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Designing digital teachers with generative AI through mixed reality technology to increase practical learning in designing characters for animation

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Abstract

The purpose of this research is to study the elements and processes of digital teacher design. Generative AI can be processed visually for navigation in conjunction with visual intelligence through mixed reality technology, thereby adding practical learning and character design for animation purposes. This research focuses on the application of generative AI technology combined with visual processing to develop digital teachers with intelligent visual abilities using mixed reality technology, to enable the creation of more dimensional and interactive practical learning experiences, especially in the field of character design for animation. Using visual intelligence allows learners to learn better using a hands-on approach, which improves learners' design and creative skills in a hybrid reality and digital environment. Education for digital teacher design can use generative AI that can be processed visually for navigation with the aid of visual intelligence. This study was conducted in the form of an observational study supported by a literature review to study the elements and processes for modeling the design of digital teachers. Use questionnaires to assess the modeling process and digital teacher design process. The researcher evaluated the design process using 3 practical teachers, 3 gen-ai experts, 3 visual intelligence experts, and 3 MR technology experts, for a total of 12 people. The evaluation led to an average value of 4.69 ± 0.40, with an average value of 4.69 ± 0.40 (the highest quality). Generative AI that can process visuals for navigation with visual intelligence through mixed reality technology enhances the practical learning of character design for animation, resulting in learners being able to effectively develop important skills and be highly involved in the learning process. The use of mixed reality technology enhances the immersive and engaging learning experience for learners. It is effective and can increase the learning of character design for animation work, which can be applied in teaching and learning management in the future.

Keywords: Digital teacher, Generative AI, Mixed reality technology, Practical learning, Spatial computing technology.

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1. Introduction

In an era of rapid technological advancement, education in the fields of art and game design must adapt to meet the growing needs of learners. Character design and animation creation are complex. Using generative AI to create digital teachers with visual processing and navigation capabilities, utilizing Mixed Reality (MR) technology, is a potential approach to effectively develop design learning skills. Generative AI improves the quality of teaching and learning by creating content relevant to learners' needs. It offers accurate image perception, allowing learners to see concrete results in terms of character design and movement. MR also enhances immersive learning experiences, enabling learners to interact with virtual environments while simultaneously acquiring the skills needed to create engaging work. Designing digital teachers supported by generative AI and MR technology not only makes learning more engaging but also promotes systematic and sustainable workshop learning in animated character design. This approach allows us to step into a new generation of education that can effectively shape the future of creators in the game and animation industry. Research related to AI and teaching, entitled "Artificial Intelligence in Education: Opportunities and Challenges," examines the application of AI in education. The use of AI also enables teachers to track student progress in real-time, making teaching more effective [1]. Research entitled "The impact of artificial intelligence on the learning experience." This study explores the impact of AI on the learning experience, finding that it makes teaching and learning more personal [2]. Learners can learn in ways that directly meet their needs and abilities. It also helps in creating learning materials that are suitable for learners. Research related to MR and teaching is reported in "A critical appraisal of mixed reality prototyping to support studio design education." MR in education enhances design learning by combining physical and digital prototypes. It facilitates reflection and supports knowledge management and visualization despite the challenges of using the tool, such as employing complex MRs within a resource-constrained studio environment [3]. The study takes place in a highly interactive environment. Research on "Enhancing learning through mixed reality" focuses on the application of MR in teaching and learning, suggesting that the use of MR can effectively enhance access to information and encourage interaction between learners and content [4]. MR-based projects have found that learners are better able to understand complex concepts [5]. Research related to technology and game animation, such as reported in "Online Learning Videos to Develop Creative Thinking Skills of Students" and research on "Integrating Game-based Interactive Media as Instructional Media: Students' Response" by Saputri et al. [6] suggests that it enhances student comprehension by delivering lessons through various formats such as images, audio, and video, making learning more engaging and effective for elementary school students. These studies demonstrate the important role of technology in education. It helps to increase learning efficiency and create valuable experiences for learners [6]. Therefore, the researcher has also conducted research on digital teacher design. The use of generative AI that can process visuals for navigation with visual intelligence through MR technology adds practical learning to character design for animation in such a way as to create a virtual and highly interactive learning environment for students. Cutting-edge technology can be used to support education and encourage participation. This research focuses on studying the key elements of modeling and designing processes involved in the development of generative AI and MR-based learning platforms. These allow learners to create and customize characters in a virtual environment, while providing real-time feedback to strengthen design and movement skills. MR technology allows learners to interact with the virtual world while being supported by data in such a way as to show tangible results when using the skills learned. This research will explore how designing digital teachers using AI and MR can improve the quality of practical learning and how it affects the development of character design skills in the animation industry. The researchers hope that the results of this study will lead to the development of even more important and progressive teaching approaches in the future.

In the case of designing digital teachers with generative AI and MR for learners to learn the movement design skills of in-game characters, experts in the fields of education, game design, and artificial intelligence technology will check the accuracy and suitability of the content used in the project to ensure that it is consistent with accepted practices and theories. In terms of analyzing the processes and techniques used, the experts will evaluate the methods and techniques used to create digital teachers and determine whether the use of MR is appropriate. They will do this by analyzing the ability to present content and interact with learners. The assessment on the part of the learner engagement experts will check whether the developed platform can increase the engagement and learning efficiency of learners. Based on the results of the experiment and feedback from learners, we will examine the modeling method to assess the adaptability of the technology, while the experts will analyze whether this learning model can be applied in different educational contexts to effectively support learning in schools or educational organizations. Combining expert opinions and evaluations will strengthen the credibility of the findings and help in the development of sustainable learning formulas in the future.

The research objective are as follows:

1. To synthesize elements of designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

2. To design models and processes to create digital teachers with generative AI that can process images for navigation with mixed reality technology to enhance practical learning in character design for animation.
3. To evaluate the model design and digital teacher design process with generative AI that can process images for visual intelligence, navigation through mixed reality technology to enhance practical learning in character design for animation.

2. Literature Review

The study of digital teacher design and development is an important approach to enriching the rich and effective learning experience in this review. We have explored the advancement of artificial intelligence (AI) focused on creating digital teachers with image processing capabilities to aid in navigation and learning in mixed reality environments, with the goal of enhancing practical learning and supporting the development of character design skills for animated cartoons. The use of AI allows the creation of differentiated learning experiences that can be adapted to the specific needs of each learner.

2.1. Digital Teacher

Since its first conception, digital transformation has been the subject of extensive investigation. Despite the growing number of research studies conducted, there still needs to be a straightforward approach or consensus on a comprehensive framework to assist organizations in their efforts to undergo digital transformation. This complexity is further increased by the rapid advancements in digital technologies, which impact business models and necessitate ongoing research to handle the uncertainties present in this field [4]. Due to the proliferation of digital technology, business structures, industrial processes, and economic relationships are all undergoing significant transformations [7]. For instance, there are rapid changes in medical libraries due to digital technology, with a particular emphasis on the transition from traditional document collections to the management and preservation of medical data in digital form [8]. Integrating mobile banking arenas and transforming sports facilities into smart stadiums and arenas, as well as improving the overall experience for organizers and spectators, are among the many ways cutting-edge technologies are revolutionizing the global sports market, resulting in increased efficiency and growth [9]. University administrators must establish sustainable digital roadmaps due to the digital transformation penetration of educational institutions. This entails effectively integrating sustainable features into strategies, technologies, processes, and practices to adapt to dynamic changes. Innovative methods for incorporating sustainable practices into an organization's digital design should be incorporated into roadmaps [10].

2.2. Generative AI

A review of the literature on gen-ai that can enhance teachers' professionalism by quickly accessing content. It provides study advice and facilitates collaboration [11]. Learners can use gen-ai for lesson planning. Creating proactive learning activities enhances engagement, supports a variety of learning styles, and helps tailor educational content while carefully considering ethical implications [12]. Gen-ai can improve education by providing personalized learning experiences, effective content creation, and real-time evaluation and feedback [13]. "Teaching and Generative AI" provides educators with insights into how AI technology can be leveraged to improve learning experiences, personalize education, and automate tasks, with an emphasis on ethical considerations and critical pedagogy, providing resources such as lesson plans and case studies for effective AI integration. Teacher preparation programs should equip prospective teachers with the skills needed to harness the potential of AI for personalized learning [14]. The use of gen-ai in education entails both benefits and risks. More research is needed on its implementation in the teaching and learning process. Teachers will have to adapt their teaching methods and understand the meaning of gen-ai to optimize its advantages [15]. Studies suggest that 90% of students feel that teachers do not support the use of AI technology, indicating a significant gap in support. It emphasizes the need for educators to be trained in integration [16]. We should use generative AI responsibly, focusing on media literacy, critical thinking, and ethical use [17]. The review concluded that the application of AI in combination with MR technology in designing and creating characters for animation is a creative approach that can improve the quality of learning. It can increase opportunities to participate and practice the skills needed in today's digitally transformed world.

2.3. Visual Intelligence

Visual intelligence refers to the ability to analyze and interpret information from images, videos, or visual media using artificial intelligence technology and machine learning. Machine learning is used to enable computer systems to understand and manipulate visual data appropriately. Visual intelligence is a technology that enables systems to understand and process visual data efficiently. By developing these technologies, they not only help the operation of computers and systems. AI is becoming increasingly intelligent, and it can be applied in a variety of fields such as medicine, security, and communications, making it possible to handle complex data effectively. This article discusses the Image STEAM program, which focuses on visual computer integration, including computer vision and machine learning [18]. It emphasizes that digital technology is transforming education by improving teaching methods and promoting visual intelligence. The role of teachers has shifted from one of disseminating knowledge to cultivating students' abilities in information processing and problem-solving [19]. The study successfully demonstrates the feasibility and effectiveness of using MR technology for experimental teaching in economic colleges and universities, providing a practical and efficient pathway for integrating this innovative technology. The system's superior performance in terms of accuracy and speed, coupled with positive user feedback, validates its potential for broader educational applications [20]. The study's findings suggest that incorporating activities that cater to students' spatial-visual intelligence can improve their ESP learning outcomes, particularly in written tasks. The researchers advocate for teachers to consider students' multiple intelligences when designing curricula and activities. The study also highlights the

potential of using various teaching approaches and materials to enhance creativity and student engagement [21]. This article discusses the application of interactive visualization and computer vision in intelligent education, highlighting that visual intelligence, as part of AI technology, improves teaching efficiency by optimizing gesture tracking and visual processing of teaching content in big data environments [22].

2.4. Mixed Reality Enhances Hands-on Learning

The review suggests that MR enhances hands-on learning. In an era of rapid technological development, MR has become an important tool to enhance such learning. It also greatly enhances the interaction and engagement of learners. By creating a realistic environment, MR can simulate real situations or create virtual environments that learners can engage with. They can undertake activities and experiment in a context close to reality. This allows for more efficient learning [23] and diverse interactions. MR provides learners with the opportunity to interact with virtual materials and equipment in an engaging way [24]. One of the strengths of MR is the creation of a learning-by-doing experience. This allows learners to engage in tasks in a risk-free environment, which enables them to learn directly from their own mistakes. Customizing learning content in a virtual environment with the use of MR can also tailor content to suit each learner, such as clearly showing steps, processes, or methods [25]. In terms of stimulating interest and creativity, the introduction of MR technology aids learning by creating fun activities and encouraging learners to develop their creativity. It offers opportunities to experiment with new things that promote effective learning [26] real-time monitoring and evaluation. MR also allows educators to track learners' learning as it happens. It provides real-time assessment and feedback, which allows for immediate improvement in the learning process based on the needs of the learner [27]. It not only supports workshop learning in designing animated characters but also effectively develops the skills needed for students in the digital age [28].

2.5. Character Design for Animation Workshop

This review of the practical learning literature on character design in animation involves project-based learning dealing with real-world projects and collaboration with peers and faculty. This hands-on approach will enhance students' skills, creativity, and professional abilities in such a way as to prepare them for a variety of careers in the animation industry [29]. This article focuses on character studies in fine arts education, identifying nine key character values for practical learning. These include creativity and responsibility, which can be applied to practical learning in character design for animation through structured educational activities [30]. Deep reinforcement learning (DRL) for character animation, with an emphasis on the use of various frameworks that facilitate development, allows users to utilize reinforcement learning without the need for deep expertise, thus optimizing character design and animation by using feature extraction and optimization processes [30]. This paper highlights the importance of an active animation learning system that uses ML technology and dynamic image retrieval technology. It allows for continuous learning and user engagement in character design [31]. Character design for animation involves creating unique and recognizable characters through the development of visuals and concepts. It requires understanding the target group. For example, Wallis's four steps are preparation, storytelling, and the application of creative processes involving incubation, lighting, and monitoring to convey the message effectively [32]. This research presents a digital drawing learning model using MR technology. It focuses on developing practical skills in character design for animation, including the use of input data, the learning process, evaluation of outcomes, and feedback that has been positively evaluated by experts in terms of effectiveness [33]. The review concludes that character design for animation in the digital age requires important skills that can be developed through hands-on learning, especially when gen-AI technology and MR are applied in the learning process, along with the application of generative AI and visual abilities in MR for animated character design. It is of high quality and in line with the preparation of learners.

3. Research Framework

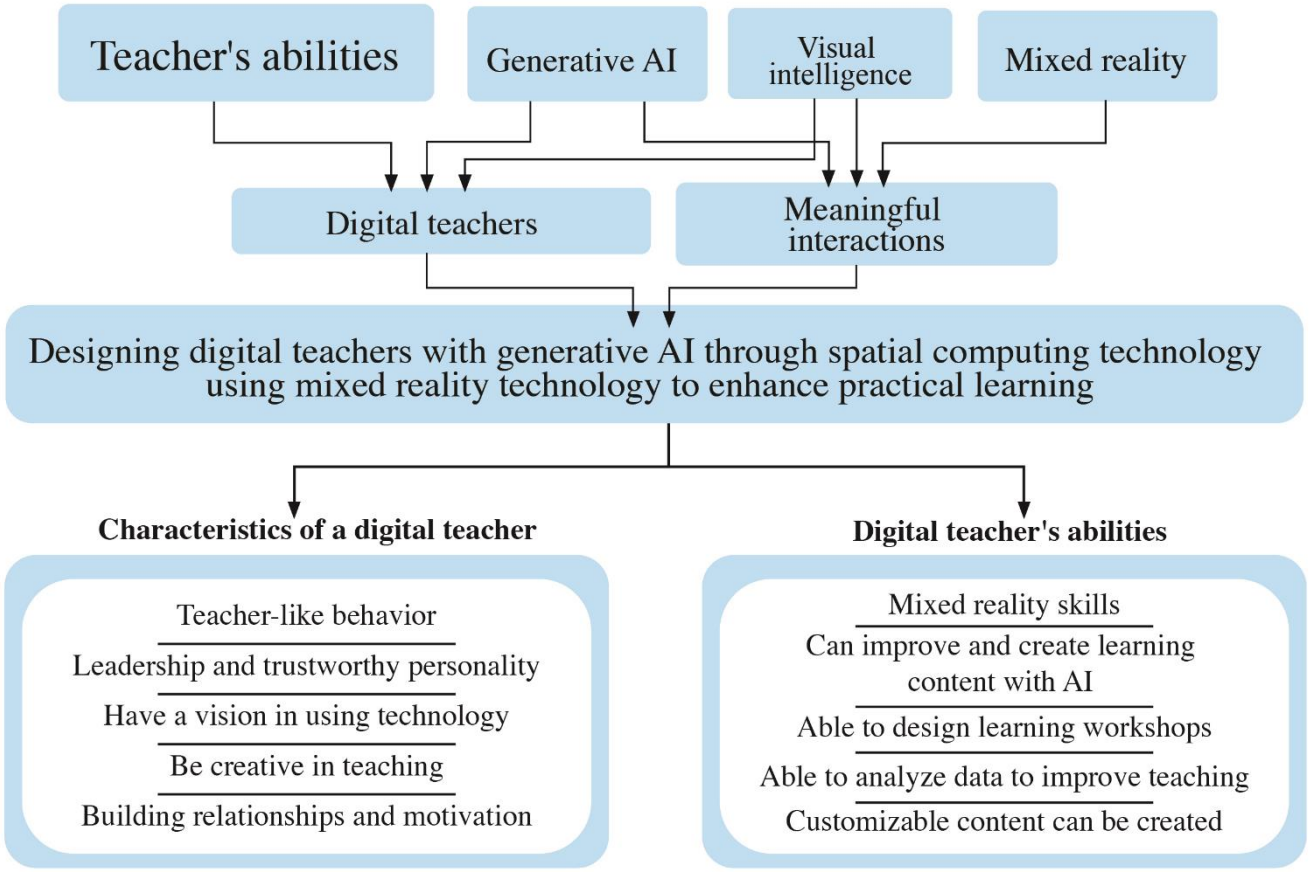

Figure 1.
Research framework for designing digital teachers with generative AI through mixed reality technology to increase practical learning in designing characters for animation.

4. Materials and Method

The study was divided into three phases as follows:

Phase 1: Synthesize the design elements of the digital teacher for animation with Gen-AI that can be processed visually for navigation using visual intelligence through MR technology, adding practical learning and character design. This synthesizing process uses document research methods through the content analysis of digital teacher design. Gen-AI can be processed visually to add practical learning with regard to character design for animation using documents in the Scopus database. The results of element synthesis are then used to create a digital teacher design model. Gen-ai adds practical learning regarding character design for animation and model evaluation with the support of the following experts: 3 teachers who provide practical knowledge, 3 teachers skilled in the use of generative AI, 3 in visual intelligence, and 3 in MR technology a total of 12 people.

Phase 2: Design the process to create digital teachers with generative AI that can be visually processed for navigation with visual intelligence through mixed reality technology to enhance practical learning.

Phase 3: In this phase, we evaluate the digital teacher design process with the support of the 12 experts identified above.

Tools used: This research also uses a quality assessment of the digital teacher design process. The gen-ai approach adds practical learning to the design of characters for animation. It is divided into 2 parts as follows: Part 1: General information with regard to the respondents. Part 2: Questionnaire to evaluate the quality of the digital teacher design by presenting data on the format, mean, and standard deviation (S.D.). The total average and standard deviation is used to analyze the quality of the digital teacher design process against the established evaluation criteria.

Instrument Test: The instrument was tested to evaluate the accuracy of the questionnaire using a total of 5 experts, with an IOC value of 0.85.

5. Results

The results of the analysis of the relationship between digital teacher design and generative AI, which can be processed visually for visual intelligence navigation through mixed reality technology to enhance practical learning of character design for animation, are based on relevant research from searches using the Scopus database. According to the relevant research, 12 documents related to the relationship between (TITLE-ABS-KEY (Practical AND learning) AND TITLE-ABS-KEY (Mixed AND reality) AND TITLE-ABS-KEY (Digital AND teacher)) Figures and Tables (Subsection Level 2).

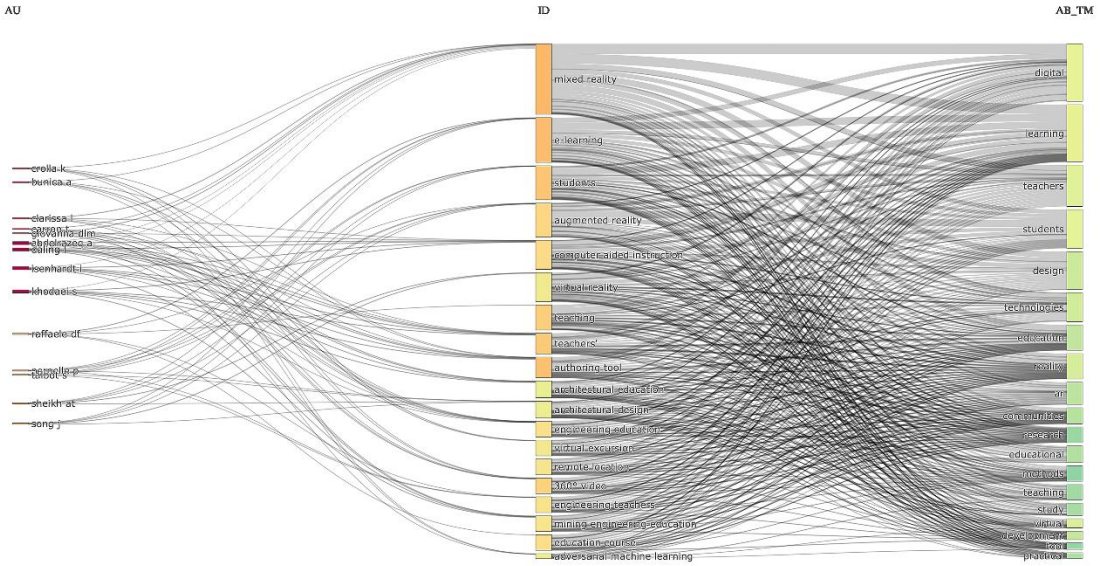

Figure 2.
Three-Field Plot analysis to analyze the relationship between three categories or fields. This involves research articles, social data, or data from various databases. Individual fields represent different categories, such as author, topic, and year of publication. The link line shows the relationship or co-occurrence between items in each field, with the thick line indicating a large number of co-occurrences to help find patterns or trends in the data used in the qualitative analysis in order to understand the relationship between the data.

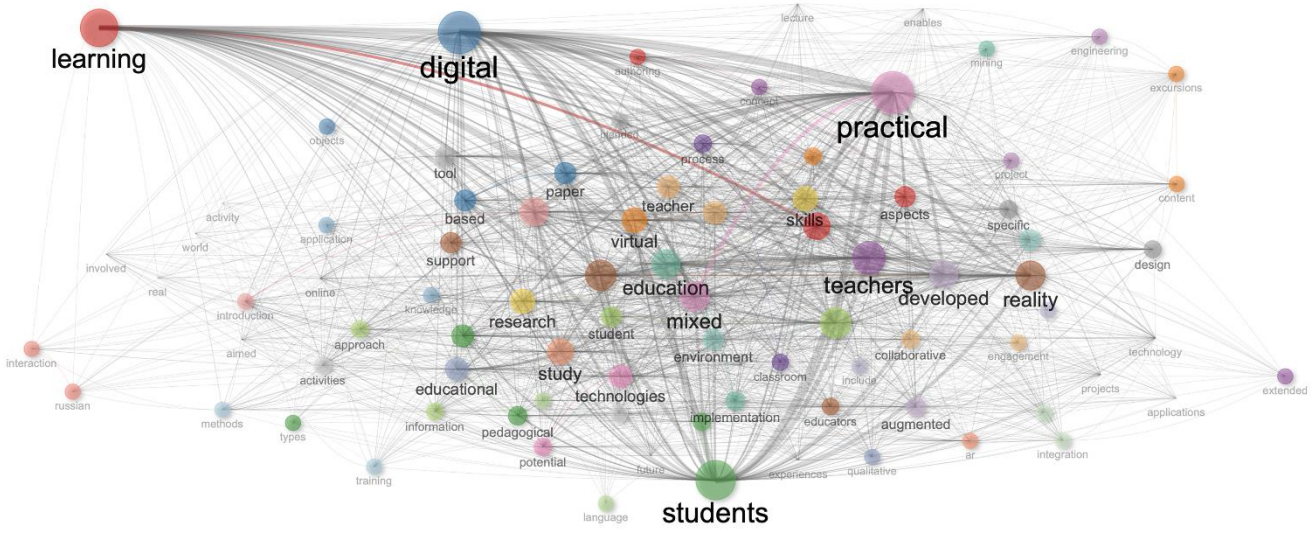

Figure 3.
Analysis of the "Co-occurrence Network". This is the relationship between words or concepts in the research articles and academic papers. Each indicator (node) in the diagram represents a word or concept such as "Learning", "digital", "practical". Edges represent a relationship or co-occurrence between different words. Thicker lines mean stronger links and helps analyze trends or patterns in the data. It is used to understand the relationship between concepts.

The results of the synthesis of elements are based on using documents in the Scopus database. The information obtained consists of four elements as follows: 1) elements of digital teacher design using Gen-AI, 2) elements of visual intelligence technology, 3) elements of MR technology to enhance practical learning, and 4) elements of practical learning with regard to character design for animation with MR technology, as shown in Tables 1 to 3.

Table 1.
Elements of digital teacher design with generative AI.

Elements of a digital teacher, as well Generative AI	Angulo and Conde [34]	Crolla et al. [35]	Abildinova et al. [36]	Cunha et al. [37]	Ruiz-Rojas et al. [38]	Zhai [39]	Belda-Medina and Calvo-Ferrer [40]	Sadykova et al. [41]	Pirker and Dengel [42]	Smith, et al. [43]	Šafranj and Zivlak [21]	Carron et al. [44]
Teacher qualifications	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Content development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Avatar creation				✓	✓	✓		✓	✓	✓	✓	
Sound and communication	✓			✓	✓			✓	✓	✓	✓	
Motion				✓	✓	✓	✓	✓	✓	✓		
Interaction with learners	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Media creation		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Table 2.
Elements of digital teacher design with generative AI.

Elements of Visual intelligence technology	Angulo and Conde [34]	Crolla et al. [35]	Abildinova et al. [36]	Cunha et al. [37]	Ruiz-Rojas et al. [38]	Zhai [39]	Belda-Medina and Calvo-Ferrer [40]	Sadykova et al. [41]	Pirker and Dengel [42]	Smith et al. [43]	Šafranj and Zivlak [21]	Carron et al. [44]
Image processing	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
Object recognition	✓		✓		✓	✓	✓			✓	✓	✓
Motion detection	✓		✓	✓			✓	✓	✓	✓	✓	✓
Elements of Visual intelligence technology	Angulo and Conde [34]	Crolla et al. [35]	Abildinova et al. [36]	Cunha et al. [37]	Ruiz-Rojas et al. [38]	Zhai [39]	Belda-Medina and Calvo-Ferrer [40]	Sadykova et al. [41]	Pirker and Dengel [42]	Smith et al. [43]	Šafranj and Zivlak [21]	Carron et al. [44]
Vision Analytics	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
3D Modeling	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Artificial intelligence	✓		✓		✓	✓		✓	✓		✓	✓
Cameras and Sensors		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 3.
Elements of mixed reality technology to enhance character design workshop for animation.

Elements of mixed reality technology to increase the character design workshop for animation	Angulo and Conde [34]	Crolla et al. [35]	Cunha et al. [37]	Abildinova et al. [36]	Ruiz-Rojas et al. [38]	Zhai [39]	Belda-Medina and Calvo-Ferrer [40]	Sadykova et al. [41]	Pirker and Dengel [42]	[Smith et al. [43]	Šafranj and Zivlak [21]	Carron et al. [44]
Direct experience	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Reflective thinking	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
Conceptualization		✓	✓	✓		✓		✓	✓		✓	✓
Active experimentation	✓	✓	✓		✓	✓	✓	✓		✓	✓	
Active engagement	✓	✓		✓	✓			✓	✓	✓	✓	✓
Feedback and Reinforcement	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓

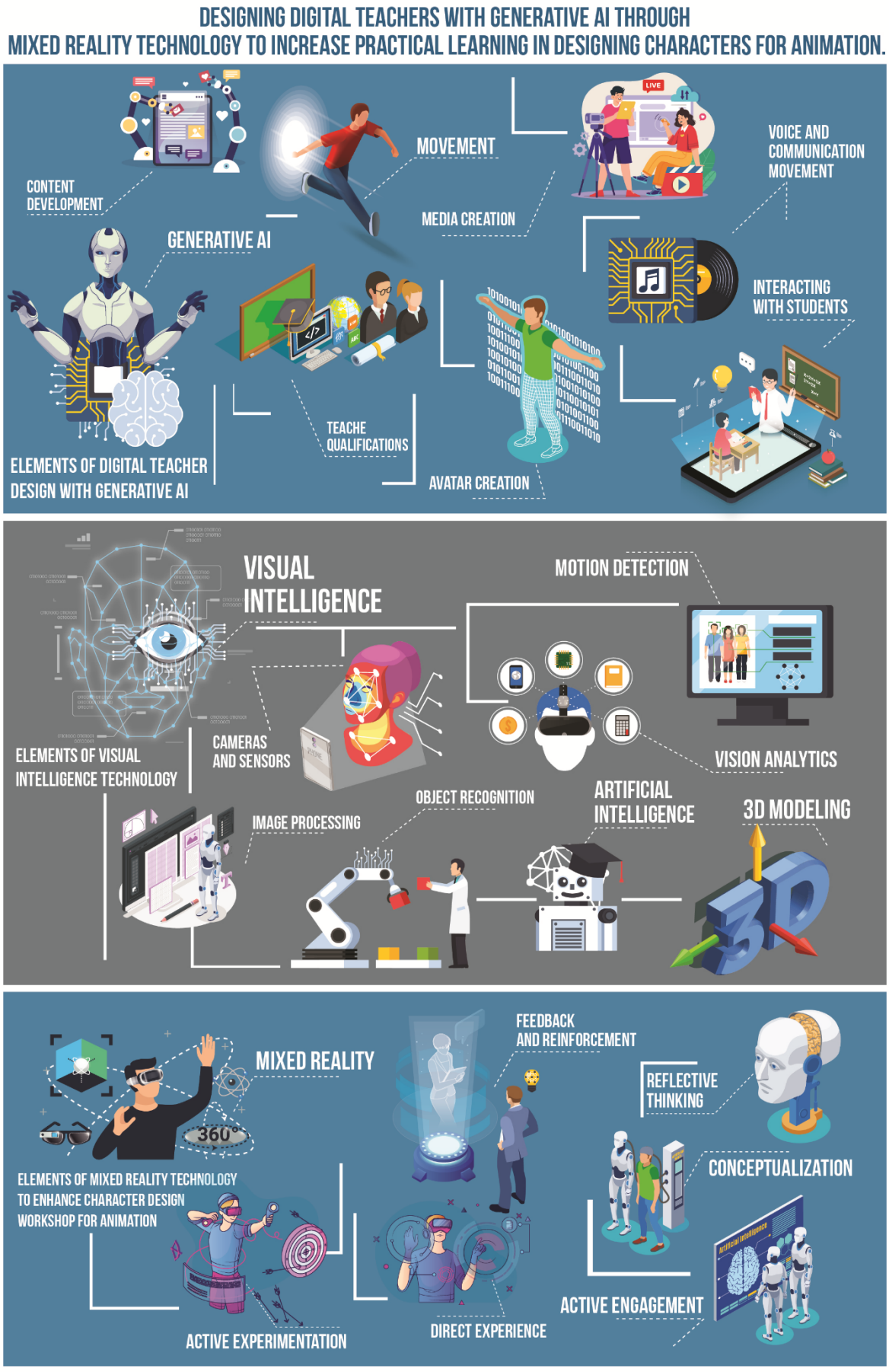

Figure 4.
Digital teacher design model with generative AI that can be processed visually for navigation with visual intelligence through mixed reality technology to add character design learning for animation.

Description of a digital teacher design model with generative AI that can process images for visual intelligence navigation through Mixed Reality technology to increase practical learning in designing characters for animation.

This model describes the elements to be used to model the design of the digital teacher. As shown in Figure 2, gen-ai using visual intelligence using MR technology to enhance practical learning has 3 components.

There are 7 elements of digital teacher design using generative AI. 1) teacher qualities that include critical thinking, communication skills, knowledge in the field taught, innovation and creativity, leadership, ethics, and responsibility; 2) content development; 3) avatar creation; 4) sound and communication; 5) motion; 6) interaction with learners; and 7) media creation, creating a virtual creation. It is not just about creating an image or sound but about creating personality, charm, and credibility. The learning content must be interesting. It must also be easy to understand and consistent with the curriculum. The teacher's avatar should express natural emotions and gestures to create a connection with the learners. Gen-AI plays an important role in creating realistic animations. The sensitive expression of emotions is necessary to engage learners and to encourage them to fully engage. An intelligent interaction system that can respond to learners' reactions in a timely manner and stimulate deep learning is key to the success of a digital teacher. Combining MR technology with gen-AI's capabilities in image processing and visual intelligence will help create immersive interactive learning experiences. Learners can learn character design in a virtual environment and receive immediate feedback from the system, which will enhance the learning experience. Such an approach creates interest and increases the efficiency of learning when it comes to creating significant animated characters.

5.1. Elements of Visual Intelligence Technology

There are seven components of such technology: 1) image processing, 2) object recognition, 3) motion detection, 4) vision analytics, 5) 3D modeling, 6) artificial intelligence, and 7) cameras and sensors. Visual intelligence is a complex system made up of several important elements that work effectively in harmony. It starts with image processing, which is the basic step of converting raw image data from cameras and sensors into a format that can be understood and processed by a computer. Object recognition is then applied; it can be used to accurately identify and classify objects in an image, along with motion detection, which can track the movement of objects, people, or things within the image. The data obtained from this processing is then analyzed in depth with the use of visual analysis. This could include 3D modeling to create virtual reality images, all powered by artificial intelligence. This is key to making the system able to learn, make smart decisions, and adapt. The synergy of these elements makes visual intelligence technology extremely important, especially in this study, which uses this technology to design digital teachers. This is done by navigating using visual intelligence through MR technology in order to reinforce the learning associated with the animation of characters in design workshops. This allows learners to have an immersive learning experience that is both efficient and attractive.

5.2. Elements of MR Technology to Enhance Character Design Workshop for Animation

There are 6 components of such technology: 1) Direct Experience, 2) Reflective Thinking, 3) Conceptualization, 4) Active Experimentation, 5) Active Engagement, and 6) Feedback and Reinforcement. MR offers a revolutionary learning method regarding animated character design workshops, which enhances the learning experience compared with traditional approaches by stimulating deep engagement. Learners benefit from direct interaction with the teacher through direct experience with the model. 3D characters and virtual environments, superimposed on the real world, allow for real-time customization, experimentation, and testing of concepts. This process promotes reflection because learners can see results from all perspectives. MR helps to conceptualize the link between creativity and action by visualizing 3D images, making it possible to clearly understand the structure and details. Additionally, it encourages active experimentation as it provides a safe space for trial and error. All of this promotes highly active engagement due to its realism and real-time responses. Consequently, it holds learners' attention and makes learning enjoyable. Real-time feedback and reinforcement from the MR system help to strengthen understanding. In this research, the integration of MR with gen-ai and visual intelligence technology will further increase potential, especially in modeling, navigation, and feedback.

Results of the evaluation of the suitability of the digital teacher design model using Gen-AI that can be processed visually for navigation with visual intelligence through MR technology to increase practical learning in designing characters for animation.

The researchers also evaluated the suitability of the component model for digital teacher design. Gen-AI that can process visuals for navigation with visual intelligence through MR technology adds practical learning to the design of characters for animation using the following experts: A total of 12 teachers provided practical knowledge: 3 teachers in the use of generative AI, 3 in visual intelligence, and 3 in mixed reality technology, with an average value of 4.65±0.23, indicating that the learning style is appropriate and effective, as shown in Table 4.

Table 4.
The results of the evaluation of the suitability of the digital teacher design model through the use of Generative AI through visual intelligence using Mixed Reality technology to enhance practical learning.

Factor	**Mean ± SD**
Elements of digital teacher design with generative AI	
Teacher qualifications	4.33±0.78
Content development	4.92±0.29
Avatar creation	4.75±0.45
Sound and communication	4.58±0.51
Motion	4.92±0.29
Interaction with learners	4.83±0.39
Media creation	4.83±0.39
Total	4.74±0.44
Factor	Mean ± SD
Elements of visual intelligence technology	
Image processing	4.92±0.29
Object recognition	4.67±0.49
Motion detection	4.67±0.65
Vision analytics	4.83±0.49
3D modeling	4.83±0.39
Artificial intelligence	4.83±0.39
Cameras and sensors	4.83±0.39
Total	4.79±0.45
Elements of Mixed Reality Technology to Enhance Character Design Workshop for Animation	
Direct experience	4.83±0.39
Reflective thinking	4.50±0.90
Conceptualization	4.75±0.45
Active experimentation	4.92±0.29
Active engagement	4.79±0.39
Feedback and reinforcement	4.92±0.29
Total	4.79±0.45

Design results of the process of designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

The researchers also designed the digital teacher design process. Gen-AI that can process visuals for navigation with visual intelligence through MR technology adds practical learning regarding character design for animation by using the results of element synthesis and the obtained data to design the digital teacher design process. Gen-AI used in this way enhances practical learning in designing characters for animation, as shown in Figure 3.

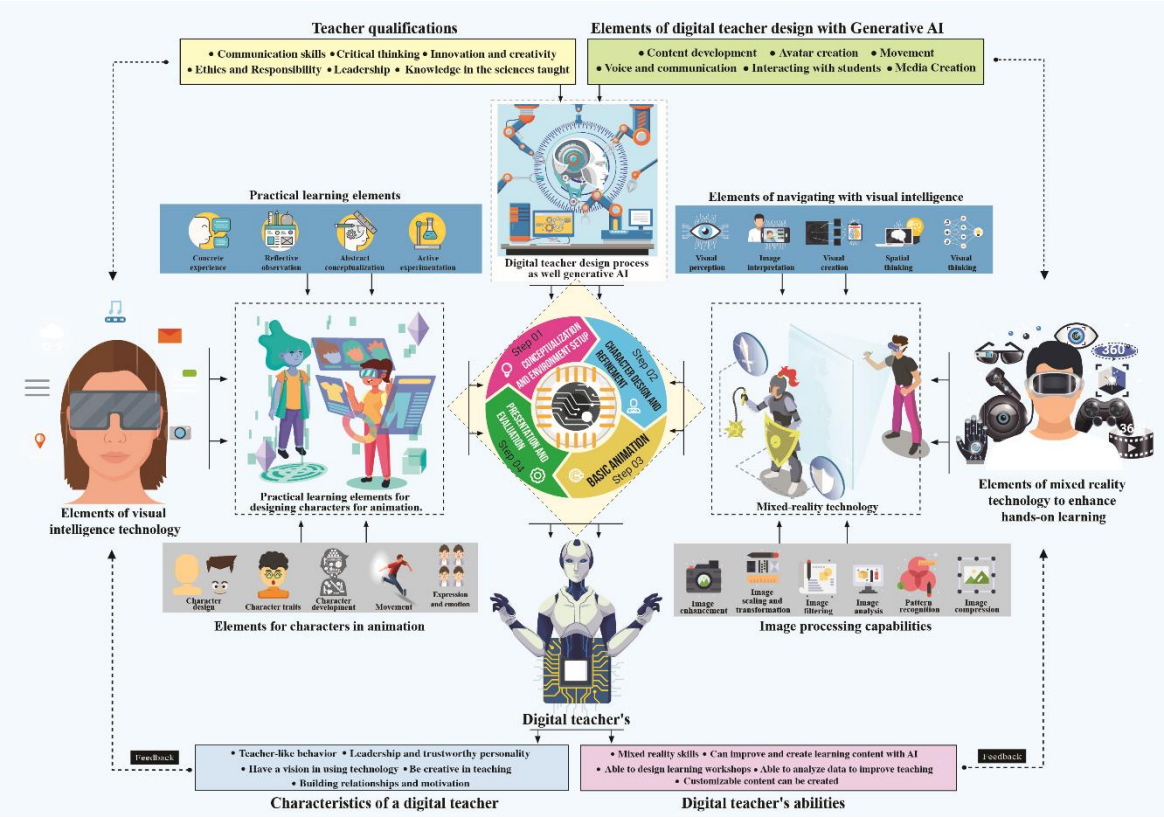

Figure 5.
The process of designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

Explanation of the process of designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

Part 1. Input

Part 1 consists of the following elements: 1) Teacher qualities that include: critical thinking, knowledge, communication skills in the field of innovation and creativity. 2) Elements of digital teacher design using gen-ai 3) Visual processing elements for navigation with visual intelligence through the use of MR technology 4) Mixed reality character design workshop for animation.

Part 2. Process

The researcher also chose to use the digital teacher design. Gen-ai that integrates MR technology for practical learning with regard to animated character design involves the following 4 steps:

Step 1: Design a digital teacher with generative AI, create a virtual environment, and develop an initial character. Use generative AI to create an avatar teacher and a 3D model of a virtual learning environment, such as a classroom. Reference images or descriptions may be used to develop the desired environment. Merge technologies. MR enables learners to interact with virtual environments realistically, such as using AR/VR glasses to see and interact with 3D models or using a mobile/tablet to control display and interaction. Create an introductory character, starting by using generative AI to develop a basic character, or allow learners to start creating their own characters using a 3D design tool, which can be integrated into a virtual environment.

Step 2: Character design & refinement for workshop learning. In this step, learners will learn animated character design techniques such as body structure design, face design, costume design, color creation, and character identity creation, using 3D design tools and/or generative AI to assist with creativity. Navigation with visual intelligence MR systems can help learners with visual navigation, such as highlighting different parts of characters, displaying hints, guiding design processes, and testing and refinement. Learners will be able to independently test and customize their characters. Results can be seen instantly in a virtual environment, and details can be easily adjusted.

Step 3: Creating Basic Animation Learning. In Step 3, students will learn the basics of animation creation, such as movement and facial expressions, using an easy-to-use and understandable animation maker. Gen-ai can help create basic animations, such as animations of walking, running, or jumping. These can be used as examples or as a basis for creating more complex animations. In terms of applications in MR, learners could test the animation of characters in a virtual environment to see if the created animation is appropriate or can be customized to meet their needs.

Step 4: Presentation & Evaluation Portfolio. In Step 4, students will be able to record their character designs and animations to create a portfolio for future presentations. Teachers can evaluate learners' work in terms of creativity, technical accuracy, and the completeness of their work. This can be used to inspire and to learn together.

Part 3 Output

The result of the first two parts is that digital teachers have the following characteristics: 1) Teacher-like behavior. 2) Leadership and a trustworthy personality. 3) Have a visionary approach to using technology. 4) Be creative in teaching. 5) Building relationships and motivation. The second part of the result is the ability of digital teachers: 1) Mixed reality skills. 2) Ability to improve and create learning content. 3) Ability to design learning workshops. 4) Ability to analyze data to improve teaching. 5) Ability to create customized content. The fully developed digital teacher will have an attractive avatar design that is modern and easy to use. There will be immersive virtual environments, and they will be adaptable to learners' needs. In addition, digital teachers also have customizable teaching capabilities. They provide navigation with visual intelligence and real-time feedback. They also offer a wide range of services, automated evaluations, and 3D modeling and animation capabilities. This digital teacher will not only be a teaching aid but also an effective teaching assistant. It will enhance the learners' experience and increase the chances of success in learning about animated character design.

Part 4: Feedback

The feedback of the system goes back to the first step in the research system in order to meet the research objectives.

The process of designing a digital teacher with generative AI that can process images for visual intelligence navigation through Mixed Reality technology to enhance practical learning in character design for animation. It is divided into four main parts.

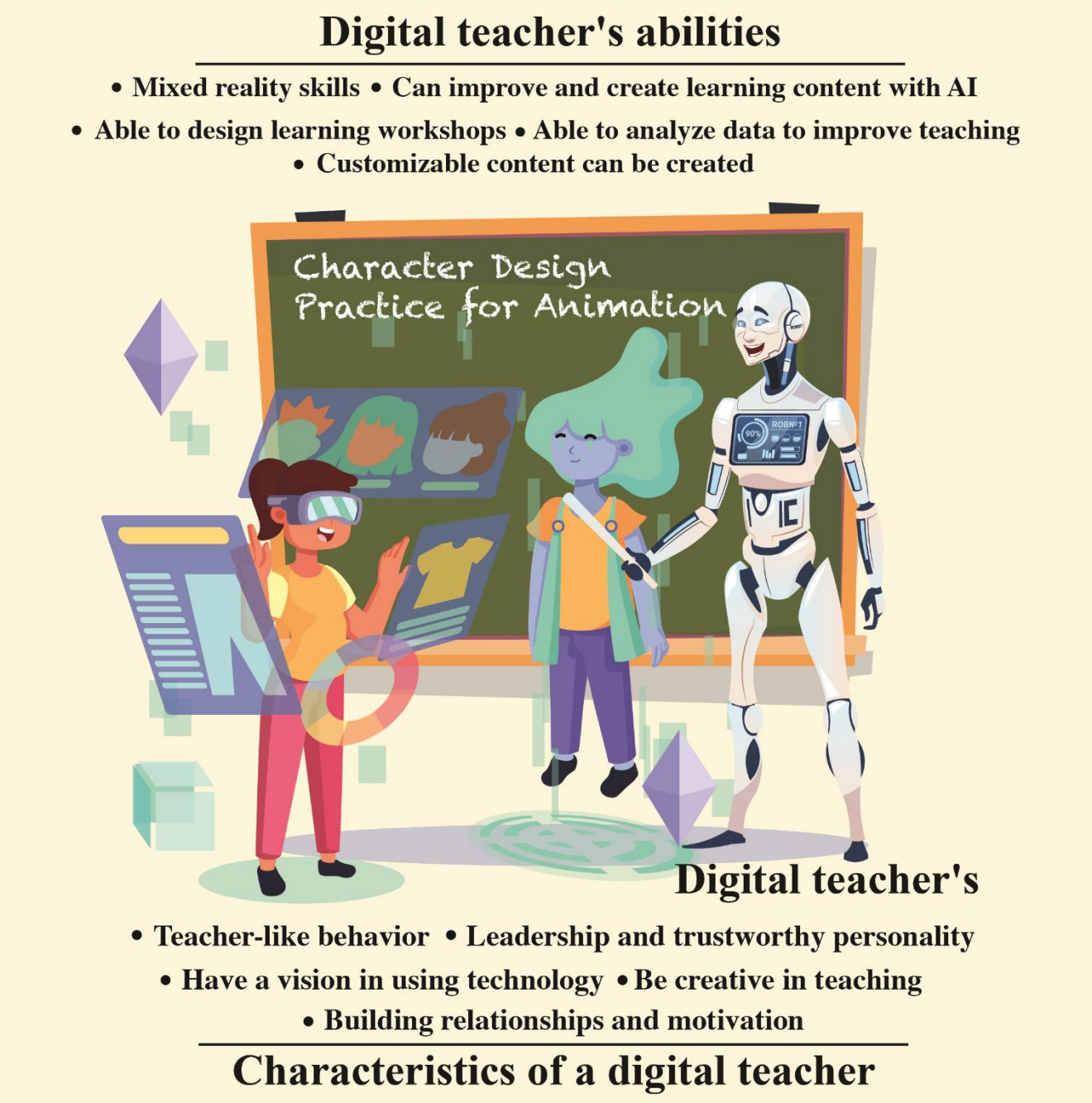

Figure 6.
The results of Designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

The results of the quality assessment of designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

The researcher also evaluated the design process using 3 practical teachers, 3 gen-AI experts, 3 visual intelligence experts, and 3 MR technology experts, totaling 12 people. The evaluation resulted in an average score of 4.69 ± 0.40 for all processes (Input, Process, Output, Feedback). Regarding gen-AI that can be visually processed for navigation using visual intelligence through MR technology, it adds practical learning and character design for animation purposes. It was found to be appropriate and effective, as shown in Table 5.

Table 5.
The results of the quality assessment of the designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation.

Factor	Mean ± SD	Quality level
Input		
Teacher qualifications	4.33±0.78	Very high quality.
Elements of digital teacher design with generative AI	4.83±0.39	The highest quality.
Visual processing elements for visual intelligence Navigation through mixed reality technology	4.75±0.45	The highest quality.
Character design workshop for animation	4.58±0.67	The highest quality.
Total	4.63±0.57	The highest quality.
Process		
Creating a virtual environment and basic characters	4.83±0.39	The highest quality.
Character design and customization	4.83±0.39	The highest quality.
Creating animation basics	4.92±0.29	The highest quality.
Presentation and evaluation	4.42±0.79	Very high quality.
Total	4.75±0.47	The highest quality.
Output		
Characteristics of digital teachers		
Teacher-like behavior	4.92±0.29	The highest quality.
Leadership and trustworthy personality	4.83±0.39	The highest quality.
Being visionary in applying technology in teaching.	4.92±0.29	The highest quality.
Being creative in teaching.	4.83±0.39	The highest quality.
Building relationships and motivation	4.42±0.79	Very high quality.
Digital teacher competencies		
Mixed reality skills	4.83±0.39	The highest quality.
Can improve and create learning content with AI	4.92±0.29	The highest quality.
Able to design learning workshops.	4.92±0.29	The highest quality.
Able to analyze data to improve teaching.	3.83±0.83	Very high quality.
Can create customizable content.	3.92±0.79	Very high quality.
Total	4.48±0.27	Very high quality.
Feedback	4.92±0.29	The highest quality.
Total	4.69±0.40	The highest quality.

6. Discussions

According to the results of the study, designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation. Based on the data provided, the results of the quality assessment regarding digital teachers created using MR and gen-AI technology show an average score, and ± standard deviation. Higher scores indicate better quality. The analysis is divided into three main sections: Input, Process, and Output. Input factors related to the basic attributes of the teacher and the design elements receive high scores in general (most of them are higher than 4.5 on a scale that assumes that higher scores mean better quality). The highest score was given to the design using gen-AI and the integration of MR technology, demonstrating that the design principles and basic elements of digital teachers are accepted and effective. In terms of the process, the process factor that focuses on various development stages also received high scores (mostly higher than 4.7). Character design, animation creation, and presentation all received high scores. This demonstrates a smooth and efficient development process. Consistently high scores represent consistent quality throughout the output creation process. Output factors that analyze the competencies and characteristics of digital teachers have shown mixed results. Although many aspects such as personality, leadership, vision, and creativity scored very highly (mostly above 4.8), some areas such as the ability to analyze data to improve teaching and the creation of customized content were also highly recommended. Receiving a score below 4 indicates that these sections need to be further developed. The overall result (overall score of 4.69 ± 0.40) indicates that digital teachers are generally of high quality. However, the difference in scores highlights the need for a balanced approach, focusing on both strengths (especially the integration of gen-AI, MR, and character design) and areas for improvement (data analysis and customizable content creation). Future development should focus on strengthening those aspects scoring relatively low in order to achieve more effective and inclusive digital teachers. Further research could explore specific techniques to improve low-scoring aspects. Qualitative data may provide valuable insights into why some aspects score lower than others.

This article will examine the performance of the model and the process of designing digital teachers with generative AI that can process images for navigation with visual intelligence through mixed reality technology to increase practical learning in designing characters for animation. The results are as follows: Overall success: The overall high-quality design of digital teachers (average score 4.69 ± 0.40) demonstrates the potential of the methodology used to create digital teachers. Strengths: The use of GenAI, MR, and animated character design is highly effective. As mentioned in the research, the study highlights the strengths of using GenAI and MR for the creation of animated avatars. Emotional expression and real-time translation address the limitations of human interpreters and enhance the collaborative learning experience [45]. As a result, the Input

and Process sections received high scores, demonstrating that these aspects are very useful in building the quality of digital teachers. However, despite their strengths, there are still areas for improvement, such as the ability to analyze data to enhance teaching and the ability to create customized content. Regarding suggestions for future research, it may be valuable to focus on developing data analysis functions and creating customized content. Collecting additional qualitative data will help better understand the limitations and areas for improvement. In conclusion, the findings indicate the potential for using gen-ai, MR, and workshop learning techniques to create quality digital teachers, but some limitations still need to be addressed to make digital teachers more effective and inclusive.

7. Conclusion

This research has successfully designed and developed a digital teacher model that uses gen-ai, MR, and visual intelligence technologies to enhance practical learning associated with animated character design. The data analysis of the results of a questionnaire completed by 12 experts demonstrates the efficiency and high quality of the model, especially in the input and process sections, which received high scores. This demonstrates the appropriateness of combining gen-ai, MR, and visual intelligence. The use of gen-ai helps to create realistic virtual environments and characters. MR allows learners to interact with virtual environments seamlessly. As a result, the learning process is smooth and efficient. However, the results also point to areas for further improvement in terms of output, especially the ability to analyze data to improve teaching and create customized content. These aspects received lower scores than others, indicating that these functions need further development. For digital teachers to be complete and meet learners' needs more comprehensively, we propose suggestions for future research. It is necessary to study techniques for developing data analysis functions and creating customized content effectively. Therefore, collecting more qualitative data is essential to develop an in-depth understanding of the research's limitations and areas for improvement. Future research may focus on testing this model with a larger sample of students to evaluate its performance more comprehensively, including studying its long-term impact on learners' skills and abilities, and conducting long-term studies to assess the model's sustained efficacy. This research has demonstrated the potential of using gen-ai, MR, and visual intelligence to create digital teachers for practical learning, but further development and improvement are needed to ensure that digital teachers are as effective as possible and fully meet learners' needs.

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