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Design and Implementation of a Game-based Learning System for Slow Learner Students in Visual Communication Design Department

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Abstract — An inclusive learning approach is essential in vocational education, especially for slow learners who need more focused, gradual, and visual experience-based learning strategies. The complexity of the material in Visual Communication Design (DKV) often makes it hard for them to grasp design concepts, visual principles, and creativity tasks that require significant cognitive effort. These challenges led to the development of game-based learning (GBL) as an alternative method aimed at increasing engagement, retention, and learning effectiveness. This study designs and implements a GBL system for slow learner DKV students at SMK N Surakarta using a design and development research approach. This includes needs analysis, design, development, and implementation testing. The system incorporates the principles of visual scaffolding, simple narratives, task-based interactions, and gamification through a point system, gradual levels, and instant feedback. Testing shows that GBL helps improve learning focus, strengthens understanding of basic design concepts, and motivates students to complete visual tasks. Teachers observed an increase in independence and self-confidence in students after they interacted with the game. These findings confirm that GBL is an effective way to create a more inclusive learning environment in vocational design education. They also open up opportunities for the development of more adaptable and personalized digital learning systems in future research.

Keywords – Design Thinking, Game-Based Learning, Inclusive, Slow-learning, Vocational School

I. INTRODUCTION

In recent years, advances in information and communication technology have significantly changed vocational education. This shift requires more flexible and inclusive learning methods. In vocational high schools (SMK), especially in the Visual Communication Design (DKV) department, students need to grasp not just color theory, typography, and composition but also become proficient in professional design software. For slow learners, challenges like slow information processing, limited working memory, and trouble with abstract thinking make traditional teaching methods, such as lectures or live demonstrations, less effective. This is where game-based learning (GBL) is particularly useful. GBL offers an interactive, structured, and repetitive learning approach that can be customized to suit various student needs [1].

The push for incorporating game-based learning into vocational education is bolstered by empirical evidence and systematic studies. The growth of gamification and game-based learning in vocational education has been substantial and can improve student engagement and learning results.

This creates a strong foundation for developing a game-based learning system aimed at vocational high schools. GBL can boost motivation and support the practical skills that are the main focus of vocational education. Additionally, a recent meta-analysis highlights the effectiveness of game-based learning in the STEM field, showing that digital educational games have a medium-to-large impact on STEM achievement compared to traditional methods, with an effect size (g) of about 0.62 [2].

These findings suggest that game elements are not only fun but also provide important cognitive support, which is vital for slow learners who benefit from reinforcing concepts through repeated interaction and immediate feedback. From an instructional design and interactive media viewpoint, Articulate Storyline stands out as a promising tool for developing game-based learning. Storyline-based media can improve student learning independence [3]. This platform supports branching scenarios, multimedia interactions, and flexible module structures, making it well-suited for slow learners who need visual aids, text, and material repetition with an adaptive learning path. Inclusivity is

vital when designing learning materials for slow learners. This game combines visual animations, audio narration, synchronized text, and physical elements [4]. These features aim to simplify complex material, improve accessibility, and boost the emotional engagement of students with slower learning rates.

In practice, evidence shows that game-based learning is highly relevant for developing entrepreneurial skills. GBL in entrepreneurship education at vocational schools promotes experiential learning, reflection, and real-world problem-solving, all essential in the industry 4.0 era [5]. By incorporating game elements, students can safely simulate running a business, make decisions, and learn from the results in a virtual environment before applying these skills in real life [6].

The learning dynamics of game-based learning also foster quick development of independent learning skills. Using serious games in logistics education promotes self-directed learning, including self-management, initiative, and reflection [7]. Although this context involves higher education, the principles apply to vocational schools (SMK) in Visual Communication Design (DKV): slow learners can gain from the chance to control their learning pace, assess their performance, and build confidence through iterative design tasks.

However, the challenges of implementing game-based learning should not be overlooked, especially regarding teacher acceptance. Some educators hesitate to embrace custom gamification due to concerns about technical difficulties, insufficient training, and the belief that traditional methods are safer. These insights suggest that successfully implementing game-based learning systems in vocational schools heavily relies on teacher training, infrastructure support, and building internal capacities to help educators feel comfortable using digital interactive tools.

Moreover, social innovation and community involvement have proven significant for developing games for slow learners through collaboration with teachers and students. Based on this theoretical framework and research, this study aims to create and use a Game-Based Learning system for slow learner students in the Visual Communication Design Department of SMK N 9 Surakarta. We will use the Articulate Storyline platform. This system will present basic graphic design topics, like color theory, typography, and layout, through interactive modules. These modules will include branching scenarios, instant feedback, and motivational features such as points and progress bars. Additionally, we will incorporate inclusive design principles. This means we will include audio narration, clear visuals, and repetition to help students who learn at a slower pace access the content more easily.

This study aims to design and implement a game-based learning system as a learning media framework based on information and communication technology (ICT)) [8]. It has several goals: 1) Identify the learning needs of slow learners. This involves understanding their traits, challenges, and specific needs when dealing with vocational education materials, especially in vocational high schools. 2) Develop a learning media model that considers the characteristics of slow learners. This means designing preliminary media that is inclusive and adaptable, addressing the cognitive, emotional, and physical challenges these learners face. 3) Use design thinking methods that focus on systematic, user-centered, and participatory research approaches to ensure the media is suitable for the students' learning environment. 4) Create an interactive learning media prototype aimed at boosting the engagement, attention, and understanding of slow learners. 5) Evaluate the media's effectiveness to see how well it helps slow learners improve their basic skills, competencies, and overall learning results. 6) Support inclusive education practices in vocational schools to establish a learning model that educators and institutions can use and enhance for fair education for all students, including those with learning difficulties.

Using information and communication technology (ICT) for learning materials is essential to achieving these goals. One effective method that can improve learning is game-based learning (GBL). Game-based learning enriches the educational experience by incorporating game elements, which helps students grasp the material better [6]. ICT offers flexibility and access to learning resources whenever needed, especially for students who learn at a slower pace. With this technology, learners can revisit material multiple times, enhancing their understanding. This approach not only boosts student engagement but also fosters critical thinking, teamwork, and problem-solving skills [9]. By integrating ICT into learning materials, we can enhance students' educational experiences and better prepare them for the workforce. Digital technology advancements have significantly transformed education. Research shows that game-based learning increases student motivation, engagement, and comprehension of the subject matter[10].

Design thinking can help create meaningful learning experiences that focus on the needs of users, especially students[11]. It is used to develop learning designs that are game-based. The iterative design thinking framework stresses the importance of understanding problems thoroughly, exploring creative ideas, and testing prototypes to achieve the best results [12]. By applying design thinking in the development of game-based learning, teachers and app developers can create solutions that are both engaging and effective in delivering educational content. This study will explore how design thinking can be applied to create clear and engaging game-based learning opportunities for students[13]. The motivations for our research include: 1) Limited studies on using design thinking in game-based learning for vocational school students, who often engage in tasks that require developing practical skills. 2) Most research overlooks a user-centered design approach and focuses on the

effectiveness of games as teaching tools. This allows for the examination of how game-based learning can aid in creating innovative and effective educational games. 3) There has been no assessment of the effectiveness of the iterative design thinking approach. The use of design thinking, which involves testing and prototyping, is rarely applied systematically in developing game-based learning.

This strategy may lead to new methods for creating more effective and user-focused game-based learning experiences. It also provides educators, instructional designers, and educational technology developers with fresh ideas on enhancing the quality of technology-based learning, particularly for slower learners. This can create a supportive and nurturing learning environment where all students can grow and learn from each other.

II. RESEARCH METHOD

This research aims to design and implement a game-based learning system that meets the needs of slow learners. Aim to develop a learning media model that meets the needs of slow learners. This will help solve the difficulties they face and fulfill the goals of this study. Additionally, we will create a prototype of an interactive learning media model tailored for these children. The purpose is to support inclusive education. We will use a direct, inclusive, and user-focused research method to achieve these objectives. In this way, the media we create, especially by using the design thinking method, will fit the learning environment. Maintaining the Integrity of the Specifications

To help create and evaluate a game-based learning system using the design thinking framework, this research requires various resources. The details of the materials used are as follows:

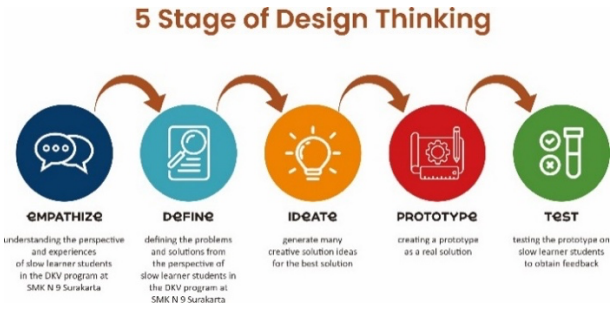

Fig. 1 Five (5) Stages of Design Thinking for Game-Based Learning Slow Learner Students of DKV Program at SMK Negeri 9 Surakarta

Figure 1 shows the Design Thinking approach applied to the study of game-based learning for slow learners at SMK Negeri 9 Surakarta. It includes five phases: empathizing, defining, ideating, prototyping, and testing [14]. Design Thinking works well for developing specialized learning solutions for slow learners, because it focuses on their needs. The aim is not just to create a "cool" game, but to design one that is truly useful and enjoyable for them. The research method starts with the analytical phase, which involves defining and empathizing. It emphasizes curriculum analysis, teacher feedback, classroom observations, and literature reviews to identify the learning characteristics of slow learners.

The research method starts with the analytical phase, which includes Define and Empathy. It aims to use curriculum analysis, teacher feedback, classroom observations, and literature reviews to identify the learning characteristics of slow learners. Interviews with two vocational high school students and their teachers also help understand the needs and challenges faced by slow learners. The study relies mostly on semi-structured interviews with a flexible interview format. This approach considers the different needs and communication styles of both teachers and students.

The two students who had difficulties with learning were interviewed informally. This method was designed to create a trusting environment and reduce any anxiety the students might feel when answering formal questions. The semi-structured teacher interviews started with direct questions to effectively gather factual information, such as the curriculum being used, the teaching methods employed, and the frequency of student interactions. Once this basic data was established[15], the interviews shifted to a more open format. Teachers were then able to share their professional insights, detailed analyses, real-life examples, and significant challenges and successes. Strict questioning would have missed the rich context gained through this method. The next step is identifying the main issue from observations and interviews. The team found a specific problem: Slow learning students struggled to remember the goals or processes of design stages due to a lack of engaging, repetitive exercises that provided immediate feedback. This precise issue guided the formulation of relevant solutions.

The aim of the third step, ideation, is to generate as many game concepts as possible. Since the target audience is vocational high school students studying visual communication design, the ideas tend to be visual. Some examples are: 1) a drag-and-drop game to practice composition and layout; 2) a short visual quiz to identify shortcuts or tool features; and 3) a simulation game where students play designers completing "missions" from a virtual client within a limited time and resources.

Prototyping is the fourth step. Here, the game-based learning process incorporates Design Thinking principles. The main goals are to develop the game flow, user interface, and preliminary prototype. The prototype will be adjusted during development based on user feedback and testing results. Multiple tests and revisions will occur until the game is fully functional. Testing is the final phase. Slow learning students will play the game in class. Data will be collected through interviews, observations, and assessments of the students' performance in the game.

The research tools used to explore game-based learning for students in visual communication design include a survey to gather student opinions about the game, an observation sheet to track student interactions with the game, interviews with students and teachers to obtain deeper insights, and documentation of the game development process. Qualitative analysis will be used on the data from observations and interviews. For numerical data, including game scores and completion times, a quantitative approach will be applied. This will demonstrate how game-based learning can effectively help slow learners improve their foundational knowledge and skills while also increasing their motivation. The objective is to create game-based learning that is both effective and enjoyable for slow learners, along with valuable suggestions for its future development. It is expected that this research will significantly enhance the creation of inclusive and effective teaching strategies for slow learners.

III. RESULT

This helps create new ways to design game-based learning that better meets needs and is more effective." Ganti dengan "This helps create new ways to design and implement game-based learning systems**.** It improves the progress of game-based learning and offers educators, instructional designers, and educational technology developers new insights on how to enhance the quality of technology-based education, especially for slow learners. This study uses a qualitative method that includes design thinking techniques.

The first step in the design thinking process is defining problems and showing empathy. It recognizes that slow learners often struggle to understand lessons presented in traditional ways. They need a learning approach that is more enjoyable and engaging. The main goals of this stage are to identify the empathy issue and figure out how to solve it.

Research, surveys, and journal reading are necessary to reach this point. These can be achieved through interviews and observations. During the define stage, the focus shifts to ensuring that the problems—such as lack of motivation, trouble concentrating, and difficulty understanding concepts—become the basis for designing the game. This aims to tackle these challenges.

Currently, two aspects of the study are being examined. First, interviews are conducted with slow learners in the DKV program at SMK Negeri 9 Surakarta about their favorite visual characters. Results from these interviews show that students prefer visual characters with bright colors (30%), simple illustrations (25%), easy-to-read fonts (20%), smooth animations (15%), and clear markers (10%).

The visual traits of slow-learning students in the DKV program at SMK Negeri 9 Surakarta come out clearly in the interview results. These children prefer basic visual features, as shown in the pie chart in figure 2. They like simple layouts, minimal visual elements, and avoid excessive color or animation. Clear, simple, and large fonts are important, as is using contrast between text or graphics and the background. Sans-serif fonts, which are straightforward and easy to read, help improve students' reading skills since they lack decorative strokes. For students who learn slowly, a model with repeated learning materials is used. These students often need more time to grasp the topic, so lessons are supported by technology and visual aids. This means that more time is needed to explain the material that gets repeated.

In the DKV program at SMK Negeri 9 Surakarta, it is crucial to find out which game models appeal most to slow learners. This knowledge will help these children understand and complete tasks at a pace similar to their peers. Interviews show that puzzle games make up 30% of their favorite and easiest-to-understand games. Simulation games follow at 25%, educational games at 20%, action games at 15%, and strategy games at 10%.

These findings suggest that slow-learning students have a preference for puzzle games. These games offer various unique visuals that can help in their development. This approach may benefit students who learn at a slower pace. Teachers working with slow learners discussed the challenges these students face during their learning process. The most common challenge for slow learners at SMK Negeri 9 Surakarta, at 45%, relates to remembering the technical steps in design creation. Understanding design ideas is the second most frequent barrier, at 33%. Eleven percent deal with comprehending media constraints and attention and concentration levels. Interviews with educators reveal that creativity is not the main issue for these students; instead, the challenges lie in the conceptual and technical areas. Instructors noted that 1) slow learners often overlook the technical procedures involved in using programs like Corel Draw or Photoshop. 2) They struggle to grasp abstract design concepts such as color theory and visual hierarchy. Furthermore, 3) they find it hard to concentrate and are easily distracted by dull presentations. Additionally, 4) students often remain unaware of their mistakes because the current media, such as video tutorials and modules, are not very engaging and do not provide immediate feedback. Based on these interview findings, the first idea was to create game-based asset designs that will engage slow learners in the DKV program at SMK Negeri 9 Surakarta. This aims to encourage them to use game-based learning and understand the course material, which will help improve their attention and focus levels through games.

Brainstorming process to generate creative ideas for designing various game concepts that meet the needs of slow learner students in the DKV program at SMK N 9 Surakarta. The main/productive subject in the visual communication design program at vocational high school is logo design. Therefore, the game-based learning conducted in this research is a visualization of the game-based learning design for the logo design subject. In game design based learning

using articulate storyline. Articulate Storyline is a tool for creating interactive e-learning content. It helps build online courses, simulations, and quizzes. The main advantage of this software is that it creates engaging and interactive learning experiences by putting together text, images, animation, sound, and video[16]. This application makes it simpler for teachers and instructors to present content[4]. It boosts student motivation and can be published on different platforms like the web, desktop, and a Learning Management System (LMS)[17].

Articulate storyline using wareframe functions to provide an overview of a design page layout. The wireframe stage is usually made before prototyping or the final product. The ideal wireframe components for an interactive game include several important aspects. First, navigation should be designed to be as simple as possible with buttons such as "Next," "Back," or "Hints" that are clear and easy to reach. Second, the visual layout should be clean, utilizing a structured text hierarchy and providing enough white space to focus students' attention on key information[18]. Third, interactive areas such as drag-and-drop features, visual quizzes, or selection buttons should be given prominent and easily recognizable visual markers, such as color highlights or certain symbols. Fourth, visual accessibility is very important, so color contrast, font size, and the presence of audio narration should be taken into account to help students who have difficulty reading or understanding long texts understand the material. Finally, the learning flow can also be visualized in the form of branching scenarios that allow students to follow different paths depending on their responses whether correct or incorrect with logical consequences that are educational and not punitive.

For example, the wireframe structure in a DKV game can consist of an opening page, instructions for use, visual materials such as design principles or composition, an interactive mini-game, a visual-based quiz, and a closing page with feedback. Each page is designed with a focus on one learning goal and one type of interaction so as not to overload students' cognition. For example, in a mini-game about symmetrical composition, students are asked to drag design elements to the correct positions on a visual grid, while the system provides immediate visual and audio feedback. Based on the results of brainstorming, several game ideas emerged, namely.

1) Interactive Adventure

Students are invited to embark on an adventure to complete missions related to the lesson material. Starting from level 1 to level 3 for the stages in designing a logo. Level 1 includes material and feedback on color, level 2 includes material and feedback on shape, and level 3 includes material and feedback on typography. The final step is creating the logo.

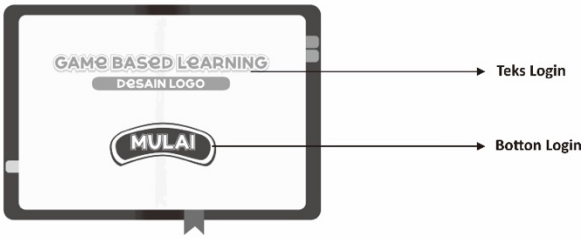

Fig 2. Wareframe Login of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

Fig 3. Result Design Login of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

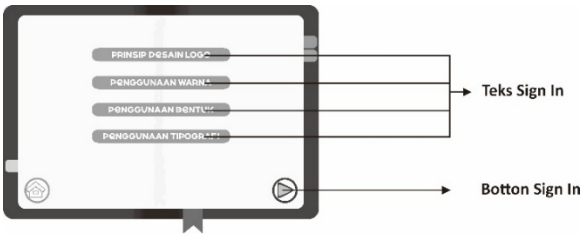

Fig 4. Wareframe Sign in of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

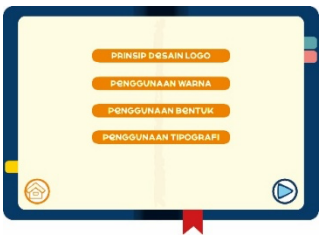

Fig 5. Result Design Sign in of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

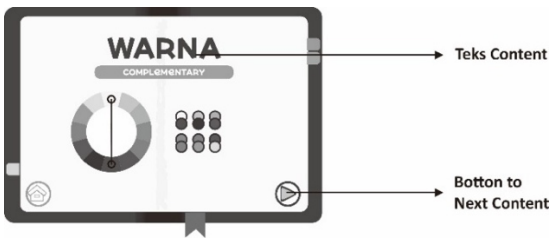

Fig 6. Wareframe Design Content of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

Fig7. Result Design Content of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

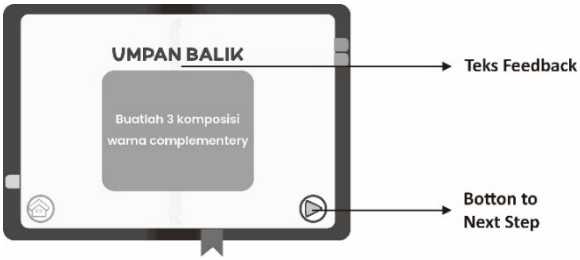

Fig 8. Wareframe Design Feedback of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta.

Fig 9. Result Design Feedback of Game-based learning level layout design for slow learner students of the DKV study program at SMKN 9 Surakarta

A. Prototype

The interactive features in the game prototype developed using Articulate Storyline for slow learner students focus on simplifying navigation and comprehension, as well as enhancing engagement. Details of the interactive features include:

1) Simple and Intuitive Navigation:

The User Interface (UI) is designed using clear and easily understandable visual elements. The visual size of the icons is large, easily recognizable, and brief and clear. This is done to minimize confusion. The design of the navigation icon when students are completing feedback is intended to indicate whether the result is correct or incorrect.

Fig 10. Game-based learning navigation design for slow learner students in the DKV program at SMKN 9 Surakarta

2) Diverse Interactions

During feedback, interactions can be integrated, such as drag-and-drop, selecting images, matching images with descriptions, and creating designs. The interaction design is tailored to support concept understanding, with difficulty levels adjusted based on the abilities of slow learner students. In the game-based learning for slow learner students at SMK N 9 Surakarta, relevant audio is also used to support understanding. The appropriate sound effects appear when students press the existing navigation, and there are simple animations that can help students understand fairly complex concepts.

B. Test

The final stage in the design and implementation process of the game-based learning system for slow learner students is carried out through usability testing using the Single Ease Question (SEQ) method. SEQ is a simple but effective evaluation tool used to measure user perceptions of the ease of completing a task [19], [20] in a digital interface, in this case an interactive game developed using Articulate Storyline. In its implementation, SEQ is given after students complete a certain task or stage in the game, with one core question: "How easy is this task to complete?", which is assessed on a Likert scale of 1 to 7, where 1 means "very difficult" and 7 means "very easy"[21].

The evaluation was conducted on two slow learner students from the Visual Communication Design department who had participated in the game prototype trial. Each student was asked to complete five task scenarios in the game, such as: understanding visual clues, choosing appropriate color combinations, arranging design elements symmetrically, answering visual quizzes, and completing the final challenge. After completing each task, students were asked to fill out the SEQ questionnaire for each task. The results of the SEQ are then summarized in an evaluation matrix, which displays each student's SEQ score for each task [22]. The results of the observations by users/testers who tested the four scenarios yielded the following test results in Fig. 11.

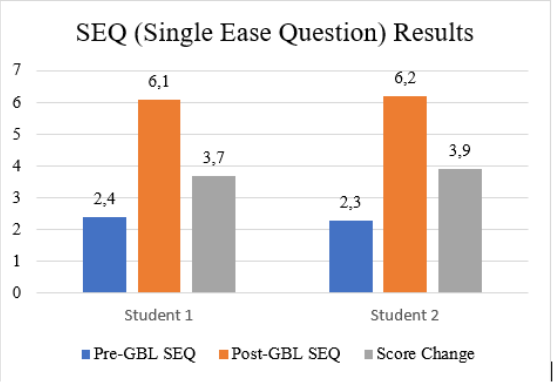

Fig 11. Evaluation Results of the Ease of Use of Game-Based Learning for Slow Learner Students of the DKV Program at SMKN 9 Surakarta

IV. DISCUSSION

This research discussion shows that using the game-based learning system (GBLS) developed with Articulate Storyline benefits slow learners. These students experienced significant improvements in their learning outcomes. Notable gains were observed in cognitive areas, especially in understanding design concepts, accuracy in practical tasks, and knowledge retention after the teaching intervention. These results align with a recent meta-analysis indicating that GBL has a moderate to strong effect on students' cognitive achievement, although its impact on metacognitive skills is still limited [23]. The repetition feature, instant feedback, and modular setup in Articulate Storyline help slow learners overcome memory challenges and deepen their grasp of visual communication design concepts[24].

The study also found improvements in students' motivation and learning attitudes. Game elements like points, progress indicators, and appealing visuals tied to the DKV content boosted emotional engagement, lowered learning anxiety, and heightened student satisfaction. These results match findings that highlight the motivational effects of GBL, though these effects are typically smaller than those on cognitive aspects [25]. However, the impact of GBL on metacognitive skills remains inadequate. This suggests that without incorporating reflective and self-assessment features, students do not develop their strategic planning and self-evaluation skills effectively. The vocational education context in SMK aligns with these findings. Recent studies indicate that GBL can improve practical and problem-solving skills in vocational areas, including multimedia and design [26]. Our implementation confirms that project-based tasks within the game, like designing interactive posters or layouts for virtual clients, aid in transferring skills to real-life situations faced by vocational high school students. However, the durability of these benefits needs to be confirmed through long-term performance assessments.

Accessibility issues also play a crucial role in developing game-based learning media. Recent research [27]; [28] highlights that game design for people with slow learner should focus on visual contrast, audio narration, simple controls, and adjustable difficulty. Implementation with slow learners shows that features like a "repeat" button, gradual audio narration, and visual progress indicators significantly improve student engagement. Therefore, collaboration between special educators, DKV designers, and e-learning developers is key to ensuring inclusivity in game-based learning.

Overall, this study confirms that Articulate Storyline-based GBL can enhance the cognitive achievement and motivation of slow-learning DKV students in vocational high schools. However, its effectiveness in developing metacognitive abilities is still limited. Future learning designs should include reflective components, learning activity logs, and real-world performance-based assessments. Evidence from research conducted between 2023 and 2025 supports this direction, while also stressing the need for larger, long-term studies to strengthen the generalizability of these findings and ensure their relevance to the design field.

V. CONCLUSSION

The design thinking method used in the research for slow learner students in the DKV program at SMK 9 Surakarta has proven effective in designing and implementing a game-based learning system with Articulate Storyline. This method focuses on developing a game that meets the specific needs of slow learner students. It increases student engagement in the learning process and helps improve their understanding of the material. This research can help educators continue to apply design thinking principles when developing new teaching materials. It is particularly relevant for creating more inclusive and effective learning practices for all students. For future research, it is suggested to explore other technologies in game-based learning and conduct long-term studies to measure the lasting impact of using games for slow learners.

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