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REVIEW ARTICLE

Synthesizing technology integration within the Addie model for instructional design: A comprehensive systematic literature review

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ABSTRACT

Instructional design continually evolves in the realm of education and training. Since the inception of the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) methodology for educational resource design, it has become increasingly pervasive. In today's educational landscape, instructional designers grapple with the integration of digital tools and resources within the ADDIE framework. This systematic literature review aims to explore the integration of technology into the ADDIE Model, examining its impact, advantages, prevalent technologies and platforms, industries utilizing ADDIE, and offering future recommendations and a research agenda. Employing the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) framework as a guide, this study incorporates insights from 54 scholarly papers to illuminate the fusion of technology with the ADDIE Model for instructional design. The findings underscore the ADDIE model's remarkable adaptability and its profound positive influence when technology seamlessly integrates into diverse educational contexts, ultimately enhancing teaching and learning. In conclusion, the synergy of technology and the ADDIE model yields a versatile and potent approach, enriching educational practices, fostering innovation, and catering to diverse learning needs across multiple domains. We recommend further exploration and implementation of technology integration with the ADDIE model in educational settings, leveraging its adaptability and potential to enhance teaching, learning, and student engagement.

Keywords: technology integration, educational technology, ADDIE Model, instructional design

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1. Introduction

In the realm of education and training, the seamless integration of technology into instructional design has emerged as a pivotal catalyst for innovation, transforming the way knowledge is disseminated, acquired, and applied[1]. As educational landscapes and corporate training methodologies evolve, it becomes increasingly essential to harness the full potential of technology in designing effective learning experiences[2]. The ADDIE model, an established framework for instructional design, serves as a beacon guiding this evolution, offering a structured approach to ensure pedagogical excellence[3]. However, as technology continues to advance at an unprecedented pace, the harmonious convergence of instructional design methodologies with cutting-edge technological tools and strategies remains a paramount challenge and opportunity[4]. This

comprehensive exploration embarks on a journey through the symbiotic relationship between the ADDIE model and technology integration, delving into the intricate processes, the manifold benefits, the multifaceted learning outcomes, and the exciting future directions that arise from their synthesis.

The ADDIE model, consisting of Analysis, Design, Development, Implementation, and Evaluation phases, provides a systematic blueprint for creating effective learning experiences[5]. It is renowned for its flexibility and adaptability, allowing instructional designers to tailor each phase to suit the specific needs of learners and the learning context[6]. However, with the rapid evolution of technology, these phases necessitate a harmonious infusion of digital tools and methodologies. This integration of technology within the ADDIE framework leads to the creation of technology-enhanced learning experiences that cater to diverse learning styles and preferences[7]. **Figure 1** illustrates the ADDIE model phases.

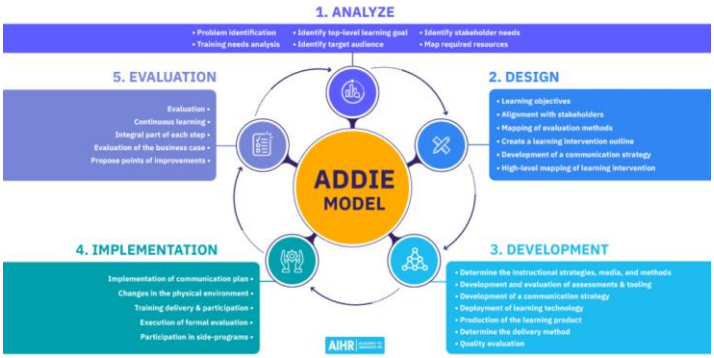

Figure 1. ADDIE Model according to Vulpen[8].

This exploration highlights the intricate processes involved in the integration of technology with the ADDIE model, beginning with the systematic analysis of learner needs and characteristics, the design of pedagogically sound content and activities, the development of technology-infused resources, the effective implementation of digital learning platforms, and finally, the rigorous evaluation of the learning outcomes[9]. Throughout these processes, a dynamic synergy between instructional designers and technology experts emerges, leading to the creation of engaging and effective learning environments[10]. Furthermore, this synthesis offers a myriad of benefits. Technology integration within the ADDIE model allows for enhanced learner engagement, personalized learning experiences, and the fostering of critical 21st-century skills, such as digital literacy and problem-solving[11]. Additionally, it paves the way for scalable and accessible learning solutions, bridging geographical and temporal gaps[12].

As technology-enhanced instructional design continues to gain prominence, it is paramount to assess the tangible learning outcomes that emerge from this fusion. This exploration investigates the impacts of technology-infused ADDIE models on cognitive growth, skill development, and knowledge retention, shedding light on the transformative potential of this approach[13]. Finally, this comprehensive study provides a glimpse into the future of technology integration within instructional design. In a world marked by ever-evolving technologies, the prospects are promising, from the rise of artificial intelligence and immersive technologies to the integration of data analytics for personalized learning paths[14]. The exploration also delves into challenges that must be addressed, including issues of equity, privacy, and evolving educational policies[15].

In sum, the synergy between the ADDIE model and technology integration stands at the forefront of instructional design innovation. As we navigate an era marked by rapid technological advancement, understanding the intricate processes, reaping the benefits, and envisioning future directions of this synthesis is imperative for educators, instructional designers, and policymakers alike. This comprehensive investigation serves as a beacon for those seeking to harness the full potential of technology in transforming education and training. Thus, the following research questions were stated to achieve this study objective.

1) What are the key benefits and contributions associated with using technology to support each phase of the ADDIE model?

Our investigation will draw insights of technology in enhancing the efficiency of development, implementation, and evaluation phases, while also highlighting potential challenges, including issues related to technological infrastructure and learner readiness.

2) What types of educational technologies, tools, and platforms have been most commonly used to facilitate the implementation of the ADDIE model?

In addressing this question, we will reference the works of Clark and Mayer[16], who have discussed the integration of multimedia, simulations, and virtual environments in instructional design. Additionally, we will explore contemporary tools and platforms such as learning management systems (LMS) and authoring software that have become central to instructional design[10].

3) How has the integration of technology into the ADDIE model influenced learning outcomes?

Our review will draw upon research by Mayer[17], who has extensively explored the impact of multimedia and cognitive theory on learning outcomes. We will also reference studies that examine learner engagement and satisfaction metrics in technology-enhanced instructional designs[18].

4) Are there specific sectors or industries where the integration of technology with the ADDIE model has been more prevalent, and what lessons can be drawn from these contexts?

This question will be addressed through the examination of industry-specific case studies and reports, including research on technology integration in corporate training and healthcare education[19,20].

5) What emerging technologies hold potential for further enhancing the ADDIE model in instructional design?

Explore how cutting-edge technologies can be leveraged to improve the instructional design process. Investigate what these technologies can address or offer new opportunities within the ADDIE framework for future researchers.

This systematic literature review will employ a rigorous methodology, systematically searching, selecting, and analyzing peer-reviewed articles. By synthesizing the insights and findings from prior research, our review aims to provide a comprehensive overview of the current state of technology-integrated instructional design within the ADDIE framework. Through this endeavor, we aspire to contribute significantly to the body of knowledge that informs instructional designers, educators, and researchers. Our goal is to shed light on best benefits, contributions, and platforms related to the use of technology for enhancing the ADDIE Model in instructional design.

2. Methodology

2.1. Research design

This systematic literature review (SLR) follows a structured and rigorous research design to comprehensively synthesize and analyze existing scholarly works. The research process adheres to established guidelines for conducting SLRs[21].

2.2. Identification

2.2.1. Database selection

A systematic search of relevant literature will be conducted in major academic database, including Scopus. This database provides a comprehensive collection of peer-reviewed articles, relevant to instructional design and technology integration.

2.2.2. Search strings

To ensure the retrieval of pertinent studies, a combination of keywords and phrases will be used, including "ADDIE Model," "instructional design," "technology integration," "educational technology," and related terms. Boolean operators (AND, OR) will be employed to refine search queries. Moreover, more keywords were applied to decrease the results. For instance TITLE-ABS-KEY (addie AND model) AND (LIMIT-TO SUBJAREA ,"ARTS") OR LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (EXACTKEYWORD, "ADDIE Model") OR LIMIT-TO (EXACTKEYWORD, "Students") OR LIMIT-TO (EXACTKEYWORD, "E-learning") OR LIMIT-TO (EXACTKEYWORD, "ADDIE") OR LIMIT-TO (EXACTKEYWORD, "Instructional Design") OR LIMIT-TO (EXACTKEYWORD, "Teaching") OR LIMIT-TO (EXACTKEYWORD, "Learning Systems") OR LIMIT-TO (EXACTKEYWORD, "Education") OR LIMIT-TO (EXACTKEYWORD, "Online Learning") OR LIMIT-TO (EXACTKEYWORD, "Higher Education") OR LIMIT-TO (EXACTKEYWORD, "Blended Learning") OR LIMIT-TO (EXACTKEYWORD, "Instructional Designs") OR LIMIT-TO (EXACTKEYWORD, "Flipped Classroom") OR LIMIT-TO (EXACTKEYWORD, "Distance Education") OR LIMIT-TO (EXACTKEYWORD, "Learning Management System") OR LIMIT-TO (EXACTKEYWORD, "Design Development") OR LIMIT-TO (EXACTKEYWORD, "Design And Development") OR LIMIT-TO (EXACTKEYWORD, "Distance Learning") OR LIMIT-TO (EXACTKEYWORD, "ADDIE Model") OR LIMIT-TO (EXACTKEYWORD, "ADDIE")).

2.2.3. Inclusion and exclusion criteria

Articles will be included if they focus on the integration of technology within the ADDIE Model in instructional design. Exclusion criteria will involve non-English publications, non-peer-reviewed sources, and studies published before 2010, as the review will prioritize recent developments in technology integration. Moreover, only articles will be included for instance, AND (LIMIT-TO (DOCTYPE, "ar")). Thus, articles written in English language only were considered, for instance this was applied "AND (LIMIT-TO (LANGUAGE, "English")).

2.2.4. Search period

The search will encompass publications from 2010 to the 2022, aligning with the emergence and rapid evolution of educational technology.

2.3. Screening and selection

2.3.1. Initial screening

The initial screening will involve assessing titles and abstracts of retrieved articles for relevance to the research questions. Irrelevant articles will be excluded at this stage. The initial screening that was found was 1679 documents. A set of inclusion and exclusion criteria were applied, then the article decreased from 1679 to 114 documents. Moreover, when we started to download the documents 38 were no retrieved for few reasons. Such as few articles were not available online\free access. few articles have no DOI\link. Thus, 76 documents only were downloaded.

2.3.2. Full-text review

Articles passing the initial screening will undergo a comprehensive full-text review. During this phase, each article will be assessed for its alignment with the research questions and the inclusion/exclusion criteria.

2.3.3. Data extraction

Data will be systematically extracted from the selected articles, including publication details (e.g., author, year), research methods, key findings, and contributions relevant to the research questions.

2.4. Quality assessment

To ensure the reliability and validity of the selected studies, a quality assessment will be performed using established criteria for evaluating the methodological rigor of each source. The assessment will consider factors such as research design, data collection methods, and sample sizes. Documents then went through assessed for eligibility/ quality assessment, so, only 54 documents were included in this review. The documents analysis is illustrated in Appendix A.

2.5. Data synthesis and analysis

2.5.1. Thematic analysis

Extracted data will be thematically categorized to identify recurring themes related to the integration of technology into the ADDIE Model. Themes will be derived from the research questions, and patterns, similarities, and differences across studies will be identified.

2.5.2. Meta-analysis (if applicable)

If a sufficient number of quantitative studies with similar methodologies are identified, a meta-analysis may be conducted to quantitatively synthesize findings and assess effect sizes.

2.6. Reporting

The findings of this systematic literature review will be reported following established reporting guidelines for SLRs[21]. A comprehensive report will include a narrative synthesis of key themes and findings, along with implications for instructional design practice and recommendations for future research. **Figure 2** shows the Prisma framework of the study.

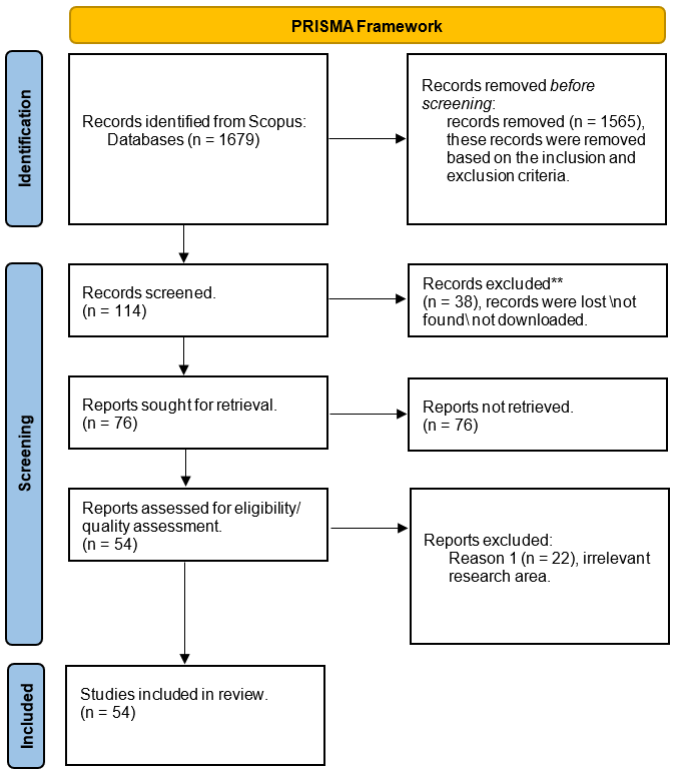

Figure 2. PRISMA framework.

3. Results

3.1. Types of educational technologies, tools, and platforms integrated with the ADDIE model

The provided information encompasses a wide array of educational technologies, tools, and platforms used in integration with the ADDIE model to enhance the instructional design process. These tools have significantly impacted the way students learn and instructors teach, offering various strategies to enhance the educational experience. **Table 1** discusses each of these elements in more detail:

Table 1. Educational technologies, tools, and platforms used in integration with the ADDIE model.

Article	Educational technologies, tools, and platforms used	Explanation
[24]	Course Design	Course design involves the process of planning and organizing the content, structure, and assessment methods of a course. Effective course design is crucial for ensuring that learning objectives are met.
[25,70]	Educational Games	Educational games use gamification techniques to make learning engaging and fun. They often incorporate elements of competition and rewards to motivate students to learn while having fun.
[26]	Print-Based Storybook	Traditional print-based storybooks continue to be valuable tools for early education, fostering a love for reading and imagination in young learners.
[27]	Pancalis: Android-Based Learning Media for Early Reading.	Pancalis is a specific tool that utilizes Android technology to facilitate early reading for children. It's an example of how technology can be used to improve literacy skills.
[28,45,64]	Blended Learning	Blended learning combines traditional classroom instruction with online elements. It provides flexibility for students while maintaining face-to-face interaction, often resulting in a more holistic learning experience.
[23,51]	Online Courses	Online courses refer to educational programs delivered over the internet. They offer flexibility, enabling students to access content from anywhere, at their convenience. They can range from short, specialized courses to full-fledged degree programs.
[30]	Open and Distance Learning Environment	Open and distance learning allows students to study remotely. It is especially valuable for those who cannot attend physical classes, such as working adults and individuals in remote areas
[33]	Cartoon Art Learning Media (CALM)	CALM uses cartoon art to deliver educational content. This visual approach can make learning more engaging, especially for younger students.
[34]	App Development	App development can be a part of educational technology, as it enables the creation of learning apps and platforms for various subjects and purposes.
[36,57]	Flipped Classroom	In a flipped classroom, traditional homework and lectures are reversed. Students learn the content at home through videos or other materials, and class time is used for discussion and application of knowledge.
[37]	Online Learning, Chain Whispering Method	The chain whispering method is a specific approach to online learning. It may involve a sequential exchange of information or ideas among students, akin to a "whispered" relay.
[39]	Learning Management System (LMS), MOODLE	LMSs like Moodle are software platforms used for delivering, managing, and tracking online courses and training programs.
[40]	e-Learning	e-Learning encompasses a broad range of online educational methods, from video lectures to interactive quizzes and assessments.
[41]	Vlogs	Vlogs, or video blogs, can be used as educational tools to deliver content in a more personal and engaging manner.
[42]	Learning Management System Supported Smartphone (LMS3)	LMSs supported on smartphones offer the convenience of learning on mobile devices.
[43]	Digital Learning	Digital learning encompasses all forms of learning that utilize digital technologies, including e-books, interactive simulations, and online courses.
[44]	Mobile Learning	Mobile learning refers to the use of mobile devices such as smartphones and tablets for learning. It allows for learning on the go.
[46]	Augmented Reality Applications	Augmented reality apps overlay digital information on the real world, making learning more interactive and immersive.
[47]	Animation Learning Media	Animation can be a powerful tool for explaining complex concepts in a visually appealing way.

Table 1. (*Continued*).

Article	Educational technologies, tools, and platforms used	Explanation
[48]	Problem-Based Learning Management System-Supported Smartphone (PBLMS3)	PBLMSs supported on smartphones can enhance problem-based learning, a student-centered approach that fosters critical thinking.
[49]	Course Instruction	This refers to the specific teaching methods and materials used to deliver a course's content.
[50]	Virtual Laboratory	Virtual laboratories simulate real-world experiments and can be used for scientific and technical education.
[53]	Electronic Evaluation System (E-ES)	E-ES systems simplify the assessment and grading of students' work through electronic means.
[54]	Game Design	Game design can be used for creating educational games that are not only engaging but also educational.
[55]	Web-Based Module	Web-based modules are self-contained units of online content designed for specific learning objectives.
[56]	Massive Open Online Course (MOOC)	MOOCs are large-scale online courses accessible to anyone with an internet connection. They are often offered by universities and organizations.
[60]	Training Kit	Training kits contain resources and materials to support a specific training or educational program.
[61]	e-Portfolio	e-Portfolios are digital collections of a student's work and achievements, which can be used for assessment and reflection.
[62]	Worksheets	Worksheets are common tools in education, providing exercises and questions for students to practice and reinforce their learning.
[63]	Linear Algebra Peer Tutoring Strategy (LAPTS)	LAPTS is a specific tutoring strategy designed for the subject of linear algebra.
[65]	Web Game	Web games can be used for educational purposes, often to make learning more interactive and enjoyable.
[66]	Teacher Research Competency Training System	This system supports teachers in developing research skills to improve their teaching methods.
[67]	Digital Interactive Math Comics (DIMaC)	DIMaC combines digital technology with comics to teach math, offering an engaging and visual approach to learning.
[68]	Camtasia Software	Camtasia is a software tool used for creating video tutorials and presentations, often used in education.
[72]	Authentic-Based Instructional Materials	Authentic-based materials are resources that reflect real-world contexts and situations, making learning more relevant.
[74]	A Mobile Learning Application "MobiEko Apps"	MobiEko Apps is an example of a mobile application designed for educational purposes.
[75]	Multimedia Mobile Learning Application (Mfolktales)	Multimedia mobile learning applications use various media formats, such as video, audio, and interactive elements, to enhance the learning experience.

In conclusion, these educational technologies, tools, and platforms cater to a diverse range of learning styles and preferences used in integration with the ADDIE model to enhance the instructional design process, offering educators and students numerous options to make the educational process more engaging, effective, and accessible. The use of technology in education continues to evolve, providing exciting opportunities for both learners and educators.

3.2. The key benefits and contributions associated with using technology to support the ADDIE model

In the realm of educational and instructional design benefits and contributions, the ADDIE approach is a widely employed framework. Numerous scholarly articles delve into the merits and contributions of harnessing technology to enhance the ADDIE methodology. For instance, in a study detailed by Sun et al.[23], the ADDIE approach is showcased as a potent tool for leadership training among Nigerian pharmacy interns. Additionally,

it has been creatively utilized to design instructional games aimed at elevating children's higher-order thinking skills, as illustrated in the study by Rakimahwati et al.[25]. Moreover, Salinas-Navarro[31] presents a comprehensive integration of experiential learning, ADDIE, sustainability, and Sustainable Development Goals (SDGs) in the domain of supply chain management. Art and culture blended learning, underpinned by the ADDIE model, is explored in the study by Nurhayati et al.[45]. Furthermore, Prasetyowati[58] underscores the significance of crafting instructional DVDs to enhance the reasoning abilities of students enrolled in the Mathematics Education Study Program, all within the framework of the ADDIE approach. These publications collectively serve as a testament to the remarkable adaptability and positive impact of the ADDIE paradigm when coupled with technology in various educational contexts[23,25,31,45,58]. While discussing educational improvements, Sun et al.[22] suggest that Shanghai East Hospital's residency training could benefit from a more robust educational approach, hinting at the potential utility of ADDIE. Similarly, Ningsih et al.[24] highlight the transformative effect of the Global Information Ethics Trust and Literacy (GIETAL) model on student learning. In a unique application, Arnilla[26] employs ADDIE to craft a narrative on Akeanon COVID-19 tailored for young children, showcasing the flexibility of the approach.

Furthermore, Shakeel et al.[28] recommend utilizing ADDIE and quick prototyping to produce highly effective blended learning instructional materials. The model has also been instrumental in developing assessments for pre-service primary school teachers to bolster their higher-order thinking skills. Ahmed et al.[30] demonstrate how linked lesson plans can be created using ADDIE, while Hamzah et al.[32] pioneer Islamic studies LMS-based blended learning. A deeper dive into the versatility of the ADDIE model reveals its role in the study by Dewi et al.[33], focusing on the development of Cartoon Art Learning Media (CALM) to enhance children's conflict resolution abilities. Additionally, Cho et al.[34] offer insights into the creation of a South Korean mental health app, with ADDIE guiding the entire design and development process. Maryani et al.[35] present compelling evidence of the significant positive impact on students' Higher-Order Thinking Skills (HOTS) attributable to the implementation of ADDIE. In response to the challenges posed by the COVID-19 crisis, Petridou et al.[36] introduce an inquiry-based sequence inspired by ADDIE, leveraging flipped classrooms and inquiry learning to enhance scientific literacy among second-year senior high school students. Sasmito et al.[37] adopt ADDIE for the development of an alternative online learning strategy tailored to the demands of the COVID-19 pandemic. The versatile ADDIE model is also at the heart of the study by Kim and Lee[38], a study that centers on the development and evaluation of a maternal nursing competence enhancement program for nursing students. Widyaningsih et al.[39] take aim at Higher-Order Thinking Skills in physics education, using ADDIE-based learning materials as a catalyst for improvement. Lastly, Sait and Tombs[40] underscore the overarching principles of effective instructional design, aligning seamlessly with ADDIE's core concepts. These articles, collectively, emphasize the adaptability and efficacy of the ADDIE model across diverse educational and instructional contexts. For instance, Rizal et al.[42] illuminate the development of an LMS3 smartphone management systems app rooted in ADDIE principles. Similarly, in the study by Syed Sazly et al.[46], the ADDIE paradigm finds application in the creation of augmented reality-based educational apps. Sustainability topics and web-based learning modules are seamlessly integrated into education through ADDIE in the study by Hsieh[54] and Ben Fadel and McAleer[55]. Bahri et al.[64] delve into the creation of blended learning lesson plans and assessment sheets for the study of Animal Physiology, all crafted within the ADDIE framework. In addition, Ismail et al.[60] accentuate the creation of a Training Kit, meticulously designed with ADDIE principles in mind. Lastly, Falahah and Irrahali[70] introduce an educational game aimed at facilitating a deeper understanding of Indonesia, thoughtfully constructed using the ADDIE methodology.

In short, these articles collectively underscore the remarkable adaptability of the ADDIE model in a multitude of educational and instructional design scenarios, thereby contributing to effective learning and skill development.

3.3. The integration of technology into the ADDIE model and learning outcomes

In relation to the integration of technology into the ADDIE model and learning outcomes. These articles contain a wide range of projects that utilize the ADDIE model in diverse educational contexts, showcasing the model's adaptability and its impact on learning outcomes. Firstly, some articles presented the integration of technology with the ADDIE model is a common theme[22–40]. Various projects employ the ADDIE approach to design training courses, instructional games, and materials aimed at enhancing learning outcomes. For example, Nwizu et al.[23] demonstrates the creation of an online leadership and clinical pharmacy program for intern pharmacists in Nigeria, while article Rakimahwati et al.[25] discussed instructional games to foster higher-order thinking in children. These articles collectively emphasize the value of incorporating ADDIE and technology in educational settings, with an array of positive outcomes noted, from improved reasoning abilities to enhanced conflict resolution skills and higher-order thinking among students.

Secondly, highlighting the application of the ADDIE model in different educational domains[41–60]. The ADDIE model is utilized for various purposes, including the development of vlogs, mobile apps, and virtual laboratories. It is notable that these applications address specific learning needs and have received positive feedback, such as improved comprehension and increased motivation among students. Additionally, these studies illustrate the versatility of the ADDIE model in creating effective learning materials and environments across different subject areas.

Finally, revealing the model's impact on pedagogical approaches and student engagement[61–74]. Several articles discuss the integration of ADDIE with other methods, such as flipped classrooms and problem-based learning, to enhance student participation and learning quality. Moreover, studies delve into the development of e-portfolios, interactive math comics, and other innovative learning resources, all contributing to improved learning experiences. These findings highlight the importance of incorporating the ADDIE model into pedagogical practices to facilitate effective teaching and student engagement. **Figure 3** presented the integration of technology into the ADDIE model and learning outcomes.

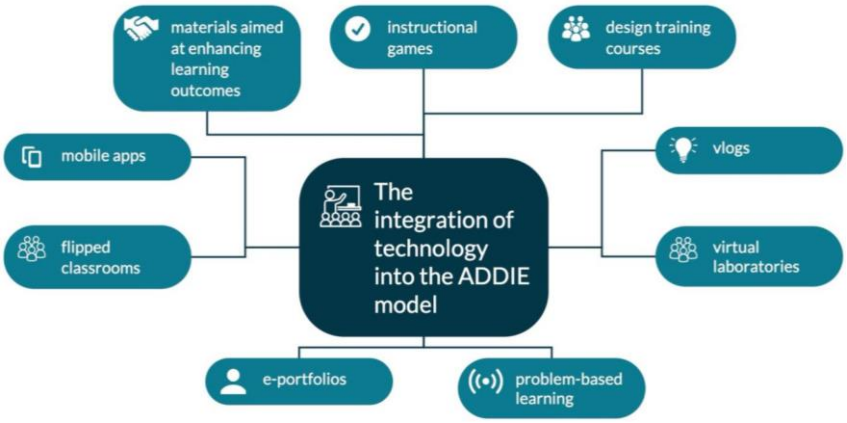

Figure 3. The integration of technology into the ADDIE model and learning outcomes.

In summary, the collection of articles underscores the versatility and positive impact of the ADDIE model in diverse educational contexts, emphasizing the potential of technology integration, its relevance across various subjects, and its role in improving pedagogical approaches and learning outcomes.

3.4. The sectors or industries where the integration of technology with the ADDIE model

In today's rapidly evolving educational and training landscape, the integration of technology with the ADDIE model has become a pivotal strategy for fostering innovation and efficiency. This transformative approach is now extending its reach across a spectrum of sectors and industries, from healthcare and education to professional training, shaping the way we design, develop, and deliver impactful learning experiences. In

this context, let's explore the diverse sectors where the synergy of technology and the ADDIE model is driving progress and excellence. The list of sectors or industries in which the integration of technology with the ADDIE model is being implemented appears to be a mix of educational, healthcare, and training settings. It is important to note that technology integration with the ADDIE model can involve a wide variety of industries and sectors, including higher education. As of this study, 29 out of 54 studies (53%) were conducted in higher education, three in primary schools (6%), and the remaining 41 percent varied between teacher training, medical training, nurse training, etc. Within each of these industries, the specific uses and effects may differ. The incorporation of technology into education and training is frequently motivated by the desire to make learning more participatory, accessible, and effective.

Here's a breakdown of the sectors or industries mentioned in your results: Clinic Training Technology may be integrated into training programs for medical clinics to improve the efficiency and effectiveness of training healthcare professionals[22]. Pharmacy Interns Technology integration in the training and education of pharmacy interns, which can include online modules and simulations[23]. Higher Education is a broad category, but it likely refers to colleges and universities using technology to enhance the teaching and learning experience[24–28,30–32,45–58,60–65,70–74]. Primary School Technology is being used to enhance the educational experience in primary schools[29,35,75]. Elementary Schools Technology integration in elementary school settings[33]. Health and Medical integration of technology in healthcare and medical education and training[34]. Nursing education and training may involve the use of technology[38]. Medical Education Technology integration in medical education and training programs[59]. School Teachers: This could refer to technology integration in teacher training or professional development. High School[67]: the use of technology in high school education and training. Training programs for educators may be incorporating technology[66].

Figure 3 illustrates the sectors or industries where the integration of technology with the ADDIE model. As technology continues to shape the future of education, training, and healthcare, the integration of the ADDIE model stands as a beacon of adaptive learning. Through the collaborative efforts of educators, professionals, and innovators across various sectors, this powerful marriage of pedagogy and technology promises to pave the way for lifelong learning and transformative growth. The journey towards a smarter, more interconnected world of education and training is just beginning.

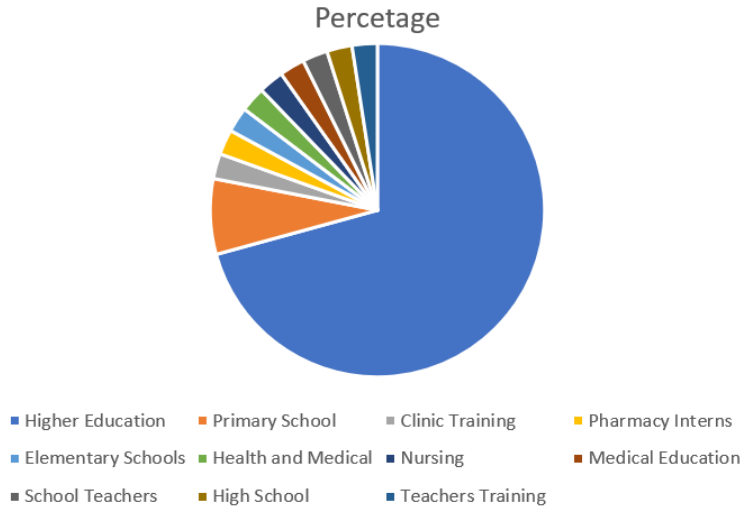

Figure 3. The integration of technology into the ADDIE model and learning outcomes.

3.5. The emerging recommendations for further enhancing the ADDIE model in instructional design

In the ever-evolving landscape of instructional design, a spotlight is cast on the emerging recommendations for refining the ADDIE model. As the demands for effective, adaptable learning experiences

surge, it becomes paramount to explore the innovative strategies and insights shaping the future of this foundational framework. Within this discussion, we delve into the latest recommendations that promise to elevate the ADDIE model to new heights in the realm of instructional design. The field of instructional design and educational research has seen significant advancements in recent years. This discussion summarizes the key findings and recommendations from a wide range of articles, shedding light on various aspects of teaching and learning. These insights offer valuable guidance for researchers, educators, and policymakers interested in improving educational practices and outcomes.

1) Enhancing the ADDIE Model: Several articles emphasize the importance of improving the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model in instructional design. Sun et al.[22] suggest creating a closed-loop teaching management model of ADDIE to enhance clinical teachers' skills, underlining the need for ongoing research and exploration in curriculum development and teacher training.
2) Pedagogical Strategies and Student Learning: Innovative pedagogical approaches are at the forefront of educational research. Ningsih et al.[24] highlight the success of the GIETAL learning paradigm in improving student learning outcomes, showcasing the potential for new teaching methods. Additionally, Rakimahwati et al.[25] discusse the independent enhancement of symbolic thinking and problem-solving skills through audio and the role of instructor aid in improving logical thinking.
3) Educational Materials and Multilingualism: The development of instructional materials is a critical aspect of effective teaching. Arnilla[26] suggests printing health literacy materials for areas with poor internet connectivity and emphasizing the importance of creating materials in the mother language to aid young children's understanding. Dewi et al.[33] recommend creating cartoon learning materials targeting various skills and considering children's cognitive growth.
4) Technology Integration: The use of technology in education is a recurring theme. Shakeel et al.[28] advocate for incorporating instructional design into blended learning for polytechnic students, highlighting the potential of technology in enhancing teaching methods. van den Berg and de Villiers[41] underscore the importance of technology-enhanced communication skills in the context of the 4th Industrial Revolution sports business.
5) Focus on Higher Order Thinking Skills (HOTS): Several articles emphasize the need to develop Higher Order Thinking Skills. Maryani et al.[29] call for further research to enhance HOTS in Indonesia, while Widyaningsih et al.[39] stressed the importance of offering HOTS-based learning tools to students.
6) Student-Centered Learning: Ensuring learner-centered teaching is a prevalent concern. Ahmed et al.[30] recommend using scaffolding and positive reinforcement to guarantee learner-centered teaching and calls for further research to evaluate these tactics.
7) Sustainability and Game-Based Learning: The intersection of education and sustainability is a growing area of interest. Hsieh[54] links game design with sustainable development, suggesting that it can inspire students and players to care about sustainable development in engaging circumstances.
8) Blended Learning: Blended learning is gaining traction, as highlighted in Nurhayati et al.[45], where it successfully enhances Art Culture learning results, emphasizing the potential of this approach.
9) Effective Online Learning: Sutama et al.[57] discusses the effectiveness of flipped classroom-centered mathematics instruction in STEM, which can be an excellent strategy for acquiring expertise and promoting active learning.
10) Technology in Language Learning: Ngui et al.[61] introduces e-Portfolios as a promising tool for assessing second language learners, highlighting its potential for enhancing language education.
11) Mobile Learning: Ibrahim et al.[74] presents mobile education software, designed to facilitate Microeconomics course study on mobile devices, emphasizing the importance of leveraging mobile technology for blended learning.

12) Multilingual Learning: Salas-Rueda et al.[65] suggests exploring video-based online system design and development using multiple languages, emphasizing the value of personalized, multilingual educational content.
13) Innovative Learning Modules: Yu et al.[50] presents a framework for scientific and technical courses that require virtual experimentation, underlining the significance of creating engaging learning modules to supplement theoretical training.
14) Sustainable Development in Education: Hsieh et al.[54] emphasizes the role of game-based learning in inspiring students and players to care about sustainable development, showcasing the potential of creative and interactive educational approaches.
15) Student Engagement and Peer Confidence: Abdurrahman et al.[63] discusses how involving students in the instructional process can enhance their mathematical thinking and boost peer confidence, highlighting the importance of interactive and student-driven learning.
16) Integrating Online Learning: Leonard et al.[66] mentions the start of a new design process, suggesting ongoing innovation and the potential for breakthroughs in educational research and design.
17) Specialized Educational Tools: Ismail et al.[60] underscores the importance of specialized kits, like the one used in HVAC programs, as essential resources in specific vocational training.

These findings reflect the dynamic and evolving landscape of instructional design and educational research. They underscore the importance of continuous improvement, technology integration, and learner-centered approaches in the educational sector. Additionally, they call attention to the importance of adapting teaching strategies to suit the needs of diverse student populations and harnessing technology's potential to enhance learning outcomes. Future research should build upon these insights to further refine and innovate teaching and learning methodologies.

4. Discussion

To In the dynamic world of education, a wide spectrum of educational technologies, tools, and platforms has emerged to enrich the learning experience and bolster effective course design. These versatile tools cater to diverse educational needs and are reshaping the learning landscape for both students and educators.

To address the first question, the most used tools were used for course Design serves as the foundation, with various methodologies like Educational Games injecting interactivity and fun into learning. Additionally, Print-Based Storybooks and Pancalis: Android-Based Learning Media for Early Reading cater to different age groups, fostering literacy and understanding. Blended Learning expertly combines traditional and online instruction, offering flexibility and accessibility. Online Courses and Open and Distance Learning Environments leverage digital resources to broaden educational reach. Innovative tools, such as Cartoon Art Learning Media (CALM) and App Development, stimulate creativity and artistic expression in education. The concept of Flipped Classrooms flips traditional teaching by engaging students with content before in-person sessions. Course Instruction is enhanced with tools such as Virtual Laboratories and Electronic Evaluation Systems (E-ES), providing hands-on experiences and streamlined assessment. Game Design and Web-Based Modules offer engaging educational content. Massive Open Online Courses (MOOCs) make education accessible worldwide. In short, the adoption of these educational technologies and tools underscores a commitment to making education engaging, accessible, and effective. Moving forward, their integration will continue to reshape the educational landscape, offering increasingly personalized and efficient learning experiences. Adaptability and innovation will be essential for leveraging these tools to their full potential in the pursuit of knowledge dissemination.

To address the second question Several articles, highlight its adaptability and positive impact across diverse educational contexts. For instance, Nwizu et al.[23] demonstrates its effectiveness in leadership training for pharmacy interns, while Rakimahwati et al.[25] creatively uses it to design instructional games for children's

higher-order thinking skills. Additionally, Salinas-Navarro et al.[31] integrates ADDIE with experiential learning and sustainability for supply chain management. Nurhayati et al.[45] explores art and culture blended learning, Prasetyowati et al.[58] enhances reasoning abilities with instructional DVDs, and Arnilla et al.[26] tailors ADDIE to create child-friendly COVID-19 narratives. Shakeel et al.[28] recommends ADDIE for blended learning materials, and it aids the development of assessments for primary school teachers in Hamzah et al.[32]. Dewi et al.[33] applies ADDIE to create Cartoon Art Learning Media for children, and Cho et al.[34] guides a South Korean mental health app's design. The implementation of ADDIE improves Higher-Order Thinking Skills (HOTS) in Maryani et al.[35]. In response to COVID-19, Petridou et al.[36] used ADDIE for inquiry-based learning, Sasmito et al.[37] developed alternative online learning strategies, and Kim et al.[38] created a maternal nursing competence enhancement program. Moreover, Widyaningsih et al.[39] focused on HOTS in physics education using ADDIE-based materials, Sait et al.[40] emphasized effective instructional design principles, and Rizal et al.[42] integrated ADDIE into an LMS3 smartphone management app. Syed et al.[46] applied ADDIE to augmented reality educational apps, Hsieh et al.[54] and Ben Fadel et al.[55] combined it with sustainability topics and web-based learning modules, Bahri et al.[64] designed blended learning lesson plans and Ismail et al.[60] created a Training Kit. Lastly, Falahah et al.[70] used ADDIE for an educational game about Indonesia. These articles collectively showcase ADDIE's adaptability and efficacy, contributing to effective learning and skill development in diverse educational settings.

Regarding the third question, the articles featured a wide range of projects demonstrating the versatility of the ADDIE model in various educational settings and its impact on learning outcomes. They commonly integrated technology with ADDIE[22–40], employing it to design training courses, instructional games, and materials that improved learning outcomes. These articles also highlighted the ADDIE model's application in diverse educational domains[41–60]. It was used for creating vlogs, mobile apps, virtual laboratories, and other learning resources, resulting in enhanced comprehension and motivation among students. Moreover, the ADDIE model's influence on pedagogical approaches and student engagement was evident in the articles[61–74]. It was integrated with methods like flipped classrooms and problem-based learning, contributing to improved teaching and learning quality. In essence, these articles collectively emphasize the ADDIE model's adaptability and its ability to positively impact learning across diverse educational contexts, particularly when combined with technology, in various subjects, and for enhancing teaching and student engagement.

Moreover, for the fourth question, Technology integration with the ADDIE model is implemented across various sectors, including education, healthcare, and training. Among the studies, 53% were conducted in higher education, 6% in primary schools, and the remaining 41% spanned teacher training, medical training, nurse training, and more. Each sector employs technology integration with ADDIE for distinct purposes. In clinics, it enhances medical training, while pharmacy interns benefit from online modules and simulations [22,23]. Higher education institutions use it to improve teaching and learning. Primary and elementary schools integrate technology for an enriched educational experience[29,33,35,75]. The health and medical sector employs it in healthcare and medical education[34], and nursing education incorporates technology[38]. Medical education and training programs also leverage technology[59]. High schools and teachers' training programs benefit from technology integration[66,67].

Finally, the fifth question, this summary distills findings and recommendations from a wide array of articles, offering valuable insights for educators, researchers, and policymakers seeking to enhance educational practices. Articles spotlight the need for refining the ADDIE model in instructional design and fostering innovative pedagogical approaches, such as the GIETAL learning paradigm for improved student outcomes and the integration of technology for higher-order thinking skills. They underscore the significance of effective educational materials, multilingualism, and technology in diverse educational contexts, including the vital role of blended learning and specialized educational tools. These articles emphasize the importance of technology-enhanced communication skills and sustainability in education and encourage personalized, multilingual

educational content. They also underscore the value of student-centered learning, innovative modules, and strategies to enhance student engagement and peer confidence. Ultimately, they provide a comprehensive guide to improving educational practices across various sectors and domains.

5. Conclusion and future implications

In conclusion, the synthesis of diverse articles spanning various educational domains and technological applications underscores the remarkable adaptability and potential of the ADDIE model when integrated with technology. These findings serve as a valuable resource for researchers, educators, and policymakers aiming to enhance educational practices and outcomes. The key takeaways can be summarized in several overarching themes:

Firstly, the importance of continuously improving the ADDIE model in instructional design cannot be overstated. Articles emphasize the need for ongoing research and exploration in curriculum development, teacher training, and clinical teaching management, underscoring the model's pivotal role in upgrading teaching skills and methodologies. Secondly, innovative pedagogical approaches are at the forefront of education, exemplified by the success of the GIETAL learning paradigm in improving student outcomes and the independent enhancement of symbolic thinking, problem-solving, and logical thinking. These insights offer fresh perspectives on teaching and learning methods. Effective educational materials are critical for impactful teaching. Articles advocate for the creation of health literacy materials, particularly in areas with poor internet connectivity, and underscore the importance of developing educational content in the mother language to aid young children's understanding. The significance of creating materials like cartoon learning resources targeting various skills, and their alignment with children's cognitive development, is also evident. The integration of technology into education is a recurring theme. Technology-enhanced communication skills and innovative educational tools, such as blended learning and mobile learning, offer new avenues for enriching the teaching and learning experience. These articles collectively emphasize the potential of technology integration in enhancing teaching methodologies.

Higher Order Thinking Skills (HOTS) development is of paramount importance, as articles call for further research to enhance HOTS, particularly in Indonesia. Offering HOTS-based learning tools to students is crucial to foster critical thinking and problem-solving skills. Student-centered learning practices are integral to effective teaching. Articles recommend the use of scaffolding, positive reinforcement, and ongoing research to ensure learner-centered teaching, ultimately enhancing the overall learning experience. The intersection of education and sustainability emerges as a growing area of interest. Game-based learning is suggested as a tool to inspire students and players to care about sustainable development in engaging circumstances. Blended learning, which effectively combines traditional and online instruction, is gaining traction and showcases its potential in enhancing learning outcomes across various subjects. Effective online learning methods, like the flipped classroom-centered mathematics instruction, are recognized as beneficial for acquiring expertise and promoting active learning. Language learning and multilingual education are areas where technology can play a crucial role. The introduction of e-Portfolios as an assessment tool highlights the potential for enhancing language education. Mobile learning is emphasized, with mobile education software designed to facilitate learning on mobile devices, underlining the importance of leveraging mobile technology for blended learning. Innovative learning modules, as exemplified by scientific and technical courses that require virtual experimentation, offer engaging opportunities for supplementing theoretical training. Sustainable development in education is crucial, and the use of game-based learning to inspire students to care about sustainable development is highlighted. Enhancing student engagement and boosting peer confidence are crucial in the educational process. Involving students in the instructional process and fostering interactive and student-driven learning can significantly enhance the learning experience. Furthermore, the integration of online learning is an evolving process that holds the promise of innovation and breakthroughs in educational research and design.

Lastly, specialized educational tools like the HVAC training kit are invaluable resources in specific vocational training, offering hands-on experiences and practical relevance.

The document provides a comprehensive review of how technology enhances the ADDIE model in instructional design. It delves into the impact, benefits, and technologies associated with the ADDIE model, alongside its application in various industries. The review suggests future research directions, notably the need for more case studies and empirical data to augment the literature review. This would enrich understanding of the practical application and effectiveness of technology within the ADDIE framework across different educational contexts.

In summary, these articles collectively underscore the remarkable adaptability and impact of the. ADDIE model when integrated with technology in diverse educational contexts. The findings and recommendations offer a comprehensive guide to improving educational practices, from refining instructional design and fostering innovative pedagogical approaches to enhancing educational materials, technology integration, and student-centered learning. As we navigate the ever-evolving landscape of education, these insights are invaluable for creating a more effective, engaging, and responsive learning environment.

Conflict of interest

The authors declare no conflict of interest.

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Appendix

Table A1. Papers analyzed.

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A1	22	In the residency standardised training at Shanghai East Hospital, there are issues with the quality of short lectures and the lecturing abilities of clinical instructors.	-	On the basis of ADDIE, the focused teacher training course Clinical Teacher Presentation Training was designed (CTPT).	Clinic Training	The Teaching and Training Department needs to conduct more teaching research and explorations to improve the curriculum and teacher training system and create a closed-loop teaching management model of ADDIE to help clinical teachers improve their teaching skills.
A2	23	The study proves the effectiveness of the ADDIE instructional design paradigm in organising and delivering leadership training for Nigerian pharmacy interns.	online courses	Using the ADDIE model, a twelve-month online leadership and clinical pharmacy improvement programme was devised and given to intern pharmacists in Nigeria.	pharmacy interns	Future initiatives should involve continuous leadership training, an increase in student numbers, and adaptations and enhancements based on the lessons acquired from this inaugural experience.
A3	24	The GIETAL methodology increases student learning outcomes, as proven by the fact that 51 students (94.44 percent) met or exceeded the minimum semester learning plan objectives.	Course design	During the Covid-19 epidemic, it may be determined that the GIETAL Model is useful for teaching Database Design courses.	Higher education	It has been shown that the GIETAL learning paradigm successfully improves student learning results
A4	25	The objective of the educational games was to enhance children's analytical or higher-order thinking. This research used the ADDIE model.	Educational games	The instructional games encouraged analytical or higher-order thinking in youngsters. Research employed the ADDIE paradigm.	Education	According to the research on symbolic thinking, problem-solving, and logical thinking, symbolic thinking and problem-solving can be enhanced independently with audio, but logical thinking requires instructor aid to finish the game.
A5	26	The ADDIE paradigm was used to create a COVID-19 preventive storybook for young children in Akeanon, the mother language.	Print-based storybook	This investigation shows that mother tongue-based COVID-19 educational materials are well received, particularly when validated tools assist increase awareness and promote preventative behaviour.	Education	Instructional material creators may print health literacy materials since they are most accessible to places with poor Internet connection. To help young children grasp health and safety messages, health literacy material should be developed in the mother language.
A6	27	This research produced Android-based Pancalis (good at reading and writing). Interactive, creative Android-based instructional material for early reading created using Adobe Flash.	Pancalis: Android-based learning media for early-reading	The Pancalis programme is appropriate for early reading instruction and learning in the early elementary grades.	Education	Pancalis is recommended for teaching early reading, and the instructors' and students' responses to the practicality questionnaire indicate that Pancalis is very user-friendly.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A7	28	This research seeks to develop a pedagogical design based on the ADDIE and rapid prototyping models in order to provide a reliable and strong instructional design for the blended learning environment.	blended learning context for polytechnic students	The suggested instructional design may aid TVET instructors and course designers in creating a strong integrated learning environment, applicable to various fields like science and engineering education.	Education	Incorporating instructional design into blended learning may be a dependable and valid technique for polytechnic students.
A8	29	Using the ADDIE approach, a test of higher-order thinking in science for pre-service primary school teachers.	-	recognising the requirements and baseline of higher-order thinking abilities of students in the Yogyakarta Department of Primary School Teacher Education.	Primary School	This study suggests more research in order to enhance HOTS using a learning strategy. This is intended to raise the HOTS of pupils in Indonesia.
A9	30	They have offered three interconnected lesson plans that use public relations and scaffolding strategies based on the ADDIE.	open and distance learning environment	The present work demonstrates how to construct an LCP-based adult learning system capable of bringing about a paradigm change in existing instructional approaches based on the ADDIE model.	Higher education	This research suggested using scaffolding and positive reinforcement to guarantee learner-centered teaching. Future research may utilise the lesson plans and evaluate the tactics employed in this study.
A10	31	It integrates experiential learning, the ADDIE paradigm for instructional design, the Triple Bottom Line for sustainability, the continuous improvement cycle, and the SDGs into an SCM model.	-	The findings indicate strong student learning outcomes and positive attitudes of learning relevance, interest, motivation, and course recommendation.	Higher education	Learning experiences must be used more to enhance study design and assessment. Next steps in developing learning experiences should include data gathering, analysis, and declarations and conclusions about the framework, its contributions, and its application.
A11	32	developing LMS-based blended learning utilising the Web-Centric Course (WCC) paradigm for Islamic studies to meet curricular requirements using ADDIE.	Blended Learning	The E-learning-based Blended Learning paradigm strives to increase learning quality by including students in the learning process, allowing them to construct their own knowledge.	Higher education	Improved learning results in experimental classes using the created approach positively complement the study program's defined curriculum.
A12	33	This project aimed to create Cartoon Art Learning Media (CALM) to enhance children's ability to resolve conflicts. using ADDIE.	cartoon art learning media (CALM)	Researchers may create cartoon learning material for several subjects. The learning material might target various skills required today. Besides that, researchers should consider a child's cognitive growth.	elementary schools	Researchers may create cartoon learning material for several subjects. The learning material might target various skills required today. Besides that, researchers should consider a child's cognitive growth.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A13	34	This research details the design, development, and evaluation of a South Korean mental health app. this instructional systems model (ADDIE) describes the complete mental health app design and development process.	App development	The app offers information on emotional, physical, and psychological responses to stress, a diagnostic self-assessment tool with tailored feedback, self-care and other-care approaches using text, audio, and video, and resources.	Health	In the usability test, numerous users proposed adding audio and video snippets to the mental health app. Current generations, especially those in their 20s and 30s, may prefer multimedia. Unfortunately, money and timing restrictions prevented us from completely implementing those proposals.
A14	35	The experimental investigation determined that the adoption of the ADDIE had a significant impact on students' HOTS, which increased by 75% (a significant effect) as a result of the model's implementation.	Online learning	The experimental investigation determined that the learning model had a substantial influence on students' HOTS, which increased by 75% (a substantial effect) as a result of its adoption.	primary school	Future study should examine additional characters that arise throughout this model's execution. Each person's learning style affects metacognition. Instructors should accommodate individual variances to provide equitable learning for all students.
A15	36	The intervention targeted second-year senior high school pupils. Inspired by the ADDIE approach, an inquiry-based sequence was created and deployed utilising flipped classroom and inquiry learning to improve students' scientific literacy during COVID-19.	flipped classroom	Even in remote learning, students' involvement in a series of flipped classroom and inquiry learning may enable them participate actively in the learning process and apply the Control of Variables Strategy (CVS) to unconfounded experiment design.	Higher education	The current research suggests that older students may learn key procedural information in designing experiments, such as CVS, without explicit conventional instruction with knowledge transfer. Lower secondary pupils might benefit from well-designed inquiry-based worksheets that encourage active learning and experiment creation.
A16	37	An alternate online learning strategy for the COVID-19 pandemic was introduced by this research. This R&D project followed the ADDIE.	Online learning, chain whispering method	Online learning may readily include the chain whispering approach with chat messaging.	Higher education	Further study may cover more topics. The Evaluation stage also indicated that locus of control, metacognition, and self-efficacy improve online learning, notably student comprehension and motivation. Research on developing online learning methods should focus on these features.
A17	38	Develop and evaluate a maternal nursing competence enhancement programme for nursing students in Korea.	Face to face	This maternal nursing competence reinforcement programme enhances performance, problem-solving, and emotional intelligence in nursing students studying high-risk care.	Nursing	This training may improve maternal nursing skills. Consider adding coaching to enhance self-directed learning and increasing programme hours for adequate training.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A18	39	This project develops Modern Test Theory-based HOTS physics questions for LMS Moodle e-learning. This research aims to enhance students' HOTS by using diverse HOTS-based learning materials.	LMS, MOODLE	The performance of the HOTS instrument, which is given by Moodle LMS for use in e-learning, is satisfactory.	Higher educating	It is necessary to practise the students' HOTS by offering learning tools that are based on the HOTS.
A19	40	This study explains how an e-learning resource may be developed using instructional models, educational theories, and educational principles.	e-Learning	Students were happy with the material and believed it helped them learn how to read chest x-rays, according to preliminary evaluations.	Medical	This resource may be accessed as a stand-alone resource or prior to beginning clinical assignments, and it may be especially valuable in the present, hard learning environment when there is a lack of resources. An increased need for digital resources.
A20	41	In this research, vlogs were used as a novel evaluation technique to determine the communication skills and material mastery of students enrolled in Sports Management courses.	vlogs	The framework for vlog production and delivery, based on rhetorical principles, enables students to build communication skills throughout planning, retrieving, recording, editing, and evaluation.	Higher education	The use of the conceptual framework for vlog creation training is intended to cover subject learning and evaluation as well as the technology-enhanced communication skills needed of graduates entering the digitally enhanced 4IR sports business.
A21	42	LMS3 is a smartphone management systems app. It was designed utilising the ADDIE model. The demands and learning goals of school physics instructors were analysed to create LMS3.	Learning Management System Supported Smartphone (LMS3)	Using LMS3, school physics professors may help students search for, assess, and save knowledge, collaborate synchronously, and create digital material.	School teachers	The LMS3 learning environment would inspire students to acquire new skills and improve their existing ones.
A22	43	This project collaborated with Taipei Zoo to recruit 37 students from the Learning Design and Practice course to build animal conservation applications and evaluation tools for digital learning materials.	Digital Learning	The five undergraduate groups discussed learning material, layout, games, and knowledge checkpoints while using and experiencing previous applications. Undergrads might also use the ADDIE approach to design, tweak, and improve animal conservation applications.	elementary school	Future elementary school students might engage in a field research utilising the applications in Taipei Zoo to obtain detailed learners' thoughts and experience to enhance and improve the apps and evaluate their learning efficacy.
A23	44	A mobile-learning framework for universities is presented in this article. The platform-independent m-learning tool framework is detailed. It would be feasible for many Saudi university students under detailed supervision.	Mobile Learning	The primary application uses (ADDIE) framework to make the curriculum adaptable, scalable, and dynamic and to provide pupils tailored instruction.	-	The next level of our MLT expansion will concentrate on contextualised game-based learning. To make the programme more appealing, we want to make it accessible on app stores and use autonomous learning.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A24	45	This research seeks to (1) define blended learning development design, (2) describe the validity of the outcome, and (3) determine the usefulness of blended learning on Art Culture using ADDIE.	blended learning	Research findings indicate that (1) ADDIE model-based blended learning design and (2) expert and user-validated product with (a) participants resulted in good blended learning outcomes.	Higher education	There are considerable changes in student learning results before and after blended learning. Blended learning successfully enhances Art Culture learning results.
A25	46	In this work, the ADDIE paradigm is used to the development of AR-based educational apps for the subject of Current and Voltage Division.	Augmented Reality Applications	Students may watch this course on their smartphones using this app. This software simplifies the concept by providing an explanation of voltage and current distribution for students.	Higher education	The AR application development has achieved the ultimate goal of developing Augmented Reality-based applications as a teaching tool.
A26	47	This study creates unique learning media animation using local knowledge, skills, indications, materials, displays, button designs, and potentials of Indonesian Kalimantan.	Animation Learning Media	The model helps teachers learn, according to the model effectiveness test. Analysis of data before and after using the model in mathematics learning revealed a higher post-test score compared to the pre-test score.	Elementary Schools	The creation of animation learning media has greatly benefited education by addressing the issues instructors and students have in utilising information technology for learning.
A27	48	The smartphone-accessible PBLMS3 app offers synchronous online learning. The ADDIE Model-based PBLMS3 application offers benefits for online courses.	a Problem-Based Learning Management System-Supported Smartphone (PBLMS3)	All online physics learning activities utilising PBLMS3 enable students to develop digital literacy. This study's findings may guide professional development for technology-based learning.	Higher education	This shows that PBLMS3 improves pupils' digital literacy. Research is needed to identify other elements that might enhance digital literacy.
A28	49	Research aims to build design course instruction on the ADDIE approach.	course instruction	This article analyses the system design building of a design education course through the adoption of the ADDIE model in teaching design pattern via social innovation.	Higher education	this study tries to shed light on strategies to change design course teaching so that the design education outputs are more in accordance with the demands and expectations of the times and society.
A29	50	Computer simulation and JavaScript are used to create a low-cost virtual laboratory integrated into a Moodle-based interactive learning environment. Instructional design model ADDIE was used.	Virtual Laboratory	Teacher and student evaluations of the virtual laboratory were excellent, and students were motivated to study physics and the virtual laboratory helped them grasp physics.	Higher education	this research presents a general framework for numerous scientific and technical courses that require virtual experimentation to supplement theoretical training.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A30	51	During the COVID-19 epidemic, this research examined the impact of ADDIE-compliant online practical courses (OPC) in physical education (PE).	Online Classes	Most learners suspected issues during implementation. Teachers noted unenthusiastic student participation and assignment submission during assessment. OPC efficacy differed dramatically amongst instructors and learners.	Higher education	University instructors should have adequate time to develop OPC-videos and train students in real time to guarantee constant feedback to prepare for the new normal following COVID-19.
A31	52	This study examined the parabolic motion material learning videos' validity and practicality. Videos are available for the flipped classroom exercise.	Flipped Classroom Learning Videos	This study produced valid and viable learning films. This study employs the ADDIE methodology and two videos: a daily physics topic analysis video and a light board-based instructor explanation film.	Higher education	Based on the findings of validator and student evaluations, learning videos are valid and practicable as learning material. This research may be used as a guide for developing effective and efficient learning materials.
A32	53	In vocational and technical schools, this project created an Electronic Assessment System (E-ES) for student teaching evaluation (VTS) using ADDIE model.	Electronic Evaluation System (E-ES)	The study found that the E-ES application programme was developed successfully and feasible	Higher education	E-ES is supposed to be learned by vocational principals and instructors to enhance instruction. Researchers should reference the E-ES for student teaching assessment studies.
A33	54	This project integrates sustainable development topics into design classes and uses design to address problems to help students think creatively and tackle environmental sustainability difficulties using ADDIE model.	Game Design	Based on course planning and implementation, this research proposed the "design course on environmental sustainability".	Higher education	Sustainable development considerations were beneficial to the creation and execution of the "Game Design Theory and Practice" design course. Game design may inspire students and players to care about sustainable development in engaging circumstances.
A34	55	A novel web-based learning (WBL) module that teaches these abilities was designed, implemented, and evaluated in our research.	web-based module	A well-designed and executed WBL resource for newborn CUS interpretation has objectively improved trainees' comprehension and ability to apply their information.	Medical	With medical education moving away from classroom instruction, WBL modules would provide prospective trainees more learning opportunities. Its success spurred the creation of comparable modules on other challenging issues in neonatal medicine, such as ven-tilation and hemodynamics.
A35	56	Chemistry MOOC e-content module development was the goal of this project (MOOC). It assessed module content, usability, design, and effectiveness, validity, reliability, and student impressions. Instructional design using ADDIE.	Massive Open Online Course (MOOC).	ADDIE instructional design approach effectively built Chemistry MOOC e-content module.	Higher education	This Chemistry MOOC e-content module may help lecturers and students teach and study chemistry in mixed or flipped classrooms.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A36	57	This paper Explains how flipped classrooms that incorporate science, technology, engineering, art, and math promote math learning (STEAM).	Flipped Classroom	This study highlights the benefits of integrating STEAM instruction into flipped classrooms to enhance student comprehension.	High School	Flipped classroom-centered mathematics instruction STEM is excellent for acquiring expertise. Therefore, learning is operable or may be applied.
A37	58	This project intended to generate mathematics learning media in the form of instructional films to improve the reasoning skills of Mathematics Education Study Program students.	learning video	According to the five-phase ADDIE model, the video on Surface Area of Cuboids, Cubes, Prisms, and Pyramids is suitable for educational purposes.	-	To foster constant interest and creativity among lecturers and students, lecturers should create learning movies on various subjects, such as the surface area of cuboids, cubes, prisms, and pyramids.
A38	59	The current research planned, developed, implemented, and evaluated a blended learning cancer management specialised course based on ADDIE.	blended learning	ADDIE was used to create a cancer management course. Participants reported excellent satisfaction with managerial competence and professional conduct changes.	Medical education	This programme is anticipated to enhance healthcare and save expenses, as well as inspire other creative educational measures for health professionals.
A39	60	The emphasis of this study is the creation of the Training Kit. It was conceived and built with the ADDIE concept in mind.	Training Kit	The results suggest that all five specialists believe that this kit may be used as a teaching tool for the Heating, Ventilation, and Air Conditioning (HVAC) topic. Twenty vocational students were finally exposed to the training gear during their training session.	Higher education	This kit is important to HVAC program particularly in Installing, Servicing, Troubleshooting and Repairing Window Type Air conditioner.
A40	61	This research describes the creation of e-Portfolio as a writing evaluation in a Malaysian public university's advanced English language course for undergraduates. ADDIE instructional design was used.	e-Portfolio	E-Portfolio aspects were well received by students, except peer preview. The majority of students also wanted e-Portfolio to remain.	Higher education	The research helps instructional designers provide new language classroom tools. The e-Portfolio shown promise for assessing second language learners in higher education.
A41	62	to develop the design of student worksheets to improve students' mathematical communication in learning activities with an RME approach. In its development, the ADDIE model was applied.	Worksheets	This study resulted in the design of worksheets of students with RME approach to improve students' mathematical communication skills.	Higher education	This study is purely design-related. Additionally, it will be used to generate and evaluate the success of student worksheets.
A42	63	This research develops and evaluates the efficacy of a linear algebra peer tutoring technique (LAPTS) in a polytechnic classroom to enhance students' mathematical thinking processes (MTPs) using Mason's method.	linear algebra peer tutoring strategy (LAPTS)	This study suggests that LAPTS may enhance students' MTPs in LA that align with Mason's approach to learning.	Higher education	Thus, while instructors guide students, students helped build their mathematical thinking processes. When students understand the instructional plan, their oral explanation will improve, boosting their peer confidence.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A43	64	This project creates valid, practical, and successful blended learning lesson plans, assessment sheets, and moodle-based e-learning media for Animal Physiology courses using the PBLRQA technique and ADDIE Model.	Blended Learning	The lesson plan, assessment sheets, and moodle-based e-learning increased student self-regulation. It verified the lesson plan, assessment sheets, and moodle-based e-learning media using PBLRQA techniques work.	Higher education	The valid and practical blended learning has empowered student self-regulated learning. This effort should help spread blended learning by evaluating student characteristics and learning content.
A44	65	This project combines ADDIE model, data science, and machine learning to analyse and build the Web Game on Descriptive Statistics (WGODS).	Web Game	Technology and the ADDIE approach may improve education. Specifically, the Web Game on Descriptive Statistics (WGODS) enhances quantitative and qualitative data education with an appealing, user-friendly interface.	Higer education	Future study might examine video-based online system design and development. Additionally, using many languages enables personalised statistical material.
A45	66	This study attempts to determine fundamental demands for a teacher research competency training system. Making use of modified ADDIE.	Teacher Research Competency Training System	This study established the ideas needed to create a teacher research training programme.	Teacher's training	This research is the start of a bigger design process, and what came out of it is something new that hasn't been seen in many scientific papers before.
A46	67	The goal of this educational design study was to create a Digital Interactive Math Comics (DIMaC) to help learners better comprehend math topics. Use of ADDIE framework.	digital interactive math comics (DIMaC)	Student feedback on Digital Interactive Math Comics (DIMaC) was excellent since the software is unique and targets digital Natives.	High school	Math instructors may use DIMaC as an excellent choice for helping students grasp math concepts.
A47	68	This research investigates the viability of utilising camtasia software to create learning videos for math topics using R&D methodology and ADDIE concepts.	CAMTASIA SOFTWARE	Incorporating instructional material, such as CDs, may increase student enthusiasm and practicality.	Higher education	It is possible to assert that the educational content presented in the form of films in the format of a CD is useful and may be used.
A48	69	The creation and development of ADDIE-based online courses by college and university professors was investigated using the grounded theory method.	Online Course Design	This study's results enhance our knowledge of how instructors construct online courses and the variables that impact their decisions. The participants viewed the design of online courses as a problem to be tackled directly, on its own terms, using whatever informal resources were readily accessible.	-	Future study should examine if presenting the informal design theory could better prepare instructors who are new to designing online courses for course design challenges. This information might subsequently be communicated to instructors who design online courses in order to promote higher quality and, thus, more trust in online courses.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A49	70	In this study create an educational game. This game is anticipated to serve as an engaging learning tool for introducing students about Indonesia. The game can be loaded with quiz on particular fact about the area that picked by the player. The game is constructed using the ADDIE model.	Educational Game	The game was developed utilising the ADDIE paradigm, a typical method to the production of learning materials.	Higher education	Future enhancement prospects for this game include the addition of features such as an internet connection or an online database, so that the information will be derived directly from the actual and current resource.
A50	71	Project aims to develop and validate an integrated assessment instrument for assessing students' analytical thinking and chemical literacy in chemical equilibrium.	integrated assessment instrument	This research developed 20 questions to evaluate students' analytical thinking and chemical literacy.	Higher education	The instrument is intended to evaluate a learning model or technique to enhance chemistry students' analytical and literate thinking. This instrument might serve as a model for developing integrated assessment tools for other chemicals.
A51	72	This study's overarching objective is to provide authentic-based training materials for writing skill utilising the ADDIE paradigm.	Authentic-based Instructional Materials	According to the study, students prioritise the following five writing skills: clear and chronological organisation, precise vocabulary, grammar, structure, and spelling/punctuation.	Higher education	The researcher proposes beginning material development with students' requirements and interests. The requirements analysis will assist instructors choose resources and presentation methods. The resources and technique should help students learn and experience the new language and be relevant to their everyday lives. Additionally, following the ADDIE stages may help instructors create successful resources that align with students' needs and interests.
A52	73	This project uses CMS to create and construct a tourism-focused Arabic learning website utilising ADDIE teaching methodology.	web-based learning	The learning prototype intends to provide Arabic learners a novel learning experience, provide after-class references, and evaluate the success of web-based learning.	Higher education	Meaningful learning requires knowledge of educational theory and instructional design. Effective learning materials need appropriate instructional models.
A53	74	This article presents how to construct "MobiEko Apps," a microeconomics mobile learning platform. The framework gives all participants easy access to mobile learning apps. This study uses the ADDIE instructional design paradigm to develop an app prototype.	a mobile learning application "MobiEko Apps"	Students also liked the presentation, aesthetic, navigation, and accessibility of 'MobiEko'. MobiEko, a mobile educational software, effectively transfers information and improves teaching and learning methods for students and instructors.	Higher education	The mobile education software aims to help instructors and students in blended learning by using mobile devices' affordance and ownership, and facilitating Microeconomics course study on mobile devices.

Table A1. (*Continued*).

Label	Article	benefits and contribution	educational technologies, tools, and platforms	ADDIE learning outcomes?	sectors or industries	Future recommendations
A54	75	MFolktales application development is described in this document. ADDIE Instructional Design (ID) model was used to outline the animation creation process of pre-production, production, and post-production.	Multimedia Mobile Learning Application (Mfolktales)	This software offers an alternative to using storybooks for teaching and learning and creates a better learning environment.	Primary schools	In future studies, the programme will be examined for use and efficacy to determine children's quality perceptions and acceptability.