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Methodology Used to Develop Prototypes of Augmented Reality Teaching Instruments: A Structured Review

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ABSTRACT

Integrating augmented reality (AR) technology in education has become increasingly prevalent, functioning as a valuable instrument to foster interactive experiences within conventional and non-conventional learning settings. The present study thoroughly analyses the developmental procedures of creating a prototype AR teaching aid. The present paper evaluated 28 studies that employed AR to enhance the pedagogical process and facilitate knowledge acquisition in several academic fields, encompassing science, engineering, and medicine. A detailed investigation was carried out on the study design, data collection procedures, and data analysis techniques utilized in each study. Moreover, the benefits and constraints of each methodology were highlighted, and possible future research endeavours were suggested. This study has identified that utilizing comprehensive and systematic research approaches is essential in developing AR (AR) teaching tools that can significantly boost learning outcomes.

Keywords:
Methodology; prototypes; AR; teaching instruments; research design; learning outcomes; enhanced learning; instructional design

1. Introduction

Technology has changed how students' study and engage [1-3]. Due to its ability to merge real and digital information, augmented reality (AR) is gaining recognition for making learning dynamic and immersive. AR technology is more commonly utilized in education to enhance the quality of teaching and learning. The development of AR teaching instrument prototypes has become an innovative approach to improving educational effectiveness [4,14]. However, there is variation in the methodology for developing these prototypes, and their effectiveness remains unclear. Therefore, this structured review aims to identify the different methodologies used in developing AR teaching instrument prototypes, evaluate their effectiveness, and provide recommendations for selecting appropriate methodologies [5-9]. This study will explore the existing literature on the development of AR teaching instruments and provide insights into the different methodologies used. The review

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will also highlight the benefits and limitations of each methodology and provide recommendations for future research in this area.

2. Purpose of the Study

This study aims to conduct a structured review of the methodology for developing a prototype AR teaching tool. This study seeks to identify the various methodologies employed, evaluate their efficacy, and provide recommendations for selecting the most suitable methodologies for developing AR teaching instrument prototypes. This study will analyse a variety of research articles, including those that employ Scrum methodology, rapid application development (RAD), and co-design techniques. The study will also investigate the efficacy of AR technology tools for education and the application of head-mounted AR in the design of interactive devices. This study's findings will shed light on the various methodologies used in developing AR teaching instrument prototypes, aiding educators and researchers in selecting the most suitable methodology for their projects.

The research objectives for this study can be referred to as follows:

i. To identify existing methodologies used in developing prototypes of AR teaching instruments.
ii. To investigate the preference for using methodologies in developing AR teaching instrument prototypes.

3. Literature Review

AR technology is increasingly used in education to encourage dynamic interactions within and outside the classroom [2,13]. Various technologies for efficiently creating virtual prototypes for AR applications were analysed [18]. This study emphasizes the need for fast prototyping tools in AR instructional aid creation [19]. A comprehensive study of AR in education shows its potential for promising applications [20]. The survey also found that many product evaluations use multiple methods [9,44]. Few articles evaluated educational development using numerous methods [21,29,38]. AR technology in educational settings boosts students' willingness to study, according to didactic prototypes for mathematics [26,28]. The educator's methodology aligns with the design of AR games for educational purposes [31,34].

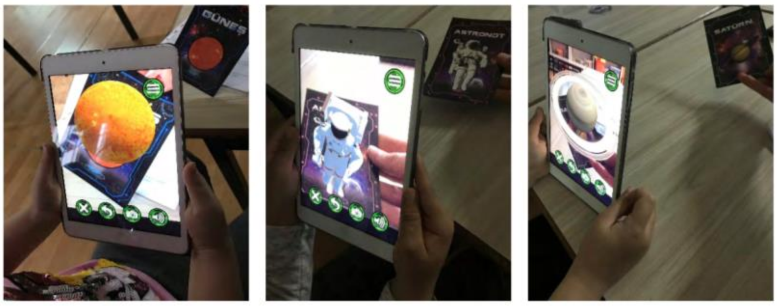

Fig. 1. Some of the image examples used in the application [1]

In addition, a mixed-method study is underway to evaluate the efficiency of AR-enhanced prototyping techniques compared to traditional prototyping methods [39]. AR systems are more effective than other methods in identifying user requirements for product development [41]. Design prototypes are a reference for incorporating AR technology, which combines digital visualization with physical objects [35]. Product development requirements are gathered using head-mounted AR technology to create interactive devices [37]. Some recent literature reviews emphasized the importance of rapid prototyping tools and the instructional capabilities of AR technology [11,14,30]. Moreover, this study demonstrates the advantages of utilizing various methods to evaluate the effectiveness of AR instructional tools. The reviewed papers provide significant insights into the development of AR educational tools and can aid in identifying suitable techniques for this process.

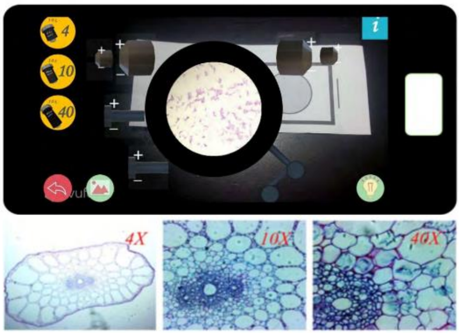

Fig. 2. Microscopic visualization of an organism at different sizes: Sample of elodea and an examination screen [2]

4. Material and Methods

4.1 Identification

In choosing several appropriate papers for this report, the systematic review consists of three main phases. The first step is keyword recognition and the quest for linked, similar terms based on the thesaurus, dictionaries, encyclopaedia, and previous studies. After all the relevant keywords were decided, search strings on Scopus and ERIC (see Table 1) database were created. In the first step of the systematic review process, the present research successfully retrieved 138 papers from both databases. The identification phase involves searching for study materials relevant to the predetermined research issue of classification of a cervical cancer cell. The keywords used are “classification of cervical cell”. Therefore, the first step was to detect keywords and search for similar, equivalent phrases in dictionaries, thesauri, encyclopaedias, and previous research. As a result, after determining all relevant phrases, search strings for the ERIC and Scopus databases were created (see Table 1). Thus, in the initial stage of the advanced search process, this study successfully retrieved 933 publications from the databases.

Table 1
The search string

Scopus	TITLE-ABS-KEY (methodology AND used AND to AND develop AND prototypes AND of AND augmented AND reality) AND PUBYEAR > 2013 AND PUBYEAR < 2023 OR methodology AND for AND augmented AND reality AND PUBYEAR > 2013 AND PUBYEAR < 2024 OR research AND design AND to AND development AND prototype AND by AND augmented AND reality AND PUBYEAR > 2014 AND PUBYEAR < 2024)
ERIC	Methodology used to develop prototypes of AR teaching instruments OR research design to develop prototypes by augmented reality PUBYEAR > 2014 PUBYEAR < 2024)

4.2 Screening

Duplicated papers should be excluded during the first step of screening. The first phase omitted 2 articles, while the second phase screened 33 articles based on several inclusion-and-exclusion criteria developed by researchers. Literature (research articles) was the first criterion because it is the primary source of practical information. The systematic review, review, meta-analysis, meta-synthesis, book series, books, chapters, and conference proceedings were excluded. Furthermore, the review concentrated exclusively on papers written in English. It is essential to note that the schedule was chosen for ten years (2013–2023). Moreover, the selection criteria specify that only research carried out in Malaysia is included for analysis. In all, 95 publications based on specific parameters were excluded.

Table 2
The selection criterion of literature

Criterion	Inclusion	Exclusion
Language	English	Non-English
Timeline	2013 – 2023	< 2013
Literature type	Journal (article)	Conference, book, review
Publication stage	Final	In Press
Subject area	Computer and engineering	Others that are not computer and engineering
Country	Malaysia	Besides Malaysia

4.3 Eligibility

During the third step (eligibility), 33 articles have been prepared. The titles and crucial content of all articles underwent a thorough evaluation to ensure they satisfied the inclusion requirements and were in line with the research aims of the study. Therefore, 6 reports were omitted because they were full text (n-1), out of field (n=2), title not significantly (n=1), abstract not related to the objective of the study (n=2) based on empirical evidence. Finally, 28 articles are available for review (see Table 3).

4.4 Data Abstraction and Analysis

This study employed integrative analysis as one of its assessment strategies to investigate and synthesize a variety of research designs (quantitative, qualitative, and mixed methods). The competent study's objective was to identify pertinent topics and subtopics. The first phase in the creation of the theme was the collection of data. Figure 3 illustrates the examination procedure on 28 publications for assertions or content pertinent to the current study's topics. The current significant studies regarding the classification of cervical cancer cells were evaluated. In addition to the research outcomes, all study methodologies are being investigated. Themes are based on evidence in the context of this study. A log was maintained throughout the data analysis process to record any relevant analyses, perspectives, riddles, or other musings. Finally, the results are compared to identify any inconsistencies in the process of theme design. The produced themes were then modified to assure consistency. To ascertain the validity of the problems, two experts in public health (Khairul Shakir Ab Rahman, an expert in pathology) and biomedical science (Wan Azani Mustafa, an expert in biomedical computing) conducted the analysis and selection. By designating the domain, the expert review phase ensures each subtheme's clarity, significance, and suitability.

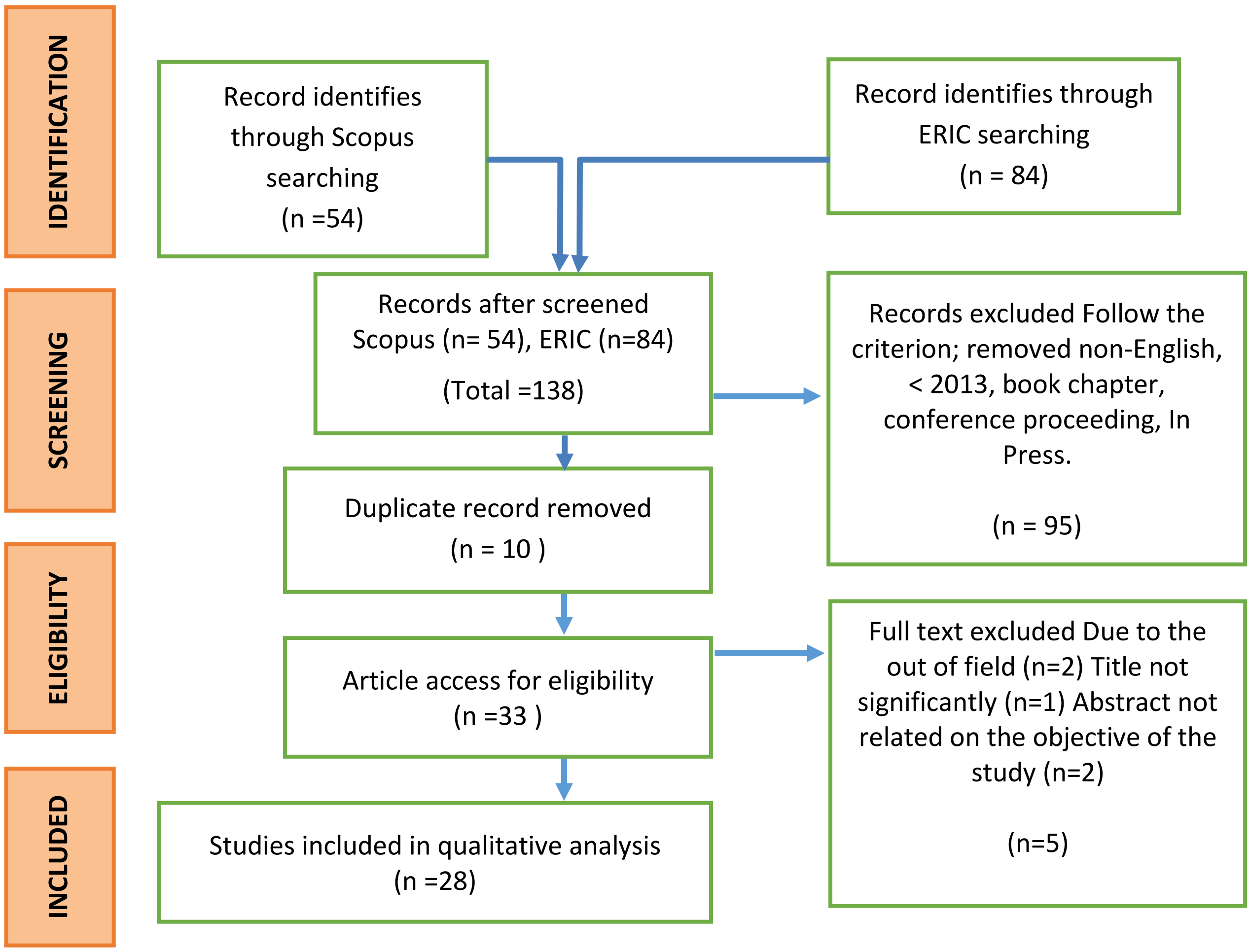

Fig. 3. Flow diagram of the proposed searching study [1]

5. Results

5.1 The Existing Methodologies are Used in the Development of Prototypes of AR Teaching Instruments

Table 3 presents a comprehensive summary of the outcomes derived from 28 scholarly publications. These publications were selected based on the search criteria established by Moher D in 2009. From 2013 to 2023, researchers have identified the present methodologies for developing prototypes for AR teaching instruments. The process of identifying records was conducted by searching the Scopus and ERIC databases.

Table 3
The research article's findings based on the proposed searching criterion

Author/ year	Title	Source title	AR prototype development
Abdusselam and Kilis [1]	Development and Evaluation of AR Microscopes for Science Learning: Design-Based Research	International Journal of Technology in Education	(MicrosAR) The study used design-based research to develop and evaluate MicrosAR iteratively. The application's learning activities and assignment distribution are based on inquiry-based learning.
Amado and Andrade-Arena [6]	Mobile Design for Disciplining Children with Attention Deficit Hyperactivity Disorder using AR	International Journal of Engineering and Technology Trends	(Figma, Tinkercad, Metaclass Studio) Design thinking was used to analyse the problems of ADHD users (children who have difficulty paying attention and are impulsive). Short-term solutions were proposed using tools such as Figma for mobile design, Tinkercad for 3D modelling, and MetaClass Studio for simulation.
Chen *et al.,* [8]	Context-Aware Mixed Reality: A Learning-Based Framework for Semantic Level Interaction	Computer Graphics Forum	Interactivity based on semantics enhances context-aware high-level interactions and solves complex interface design issues. Dense scene reconstruction and thorough image interpretation provide the semantics of this work in the real world. Material-aware prototyping enables physical interactions between actual and virtual objects that are context-aware.
Düzyol *et al.,* [9]	An investigation of the effects of AR applications on preschool children's spatial knowledge	Journal of Educational Technology and Online Learning	(AR card) The study assessed preschoolers' spatial and scientific knowledge by teaching them about two-dimensional space. Arkansas University-educated scholar. Children favour AR over 2D.
El-Firjani and Maatuk [10]	Mobile AR for interactive catalogues	Proceedings - International Conference on Engineering and MIS 2016, ICEMIS 2016	(AR Catalogue) Collect prototypes of functional and non-functional requirements using standard design techniques. The prototype was informative and user-friendly for both experts and common consumers. The promotion of sales requires AR. Catalogues promote the sale of goods. Print catalogues contain a few words, images, and details. Specifications and a dearth of information make it difficult for many to purchase a product.

Philip *et al.,* [11]	Technology to build AR prototypes space to act as a creative resource for designers and artists	International Journal of Visual Design	(White box) This prototype will be used to develop a framework for analysing the impact of SAR on the creative, emotive, and design processes of architects, designers, and artists involved in creating built environments. This structure is a "white box" residence. Gestures control the primary volume's walls and graphics. The projected image interface is independent of gestures and devices. The infusion of limitless creativity will revolutionize the workplace.
Hammady *et al.,* [12]	Design and development of a spatial mixed reality tour guide to the Egyptian museum	Multimedia Tools and Applications	(MuseumEye Demo -Museum Space MR HMD App) MR processing of public entertainment communications boosts tourism, events, and business. The HMD Space Museum makes MR possible. Visits to museums are enhanced by interactive visualizations and physical displays facilitated by MR. Studies influence spatial movement, perception, and interactivity at MR sites.
Hensman [14]	Holonovel - A powerful methodology for prototyping and creating the future	Proceedings of the 23rd International Conference on Virtual Systems and Multimedia 2017, VSMM 2017	(Holonovel) The concept is compared to a science fiction prototype that forecasts the future of corporations and industries. Virtual reality and blended reality take the place of the text. The study of Holonovel stories, scenario ecosystem interactions, and collaborative networks.
Hiramatsu *et al.,* [15]	Development of a dementia care training system based on AR and whole-body wearable touch sensors	IEEE International Conference on Robots and Intelligent Systems	AR-based human interaction and interaction training system to simulate patient-carer interactions, AR superimposes a three-dimensional computer-generated patient visage on a soft doll head. Full-body contact sensors measure force and position of contact. This exercise simultaneously examines eye contact and touch. Public presentations of educational system prototypes.
Huang *et al.,* [16]	Applications of AR and 3D unity in interaction with intangible cultural heritage	Evolutionary Intelligence	The focus of the study is the intangible cultural heritage of the populace. Items of cultural significance that are uncommon and difficult to transmit. When traveling, consult the local ICH. Digital advancement. Smartphones and AR are powered by Unity 3D, head-mounted display, and leap motion. Virtual reality cultures are used for subjects in structured light contact photometry. It disseminates data about 3D exhibition attendees. The research data allowed the Institute of Intangible Cultural Heritage to develop an AR (AR) interactive mode.

Ivonne *et al.,* [17]	An AR Application for Teaching Basic Operations with Fractions with Common Denominators	Journal of Computer Science	The AR application teaches the procedure of fractionation with a common denominator. It was developed using a prototyping methodology. The app enables students to visualize captivating 3D figures to help explain and practice fractional operations such as addition, subtraction, multiplication, and division.
Kasinathan *et al.,* [21]	Gesture-based recognition system for AR	International Journal of Advanced Science, Engineering and Information Technology	The unit, system, and user acceptability tests of the RAD hand gesture recognition system were successful. Research into gesture-based input is necessary for natural and intuitive control due to the limitations of conventional input devices.
Lee *et al.,* [22]	Applying embodied design improvements to physical interactions in augmented and virtual reality	Design Research Archives	(Woz Prototype) Health professionals evaluate prototypes of VR therapeutic exercises. Designers require implementation. Developments in embodied design focus on studying design interaction. This VR experience incorporates design modifications based on body movements. VR writing enhancement and development. Classes on body motion, visuals, storyboards, and WOz prototypes. Recognizing body interaction with AR/VR.
Meža *et al.,* [24]	Measuring the potential of AR in civil engineering	Advances in Software Engineering	Information models increase the clear semantic content of design information. Infomodels started project development. Building sites use line drawings or portable display projectors. AR integrates time, place, and context.
Mokhsin *et al.,* [27]	ARMyPat: A mobile application in learning Malay history patriots using AR	Lecture Notes in Networks and Systems	(ARMyPat) The study only considers textbooks that cover Malay history. We study Malay historical figures interactively, involving AR battles. ARMyPat Malay is a history-learning AR mobile application. The Android history course prototype dates back 10 to 15 years. Students enjoy heritage, character, and biodata. The apps show an excellent Silat 3D character model and act as a martial arts teacher. Malaysian students will learn to respect historical personalities using AR.

Pappa and Papadopoulos [29]	Designing a prototype training environment for physiotherapists building on advanced gaming technology	Proceedings of the European Conference on e-Learning, ECEL	Using DSRM, this study creates an authentic and holistic learning system. AR modules are added to game simulations and virtual world environments to provide players with a realistic gaming experience. Interactive fun in a serious professional game teaches real issues, obstacles, and applications. It also improves awareness, critical thinking, emotional awareness, (collaborative) knowledge acquisition, creative problem-solving, and creativity. AR/VR replaces clinics and medical books. Innovative software and best practices enable game-based physiotherapy training.
Pombo *et al.,* [31]	Transferring learning to smart city parks: Student perceptions of EduPARK's AR mobile game	Interaction Design and Architecture	(EduPARK) EduPARK game-based learning. Outdoor learning using geocaching and smartphone AR. In the smart city park, the game promotes authentic and autonomous transdisciplinary learning. It covers basic education for many groups. 74 9-10 and 13-14-year-old review games. Research the game. Participation and focus groups took place. Fast feedback and cooperation are the strengths of the game.
Spitzer *et al.,* [38]	A Research Agenda for Using Technology-Enhanced Learning with AR in Industry	Lecture Notes in Informatics (LNI), Proceedings - Gesellschaft fur Informatics Series (GI)	(EU FACTS4WORKERS and iDEV40) Focusing on applying Technology Enhanced Learning (TEL) with AR (AR) in industry is how to use and evaluate AR learning scenarios in an industrial environment. This prototype is then improved during several iterations according to the feedback of industry partners. When the prototype reaches the appropriate Technology Readiness Level (TRL), a final evaluation is conducted to validate the software artifact against the gathered requirements.
Tan *et al.,* [40]	An interactive and collaborative AR environment for civil engineering education: teaching steel rebar as an example	Engineering, Construction and Architectural Management	(ICARE) Inspecting photos of 2D concrete steel reinforcing bars. Children's 2D vision limits education. This study uses ICARE's collaborative AR for school students. ICARE improves information comprehension, retention, and understanding of steel bar drawings better than civil engineering. This study shows that AR improves regular course students' information retention and understanding of steel bar drawing.
Vonitsanos *et al.,* [42]	A Proposed Methodology for Improving User Experience in Mobile Application Design for Cultural Promotion	7th Southeast Europe Design Automation, Computer Engineering, Computer Networks and Social Media Conference, SEEDA-CECNSM 2022	User Experience (UX) research based on Human-Computer engagement (HCI) analyses IT systems, products, and services to improve user happiness and system engagement. In the last decade, Mobile Device Applications (MDA) have created new interaction contexts requiring UX ideas and methodologies.

Wang *et al.,* [43]	Mechanical assembly assistance using a markerless AR system	Assembly Automation	Real-time AR installation helps coarse-to-fine markerless tracking. Construction topology automatically adjusts tracking requirements. The paper's contribution is to propose the modified LINE-MOD detects without coarse camera markers. ORB camera tracking point. Our tracking pipeline achieves real-time AR assembly of 24.35 ms/frame. AR tool track installation feature. 2. The orientation vector removes feature point mismatch. Tracking matches the feature exactly. ARToolKit lowers the research camera posture.
Xue *et al.,* [44]	How AR can improve fashion retail: a UX design perspective	International Journal of Retail and Distribution Management	This study examines AR in fashion retail, best form (app vs. magic mirror), and consumer behaviour. The use of AR leads to higher satisfaction levels and purchase intent. AR will improve high-end retail. AR improves learning and interactive experience. AR can improve customer service for luxury brands. This study suggests six customer-pleasing AR sales environment designs.
Yamamoto *et al.,* [45]	See-through vision with handheld AR for sightseeing	Lecture Notes in Computer Science (including the subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	This article describes our engineering techniques for developing and implementing our prototype system to validate our methodology. The performance of a real-world prototype system is described in this investigation. See-through AR vision enhances sightseeing. Time and space are constraints on travel in the real world. This project utilizes transparent visibility, alpha compositing, and parallax effects to make the intended object appear three-dimensional. We specialize in handheld devices that facilitate AR (AR) experiences with high-precision virtual object alignment on cube-mapped scene images.

Table 3 displays this collection of statements that describe many studies and prototypes that use AR technology in several industries, including education, healthcare, architecture, and retail. Table 3 is organized as a table since it is easier to read. Numerous research approaches, including design-based research, design thinking, and user experience research, have been utilized in various studies to construct and evaluate AR prototypes. Microstar, AR card, AR Catalogue, Holonovel, ARMy Pat, and EduPARK are a few examples of the prototypes that have been developed. This study intends to evaluate the effectiveness of AR prototyping, identify relevant approaches for AR development, and make recommendations for the deployment of AR. In order to enhance the user experience and the interaction between users, prototyping makes use of a variety of tools and techniques, such as signal input, material-aware prototyping, and modelling. Research has indicated that AR technology could enhance learning, involvement, memory, and overall understanding across various contexts.

5.2 Preference for AR Instructional Tool Prototype Creation Methods

The prototyping and iterative development of AR (AR) ideas can be accomplished with a variety of technologies and approaches. Unity, Unreal Engine, Spark AR Studio, and Reality Composer are among the leading practices and tools for AR prototyping [1,5]. The use of design thinking and toolkits can assist designers in developing their self-assurance when it comes to the creation of AR and VR experiences [2]. Teachable reality is a tool for AR prototyping that blends interactive machine training with real-time AR scene authoring to allow for the development of interactive, tactile AR applications [3]. Pronto, Montage, Pro-toAR, 360proto, 360theater, and WozARd are examples of further AR prototyping tools [3]. Developing AR prototypes is possible on a variety of platforms, including Unity, Vuforia, and Microsoft Visual Studio [4,6]. Mixed-method research can aid in evaluating the success of AR prototypes in fulfilling their intended function [5]. When developing AR prototypes, the Scrum technique can serve as a useful guide [6].

6. Discussion

AR is becoming a popular educational tool. AR helps students learn math, reading, and history more successfully and enjoyably. Top-notch AR educational products can be developed by investigating customer requirements. AR development resources can be found through a literature review. Reviewing an AR prototype can help determine its efficacy and suggest implementation. AR improves performance, motivation, and access for disabled students. Implementing AR in the classroom requires hardware, software, time, financial resources, and educator training. AR should be evaluated compared to other educational methods, and the requirements of all students should be considered. There are several ways to create educational AR prototypes. Several methods can be used to evaluate AR prototypes, including user testing, heuristic evaluation, and analytics [25]. A sequential app creation paradigm, a co-design approach to AR usability in makerspaces, and AR prototypes for education employing digital sketching, paper, or CAD modelling [4,6]. These strategies allow designers and teachers to construct AR learning aids that encouraging innovation, interest, and comprehension. AR makes learning accessible for disabled pupils by inspiring their motivation and facilitating their learning process. Implementing AR in the classroom requires hardware, software, time, and financial resources, as well as training for educators.

AR prototypes can be used in educational materials in numerous ways. Certain Events Virtual reality and AR education can eliminate modern design illiteracy [1]. Secondly, AR should be employed in class to help students visualize and engage with theoretical subjects. Thirdly, AR improves classroom participation and retention [3,4]. Granting the first-year students with XR experimental time and materials [4] will expose them to the prototype and co-design makerspace AR standards [5]. Examine the impact of AR, gaming, and serious gaming on computer science education [6]. AR prototypes in the classroom can inspire, inform, and help visually impaired students. Poor instructional content and outdated technology and software must be rectified.

AR can help teachers to provide students with a more engaging education environment. AR should be assessed by benchmarking it to other educational approaches and considering all students' needs. AR is hard for teachers to implement. The prevalence of hardware failures, malfunctioning devices, improper materials, and patchy connectivity has been reduced by technology [2,6]. Some challenges in implementing AR education include

i. insufficient curriculum and teacher training [1,3]
ii. separating classes and regulations [1]
iii. lack of education focuses on AR [5]
iv. expensive to adopt [2]
v. AR classroom effectiveness issues [4].

Testing, prototyping, and co-design research can assist educators in solving these challenges. AR rules can be created in a maker space, and students can evaluate the impact of gaming and serious game design on CS education. Furthermore, it supports educators in crafting game-oriented educational materials. Using AR, teachers can engage pupils in dry topics.

Industrial collaborators focused on the study involving cases, concepts, and prototypes [9]. Criteria examine software artifacts when the prototype reaches the relevant technical readiness level (TRL) [9]. The industry's input can help to improve prototypes such as Facts4Workers and iDEV40 [9]. For prototype development, design-based research should consider functional and non-functional needs. The prototype and the first twelve game levels were evaluated through focus groups and participant observations. The main advantages of the game include its interactive gameplay, which provides immediate feedback. Several learning guide questions were unclear and required modification [12]. AR game prototype creation [13] and design-based research should consider functional and non-functional prototype needs. The prototype and the first thirteen game levels were examined through focus groups and participant observations.

Identifying functional and non-functional prototype development requires a complete design approach. In general, in creating an AR prototype [13], design-based research is required by considering the functional design technique and functional requirements. Concept definition, prototype development, and industry partner input are the factors that can improve the prototypes. It is necessary to perform final testing to validate software artifacts according to specifications.

7. Conclusions

The AR prototype's optimal education is determined by the project's objectives, team composition, resources, timeline, and target audience's requirements. Best practices indicate hybrid strategies incorporating multiple methods can produce the most effective results. This study's user-centred design (UCD) highlighted AR prototype users' needs, preferences, and expectations in accordance with the design philosophy. User research, interviews, and surveys yield useful information. This effort ensures that the final AR prototype meets the learners' requirements. Initial prototyping involves creating fundamental models that showcase key concepts and interactions, enabling early feedback from students and instructors. Rapid prototyping reveals early defects and the direction of a project prior to investment. Before employing agile development, it is important to consider the user's needs and input. Sprints are required for AR prototype features. This method is simplified by user-driven prototype adaptation and refinement.

The AR prototype's learning objectives and user content are evaluated and refined. Leveraging quantitative (user engagement) and qualitative feedback to boost Agile development incorporates ADDIE's "evaluation" phase. The AR prototype is enhanced through action research in authentic learning environments with instructors and students collaborating. Teacher and student feedback is required to achieve the prototype's curricular objectives. The method is adaptable to meet project requirements. It can utilize alternative approaches effectively. Flexibility ensures that the system considers development challenges and potential. UCD, fast prototyping, Agile approach, assessment, cooperation, and flexibility boost the probability of developing an AR prototype that matches learner requirements, educational aims, and real-world feedback.

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