From Analysis to Creation: Utilizing the ADDIE Model for Developing and Educational Game for Children

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Abstract
Designing educational games for children is a topic that warrants attention, particularly when using the ADDIE model as a game development framework. In this exposition, we evaluate three notable children's video games to highlight the complexities associated with designing games for children. Additionally, we present the ADDIE model, a well-known instructional design framework, to our audience to elaborate on its potential applications within the video game industry. The importance of creating educational video games for children is emphasized in this discussion. The ADDIE paradigm offers game designers a structured approach to creating educational video games that are both enjoyable and advantageous to a child's growth and education. To summarize, the process of developing a children's video game entails numerous stages and components that demand considerable effort. Game designers may employ established methodologies like the ADDIE model to create educational games that provide young children with a fun and informative experience. Games that require children to utilize their analytical and problem-solving abilities and decision-making skills can equip them with essential life skills that they can use throughout their lives. A combination of constructivist and social learning theories may be utilized to foster educational play by promoting exploration, cooperation, and reflection. Designing engaging and educational video games for children necessitates a thorough understanding of child development and various learning theories. And through the combination of theory to sort out the framework of children's video game design and detailed process.

Keywords: ADDIE Model, Children Video Game, Game Design Framework

Introduction

The potential of digital games to promote early childhood learning and development has been increasingly clear in recent years. In response, we created a video game for children age below 7 to promote the development of early reading, numeracy, social, and emotional abilities. We discovered that the ADDIE model has significant strength in educational games through case studies and market research of popular children's games. The ADDIE paradigm, which is a proven instructional design framework encompassing a systematic approach to analysis, design, development, implementation, and assessment, was used to create our games. We conducted a thorough examination of existing children's games, investigated effective game design methodologies, and contrasted our approach to discover areas for improvement. This article describes our design and development process, as well as the methodologies we employed to assess the game's effectiveness. According to our findings, the game has the potential to improve children's early education by delivering interesting and relevant learning experiences. This study's findings have significant implications for the development of effective play-based learning practices in early childhood education.

1. Related Video Game Analysis

Explanation Video Game Classification

In the past decade especially, video games have received a growing amount of attention, and children's video games constitute a substantial portion of the gaming market (Lenhart et al., 2008). Increasing numbers of researchers are emphasizing on game-based learning and the gamification of education and training. Video games, which use electronic products as a medium, are increasingly utilized as the popularity and development of electronic products increase. Educators recognize the potential educational and developmental benefits of video games for students (Papastergiou, 2009; Rosas et al., 2003). Some parents but with a skeptical attitude to video game (Steinkuehler, 2010). The content of children's video games is deemed appropriate for their age. The educational value of children's video games deserves recognition, and most of these games are intended to educate players in fundamental cognitive-related knowledge, mathematics, science, language, or art-based games. In addition, they have the potential to foster problem-solving, critical reasoning, and social and emotional intelligence.

In addition to the educational benefits they offer, video games for children can also be a source of amusement that is both enjoyable and interesting. After a hard day at school, they can help children relax, and they offer a healthy outlet for youngsters to use to deal with stress and worry. However, parents are responsible for keeping a close eye on their children's use of video games and ensuring that the games their children play are suitable for their age and current level of development. They should also limit the amount of time spent in front of screens and encourage alternative types of play as well as physical activity. Children's video games have the potential to be an educational and developmental asset if they are played appropriately and in moderation.

The categorization of video games into various genres has been a significant aspect of game design and development. As a result, game categories have emerged based on common themes and mechanics. These categories have unique characteristics and are often associated with specific types of games. Adventure games, for instance, involve exploration, puzzle-solving, and storytelling, while sports games simulate real-world sports and allow players to control individuals or teams. In addition to these genres, there are also several classifications of educational games, depending on their educational scope (Breuer & Bente, 2010). Subject-

specific games are designed to teach specific subjects, such as math, science, or language arts. On the other hand, cognitive skills games aim to improve cognitive skills like memory, attention, and problem-solving. Social and emotional learning games are designed to teach social and emotional skills, such as empathy, self-awareness, and conflict resolution. Serious games, which aim to have a real-world impact, can teach players about social issues or train them for specific jobs. Furthermore, augmented, and virtual reality games use immersive technology to create engaging learning experiences.

The classification of educational games is crucial to their design and intended learning outcomes. This categorization ensures that games are not only engaging and fun for children but also educational and aligned with specific learning objectives. Moreover, game developers and educators must ensure that the design of these games is based on sound pedagogical principles, such as scaffolding and social learning theory, to facilitate effective learning. By considering these aspects, developers can create effective and impactful educational games for children.

The Influence of Genres of Theory on Educational Games

Video game design and production have been heavily influenced by several theoretical genres. To encourage desirable player behaviors and discourage undesirable ones, behaviorist principles from the field of psychology have been incorporated into game design. In video games, players are often rewarded for successfully completing missions and punished for failing to do so. Games that encourage players to experiment, investigate, and discover novel solutions to issues have been designed using constructivism, a learning philosophy that places a premium on active learning and problem-solving.

According to social learning theory, people pick up new skills by emulating the actions of those they see and trust. Games that promote cooperative play and player-to-player instruction are a common application of social learning theory in the video game industry. For instance, in a multiplayer game, players may need to work together to accomplish a common goal, or the game may have leaderboards and other social elements that foster friendly competition amongst players. According to the hypothesis of cognitive load, the human brain can only take in so much information before it becomes overwhelmed. Cognitive load is frequently employed in game design to strike a balance between difficulty and immersion.

A game could, for instance, start off easy and get progressively harder as the player makes progress. Video games may be a fun and effective learning tool for kids if they use social learning theory and employ scaffolded lesson plans. Motive and interest in learning can be boosted by using video games because of its ability to provide instantaneous feedback, individualization of content, and opportunity for mastery. Furthermore, video games can offer a risk-free setting where kids can hone their interpersonal and problem-solving abilities including communication and teamwork. Social learning theory and scaffolded teaching sessions in video games have the potential to be useful educational tools that can help kids learn and grow.

Comprehensive Review of Children Video Games

To create a suitable video game, several critical criteria must be considered. The game's content—storyline, characters, and themes—should be assessed (Clarke et al., 2017). At the same time, the game should be enjoyable and informative without violent or upsetting elements

that might be damaging to children (Kirsh, 2011). The game's mechanics and gameplay should be enjoyable and challenging for children, promoting skill-building and learning (Kulman et al., 2014). Furthermore, the game's visuals and music must be entertaining for young players. Parents and educators can assist children select educational games by using a complete game review method.

A game that focuses solely on remembering and comprehending objectives may not require players to apply or analyze the acquired knowledge (Arnab et al., 2015). Conversely, a game that concentrates solely on higher-level objectives, such as evaluation and creation, may not provide the necessary foundational knowledge to support these higher-level skills (Carvalho et al., 2015). By integrating the objectives of each level of Bloom's Taxonomy, educational video games can provide a comprehensive learning experience that promotes critical thinking and foundational knowledge (Forehand, 2010). In addition, by integrating educational objectives with Bloom's Taxonomy, game designers and educators can assess student learning more accurately and modify instruction as necessary. Bloom's taxonomy of objectives is a well-established educational framework that divides learning objectives into six levels: remembering, understanding, applying, analyzing, and evaluating. The taxonomy provides a clear and systematic method for organizing educational objectives, making it simpler for educators to plan instruction and evaluate student learning. Czauderna and Guardiola (2019) by using the Bloom Taxonomy to classify the objectives of educational video games, game designers and educators can ensure that the games provide a well-rounded learning experience.

This research chose three games for children aged 3-6 years old that are now accessible on the iOS Online App Marketplace as well as the Google Online App Marketplace. The categories are shown in Table 1. These games were given the names X, Y, and Z. The selection process was based on Bloom's goals. In only one nation, X has 8.54 million downloads, but Y has just 2.76 million downloads (Marko Dimitrievski, 2023). It is generally agreed that the Z game is now the video game that has the greatest level of popularity.

Table 1. Classification of Three Types of Video Game Content

	Adventure	Role play	Sports	Simulation	Construction
Remembering		X, Y, Z			X, Y, Z
Understanding	Y, Z		X	X, Y, Z	
Applying	X			Y,	Z
Analyzing	X, Y		X		X, Z
Evaluating					
Creating	Y			Y,	X, Z

These categories are not mutually exclusive, and many instructional games may fall under more than one. The educational games in this study are classified based on their design and process. A careful classification can reveal the distinguishing characteristics and traits that make them useful teaching tools. Understanding the entire process of educational games allows us to better examine their impact and potential to give children with meaningful learning experiences.

Other types of educational games are classified according to their instructional scope. Subject-specific games, cognitive skill-based games, social and emotional learning games, serious games, and augmented reality and virtual games are all examples of educational games. As shown in Table 2. These classifications will be compared and summarized using Bloom's educational aims as a foundation.

Table 2. Classification of Three Types of Children Video Game Themes

	Domain-specific	Cognitive skills	Social Emotion	Serious Games	Augmented and virtual reality
Remembering				Y	
Understanding	Y, Z	X, Y			Z
Applying			X, Z	Y	
Analyzing	Y	X, Y			
Evaluating		Z			
Creating	X				

While there are educational children's video games that focus on cognitive skill development, it is difficult to locate games that handle numerous issues holistically through analysis. However, via play, these games can significantly improve children's skills and support social-emotional development, as well as aid in the learning and consolidation of subject-specific knowledge. Thus, designing and developing educational and engaging video games for children is a hard but necessary undertaking that demands careful consideration of the target population and their learning needs.

In video games, Kapp (2012) has identified several essential components. These components consist of objectives, rules, conflict, competition, and cooperation, reward structures, feedback, hierarchical narrative, interest curves, aesthetics, and repetitive gameplay. Each of these components contributes significantly to the overall experience of a video game. Goals provide participants with a distinct sense of purpose and direction and motivate them to actively participate in the game (Hoffman & Nadelson, 2010). The rules establish the parameters within which participants must operate, laying the groundwork for conflict and competition to develop (Stenros, 2017). In turn, conflict generates tension and excitement, driving participants to compete against one another or collaborate to achieve a common objective (Barnett & Coulson, 2010). Reward structures and feedback help reinforce positive behavior and encourage players to continue playing, while levelled storytelling and interest curves maintain player engagement by providing a sense of progression and difficulty. Aesthetics are also essential because they contribute to the creation of a world that players want to explore (Kim & Lee, 2015). Repetition is essential to the success of video games because it enables players to hone their abilities and grasp the game's mechanics over time. Game designers can create engaging, challenging, and rewarding experiences for players of all ages and abilities by incorporating these various elements into their designs.

2. Applying the ADDIE Model for Effective Game Development

2.1 ADDIE Model

The ADDIE model is frequently used in instructional design and game development to ensure that the final product effectively meets the intended learning objectives. Analysis, Design, Development, Implementation, and Evaluation are the five phases of the ADDIE model, which provides a systematic approach to the design and development process (Davis, 2013; Muruganantham, 2015). Using this model, game designers can guarantee that the game is well-structured, meets the learning objectives, and is engaging for the target audience. The Figure 1. shows the ADDIE model's five phases: Analysis, Design, Development, Implementation, and Evaluation. Each phase of the ADDIE paradigm is crucial to game development success. Analyse the target audience, learning objectives, and needs. Design entails generating the game concept, mechanics, and a prototype. Game development includes programming, graphic design, and audio production. Implementation includes game launch, testing, and distribution. Finally, the Evaluation step evaluates the game's learning objectives and makes modifications depending on input. The ADDIE paradigm ensures that all aspects of game development are studied and addressed. It lets developers tweak and improve the game during development.
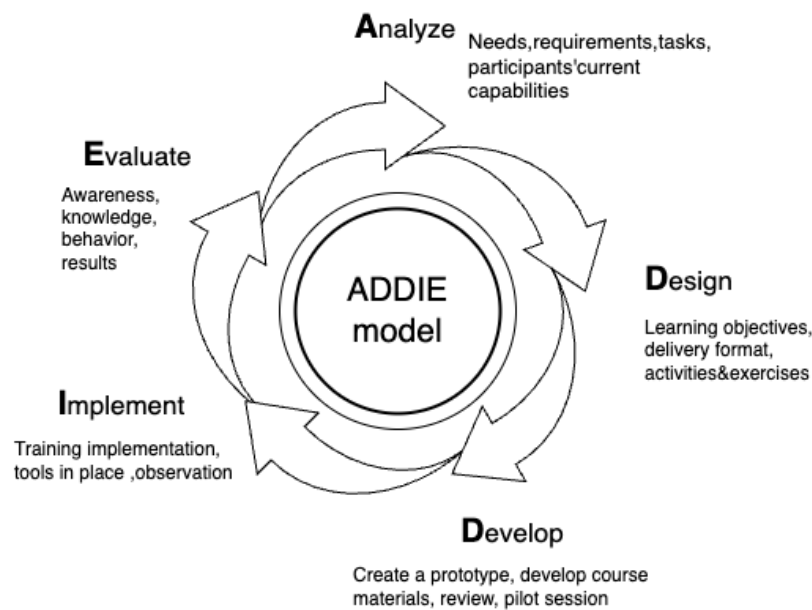
Figure 1: The ADDIE Model

The previous framework MDA (Mechanics, Dynamics, Aesthetics) was designed to analyse games, not necessarily to create them (Kim, 2015). These frameworks do not address specific aspects of game design beyond gameplay, they do not include telling a specific narrative, and they do not include having a completed story line, which emphasises the interplay between the game's laws (mechanics), the player's experience of playing the game (dynamics), and the player's overall emotional response (aesthetics). Another common game design paradigm is the LGD (Lean Game Design) framework, which emphasises quick iteration and feedback to develop a minimal viable product (MVP) before expanding the game (Coleman et al., 2014; Hyrynsalmi et al., 2018). Other models include the design thinking method and the human-centered design approach (Deterding et al., 2011).

As illustrated in Figure 2., the ADDIE paradigm provides a systematic and structured approach to game development. This enables the unambiguous identification of goals and objectives. Provides a framework for team members to collaborate. Assists in ensuring that all components of the game are carefully planned and developed. Allows for more accurate evaluation and assessment of project progress.
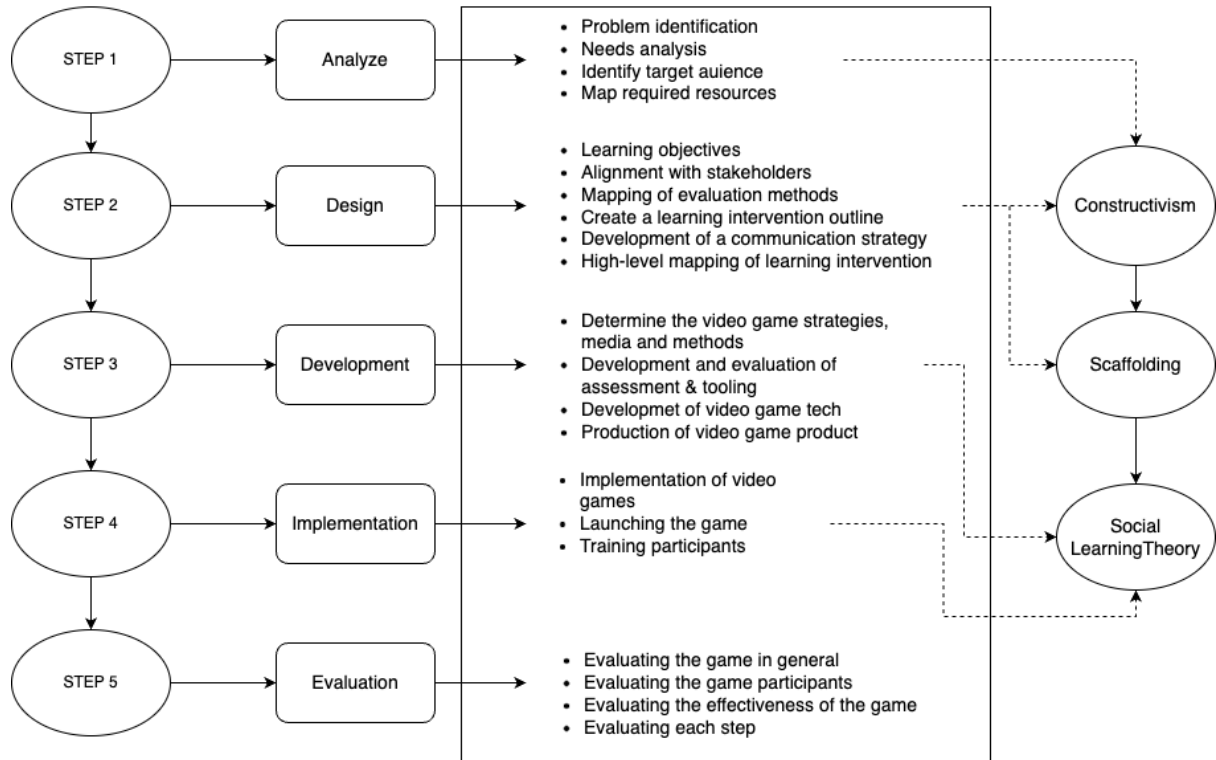

Figure 2: The ADDIE Paradigm

Each step of the game design can be identified through the approach and methodology research design, as shown in the overall flow diagram in Figure 2. Explain how the ADDIE model can be carried out at each stage of video game design. and how theory can support video game design. Constructivism can be applied to all stages of game creation as defined by the ADDIE model, although it is essential during the Analysis and creation stages. Game designers can identify the skills and knowledge that players need to gain during Analysis, and they can create learning experiences that enable players to construct their understanding of the subject during Design. In the ADDIE-structured game design development phase, scaffolding theory plays a role. During this stage, game designers build learning experiences that steadily increase in difficulty while giving support and advice to assist players in acquiring and mastering new skills. Social learning theory can be applied to several stages of ADDIE-framed game design, most notably the Development and Implementation stages. Game designers can construct multiplayer games that enable players to interact and learn from one another during development. Through online forums and social media, game designers can give opportunities for players to share their experiences and learn from one another during implementation.

2.2 ADDIE Model in Game Design Process

The ADDIE model is a methodical approach that ensures that the game is built with a clear goal in mind and that it satisfies the intended audience's needs. Braad et al. (2016) study in

game design and found the ADDIE model is critical in the game development process since it provides an organized approach to game creation. It aids in the identification of learning objectives, target audiences, and game mechanics to meet the objectives. The methodology also ensures that the game's design is based on research-based best practices for learning and engagement. Using the ADDIE paradigm, game designers can construct effective and interesting games that meet their targeted learning goals. Figure 3. illustrates the ADDIE model's connections throughout the game design process.

ADDIE MODEL IN GAME DEVELOPMENT

| Lane 1 | Lane 2 | Lane 3 | Lane 4 | Lane 5 |

Analysis

1. Target audience
2. Age range
3. Developmental stage Interests
4. Learning needs
5. Learning objectives
6. Specific skill, knowledge
7. Cultural, linguistic
8. Existing resources
9. Potential limitations

Design

1. Developing: game objectives, mechanism, story, the characters, interface, levels and evaluation

2. Creating storyboards and concept art to visualise the game

3. Mapping learning objectives to specific game elements and levels

4. Appropriate game mechanics and dynamics for the cognitive and emotional development of the target audience

Development

Core game mechanics

1. Sample test prototype
2. Refinement based on user response
3. Usability, playability, engagement and effectiveness of the game

Implementation

Game testing

Training Educators

Evaluation

Learning objectives of the game

Educational game objectives

1. Development tools selection
2. Functional realisation

Game Refinement

Before & after testing

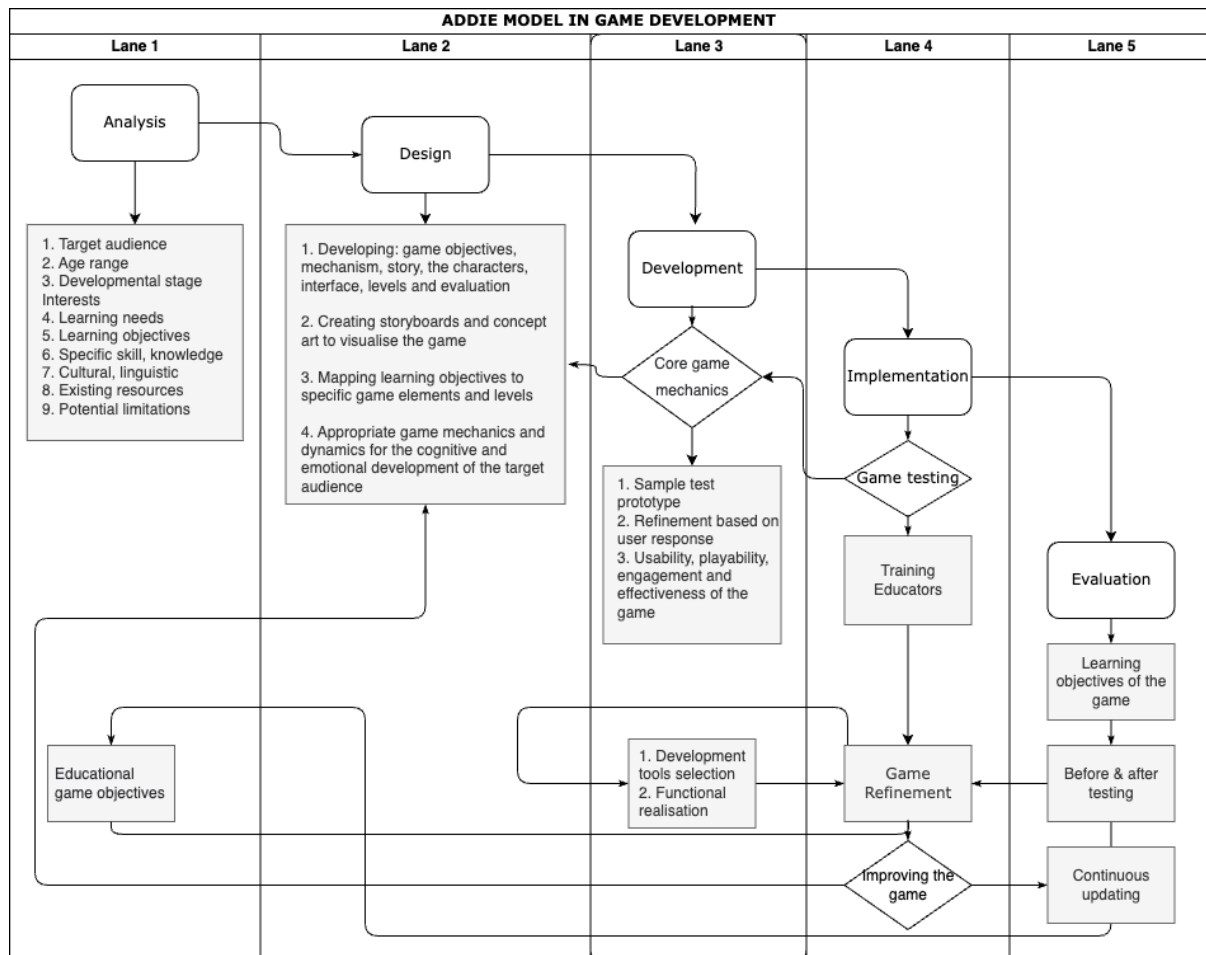Improving the game

Continuous updating

Figure 3: The ADDIE Game Design Process

A box represents each step in the process, and the arrows indicate the flow of the process from one step to the next. The game designer will evaluate the game's intended players and any pedagogical or educational aims that must be met. The game designer then draws out a plan for the game, complete with all the features discovered in the analysis stage. The development process for a video game starts when its blueprint has been finalized. The development stage is where the game's code and mechanics are written and refined. All the game's mechanics and difficulty settings are fine-tuned and tested for any remaining issues during this phase. The ADDIE methodology culminates in an assessment phase in which the designer determines whether the game was successful in teaching the intended lessons. The ADDIE model is a useful framework for makers of educational games who want to maximize its impact.

Conclusion

Educational games can be a fun and efficient method for children to learn essential concepts and abilities. By employing the ADDIE model to the game development process, designers can ensure that the game is created with clear learning objectives in mind and that its content, mechanics, and activities are aligned with these objectives (Kapp, 2012; Lim et al., 2013). We saw the possibilities of applying the ADDIE model to drive the game production process, as well as analyzing how different design frameworks such as constructivism and scaffolding might be utilized to improve learning results, after analyzing three instances of educational games. The study emphasizes the relevance and breadth of designing educational games with children's specific needs and features in mind, as well as ensuring that games match educational objectives and learning results. The ramifications of this study extend to game creators and educators, as successful deployment of educational games can improve learning quality and classroom engagement. Finally, the development of educational games for children has considerable promise for boosting learning quality and classroom engagement. Developers can create learning games that are both interesting and effective by utilizing design frameworks such as the ADDIE model, constructivism, and scaffolding.

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