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بررسی مولفه‌های طراحی بازی‌های آموزشی بر اساس جذابیت(جویسینس): یک مرور سیستماتیک

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چکیده

یادگیری مبتنی بر بازی از طریق گیم‌پلی تعاملی و جذاب به طور قابل توجهی انگیزه و درک دانش‌آموزان را در موضوعات پیچیده افزایش می‌دهد. این رویکرد با ایجاد محیط‌های یادگیری غنی، فرصت‌های متنوع یادگیری را فراهم کرده و به توسعه مهارت‌ها کمک می‌کند. یک جنبه حیاتی در طراحی بازی‌های آموزشی، ادغام اصول "جویسینس" (جذابیت) است که برای تضمین جذابیت بازی اهمیت دارد. این مطالعه به بررسی اجزای جویسینس در طراحی بازی‌های آموزشی می‌پردازد. برای شناسایی عواملی که بر جویسینس در بازی‌های آموزشی تأثیر می‌گذارند، یک مرور سیستماتیک جامع با استفاده از رویکرد ترکیبی سندلووسکی و باروسو و چارچوب PRISMA انجام شد. جستجویی در پایگاه‌های داده مانند Scopus، ScienceDirect و Emerald Insight برای مقالات منتشر شده بین ۲۰۰۴ تا ۲۰۲۴ انجام گرفت. کلمات کلیدی شامل "جویسینس"، "بازخورد"، "گرافیک"، "صدا" و "اجزای بازی" استفاده شد. این جستجو به شناسایی مقالات مرتبط کمک کرد و تحلیل آن‌ها به استخراج دیدگاه‌های کلیدی در مورد عوامل مؤثر بر جذابیت و لذت‌بخشی بازی‌ها انجامید. این مطالعه سه دسته اصلی از اجزای جویسینس را شناسایی کرد: مکانیک‌ها (۷ مؤلفه)، دینامیک‌ها (۵ مؤلفه) و زیبایی‌شناسی (۶ مؤلفه). مکانیک‌ها شامل ساختار گیم‌پلی، بازخورد درون بازی، سیستم‌های دستاورد و قدرت‌افزایی هستند. دینامیک‌ها به فرآیندهای تعاملی مانند همکاری اجتماعی، اکتشاف و مدیریت زمان می‌پردازند. زیبایی‌شناسی شامل مؤلفه‌های حسی و احساسی مانند سفارشی‌سازی آواتار، داستان بازی، طراحی گرافیکی و بازخورد چندحسی است. این دسته‌ها چارچوبی جامع برای طراحی بازی‌های آموزشی فراهم می‌کنند که تعامل، نتایج یادگیری و رضایت کاربر را بهینه می‌کند. استفاده از اجزای جویسینس به طراحان بازی این امکان را می‌دهد که بازی‌هایی طراحی کنند که نه تنها آموزشی، بلکه جذاب و لذت‌بخش باشند. این تحقیق یک چارچوب ساختاریافته برای توسعه بازی‌های آموزشی مؤثرتر فراهم می‌آورد.

واژه‌های کلیدی

بازی‌های آموزشی، جویسینس، طراحی بازی، تعامل، مکانیک‌ها، دینامیک‌ها، زیبایی‌شناسی.

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ORIGINAL ARTICLE

Investigating the Components of Educational Game Design Based on Juiciness Principles: A Systematic Review

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ABSTRACT

This study systematically investigates the design principle of "juiciness" the use of satisfying, responsive, and multisensory feedback in educational games to enhance learner engagement and effectiveness. Through a comprehensive systematic review guided by an integrated Sandelowski and Barroso and PRISMA framework, literature from ٢٠٠٤–٢٠٢٤ sourced from Scopus, ScienceDirect, and Emerald Insight was analyzed. Our analysis, employing rigorous validity measures including dual screening (Cohen's κ = ٠,٨٩) and thematic synthesis, identified a framework of juiciness components organized into three core categories: Mechanics (encompassing structural elements such as in-game feedback systems, quest systems, achievement systems, and power-ups), Dynamics (encompassing interactive processes such as dynamic interactivity, social collaboration, exploration systems, and time management), and Aesthetics (encompassing sensory and emotional dimensions such as avatar customization, game narrative, visual and graphical structure, and multisensory feedback). The findings demonstrate that the strategic integration of these components is pivotal for creating game-based learning environments that are both compelling and pedagogically effective. The resulting framework provides a concrete and actionable roadmap for developers, instructional designers, and educators to design educational games that not only effectively achieve learning objectives but also maximize intrinsic motivation and user satisfaction through a rich and enjoyable experience. This research underscores the importance of intentional, informed design of "juicy" elements as a key determinant in the success of serious educational games.

KEYWORDS
Educational Games, Juiciness, Game Design, Mechanics, Dynamics, Aesthetics.

Introduction

The rapid advancement of digital technology has significantly impacted contemporary society, transforming the way individuals interact, work, and learn. In the face of these changes, educational systems must evolve to effectively prepare learners for the digital age. While technological advancements are crucial, a more profound transformation is needed, one that rethinks the goals, missions, content, teacher training, teaching methods, assessment procedures, and the role of the learner (Saraji & Attaran, ٢٠١٩). Failure to adapt risks rendering educational systems obsolete. To meet these challenges, educational systems are exploring innovative teaching methods, with one promising approach being the integration of digital games into the learning process. Research has shown that games can enhance interaction, motivation, and learning outcomes, offering an engaging, interactive environment for students (Prensky, ٢٠٠١).

Well-designed games incorporate sound learning principles, encouraging active and reflective engagement and fostering skills such as problem-solving, technology use, and collaboration (Gee, ٢٠٠٣). One key concept in educational game design is juiciness, which refers to the design approach wherein game designers provide abundant audiovisual feedback in response to player actions to create a more satisfying and engaging experience. Hicks et al. (٢٠١٩) define juiciness as "a term that describes a game experience that contains a coherent design of game mechanics and visuals, while providing feedback to the player with both direct feedback that is confirmatory, relevant and explicit, but also offering superfluous feedback that helps to inform players about the game state, and contribute to the game being perceived as a coherent whole" (p. ١٩٧). More specifically, juiciness involves the provision of redundant feedback where a single player action triggers multiple non-functional reaction—such as visual effects, sound cues, animations, and particle effects—that collectively amplify the sense of responsiveness and delight (Hicks et al., ٢٠١٩; Kao, ٢٠٢٠). This design philosophy emphasizes creating games that feel "alive" and rewarding through excessive positive feedback, thereby enhancing player engagement and motivation through continuous sensory reinforcement (Deterding et al., ٢٠١١; Swink, ٢٠٠٩).

By incorporating these principles into game design, educators can create educational games that are not only enjoyable but also enhance the learning experience. The learner-centered approach, which prioritizes active participation and motivation, aligns with the concept of juiciness, ensuring that students remain engaged and invested in their learning (Prensky, ٢٠٠١).

A significant issue with traditional classrooms is the lack of active student engagement. In teacher-centered classrooms, instructors primarily deliver information through lectures, leaving students as passive recipients of knowledge. This approach often leads to disengagement, as students may feel disconnected from the learning process (Biswas & bin Ahsan, ٢٠٢٣). In contrast, modern classrooms emphasize student-centered approaches, encouraging students to actively participate in the learning process. Research has shown that this shift toward active learning increases student engagement and motivation, making modern classes more dynamic and engaging (Freeman et al., ٢٠١٤; Prince, ٢٠٠٤).

Traditional teaching methods, often devoid of meaningful interaction between teachers and students, can foster a sense of isolation, further contributing to boredom (Deslauriers et al., ٢٠١١). However, modern classrooms incorporate interactive elements such as group discussions, collaborative projects, and technology-enhanced activities. These interactions not only improve communication between teachers and students but also foster a more collaborative learning environment, thus reducing boredom and increasing student satisfaction (Johnson et al., ٢٠١٤).

Moreover, traditional classrooms often focus on theoretical knowledge without connecting it to real-world applications, which makes learning seem abstract and disconnected from students' lives (Kolb, ١٩٨٤). In contrast, modern classrooms emphasize contextual learning, where students apply their knowledge to solve real-world problems, enhancing engagement and helping students develop practical skills relevant to their future careers (Lave & Wenger, ١٩٩١). The limited use of technology in traditional classrooms further contributes to the perception of boredom, as students accustomed to using digital tools in their everyday lives may find traditional methods slow and uninteresting (Prensky, ٢٠٠١). In modern classrooms, the integration of technology provides students with access to a wide range of resources, making learning more engaging and interactive (Clark & Mayer, ٢٠١٦).

Therefore, the perceived boredom in traditional classrooms is largely due to factors such as limited student engagement, lack of interaction, absence of real-world relevance, reliance on passive learning, and limited use of technology. In contrast, modern classrooms, with their focus on active learning, real-world applications, and technology integration, offer a more engaging and dynamic learning environment that fosters greater student motivation.

In recent years, many educators and researchers have emphasized the importance of play in both formal and informal education (Whitton, ٢٠١٠). Games have been an integral part of human life for centuries, engaging individuals not only in childhood but also throughout adulthood (Huizinga, ١٩٥٥). Historically, philosophers such as Plato and Aristotle recognized the role of play in education, and educational thinkers like Froebel strongly advocated for its use in educational settings (Bruce, ٢٠٠١). Play-based learning encourages active involvement and supports experiential, problem-based learning approaches (Kolb, ١٩٨٤).

With technological advancements, computer games have emerged as a modern approach to teaching. Video games, as a significant cultural phenomenon, have become a primary source of entertainment for children and adolescents due to the growth of communication technologies. Their engaging nature has drawn considerable attention, and they have even begun to replace academic tasks and family interactions in some cases (Anderson & Dill, ٢٠٠٠; Gentile, ٢٠٠٩).

Game-based learning (GBL) offers an innovative departure from traditional, lecture-based methods that often result in passive learning. Unlike traditional instruction, which emphasizes memorization and teacher-centered delivery, GBL actively involves students in the learning process, fostering engagement, motivation, and cognitive development (Gee, ٢٠٠٣). Educational games enhance critical thinking, problem-solving skills, and knowledge retention through interactive experiences (Mayer, ٢٠١٤). They also provide a dynamic and stress-free environment, particularly for language acquisition, where they foster social interaction and boost motivation (Rama et al., ٢٠١٢).

Moreover, in teacher education and interdisciplinary fields such as healthcare, game-based learning has been found to improve instructional competencies and strengthen collaborative learning (Wouters et al., ٢٠١٣). The increasing use of educational games highlights their potential to transform education, making learning more engaging and interactive.

Despite their widespread popularity, traditional video games primarily focus on entertainment rather than practical application. However, educational video games combine learning with entertainment, enabling players to assess their progress toward specific learning goals through their actions (Van Eck, ٢٠٠٦). The rapid development of complex video games has been fueled by advancements in information and communication technology, offering visually appealing, fast-paced, and self-directed learning experiences (Squire, ٢٠١١). Video games have become a staple in the lives of young people, prompting researchers to examine their cognitive, emotional, and behavioral effects (Green & Bavelier, ٢٠١٢). Educational video games place users in simulated real-world scenarios, allowing them to enhance their emotional intelligence and practical abilities (Connolly et al., ٢٠١٢). These games can significantly increase motivation, making them an effective tool for educational purposes (Ryan & Deci, ٢٠٠٠).

However, conventional pedagogy has been criticized for its failure to engage students, often prioritizing rote memorization and teacher-centered instruction, which limits critical thinking and meaningful interaction (Freeman et al., ٢٠١٤). These methods typically restrict student agency, leading to disengagement and a lack of participation. They also fail to accommodate the diversity of learners and neglect the development of essential communication skills (Bonwell & Eison, ١٩٩١). This failure contributes to students' disconnection from the material, especially in subjects like language and science, further hindering academic achievement (Prince, ٢٠٠٤). Consequently, there is a pressing need to rethink and transform traditional teaching practices to create more engaging, inclusive, and learner-centered environments.

The challenges in games play a crucial role in player enjoyment. Players derive satisfaction from overcoming challenges, which create tension and drama. This is particularly true when players feel a sense of accomplishment or success after completing a challenge (Csikszentmihalyi, ١٩٩٠). In game design, juiciness refers to the design technique of providing excessive positive audiovisual feedback that enhances player engagement (Juul, ٢٠١٠). Juicy games are characterized by abundant sensory feedback, such as visual effects, sounds, and animations, that make the game feel lively and rewarding (Gray et al., ٢٠٠٥; Schell, ٢٠٠٨).

These elements are particularly crucial in educational games, as they enhance player engagement and motivation through continuous feedback and rewards (Deterding et al., ٢٠١١). However, research on the impact of juiciness in educational settings remains limited, despite its importance in enhancing user experience and motivation (Hicks et al., ٢٠١٨; Hicks et al., ٢٠١٩).

Educational games designed with juiciness in mind can significantly enhance learning experiences by making them more interactive and enjoyable. The increasing interest in juiciness is reflected in studies that demonstrate its positive effects on engagement and motivation (Kao, ٢٠٢٠; Hicks et al., ٢٠١٩). However, developers must be cautious not to overuse juicy elements, as this could lead to cognitive overload or distract from educational content (Kao, ٢٠٢٠; Sweller, ٢٠١١).

The key to effective educational game design is to balance sensory richness with pedagogical clarity, ensuring that the game remains engaging without compromising learning outcomes. This research aims to address the gap in understanding how juiciness can be applied effectively in educational games by exploring the core components of juiciness and their implications for game design (Hicks et al., ۲۰۱۸; Johansen & Cook, ۲۰۲۱). Given the lack of cohesive and high-quality educational games that integrate juiciness, this research seeks to identify the primary components of juiciness in educational games and provide a framework for their implementation. By focusing on these elements, the research aims to improve the design of educational games, making them more engaging, effective, and capable of enhancing learning outcomes. This effort aligns with the growing recognition of the importance of game-based learning in education, and it will contribute to creating more engaging and pedagogically sound educational games.

Considering the established role and importance of video games in education and improving student learning processes, and recognizing the apparent lack of effective and significant initiatives in game design within the education sector, despite the existence of a few low-quality games, there is a clear need for games with a cohesive and purposeful internal design, suitable for educational purposes, and capable of engaging the audience (juiciness). Therefore, this research aims to take a small step toward addressing this need. Based on the reviewed literature, this research seeks to answer the following main question: What are the primary components of juiciness in educational games?

Research Questions

RQ۱: What are the components of "juiciness" in educational games?

RQ۲: What are the dynamics of "juiciness" in educational games?

RQ۳: What are the mechanics of "juiciness" in educational games?

RQ٤: What are the aesthetic elements of "juiciness" in educational games?

Materials and Methods

Secondary studies, such as Systematic review involve the synthesis and analysis of information from primary studies. According to Baumeister and Leary (۱۹۹۷), Systematic reviews entail a comprehensive examination of scholarly articles, books, and other relevant resources to describe, summarize, and critically evaluate existing work on a specific topic. As a valuable method for developing new and existing theories, identifying research gaps, and providing a historical overview of a research area, Systematic review have been widely adopted in academic research. In this study, we employed the seven-step approach outlined by Sandelowski and Barroso (۲۰۰۷) as a well-established framework for conducting Systematic review.

Step۱: In this study, Sandelowski and Barroso's (۲۰۰۷) seven-step meta-synthesis method was fully implemented. As shown in (Table ۱)the main research questions focused on "factors affecting game juiciness" and "factors influencing the design of educational games based on juiciness." The study population included all articles indexed in the Scopus, Science Direct, and Emerald scientific databases from ۲۰۰٤ to ۲۰۲٤. In the following sections, each of the seven steps in Sandelowski and Barroso's (۲۰۰۷) meta-synthesis method is detailed, along with an explanation of how these steps were applied in this research.

Table ۱. Research Question Parameters in PRISMA-Based Meta-Synthesis

Question answer	Question parameters
What are the factors affecting the game's juiciness? What are the factors influencing the design of educational games based on juiciness?	What?
All articles indexed in Scopus, Science Direct and Emerald scientific database	Study community (Who)?
۲۰۰٤-۲۰۲٤	Limited time (When)?

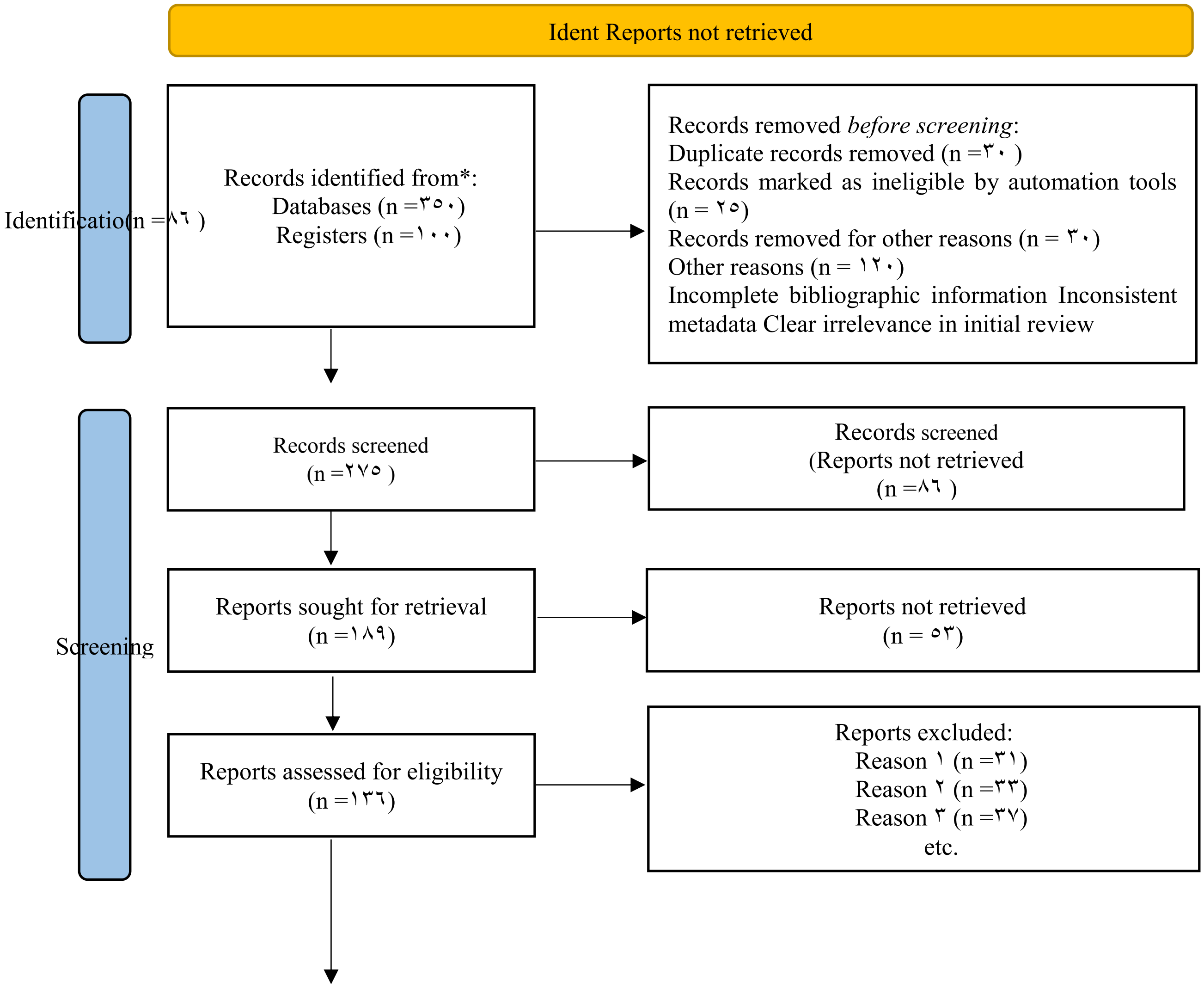
Step۲: We conducted a comprehensive search across three major scientific databases: Scopus, ScienceDirect, and Emerald. The search was limited to studies published between ۲۰۰٤ and ۲۰۲٤ to ensure relevance to contemporary game design approaches while capturing foundational work in the field.

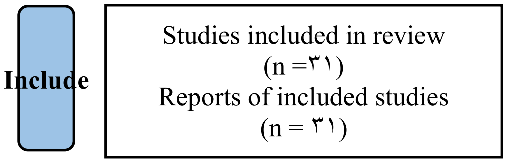
Step۳: The systematic review investigating the components of educational game design based on juiciness employed a comprehensive PRISMA methodology to ensure robust and transparent reporting. The initial identification phase yielded a substantial dataset of ۳٦۰ potentially relevant records, comprising ۳۵۰ database entries and ۱۰ register entries. This preliminary corpus represented a diverse range of research outputs addressing various aspects of game feel, feedback mechanisms, and educational efficacy in serious games. The methodological rigor of the identification phase ensured broad coverage across relevant academic databases and specialized registers, establishing a solid foundation for subsequent analytical stages.

The screening phase implemented a multi-tiered filtration process that systematically excluded records based on predefined criteria. Initially, ۸۵ records were removed through preliminary screening: ۳۰ due to duplication, ۲۵ through automated eligibility assessment tools, and ۳۰ for miscellaneous reasons. This reduction resulted in ۲۷۵ records proceeding to detailed screening, where an additional ۸٦ records were excluded based on more specific criteria. The granular nature of this screening process helped maintain the integrity of the review while ensuring that only the most pertinent studies progressed to the eligibility phase. This systematic review establishes clear inclusion and exclusion criteria to investigate juiciness components in educational game design across all subject areas. The inclusion criteria encompass: (۱) peer-reviewed studies focusing on educational games in any academic discipline (mathematics, science, language learning, etc.); (۲) research explicitly examining juiciness elements such as satisfying feedback mechanisms, rewarding animations, and rich audiovisual effects; (۳) empirical studies (qualitative, quantitative, or mixed-methods) published between ۲۰۱۰-۲۰۲٤ in English; and (٤) accessible full-text articles from reputable databases including IEEE Xplore, ACM Digital Library, ScienceDirect, SpringerLink, and ERIC. Exclusion criteria eliminate: (۱) non-educational or entertainment-focused games; (۲) studies lacking specific analysis of juiciness components; (۳) theoretical papers without empirical data; (٤) studies with small sample sizes (<۱۰ participants); (۵) research using invalid measurement tools; and (٦) publications where full text is unavailable. The review employs the Joanna Briggs Institute (JBI) checklist for quality assessment, ensuring methodological rigor while maintaining focus on how juiciness enhances engagement across diverse educational game genres. This framework enables comprehensive analysis of juiciness's role in optimizing learning experiences through game design, regardless of subject matter.

During the eligibility assessment, ۱۸۹ reports were identified for potential retrieval, though ۵۳ proved inaccessible despite comprehensive search efforts. The remaining ١٣٦ reports underwent rigorous eligibility assessment, during which ١٠١ reports were excluded based on three primary criteria: ٣١ under the first exclusion parameter, ٣٣ under the second, and ٣٧ under the third. This systematic evaluation process was crucial in establishing a refined corpus of studies that specifically addressed the core research questions regarding juiciness in educational game design. The detailed documentation of exclusion reasons ensures transparency and replicability of the review methodology. The final synthesis phase incorporated ٣١ studies (Figure٢) that met all inclusion criteria and quality standards, representing approximately ٨,٦٪ of the initial dataset. These studies formed the empirical foundation for analyzing how juiciness components contribute to educational game effectiveness. The relatively selective inclusion rate reflects the stringent quality controls implemented throughout the review process and ensures that the findings represent the most methodologically sound and relevant research in the field. This final corpus provides a robust evidence base for understanding the relationship between game feel mechanics and educational outcomes in serious games, while also highlighting potential areas for future research in this emerging field.

Figure ٢. Identification and Selection of Articles According to the PRISMA Framework





Step Four - Extracting Results: In this phase, selected articles were reviewed iteratively to identify distinct content findings where primary studies were conducted. After choosing key documents and reports, codes were systematically extracted from selected texts. For this purpose, a systematic review method was applied to analyze the findings of the articles, with each extracted factor being assigned a code. Then, these codes were categorized into overarching concepts based on their content, allowing themes to emerge from the codes and concepts. The coding results were validated by academic experts in the relevant field.

Step Five - Qualitative Analysis and Synthesis of Findings: During the analysis, the researcher conducts a thematic examination, organizing classifications based on the similarity and interrelationship of the emerging themes to represent them most accurately. In this study, articles were initially categorized according to the research topic, coded based on both explicit and implicit factors, and subsequently re-coded based on the primary codes and their interrelationships to identify dimensions. Further coding was conducted to classify these dimensions to facilitate the comprehensive development of a causal model that addresses the research questions.

Step Six - Verification of Extracted Codes: The validity of the proposed conceptual framework was ensured through content validity. This validity assessment was conducted in two aspects: the first involved utilizing elements and factors presented in previous research, which themselves had established validity; the second involved validation of the derived model by domain-specific experts and scholars. In the qualitative section of this study, two experts were informed of the research scope and confirmed the alignment of the results with the research objectives.

To assess the reliability of the final designed framework, the Kappa coefficient (κ) can be employed, as it measures agreement levels. In this case, either the entire work or all required elements are organized in a checklist format with binary responses (yes/no) to streamline feedback and save time. The checklist is provided to two experts, and after receiving their responses, the following formula is used to calculate the Kappa coefficient, which yields a value between -١ and +١.

$$\kappa = \frac{P_{.} - P_E}{١ - P_{.}}$$

Cohen’s Kappa coefficient and Scott’s Pi differ in calculating expected agreement. In Scott’s Pi formula, the observed proportions for each value in a category are squared. In contrast, Cohen’s Kappa multiplies the proportion for a specific value in a category used by one coder by the proportion of the same value used by the second coder. These proportions are then summed to obtain the expected agreement. A coefficient value greater than ٠,٦ indicates acceptable reliability (table ٢).

Table ٢. The Kappa statistic, based on expert consensus.

Agreement Strength	Kappa Statistic Value	Kappa Statistic Value in This Study
Low	٠ to ٠,٢٠	٠,٨٢
Below Average	٠,٢١ to ٠,٤٠	
Average	٠,٤١ to ٠,٦٠	
Good	٠,٦١ to ٠,٨٠	
Excellent	٠,٨١ to ١,٠٠	

The high agreement coefficient, above ٠,٨, indicates an excellent level of agreement.

Step٧: Based on previous studies and extracted codes, ٢٨ criteria and ١٠٤ indicators were identified in the section of factors affecting the game design pattern for a "juiciness" basis (Table ٣).

What game design elements are essential for creating a highly enjoyable and engaging 'juiciness' experience? and Given the identified ٢٨ criteria and ١٠٤ indicators for 'juiciness' in games through our research, what specific design patterns can maximize a player's 'juiciness' experience? Within these patterns, what elements should be prioritized, and how can we balance these elements effectively?"

Table ٣. The pattern of educational game design based on juiciness

Educational JUICINESS COMPNENTS	MDA Category	Criterion	Indicator	Resources
Interactivity	Dynamics	Interactive game environment	Dependent environment; environment with change among group members; conditions based on group synthesis and analysis	(Swink, ٢٠٠٨) (Hicks, ٢٠٢٠) (Hicks et al., ٢٠١٨) (Caroux et al., ٢٠١٥) (Ritterfeld et al., ٢٠٠٩)
	Dynamics	Need for strategy and decision-making	The role of decisions for each person, the role of individual decision on the fate of the group; the role of the situation and the effects of each person on the group; The role of decision-making changes	
	Dynamics	Player interaction	importance of mission completion based on participation, coordination role, quantity of relationships, quality of relationships.	
	Dynamics	Team plays	Unique integration, covering social needs, social adaptation	
Gameplay and in-game feedback	Mechanics	Contextual Feedback	Coordination of conditions with the situation, necessary changes according to the circumstances, pattern changes according to the situation, and differentiation based on the process	(Abdul Jabbar & Felicia, ٢٠١٥; K Hicks et al., ٢٠١٩) (Pichlmair & Johansen, ٢٠٢١) (Kao, ٢٠٢٠) (Drachen & Canossa, ٢٠٠٩; Huang et al., ٢٠١٩) (Liao et al., ٢٠١٩)
	Aesthetics	Emotional feedback	"Creating excitement; increasing excitement; changing excitement; creating different emotions based on the goal."	
	Mechanics	Content	Content aligned with the type	

Educational JUICINESS COMPNENTS	MDA Category	Criterion	Indicator	Resources
		feedback	of game; rewards based on the content performed; alignment of content and process within the game	
Avatar	Aesthetics	Exclusive	Customized; specific features; resemblance to the player's characteristics Avatar-Player Similarity،	(kao et al., ٢٠١٥) (kao et al., ٢٠١٦) (Segaran et al., ٢٠٢١) (Nizam et al., ٢٠٢٢) (Burleigh et al., ٢٠١٨)
	Aesthetics	Diversity	Superpower indicators; imaginative, distinctive features	
	Mechanics	Upgradability	Appearance; power-based; evolutionary	
Game Story	Aesthetics	story challenges	story challenges, story variety, unpredictability, creativity	(Padilla-Zea et al., ٢٠١٤) (Atanasov, ٢٠١٣) (Rapeepisarn et al., ٢٠٠٨) (Arsenault, ٢٠٠٩; Hua et al., ٢٠٠٩) (Shin & Chung, ٢٠١٧) (Silpasuwanchai & Ren, ٢٠١٧)
	Aesthetics	Game Genre	Perceptive, cognitive, movement, imaginative, emotional	
	Aesthetics	Role in the Story	Role adaptability, role alignment; changes in the story flow; role coordination	
	Aesthetics	Storytelling	Continuity, clear rhythm, narrative structure	
Visual and Graphical Structure	Aesthetics	Game Graphics	Graphic quality, graphic design, visual appeal	(Soylucicek, ٢٠١٢) (Kieran Hicks et al., ٢٠١٩) (Bevz, ٢٠٢٣) (Dickey, ٢٠١٥) (Laurier & Reeves, ٢٠١٣) (Whitton & Whitton, ٢٠١١) (Bateman et al., ٢٠١٠) (Kieran Hicks et al., ٢٠١٩)
	Aesthetics	Color	Color diversity, color quality; color harmony; color changes	
	Aesthetics	Effect Structure	٣٦٠-degree view, overlay structure, structural quality	
Power-Ups	Mechanics	Hidden Powers	Increased ability, extended duration, enhanced speed, improved accuracy; increased coordination	(Denisova & Cook, ٢٠١٩) (Plass et al., ٢٠١٥) (Félix et al., ٢٠٢٤) (Swink, ٢٠٠٨) (Lange-Nielsen, ٢٠١١)
	Mechanics	Special Features	Shortcuts, special services, leap achievements	
	Mechanics	Uniqueness	Distinct appearance, role differentiation from other players; different interactions	
Multisensory Experiences	Mechanics	Game Mechanics	Power changes, sensory changes, increased tactile sensation, reduced tactile sensation	(Covaci et al., ٢٠١٨)

Educational JUICINESS COMPNENTS	MDA Category	Criterion	Indicator	Resources
	Mechanics	Sensory Integration	Combining touch and sight, combining touch and sound; integrating touch, sound, and sight; sensory and tactile shocks	(Tao et al., ٢٠٢١) (Lyu et al., ٢٠٢٣) (Reese et al., ٢٠١٦) (Price et al., ٢٠١٧) (Hicks, ٢٠٢٠) (Chang et al., ٢٠٢٢)
Music and Sound	Aesthetics	Enhancing Emotion	Excitement, emotional states, sensory changes, immersion	(Yang et al., ٢٠١٩) (Wharton & Collins, ٢٠١١) (Grimshaw et al., ٢٠١٣) (Byun & Loh, ٢٠١٥) (Rogers, ٢٠١٤) (Collins, ٢٠٠٨) (Nacke et al., ٢٠١٠) (Abia & Caroux, ٢٠١٨) (Nacke et al., ٢٠١٠)
	Aesthetics	Significance	Making things appear important; assigning roles to situations, giving warnings, reporting game progress	
	Aesthetics	Music Diversity	Notes, musical instruments, songs	
Image	Aesthetics	Image Type	Angle, image type, shape changes in the image, content overlay of images	(Javora et al., ٢٠١٩) (Jafarkhani et al., ٢٠٢٤) (Goethe, ٢٠١٩) (Clemens et al., ٢٠١٨) (Sepúlveda, ٢٠٢٠)
	Mechanics	Camera Movements	Slow movements; fast movements; continuous speed changes, movement structure, forward and backward image shifts	
	Mechanics	Focuses	Image zooming; zooming on characters, zooming on positions, zooming on the environment	
Education juiciness Components	MDA Category	Criterion	Indicators	Resources
Quest System	Mechanics & Dynamics	Progressive Challenge Design	١. Adaptive difficulty scaling based on player performance ٢. Clear milestone achievements ٣. Branching quest paths with meaningful choices	Hamari, J., & Nousiainen, T. (٢٠١٥). 'Why Do Teachers Use Game-Based Learning Technologies?'
Achievement System	Aesthetics	Reward Psychology	١. Immediate feedback mechanisms ٢. Visual progression tracking ٣. Milestone celebration events	Dicheva, D., & Dichev, C. (٢٠١٥). 'Gamification in Education: Where Are We in ٢٠١٥?'
Social Collaboration	Dynamics	Peer Learning Integration	١. Team-based problem solving ٢. Knowledge sharing mechanisms ٣. Collaborative challenge	Romero, M., & Usart, M. (٢٠١٣). 'Serious Games Integration in an Entrepreneurship Massive Online Course'

Educational JUICINESS COMPNENTS	MDA Category	Criterion	Indicator	Resources
			completion	
Interactive Storytelling	Aesthetics	Narrative Engagement	۱. Character-driven plot development ۲. Player choice impact on story ۳. Environmental storytelling elements	Dickey, M. D. (۲۰۱۵). 'Aesthetics and Design for Game-based Learning'
Skill Tree Progression	Mechanics	Competency Development	۱. Visual skill mapping ۲. Multiple advancement paths ۳. Skill application scenarios	Toda, A. M., et al. (۲۰۱۹). 'A Taxonomy of Game Elements for Gamification in Educational Contexts'
Resource Management	Mechanics & Dynamics	Strategic Planning	۱. Resource allocation decisions ۲. Long-term strategy development ۳. Resource optimization challenges	Arnab, S., et al. (۲۰۱۵). 'Mapping Learning and Game Mechanics for Serious Games Analysis')
Exploration System	Aesthetics	Discovery Learning	۱. Hidden content rewards ۲. Interactive environment design ۳. Progressive area unlocking	Boyle, E. A., et al. (۲۰۱٦). 'An Update to the Systematic review of Empirical Evidence of Gaming'
Challenge Towers	Mechanics	Mastery Development	۱. Tiered difficulty levels ۲. Skill-specific challenges ۳. Performance benchmarks	Kapp, K. M. (۲۰۱۲). 'The Gamification of Learning and Instruction')
Knowledge Crafting	Dynamics	Content Creation	۱. Information synthesis tools ۲. Knowledge combination mechanics ۳. Creation sharing system	Prensky, M. (۲۰۱٤). 'Digital Game-Based Learning'
Time Management	Mechanics & Aesthetics	Efficiency Learning	۱. Time-based challenges ۲. Priority management tasks ۳. Resource optimization under time constraints	Clark, D. B., et al. (۲۰۱٦). 'Digital Games for Learning: A Systematic Review'

Table ٤ illustrates the juiciness components (sensory richness or "juice") of educational games based on the MDA framework (Mechanics, Dynamics, Aesthetics). In this framework, Mechanics refer to the core rules and foundational game components, Dynamics to the emergent behaviors and interactions produced during gameplay, and Aesthetics to the emotional responses and desirable player experiences (e.g., pleasure, immersion, and motivation). The table indicates that elements such as Power-Ups, Challenge Towers, Skill Tree Progression, Multisensory Experiences, Gameplay & Feedback, Resource Management, Quest System, and Achievement System primarily operate at the Mechanics level, directly tied to programmable rules and systems. Conversely, features like Interactivity, Social Collaboration, Knowledge Crafting, and Interactive Storytelling align more with Dynamics, arising from player-system interactions. Components including Game Story, Music & Sound, Visual Structure, and Exploration System predominantly contribute to Aesthetics, enhancing sensory and emotional engagement. Certain elements, such as Achievement System, Interactive Storytelling, Avatar, Image, and Time Management, span multiple MDA layers, underscoring their pivotal role in fostering comprehensive juiciness in educational games where visual, auditory, and interactive richness not only boosts learning motivation but also delivers a pleasurable and memorable experience for learners.

Table ٤. Juiciness Components of Educational Games Based on the MDA Framework

Characteristic	Mechanics	Dynamics	Aesthetics
Power-Ups	Yes	No	No
Challenge Towers	Yes	No	No
Skill Tree Progression	Yes	No	No
Multisensory Experiences	Yes	No	No
Interactivity	No	Yes	No
Social Collaboration	No	Yes	No
Knowledge Crafting	No	Yes	No
Game Story	No	No	Yes
Music & Sound	No	No	Yes
Visual Structure	No	No	Yes
Exploration System	No	No	Yes
Gameplay & Feedback	Yes	Yes	No
Resource Management	Yes	Yes	No
Quest System	Yes	Yes	No
Interactive Storytelling	No	Yes	Yes
Avatar	No	Yes	Yes
Image	Yes	No	Yes
Time Management	Yes	No	Yes
Achievement System	Yes	Yes	Yes

Figures ٢, ٣ and ٤ presents a conceptual model of juiciness elements in educational games, structured around the MDA framework (Hunicke et al., ٢٠٠٤), which categorizes game design into Mechanics (M: core rules and systems), Dynamics (D: runtime behaviors and player interactions), and Aesthetics (A: emotional and sensory experiences). Mechanics (in blue) encompass foundational elements like Quest Systems for progressive challenges, Skill Trees for competency development, Power-Ups and Challenge Towers for mastery, Resource Management for strategic planning, and Team Play for social dynamics. Dynamics (in green) emerge from player engagement, including Social Interactions for peer learning, Knowledge Crafting for content creation, Player Interactions for coordination, Interactive Storytelling for narrative immersion, Exploration Systems for discovery learning, and Contextual Feedback for situational adaptation. Aesthetics (in yellow/orange) focus on sensory appeal, such as Achievement Systems leveraging reward psychology, Music & Sound for emotional enhancement, Avatar Design with customization, Visual elements (graphics, color, effects), Time Management for efficient learning, and Multisensory Integration. Overlapping zones (e.g., M+D, D+A, M+A, M+D+A) highlight interconnected elements that amplify juiciness, fostering immersive, motivating, and effective educational experiences by blending structural rules, emergent play, and affective responses.

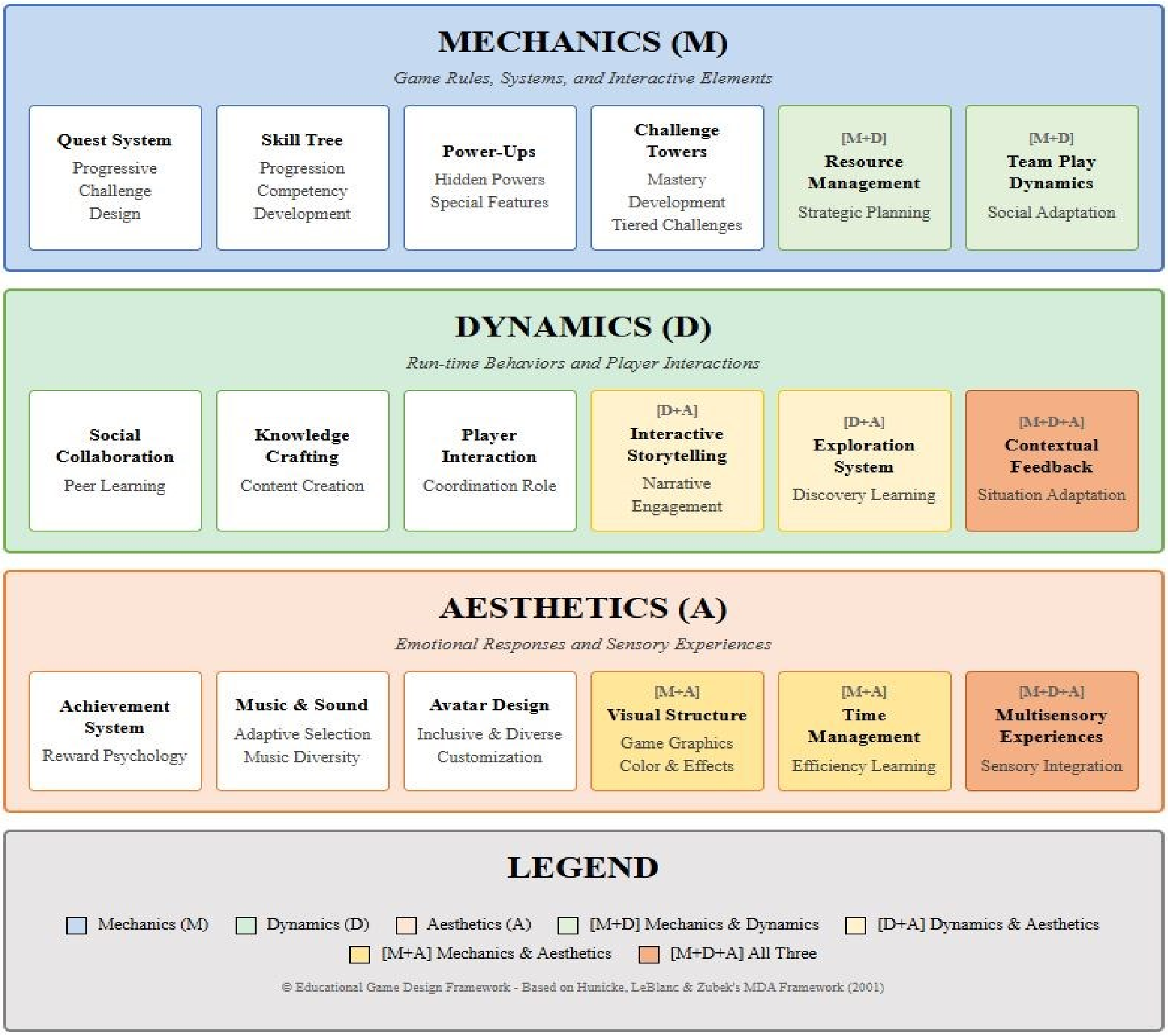


Figure ٢. A Conceptual Model of Juiciness Elements in Educational Games

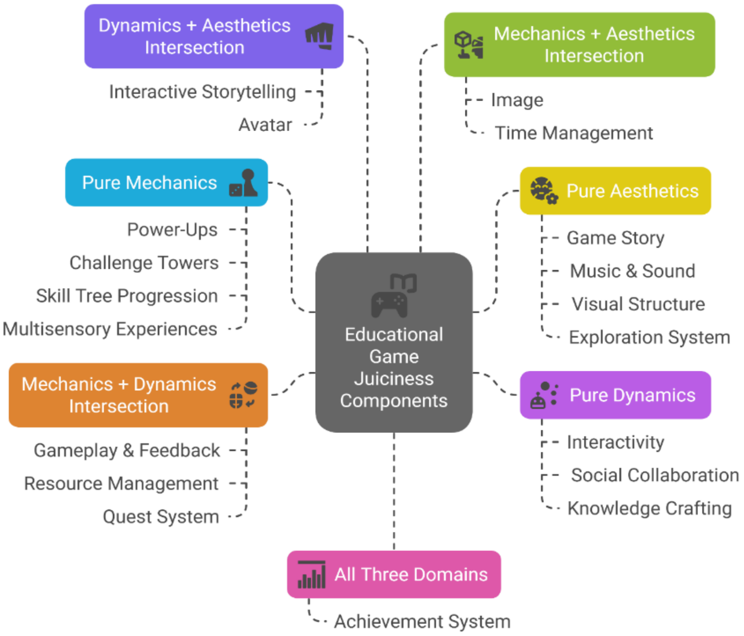


Figure ٣. A Conceptual Model of Juiciness Elements in Educational Games Based on the MDA Framework

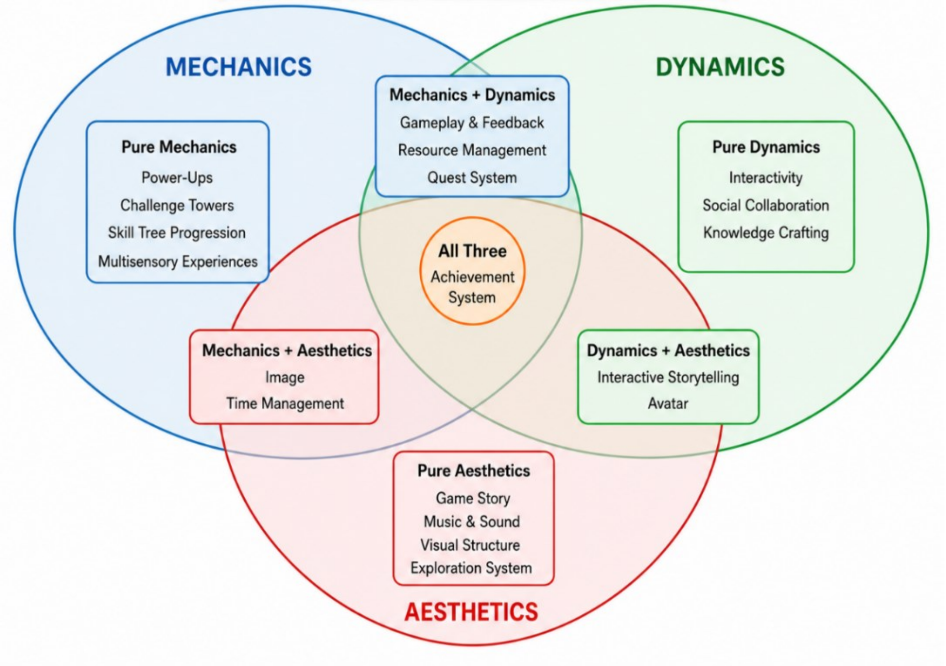


Figure ٤. A Conceptual Model of Juiciness Elements in Educational Games Based on the MDA Framework(B)

Result

Based on the findings, four criteria related to interactive environments, the need for strategy and decision-making, player interaction, and team play are identified according to ١٤ indicators: a dependent environment, an environment with changes among group members, conditions based on group synthesis and analysis, the role of decisions for each person, the impact of individual decisions on the group's fate, the role of the situation and the effects of each individual on the group, changes in decision-making, team play, the importance of mission completion based on participation, the role of coordination, the quantity and quality of relationships, unique integration, and social adaptation. These elements are associated with interactivity in the game design model for a basis of "JUICINESS."

Additionally, three criteria—contextual feedback, emotional feedback, and content feedback—are based on ١١ indicators: coordination of conditions with the situation, necessary changes according to circumstances, changes in patterns based on the situation, differentiation by process, creating excitement, increasing excitement, changing excitement, and creating different emotions depending on the content goal, rewards based on the content performed, and the alignment of content and process in the game. These elements contribute to the feedback compatibility aspect in the game design model for the "JUICINESS" basis.

Furthermore, based on the findings, three criteria—exclusivity, diversity, and upgradability—are linked to nine customized indicators: specific features, similarity to the player's conditions, superpower indicators, imagination, distinctive features, appearance, power-based, and evolutionary aspects. These elements pertain to avatar-related factors in the game design model for "JUICINESS."

For story-related aspects, four criteria—story challenges, game genre, role in the story, and storytelling—are identified based on ١٥ indicators: story diversity, unpredictability, creativity, cognitive, perceptual, movement, imaginative, and emotional load, role adaptability, role alignment, changes in the story flow, role coordination, continuity, rhythm, and narrative structure. These elements are connected to the story-related factors in the game design model for "JUICINESS."

Three criteria related to the game's graphics, color, and effect structure are based on ١٠ indicators: graphic quality, graphic design, visual appeal, color diversity, color quality, color harmony, color changes, ٣٦٠-degree view, overlay structure, and structural quality. These elements contribute to the visual and graphic structure in the game design model for "JUICINESS."

For power-ups, three criteria—hidden powers, special features, and uniqueness—are derived from ١٣ indicators: increased ability, extended duration, enhanced speed, improved accuracy, increased coordination, shortcuts, special services, leap achievements, different appearance, and role differentiation from other players. These elements are associated with power-up factors in the game design model for "JUICINESS."

Two criteria related to game mechanics and sensory integration are identified based on eight indicators: power changes, sensory changes, increased tactile sensation, reduced tactile sensation, combining touch and sight, combining touch and sound, integrating touch, sound, and sight, and sensory and tactile shocks. These elements are related to multisensory experiences in the game design model for "JUICINESS."

Three criteria related to enhancing emotion, significance, and music diversity are based on ١١ indicators: excitement, emotional states, sensory changes, immersion, making things appear important, assigning roles to situations, giving warnings, reporting game progress, notes, musical instruments, and songs. These elements contribute to sound and music-related aspects in the game design model for "JUICINESS."

Finally, three criteria related to image type, camera movements, and focuses are identified based on ١٣ indicators: angle, image type, shape changes in the image, content overlay of images, slow and fast movements, continuous speed changes, movement structure, forward and backward image shifts, and zooming in on characters, positions, and environments. These elements are linked to image-related factors in the game design model for "JUICINESS."

Number of criteria and indicators, highlighting its pedagogical depth and systematic integration into learning processes. A total of ten components are identified, each aligned with the Mechanics, Dynamics, and Aesthetics (MDA) framework. The "Quest System" includes three indicators under the criterion of Progressive Challenge Design, emphasizing adaptive difficulty, milestone achievements, and branching paths. Similarly, "Achievement System" focuses on Reward Psychology, with three indicators addressing feedback, visual tracking, and milestone celebrations. "Social Collaboration" integrates Peer Learning through three indicators related to team problem-solving, knowledge sharing, and collaborative challenges.

Other components, such as "Interactive Storytelling" and "Skill Tree Progression," each also feature three indicators tied to their criteria of Narrative Engagement and Competency Development, respectively. Notably, "Resource Management" emphasizes Strategic Planning through three decision-making and optimization indicators, while "Exploration System" incorporates Discovery Learning with three engaging design elements. Finally, "Challenge Towers," "Knowledge Crafting," and "Time Management" consistently present three indicators each, addressing their respective criteria of Mastery Development, Content Creation, and Efficiency Learning. This systematic alignment ensures that each component is deeply analyzed, making the table a valuable resource for understanding gamified educational practices in a comprehensive manner. The consistent presence of three indicators per component reflects a deliberate design, supporting robust implementation and review.

Discussion

The systematic review of literature on juiciness in educational game design reveals several significant insights into how these components contribute to creating engaging and effective learning experiences. The MDA (Mechanics, Dynamics, Aesthetics) framework applied to educational games demonstrates the multifaceted nature of juiciness and its potential impact on learning outcomes.

Our analysis indicates that juiciness extends beyond mere visual or auditory embellishments; it represents a holistic approach to game design that addresses cognitive, emotional, and social aspects of the learning experience. The mechanics components, including gameplay feedback, quest systems, and achievement structures, create a scaffolded learning environment that provides immediate reinforcement and clear progression paths for learners. These elements align with established educational theories such as operant conditioning and mastery learning, suggesting that well-designed juicy mechanics can support pedagogical objectives while maintaining engagement.

The dynamics components identified in our review highlight the importance of interactivity and agency in educational games. The presence of social collaboration features, exploration systems, and adaptable difficulty levels allows for personalized learning experiences that can accommodate diverse learning styles and abilities. This finding correlates with contemporary educational approaches that emphasize student-centered learning and differentiated instruction.

Perhaps most interestingly, the aesthetics components demonstrate that sensory and narrative elements contribute significantly to the educational value of games. Avatar customization and game story, for instance, provide opportunities for identity exploration and contextual learning that can deepen understanding and retention of educational content. The multisensory feedback systems facilitated through visual and audio elements create immersive learning environments that can enhance cognitive processing through multiple channels of information.

A notable pattern emerging from our analysis is the interconnected nature of these components. The most effective educational games integrate mechanics, dynamics, and aesthetics in ways that mutually reinforce learning objectives. For example, achievement systems (mechanics) become more meaningful when connected to exploration systems (dynamics) and embedded within compelling narratives (aesthetics). This suggests that juiciness should be considered as an integrated design principle rather than a collection of isolated features.

Conclusion

This systematic review has established a comprehensive framework for understanding juiciness in educational game design through nineteen distinct components organized within the mechanics, dynamics, and aesthetics categories. The findings demonstrate that juiciness is a sophisticated design concept that significantly influences the effectiveness of educational games by enhancing engagement, motivation, and learning outcomes. The research reveals that juicy game design creates a positive feedback loop where increased engagement leads to greater persistence, which in turn results in improved learning. By incorporating appropriate juiciness components, educational game designers can create experiences that are not only informationally rich but also intrinsically rewarding, addressing one of the fundamental challenges in educational technology: maintaining student engagement over time. Our analysis also highlights the evolving nature of juiciness in educational games, with recent developments in technology enabling more sophisticated implementations of these components. The increasing accessibility of game development tools has democratized the creation of educational games, making it possible for educators with limited technical expertise to incorporate juiciness principles into their instructional materials. While this review provides a structured framework for understanding juiciness in educational game design, it also reveals areas where further research is needed. The relative importance of different juiciness components may vary depending on factors such as learner age, subject matter, and learning context. Additionally, the optimal balance between educational content and juicy elements remains an area for exploration, as does the long-term impact of juicy educational games on knowledge retention and transfer.

Conflict of Interest

The authors hereby declare that no conflicts of interest exist in connection with the research and publication of this article. This study was conducted independently, without any financial, commercial, or personal relationships that could have influenced the outcomes or interpretations presented. The authors confirm that all aspects of the research process, including study design, data collection, analysis, and reporting, were carried out objectively and free from any external bias.

Practical and Research Recommendations

Practical Recommendations

١. **Balanced Integration**: Educational game designers should strive for a balanced integration of mechanics, dynamics, and aesthetics components rather than focusing exclusively on one category. Our findings suggest that the most effective educational games incorporate elements from all three categories in ways that support learning objectives.

٢. **Age-Appropriate Juiciness**: The implementation of juiciness components should be calibrated according to the target audience's age and developmental stage. Younger learners may benefit from more explicit visual and auditory feedback, while older students might appreciate more sophisticated narrative elements and complex achievement systems.

٣. **Educator Involvement**: Involve educators in the game design process to ensure that juiciness components enhance rather than distract from learning objectives. Educators can provide valuable insights into how game elements can be aligned with curriculum standards and pedagogical approaches.

٤. **Accessibility Considerations**: Design juiciness components with accessibility in mind, ensuring that learners with different abilities can benefit from these elements. For example, provide multiple modes of feedback (visual, auditory, haptic) to accommodate various learning preferences and needs.

٥. **Cultural Relevance**: Incorporate culturally relevant aesthetics and narratives to increase relatability and engagement for diverse learner populations. This approach can make educational content more meaningful and contextually relevant.

Research Recommendations

١. **Longitudinal Studies**: Conduct longitudinal studies to assess the long-term impact of juicy educational games on knowledge retention, skill development, and transfer of learning to non-game contexts.

٢. **Component Effectiveness**: Investigate the relative effectiveness of specific juiciness components for different subject areas, learning objectives, and learner profiles to develop more targeted design guidelines.

٣. **Measurement Tools**: Develop and validate standardized tools for measuring juiciness in educational games to facilitate more rigorous comparative studies and benchmark analyses.

٤. **Cognitive Load Considerations**: Explore the relationship between juiciness and cognitive load to determine optimal levels of juiciness that enhance rather than hinder learning processes.

٥. **Emerging Technologies**: Investigate how emerging technologies such as virtual reality, augmented reality, and artificial intelligence can enhance juiciness components in educational games and create new opportunities for immersive learning experiences.

٦. **Cross-Cultural Perspectives**: Examine how cultural factors influence the perception and effectiveness of juiciness components in educational games across different societies and educational systems.

By addressing these practical and research recommendations, the field can advance toward more sophisticated and evidence-based approaches to incorporating juiciness in educational game design, ultimately enhancing the learning experience and outcomes for students across various educational contexts.

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