored to meet the numeracy literacy requirements of the students; (3) Development by designing and generating the interactive educational content, then validating it through evaluations by experts and feedback from students; (4) Implementation by carrying out a trial run of the created media with a group of tenth-grade vocational students to evaluate usability and effectiveness; and (5) Evaluation by gathering and examining responses from users (students) and specialists to enhance the material for better educational results. In this research, the Implementation and Evaluation phases were partially executed with restricted pilot testing and feedback gathering because of time limitations. As a result, although the initial usability and acceptance were assessed, a wider and more prolonged evaluation is left for future studies. This constraint could influence the applicability of the findings but offers important perspectives for additional enhancement. Following the five-step ADDIE framework, the procedure can generally be categorized into three primary phases. The phases among them are (1) analysis of numeracy literacy issues faced by students in Pattern Making; (2) design of the educational game media tailored to these needs using Liveworksheet; and (3) development and validation of the media by expert review and student feedback.

The creation and evaluation of GEBI (Game Edukasi Berbasis IoTss) included a research team made up of two specialized groups—media specialists and content specialists and 30 tenth grade vocational learners from the Fashion Design and Production program at SMKN 7 Malang Phase E. Participants were chosen through purposive sampling, a non-random sampling method where subjects are intentionally selected according to

established criteria linked to the study's goals (Subhaktiyasa, 2024). This approach was used to guarantee that the sample included people directly engaged with the Pattern Making topic and knowledgeable about smartphone technology, which is crucial for engaging with the GEBI media. The criteria for inclusion included: (1) vocational tenth-grade students focused on Fashion Design and Production Phase E; (2) educators currently instructing in the same competency area; (3) frequent smartphone users; (4) subjects who had not utilized GEBI media before; and (5) readiness to participate fully in the research process. Although purposive sampling allows for targeted and pertinent data gathering, it brings about possible selection bias and restricts the sample's representativeness. To address this, the criteria were rigorously enforced, and participants were chosen to represent ordinary users of the school. Nonetheless, the limited sample size and the single-school setting limit the applicability of the results. These constraints must be recognized when analyzing and utilizing the findings.

The initial data collection method employed in this research was direct observation, intended to pinpoint the difficulties students encounter regarding numeracy literacy skills in the tenth-grade Pattern Making course of the Fashion Design and Production expertise program. This observation took place in SMKN 7 Malang during the PPL I (Preservice Teaching Practice I) of the PPG Prajabatan Batch 2, which was conducted over seven weeks from September to December using a blended (in-on-in) learning model at Universitas Negeri Malang. The researcher acted as a participant observer, employing a systematic observation protocol that centered on essential indicators of numeracy skills, including precision in body measurements, understanding of pattern formulas, and the capacity to execute arithmetic calculations. The gathered data underwent qualitative analysis to pinpoint recurring issues and skill deficiencies. This observation task seeks to gather information across different scientific disciplines and particular elements, offering advantages like simplifying the creation of an all-encompassing summary of the phenomena being studied (Prasetyo & Harsani, 2023). Moreover, photo documentation was utilized to record student learning activities and product results throughout the observation. These visual documents helped to strengthen observational results and demonstrate students' involvement and achievement in real-world situations. To maintain the objectivity of the validation process, the researchers refrained from acting as expert validators in evaluating the media they created. External validators were chosen, comprising one specialist in instructional media and one expert in Fashion Design and Production subject content, both of whom had no direct participation in the creation or development of GEBI. This division of responsibilities aimed to reduce bias and avoid conflicts of interest throughout the assessment process. The researchers were responsible for managing the validation process, gathering the outcomes, and examining the feedback for future updates of the media.

The primary tool utilized in this research is a questionnaire created to evaluate the practicality of the GEBI media, employing four evaluation categories founded on a 4-point Likert scale: 4 (Strongly Agree), 3 (Agree), 2 (Disagree), and 1 (Strongly Disagree). This scale was deliberately selected to remove neutral answers, thus prompting respondents to articulate a more definitive viewpoint and improving data interpretation (Preston & Colman, 2000). The survey assesses experts' views, beliefs, or insights from standpoints concerning media content, teaching methods, interface design, and technological effectiveness (Pranatawijaya, 2019). The tool was subjected to expert validation with the participation of three specialists—two in instructional media and one in content pattern-making—to confirm construct and content validity. Examples of items from the tool consist of visual aesthetics of GEBI's game design are attractive and appropriate for vocational students, mathematical challenges in GEBI pertain to pattern creation and assist in enhancing students' numeracy abilities, responses given following each game interaction are straightforward and aid student learning. The results of the questionnaire were analyzed by determining the feasibility percentage for each indicator and the overall eligibility of the media. The validity of the GEBI media was assessed using a modified percentage formula as follows:

$$AP = \frac{actual\ score}{ideal\ score} x\ 100\%$$

AP : Represents the achievement precentage, Actual Score : Total score given by expert validators, Ideal Score : Maximum possible score, calculated by multiplying the number of items by the maximum score per item. (Source: Windawati & Koeswati, 2021). The result of the validity test was interpreted using the classification criteria presented in Table 1.

In this research, a minimum level of 61% was utilized to assess the feasibility of the media. When the validity percentage reached by GEBI is in the "Feasible" or "Highly Feasible" range, the media will be regarded as suitable for execution or additional enhancement. On the other hand, should the outcome be below this limit, especially in the "Moderately Feasible" or lesser categories, the product will be modified according to expert input prior to retesting. This process of decision-making guarantees that the media satisfies both educational and practical criteria prior to wider implementation.

Table 1 <Expert Validation Tests Categories>

Criterion	Score
Highly Feasible	81 - 100
Feasible	61 - 80
Moderately Feasible	41 - 60
Less Feasible	21 - 40
Not Feasible	1 - 20

Source: Shalahuddin & Hayuhantika, 2022

Results and Discussions

The creation of GEBI (Game Edukasi Berbasis IoTs), leveraging the Liveworksheet platform, successfully completed a validation test for feasibility through a structured questionnaire. This study focuses on creating and assessing an educational game that improves tenth-grade students' numeracy skills in the Pattern Making subject within the Fashion Design and Production Phase E competency. The development process adhered to all five phases of the ADDIE framework: Analysis (recognizing students' math challenges), Design (creating game ideas that match educational goals), Development (producing and verifying the media), Implementation (carrying out tests with target users), and Evaluation (assessing feedback from students and specialists to improve the product). Expert validation results showed excellent feasibility, with media experts giving scores of 88% and content experts scoring 98%, both classified as "Highly Feasible." This research is based on the PISA numeracy framework, which describes numeracy as the capacity to use mathematical reasoning and analyze quantitative information in different real-world situations (OECD, 2019). GEBI incorporates math tasks related to vocational skills in Fashion Design and Production to assist students in reasoning, decision-making, and utilizing measurements in digital contexts.

Moreover, the GEBI design is guided by the Technological Pedagogical Content Knowledge (TPACK) framework. This framework highlights the convergence of content expertise, teaching methods, and technological resources in educational media (Mishra & Koehler, 2006). Integrating Liveworksheet into pattern-making teaching, GEBI improves the educational experience with instant feedback and engaging activities, in line with 21st-century learning principles that promote numeracy and digital literacy. Following the five-step ADDIE framework, the procedure can generally be categorized into three primary phases. The phases among them are (1) analysis of numeracy literacy issues faced by students in Pattern Making; (2) design of the educational game media tailored to these needs using Liveworksheet; and (3) development and validation of the media by expert review and student feedback. The results from the three phases are outlined as follows:

Analysis of numeracy literacy issues faced by students in Pattern Making

The analysis phase was carried out to pinpoint the issues experienced by tenth-grade students in the Pattern Making course, especially regarding their numeracy literacy skills. During the PPL I (teaching practicum) of the PPG Pre-service Batch 2 program at SMKN 7 Malang, observations showed that students and teachers faced difficulties in incorporating interactive digital learning media into the classroom. In Phase E, digital learning mainly utilized YouTube videos that offered step-by-step guides for creating patterns. Nonetheless, these videos generally focused on the teacher and lasted between 3 to 15 minutes durations that often-caused students to lose interest and diminish their motivation to learn (Tama, 2022). Furthermore, the videos failed to adequately focus on or promote the growth of numeracy literacy skills, which are essential for mastering pattern-making methods. According to the assessment results, 45% of stud=ents faced challenges with fundamental arithmetic operations like multiplication, division, addition, and subtraction that involve decimals. Additionally, 30% of students showed challenges in interpreting reading tools, such as rulers and measuring tapes, which are crucial instruments in the process of creating patterns. These results highlight the immediate necessity to improve students' numeracy skills, as these abilities are essential for vocational school students getting ready to join the workforce where they will encounter assignments that demand not just technical knowledge but also solid practical mathematical reasoning (Hafid & Kamaludin, 2024)

Development and Validation of The Media by Expert Review and Student Feedback

In the stage titled "Development and Validation of The Media by Expert Review and Student Feedback," the explanation is divided into three parts: Development of GEBI, Expert Validation, and Student Feedback, which will be detailed as follows:

Develompment of GEBI

In this study's design phase, a preliminary design of the educational game was made using the Canva application to generate visually attractive and pertinent materials that cater to students' learning requirements, especially in

enhancing numeracy skills within the Pattern Making topic. Canva offers a variety of interesting visual components, boosts creativity in creating educational materials, user-friendly, and accessible on both laptops and mobile devices (Jannah et al., 2023). The structure of the created educational game includes student identification form, concise educational content, rules for gameplay, and game tasks that align with the given material. The game's content utilizes a contextual learning method, incorporating simulations for reading measurement tools and integrated learning videos, to assist students in achieving a more profound comprehension of the subject matter. This method promotes significant and genuine learning experiences by linking theoretical ideas with practical situations, especially by utilizing lifelike images (Wulandari & Wijaya, 2023). Applying a contextual strategy in numeracy literacy is seen as an effective way to improve teachers' professional standards and foster students' critical thinking by linking essential knowledge to real-life situations (Rahmadani et al., 2022). This game is intended to be conducted across two class sessions, addressing topics like interpreting measuring tools, recognizing body parts for measurements, measurement methods, and creating the foundational pattern of the female form. The figure below illustrates a design display of the GEBI (IoT-Based Educational Game) media.

Figure 1. Display of GEBI (Game Edukasi Berbasis IoTs) Media Design. Source: Research Documentation

Expert Validation

The validation of the GEBI media occurred during the development phase of this research. Validation was performed by two specialists: a media expert and a subject matter expert. These specialists comprised educators and instructors with demonstrated expertise in fashion design education and educational technology. The goal of this validation process was to evaluate the practicality of the created media. Data were gathered through a validation questionnaire, distributed online through Google Forms and offline using printed versions. The survey contained the validator's identity, evaluation forms, improvement recommendations, and a general conclusion about media viability. The media specialist evaluated four aspects consisting of 26 statements on a Likert scale, namely: (1) design layout, (2) language and text, (3) visual components (illustrations and drawings), (4) navigation and tools, and (5) device and platform compatibility. Employing the Likert scale in this scenario

is consistent with the use of quantitative assessment tools in media development studies (Pranatawijaya et al., 2019). Additionally, expert judgment validation is a typical phase in creating educational games to confirm that the media adheres to both pedagogical and technological criteria (Arif, 2016). The next section provides the outcomes of the media feasibility test, as established by the expert validation feedback

Table 2 <Results of Media Expert Validation>

Aspects	Present (%)	Category
Layout design feasibility	81%	Highly Feasible
Text and language accuracy	95%	Highly Feasible
Image and illustration feasibility	96%	Highly Feasible
Tool and navigation functionality	78%	Feasible
Device and platform compatibility	92%	Highly Feasible
Average Score (%)	88%	Highly Feasible

According to the media expert validation results shown in Table 2, a total percentage score of 88% was achieved, classified as highly feasible. The top score was observed in the text and language category, achieving a percentage of 95%. This is backed by a contrasting color scheme that improves readability, properly sized fonts for players, grammatical correctness following the Enhanced Spelling System (EYD), uniform punctuation usage, and vocabulary that is easily comprehended by vocational students. The sentences were well-organized and contained suitable technical terms associated with pattern making (Wibawanto, 2018). In the tools and navigation category, the minimum score of 78% was recorded. This was caused by various factors, including the restricted feedback mechanism that only showed scores and highlighted wrong answers without revealing the correct ones. Furthermore, the descriptions of features in the game were not clearly presented, and vital instructions—like game goals, gameplay mechanics, and task guidelines—were absent when the game was initially accessed (Vitianingsih, 2016)

Table 3 <Results of Material Expert Validation Test>

Aspects	Present (%)	Category
Material suitability	96%	Highly feasible
Content completeness	100%	Highly feasible
Average Score (%)	98%	Highly feasible

The analysis results presented by media experts in Table 3 demonstrate an overall percentage score of 98%, placing it in the Highly Feasible category. The most highly rated aspect is the thoroughness of the content, as it provides not only theoretical concepts but also features examples, exercises, and practical applications. The provided answer keys are correct and correspond to the numeracy literacy skills needed for pattern creation. The content is organized in a gradual manner, moving from basic to advanced ideas, and the questions and challenges within the game are suitably diverse to align with students' skill levels (Panjaitan et al., 2020). The aspect of material suitability, with a score of 96% and classified as Highly Feasible, aligns with the defined indicators. The in-game resources efficiently assist players in grasping numeracy ideas tied to pattern creation by integrating essential mathematical computations, addressing pertinent numeracy abilities, and displaying numbers in a straightforward way. Moreover, the content is methodically arranged from fundamental ideas to real-world applications in the game, accompanied by visuals to improve students' understanding

Student Feedback

Following the revision of the GEBI media development product informed by feedback from media and material validation specialists, the subsequent step involved gathering student perception data to assess reactions to the enhanced GEBI media. Student feedback is a crucial type of user input that contributes to improving the practicality of the GEBI media (Arini & Lovisia, 2019).

The student feedback on the GEBI media development reports an average score of 75%, classified as viable. The GEBI (Game Edukasi Berbasis IoTs) learning media, leveraging the LiveWorksheet platform, aids in enhancing students' numeracy literacy abilities in the Pattern Making topic. Utilizing a contextual strategy from game-based learning can improve students' critical thinking and comprehension (Nuraisah et al., 2016). Additionally, the LiveWorksheet platform supports the automatic gathering of feedback, encouraging more student-focused learning experiences (Wati et al., 2021). After the validation process by media and material specialists, changes were implemented according to their feedback and recommendations. Main suggestions consist of include a front cover page with explicit instructions prior to the game beginning to avoid any misunderstandings; enhance the clarity of in-game asset images and maintain suitable margins to improve layout visibility; alter the background hue of game switches to enhance their clarity and visual attractiveness; incorporate audio elements into interactive maps, as this will assist students who comprehend better with

auditory information and enhance the game's engagement.; and enhancing educational media is essential to avoid dullness and tedium in the learning experience, thus enriching students' comprehension (Wulandari et al., 2023).

Table 4 <Student Response Survey Results>

Aspects	Present (%)	Category
Feasibility of layout design	74%	Feasible
Textual and grammatical feasibility	79%	Feasible
Eligibility of images and illustrations	75%	Feasible
Tools and navigation eligibility	76%	Feasible
Device and platform affordability	73%	Feasible
Material suitability eligibility	75%	Feasible
Content coherence	76%	Feasible
Average Score (%)	75%	Feasible

Conclusions

This research effectively created GEBI (Game Edukasi Berbasis IoTs) as an engaging educational tool for the Pattern Making topic, using the Liveworksheet platform. The validation outcomes indicated that the media is very effective in improving students' numeracy literacy abilities, particularly for vocational high school students in the Fashion Design and Production specialization. Expert validation indicated an average feasibility rating of 98% from content specialists and 88% from media specialists, with both classified as "Highly Feasible." At the same time, student feedback revealed a "Feasible" assessment with an average score of 75%, pointing out areas needing enhancement. The development process followed the ADDIE model, which included three main phases: (1) analysis of numeracy literacy issues faced by students in Pattern Making, (2) design of the educational game media tailored to these needs using Liveworksheet, and (3) development and validation of the media by expert review and student feedback. The inclusion of Liveworksheet enables immediate feedback and interactive elements consistent with 21st-century educational principles, a finding also backed by Ambarwati (2019), who noted that web-based gaming tools significantly enhance problem-solving abilities in daily situations.

Despite the media demonstrating high feasibility and favorable initial reactions, various enhancements were made following recommendations from experts and students. These involve providing explicit instructions prior to gameplay, improving visual clarity and design, including audio components to accommodate various learning preferences, and enhancing navigation features to boost usability and involvement. These modifications seek to minimize student fatigue and enhance the overall educational experience, aligning with suggestions from media development research (Wulandari et al., 2023). The limitations of this study comprise the small sample size confined to a single vocational school and the lack of assessment for long-term effectiveness. It is suggested that future studies carry out wider implementation trials in various schools and create more interactive elements to improve student involvement and educational results

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