

Research on gamification and perceptual improvement of online course interaction design in children's online education



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Abstract With the rapid advancement of global information technology, the integration of online course resources with traditional classroom teaching has become an increasingly popular trend. This transformation not only demands that learners improve their self-directed learning abilities but also significantly raises users' expectations for the functionality and learning experience of online learning platforms. Consequently, optimizing the interactive design of online learning platforms has emerged as a crucial topic in contemporary educational technology research. This study draws on theories of educational engagement, gamification design, interaction design, and relevant studies in children's online education. First, this research analyzes the interactive design of existing online education platforms for children, identifying deficiencies in user interaction, content presentation, and learning experience. Building on these findings, it explores how innovative design concepts can enhance the interactivity and user experience of such platforms. Specifically, this study focuses on two dimensions: gamification and emotional design, investigating how these concepts can be effectively applied to children's online education. By analyzing children's psychological needs and behavioral patterns during the learning process, the study finds that gamified interactive designs can significantly improve learners' sense of engagement and immersion, thereby enhancing their motivation and capacity for self-directed learning. Moreover, the study emphasizes the diversified application of digital tools and platforms, proposing that, in the context of big data, interactive design for children's online education should prioritize data-driven approaches and personalized recommendations. By analyzing learners' behavioral data, online platforms can dynamically adjust learning content, difficulty levels, and interaction methods to provide each learner with the most tailored learning experience. This not only improves learning outcomes but also helps educators better understand students' learning needs and behavioral characteristics, thereby supporting the realization of personalized education.

Keywords: children's online education, interactive design, interaction theory, emotionalization, gamification ast

1. Introduction

With the development of mobile communication technology and information-based education, learning methods based on wired networks and mobile internet have garnered increasing attention, while the design and development of related online courses continue to flourish. Online courses allow students to acquire knowledge and develop skills without the constraints of time and space, offering flexibility in selecting suitable times and modes of learning (Barua & Lockee, 2024). This provides new avenues and perspectives for lifelong learning and universal education. However, existing online courses often fail to adequately emphasize the interaction between students and teachers, the learning content, and the learners themselves, which significantly impacts the effectiveness of online teaching (Cavinato et al., 2021). The proliferation and advancement of information and internet technologies have subtly transformed human lifestyles, making many activities smarter, more human-centered, and more efficient. This influence extends not only to adults but also to children, (Li & Begaliev, 2022) whose childhoods are enriched by immersive games and learning experiences beyond traditional classrooms. They now have access to high-quality, comprehensive, and engaging online educational resources from around the world (Haleem et al., 2022).

In the learning process, interactive design is a critical factor in determining learning outcomes. Interaction features, such as real-time engagement and operational elements in live course applications, directly influence students' attention and interest during classes, serving as key determinants of effective teaching (Al-Adwan et al., 2021). Consequently, there is growing emphasis on the interactive design of educational applications, although research specifically focused on live course interactivity remains limited. Studies have demonstrated that positive social interactions can significantly benefit early education. Sammer reported that the quantity and quality of interactions can predict engagement in learning activities, which in turn influences future academic development (Sammer et al., 2024). Positive and enjoyable interactions effectively stimulate



interest in reading (Amaefule et al., 2023). Furthermore, research has revealed that parental behaviors supporting autonomy—such as fostering interest and independence—increase learning outcomes, whereas interference and excessive control lead to poorer results (Linkiewicz et al., 2021).

With the rapid development of computer, network, and multimedia technologies, the hardware advantages in online education are gradually diminishing, while the importance of educational resources has become increasingly prominent. Ultimately, the quality and accessibility of these resources are key determinants of the success or failure of online education. As the fundamental unit of online teaching, online courses constitute the core of educational resources and serve as the essential foundation for implementing online education (Boettcher & Conrad, 2021). Designing and developing high-quality online courses is not only a necessary requirement for the advancement of online education but also a powerful guarantee for improving the quality of online teaching (Alenezi, 2023). At the same time, it presents a significant challenge for educational technology professionals. Compared with traditional classroom teaching, the advantages of online education lie in its abundant and shareable digital learning resources, diverse forms of information representation, and emphasis on autonomous learning. In traditional classroom settings, teachers and students share the same physical space, enabling convenient face-to-face interaction and emotional communication, as well as adaptive adjustments based on mutual feedback (Gloria & Uttal, 2020). However, in online environments, the near-permanent separation of teachers and students in time and space makes such interactions much more challenging. Learners in online education often interact only superficially with learning resources, limiting their ability to engage in broad and deep exploratory learning. Furthermore, insufficient interaction occurs between teachers and students, among learners, and between learners and resources. This lack of interaction hinders learners' ability to conduct extensive, in-depth inquiries around problems and to effectively transfer and apply acquired knowledge, thereby impacting the overall effectiveness of online learning. Interaction is the foundation and primary pathway for successful online teaching, and the effectiveness of interaction is the lifeblood of online courses (Maiya & Aithal, 2023).

The quality of interaction design in online courses directly influences learners' outcomes. Well-conceived and scientifically designed interactions can fully engage learners, motivating them to immerse themselves in the learning process and thereby improving the quality of learning. Achieving effective instructional interaction requires meticulous design. Consequently, a comprehensive study of interaction design in online courses, culminating in a complete theoretical framework, practical methods, and developmental pathways, is highly important. Such research will enable online teaching activities to be conducted in a rational, standardized, and orderly manner, ultimately contributing to the advancement of online education. This study aims to achieve the following research objectives: to conduct a comprehensive analysis of the interactive design of existing online education platforms for children, identifying deficiencies in user interaction, content presentation, and learning experience; to investigate how innovative design concepts (including gamification design and emotional design) can enhance the interactivity and user experience of online education platforms for children; to analyze the psychological needs and behavioral patterns of children during the learning process, exploring the effectiveness of gamified interactive design in improving engagement and immersion, thereby enhancing their motivation and capacity for self-directed learning. The goal of this study is to improve learning outcomes by making online learning platforms better designed. This will also help assist educators better understand each student's learning needs and behavioral traits, which will support the realization of personalized education.

1.1. Development status of interactive design online course

Interactivity is a multifaceted concept that fundamentally involves mutual actions triggered by the exchange of information. Interaction in distance education represents an educationally significant phenomenon, which she terms "instructional interaction." This type of interaction plays a critical role in the effectiveness of online courses, and clarifying its essence is a prerequisite for achieving effective instructional interaction design (Zhang et al., 2024). Moore identifies three types of interactions in distance education: interactions between learners and learning content, interactions between learners and teachers, and interactions among learners (Moore et al., 2011). Bouhnik et al. suggested that the interaction between learners and the system also significantly influences the learning process and should be considered a fourth type of interaction in distance education (Bouhnik & Marcus, 2006).

Laurillard proposed the "Conversational Framework" for the learning process, emphasizing that two levels of interaction occur simultaneously: the adaptive interaction between the learner's actions and the teacher-constructed environment and the conversational interaction between the learner's concepts and the teacher's concepts (Yong et al., 2020). Building on Laurillard's research, Zhang developed a model of instructional interaction for distance learning comprising three levels: operational interaction between students and media, informational interaction between students and instructional elements, and conceptual interaction between a learner's concepts and new concepts (Zhang et al., 2022). These three levels progress from concrete to abstract and from basic to advanced, forming a "hierarchical instructional interaction pyramid." This framework proposes the "dual instructional interaction hierarchy pyramid" model for distance teaching (Li & Begaliev, 2022). This model includes four levels of interaction, arranged hierarchically from basic to advanced: human-media interaction, communication interaction, interpersonal interaction, and internalized interaction. Online education places greater emphasis on the interaction and communication between teachers and students, as well as among students themselves. By leveraging

multimedia tools and interactive methods, it bridges emotional and psychological gaps between teachers and students, enhances opportunities for communication and collaboration, and reduces the barriers and isolation caused by physical distance. Additionally, with the support of big data, educators can statistically analyze students' weak points, enabling more targeted and personalized instruction. This data-driven approach enhances the precision and effectiveness of teaching, making online education more responsive to individual needs.

Online courses represent the entirety of a subject's instructional content and the teaching activities conducted through a network. They consist of two main components: the instructional content, which is organized according to specific teaching objectives and strategies, and the network-based teaching support environment (Kryvorot & Pryhodii, 2020). By presenting course content through various media formats in an integrated manner, online courses leverage the complementary strengths of different media, making instruction more vivid and engaging. This approach helps to increase learners' interest and self-motivation in studying. Furthermore, with the network as the medium, course content can be updated at any time, ensuring that learners have access to the latest information. Through various forms of online communication, teachers and students, as well as learners themselves, can engage in extensive, in depth, and more personalized interactions, fostering a richer and more dynamic educational experience. Compared with traditional education, where students must attend schools or training institutions with designated classrooms, teachers, and coordinated schedules, online education effectively overcomes these spatial and temporal limitations. Children need only internet access and simple devices (such as a computer, tablet, or smartphone, which are now widely available) to access a vast array of knowledge and share global educational resources anytime and anywhere. Traditional education often follows standardized curricula with uniform teaching outlines and single-mode instruction, whereas online courses offer more diverse content and innovative, trend-driven designs. Students can actively choose the learning methods that interest them, select preferred schedules, and even opt for their favorite teachers, transforming learning from a passive, pressure-driven process into an active, self-motivated process, often yielding better results (Owens et al., 2020).

However, while students benefit from the flexibility of learning via computers or mobile devices, they lose the structure and oversight provided by schools, classrooms, teachers, and peers. In home or other unregulated environments, distractions abound, making it easy for students, especially young children with limited self-discipline, to be drawn to more entertaining activities. Online education also lacks essential emotional communication. When delivered through digital media such as computers, tablets, or smartphones, it struggles to replicate the face-to-face interactions of traditional offline education. Teachers find it challenging to quickly grasp each student's specific learning progress, physical state, and psychological well-being, making it harder to provide timely, tailored responses through verbal or emotional communication (Asghar et al., 2022). Furthermore, traditional classroom education offers opportunities for interaction among students. In a physical classroom, students can engage with their peers, improving their communication skills and fostering a sense of cooperation. The collaborative atmosphere cultivated during group discussions and activities is difficult to replicate in online education. As a result, online learning often lacks the enriched learning environment that emerges from teamwork and social interaction.

1.2. Common problems in current interactive design software

To effectively guide learners in interacting with online course content, guiding information needs to be prominently displayed. However, some online courses fail to recognize this and instead prioritize aesthetic appeal, unintentionally introducing excessive distracting elements that "pollute" the interface. This makes it difficult for learners to identify useful information, creating barriers to navigation. For example, certain courses use brightly colored images as backgrounds, obscuring critical information. Some developers focus on flashy web effects and integrate them into courses without considering their utility for learners (Hsiao & Su, 2021). Surveys have revealed instances of online courses where continuously blinking cursors distract learners, whereas others feature eye-catching banner ads made with Flash, diverting attention to nonessential content. A well-designed navigation system is crucial for online courses, functioning like maps and road signs for travelers, enabling learners to efficiently locate information or execute functions to interact with the course. Unfortunately, this vital aspect is often overlooked. Some courses require learners to endure multiple unnecessary page transitions to reach their desired destination, compounded by long loading times. In some cases, navigation links are one-way, with no return option, restricting learners' ability to move freely. Moreover, some courses have navigation systems so convoluted that they require a user manual to operate, making it difficult for learners to locate needed information.

Buttons are another fundamental interactive element in online courses, often serving as both functional tools and navigation aids. However, many courses feature buttons that are ambiguous and difficult to interpret. Learners cannot deduce their purpose from their appearance and must resort to trial and error to understand their function (Bartlett et al., 2023). Furthermore, as developers explore diverse design options, buttons are no longer limited to simple rectangular shapes. While this can add visual appeal, it also creates confusion—users might not even recognize these elements as buttons, thereby impeding interaction. To address this, buttons should adhere to conventional shapes and styles that clearly indicate their functionality, ensuring ease of use and reducing design complexity (Miraz et al., 2021). Cursor behavior also plays a critical role in guiding user interaction. Different cursor shapes provide intuitive cues for interaction, such as the hand icon over clickable links or the double-sided arrow for resizing windows. Long-term web users are familiar with these cues, which encourage

specific actions. However, some courses fail to implement these conventions, leaving cursors unchanged when hovering over interactive elements such as buttons. This oversight creates the illusion that the buttons are inactive, introducing unnecessary interaction barriers.

Mapping describes the relationship between controls, the affected elements, and the expected outcomes. This relationship should feel natural and intuitive to help learners understand how to interact with the course. When mapping is unnatural, it disrupts the user experience and may even lead to errors. In some online courses, the connection between controls and their effects is unclear, with no spatial relationship or textual explanation to guide users. This lack of clarity severely hampers usability. The root cause of these issues often lies in the mismatch between implementation models, conceptual models, and presentation models. The implementation model describes the internal mechanisms of how a system works, including the code structure, function calls, and operational logic. While developers are intimately familiar with these details, they are irrelevant to users. Instead, users form their own conceptual models—simplified understandings of how a system functions on the basis of their interactions. For example, most television viewers do not need to know how signals are transmitted from broadcasting stations to their screens; they only need to understand how to turn on the TV and switch channels. The presentation model is the outward representation of a system's functionality, designed by developers to communicate with users. Ideally, this model should align closely with the user's conceptual model rather than the internal implementation model. When the presentation model reflects users' mental models, the software feels intuitive and user friendly. Conversely, when it mirrors the implementation model, the system appears opaque and complex, alienating users who lack technical expertise. Developers, who are deeply familiar with the system's inner workings, often design presentation models on the basis of their own logic, believing it to be the most precise and efficient representation. However, this approach neglects the needs and perspectives of the end-users. In online course design, this disconnect becomes apparent in issues such as ambiguous button design. Developers understand the button's purpose but fail to convey its function through its appearance, resulting in confusion among learners. Resolving this problem requires aligning the presentation model with the learner's conceptual model, creating interfaces that are intuitive, accessible, and conducive to effective interaction.

1.3. Risks and challenges in educational interactive design

In online learning, instructional interaction serves as a supportive element, facilitating communication between teachers and students, as well as among students themselves, in a context where spatial and temporal separation exists. It occurs throughout the learning process, and any stage of the process can potentially trigger instructional interaction. However, most online courses treat the acquisition of course content and instructional interaction as two distinct activities (Wekerle et al., 2022). For example, if students encounter questions while studying course materials, they must navigate to a separate course forum to post their questions and wait for responses. This artificial separation of learning and interaction into different times and spaces disrupts the seamless integration of the instructional process.

Instructional interaction can occur at any point during online learning, such as while studying course content, completing assignments, participating in discussions, or practising exercises. It offers multifaceted support throughout the learning journey. However, investigations reveal that in most online courses, instructional interaction is limited to postcontent discussion activities. For example, after completing a chapter or unit, students are often assigned a discussion topic and are required to participate in forum discussions, with participation often tied to grades to ensure engagement. This approach reduces instructional interaction to a few preplanned discussion topics, simplifying it to an auxiliary activity and undervaluing its critical role in supporting the learning process. Instructional interaction, fundamentally a dynamic exchange of information between teachers and students or among students, is often confused with interaction methods, which are merely tools or means to enable interaction (Prati et al., 2021). These two concepts are inherently different. Many online courses focus solely on providing interaction tools, treating instructional interaction as a website feature embedded within course platforms, with minimal attention given to the design of meaningful interactive activities. Consequently, the essence of instructional interaction is distorted, reducing it to the provision of tools rather than the design of purposeful exchanges. While instructional interaction and everyday online communication share commonalities—both involve information exchange through digital tools—educational interaction is far more targeted and purposeful. Most instructional interactions are closely tied to learning content and are designed to achieve specific learning objectives. However, research indicates that instructional interaction in many online courses has been generalized to mimic everyday online communication, adopting conventional online forums as the primary medium (Khalil et al., 2020). These forums are often simplified, sometimes limited to text-only exchanges, and applied indiscriminately across courses without tailoring them to the unique characteristics of students or course content. Instructional interaction is often presented in course forums as a chronological list of discussions, lacking tailored organizations aligned with students' learning needs or the specific nature of the course material. This unstructured approach undermines the potential of instructional interaction to provide targeted, contextually relevant support for students, diminishing its effectiveness as a tool for enhancing the learning experience (Hennekeuser et al., 2024).

To address these challenges, educational interactive design must shift its focus from simply providing tools for interaction to designing meaningful and context-aware instructional activities. Interaction should be seamlessly integrated into the learning process, supporting students dynamically at each stage. Additionally, a clearer distinction between instructional

interaction and generic online communication must be maintained to preserve its educational purpose and maximize its impact on learning outcomes.

The rapid development of the internet has led to the emergence of a multitude of online education applications (apps, mini-programs) and computer-based programs (Marcus, 2024). However, this growth has also resulted in increasing homogeneity among online education platforms, accompanied by numerous issues. These platforms currently fall short of replacing the essential roles of offline schools, classrooms, and teachers in educating students and fostering their development. Challenges such as inconsistent course quality, difficulty in defining teaching effectiveness, and the inability to manage students' autonomy highlight the stark contrast between these limitations and the growing demand for online education among children. Childhood is a critical period for intellectual development, physical and mental health, and the formation of values. Educational guidance during this stage is pivotal, as it can subtly influence a child's life planning and developmental trajectory. One notable advantage of engaging and interactive learning experiences is their ability to help children concentrate on their current learning tasks, effectively minimizing external distractions. This aligns closely with the principle of focused, attentive learning. Additionally, when children are fully immersed in their studies, timely interactive feedback mechanisms can provide immediate results and outcomes, offering a sense of accomplishment and emotional satisfaction. This positive reinforcement not only sustains their engagement but also cultivates deeper enjoyment of the learning process, further enhancing their educational experience.

1.4. Causes of current interaction design shortcomings

When learners engage in online learning, the operational interaction design of the online courses with which they directly interact is often overlooked. Scholars have not sufficiently recognized the importance of operational interaction design, failing to treat it as a necessary factor influencing learning outcomes in online environments. From the perspective of online course developers—an issue that has long existed in software development—the primary focus remains on functionality (Wang et al., 2022). Operational interaction design is frequently conflated with visual interface design and is often considered a superficial enhancement meant to please users after the main functionality has been implemented. This lack of emphasis on visual interfaces is often "transferred" to operational interaction design, with the majority of effort directed toward ensuring the system's functional implementation. If time permits, interaction design might be considered, but the resulting design often feels like an afterthought, akin to a patch on clothing, poorly integrated with the overall system. This functionality-first mindset has led to the creation of many software applications, including some online courses, that are not user friendly. While operational interaction design and visual interface design share some overlapping research areas, they are distinct disciplines. Interaction design focuses not only on the aesthetic appeal of the visual interface but also on other critical aspects, such as the purpose of using the software and the user experience during its operation. As an international interaction design consultant noted, "Interaction design is about creating products that gradually reveal themselves over time." It is unnecessary for users to immediately perceive all the features of an interactive product (Sun et al., 2021). For example, a smartphone's home screen does not reveal all its capabilities at first glance. However, as users engage with it, they gradually discover additional features. Similarly, the development of web or Windows applications follows this principle. During use, users find themselves in different states and may suddenly realize that they can perform new actions. The essence of operational interaction design lies in shaping user behavior during use. It tailors the system's responses to users' actions, presenting different screens and functions to allow them to achieve their goals through a sequence of operations (Diederich et al., 2022). This focus on user interaction significantly differentiates it from visual interface design, which aims primarily to create an aesthetically pleasing interface that enhances the visual experience during use. While visual interface design serves as the foundation of operational interaction design, it is insufficient on its own. A clear and visually appealing interface is essential for successful interaction design, but operational interaction design goes further by emphasizing how users can achieve their objectives.

The technical limitations of web browsers themselves are a significant factor contributing to the low quality of operational interaction in online courses. Unlike the highly advanced development technologies available for desktop applications, the tools and capabilities accessible within web browsers are relatively limited (Goh et al., 2023). As a result, the interaction forms in online courses are often less engaging than those found in certain desktop applications. In the early days of web development, web pages primarily consisted of text information, occasionally supplemented with images. Interaction was limited to clicking hyperlinks for navigation between pages. However, in recent years, advancements in web browser technologies have led to the development and adoption of various web plugins, offering new opportunities for web page developers. The introduction of 2D GIF animations, Java Applets, Flash animations, and JavaScript marked a significant step forward, highlighting the potential for rich and engaging web-based interaction. These technologies capture users' attention by enhancing the diversity and entertainment value of web interactivity. Following this, the emergence of Web3D technologies allowed for the embedding of 3D interactive animations into web pages, greatly enriching the user experience. Despite their promise, most of these technologies are relatively new and have not yet been widely adopted as standard development tools. Some remain in early or experimental stages, and online course designers may not have fully explored their application in educational settings. Additionally, the inertia of established practices often leads developers to rely on traditional development techniques, resulting in the limited adoption of innovative interactive technologies in online courses. Consequently, online

courses frequently fall short of meeting learners' interaction needs. To address this, developers must embrace the potential of newer technologies, experiment with their integration into course design, and prioritize interactive features that enhance user engagement and learning effectiveness.

2. Advantages of Improving Online Courses via Interaction Design Theory

2.1. Interaction Design Can Address the Problem of Emotional Deficiency in Online Learning

Compared with traditional classroom teaching, online education offers unparalleled advantages. In traditional classrooms, teachers can engage in face-to-face interactions and emotional exchanges with students, adapting their teaching on the basis of immediate feedback. However, in an online environment, the separation of teachers and students in time and space prevents timely and effective communication, making it difficult for teachers to address students' questions and concerns promptly. This lack of interaction can adversely affect learning outcomes. Research indicates that most current online courses lack complex and deep emotional interaction activities that are integrated with the learning context. Moreover, few course designers consider emotional interaction a key factor in their course design. Therefore, strengthening research on emotional interaction in online courses is crucial. Emotional deficiency is one of the most pressing challenges facing online education today. In most online courses, communication occurs primarily through tools, with minimal emotional interaction. Teachers tend to focus on addressing knowledge-related issues while neglecting support and encouragement for students in areas such as learning strategies, methods, and psychological or emotional needs. By incorporating emotional interaction into the design of online courses, interaction design theory can help bridge this gap. For example, tools and features such as personalized feedback, virtual mentorship, interactive avatars, or emotion-sensitive AI can simulate face-to-face emotional engagement (Khosrawi-Rad et al., 2023). This creates a more supportive and empathetic online learning environment, significantly enhancing students' overall learning experience and motivation.

2.2. Gamified interaction design can enhance learning outcomes

Gamification involves applying game design elements, mechanisms, or principles in nongame contexts to influence user interaction with a system and improve engagement. It has proven effective in stimulating students' interest in learning. When gamification is closely tied to desired learning outcomes, students can translate practical experiences gained through game-like activities into classroom learning. Gamified interaction design emphasizes the mechanics and methods of interaction between users and a product rather than focusing on the game itself. It incorporates multiple components and mechanisms to form a complete gamified system. These components are arranged hierarchically on the basis of their level of abstraction, with each mechanism linked to one or more dynamic systems and each component connected to higher-level mechanisms. The design of gamified systems comprises three key elements: These are the fundamental building blocks. These define the rules and processes through which components interact, forming a structured and engaging system (Battiston et al., 2020). These address user experience and psychological engagement, driving intrinsic motivation through well-designed interactions.

In gamification, interaction mechanisms serve as the driving force behind dynamic systems, enhancing users' overall experience and fostering intrinsic motivation. Game components supplement these mechanisms, reinforcing the system's ability to engage users. Providing points, badges, or certificates for completing tasks enhances motivation. Gradually increasing the complexity of tasks keeps learners engaged. Group challenges or leaderboards foster social interaction and teamwork. By integrating gamified interaction design into online courses, educators can create more engaging, interactive, and motivating learning experiences. This approach not only increases student participation but also improves knowledge retention and the transfer of learning to practical applications.

Both emotional interaction and gamified interaction design address key challenges in online learning, such as emotional isolation and lack of engagement (Yang et al., 2024). By leveraging interaction design theories, online courses can foster a supportive and stimulating learning environment, ultimately leading to improved learning outcomes and a more fulfilling educational experience.

3. Methods to Improve Interactive Design

3.1. Enhancing Human-Computer Interaction Solutions

Interactive experiences in online courses can be broadly divided into two types: interpersonal interaction, which refers to exchanges between learners and teachers, experts, or peers, and human-computer interaction, which involves learners engaging with learning materials, educational software, or other digital interfaces. Interpersonal interaction can be either real-time or asynchronous. On the other hand, human-computer interaction methods and tools are highly flexible and creative, and their quality is closely tied to the designer's ingenuity and technical expertise. One effective method for enhancing human-computer interaction is through problem-solving tools such as FAQ systems (Ortega, 2021). Experts can anticipate common questions and prepopulate a searchable database with answers. Learners can search for solutions, and if they cannot find a satisfactory answer, they can submit questions via a dedicated page. Experts respond via email and update the database,

ensuring that future learners have access to the solutions. Other tools, such as forums, emails, and live chat systems, can further facilitate both individual and group interactions, offering multiple pathways for learners to address challenges. In terms of visual and interface design, a unified design approach ensures consistency and minimizes distractions caused by changing layouts, helping learners concentrate on new content. Interfaces should prioritize learning content by reducing decorative elements and focusing on intuitive navigation with clear links between content areas.

Control logic plays a critical role in delivering content dynamically. While many online courses rely on static hypertext links resembling "electronic page-turners," such approaches fail to engage learners effectively. Instead, dynamic and participatory methods, such as interactive animations, should be used. These animations can explain complex concepts while allowing learners to control playback, such as adjusting speed or replaying sections, thus aligning with individual learning paces. Additionally, animations designed to proceed only when learners actively engage can increase motivation and foster active participation. Interactive elements such as hover effects, where additional content appears when the mouse hovers over keywords or hotspots, can further enhance engagement. This method reduces the monotony of static text links, minimizes the cognitive load, and simplifies navigation while making the interface more dynamic and engaging. Ensuring logical layouts, appropriate color schemes, and a clean interface can create a focused and visually calming learning environment, avoiding learner frustration or distractions. Finally, it is crucial to prioritize active and frequent information exchange to make content delivery more engaging. Interactive tools and mechanisms that guide learners through demonstrations or simulations can foster problem-solving skills, encourage active participation, and enhance learning outcomes (Bloomberg, 2021). By embedding interactivity at every stage of the learning process, online courses can transform the passive consumption of content into an engaging, learner-centered experience.

3.2. Gamified interaction design to increase online learning efficiency

In interaction design, gamified components can showcase users' achievements and progress through visualized data and representations of self-efficacy. This allows users to perceive improvements in their abilities while comparing their performance to that of others, motivating further engagement. For example, language learning apps such as Duolingo adopt game-like level progression and achievement displays, whereas platforms such as CCTalk use leaderboards and learning points to present learning data (Kazu & Kuvvetli, 2024). Instructors can also set leaderboard rewards to satisfy users' need for competence, which is a significant driver of continued learning motivation. A sense of achievement and self-realization during autonomous learning processes serve as critical factors in sustaining users' willingness to learn. Leveraging dynamic motivational components in the design, motivation, control (DMC) system, tools such as progress-based rewards and emotional reinforcement can strengthen individuals' sense of competence in learning activities (Pauly et al., 2022). Progress-based rewards provide users with clear indicators of growth and development throughout the learning process. For example, platforms can visually display learning durations, use "check-in" tools to track daily goal completion, generate learning logs or weekly reports to summarize achievements, and design periodic review reminders to promote knowledge retention. Emotional reinforcement can be categorized into self-motivation and social motivation. Self-motivation includes mechanisms such as levelling up or awarding certificates upon completing lessons, highlighting users' progress. Social motivation incorporates competitive elements, such as leaderboards that compare users' learning data, fostering a sense of peer recognition and encouraging positive competition. To foster collaborative creativity in online courses, tools such as brainstorming whiteboards, collaborative mind-mapping, process chart creation, and document coediting can create interactive environments where learners efficiently solve research problems (Borodo et al., 2022). For example, the "collaborative blackboard" on the ClassIn platform replicates the physical classroom activity of writing answers on a board, recreating a "face-to-face" interactive context that reduces feelings of isolation and fatigue in online learning. Additionally, nonclassroom collaboration mechanisms can be designed, such as allowing users to "exchange" learning resources acquired through the platform via game-like mechanics (Hassan, 2023). By assisting peers, users experience positive emotions associated with altruism, while the platform simultaneously incentivizes efficient learning behaviors.

From a visual design perspective, gamified aesthetics can satisfy cognitive needs while enhancing the user experience. Online learning platform interfaces should integrate text, imagery, color, and layout design to guide user interaction while providing a high-quality visual experience. First, information presentation should consider the user's environment, using image-based representation to highlight key learning content and reducing irrelevant information to lower the cognitive load. Second, rich component elements can serve as interaction points and packaging mechanisms in intuitive and visually engaging ways to help users understand product functionality. For example, platforms can incorporate dynamic, real-time learning hotspots in the central visual area on the basis of users' recent browsing or learning activities. This aligns with modern learners' preferences for entertainment and fragmented study habits, providing associative cues that trigger learning behaviors. Presenting content in brainstorming formats can enhance semantic network activation and stimulate intrinsic motivation. Learning materials should also be presented in multiple ways to evoke implicit memory stored in long-term memory (Bai & Li, 2021). Furthermore, the platform should maintain a unified and cohesive visual style across its diverse functionalities. The incorporation of user-friendly illustrations and aesthetic elements can create an engaging atmosphere, enhancing immersion and enjoyment in learning activities and ultimately driving users' autonomous learning motivation.

3.3. Emotional interaction design in online courses

Learners' messages and feedback can also facilitate interaction among peers and between learners and teachers. These exchanges—whether focused on academics, thoughts, or personal matters—can help foster mutual acceptance and trust, creating a harmonious and productive learning relationship. Teachers can further enhance this by leveraging tools such as learner profiles, personal webpages, email, instant messaging, and even phone calls or occasional in-person meetings to understand each student's background (e.g., personality, family environment, and upbringing). This allows for more targeted, personalized instruction. For interactions among learners, each participant in an online course should be encouraged to actively engage and assume specific roles in group activities (Alamri et al., 2020). For example, group members can take on roles such as leader, technician, assistant, or presenter. Teachers can either assign these roles or allow the group to distribute responsibilities among themselves. By working collaboratively on a set learning plan within a specified timeframe, groups can achieve predetermined learning goals. Teachers can also adopt a different approach by participating in the group as a peer learner. This shift in role enables learners to accept the teacher more readily and allows the teacher to provide timely and constructive feedback, fostering positive emotions within the group. Overall, incorporating emotional interaction design into online courses not only addresses the shortcomings of purely autonomous learning environments but also enhances learners' sense of connection, motivation, and engagement (Mystakidis et al., 2021). Such efforts can significantly improve learning outcomes and create a more humanized, effective educational experience.

4. Conclusions

Online learning has gradually become the norm, making it imperative for learning platforms to focus on optimizing design to encourage learner engagement and cultivate a positive attitude toward online learning. From the perspective of meeting users' basic psychological needs to stimulate learning motivation, incorporating gamified systems into platform interaction design can enhance effective learning behaviors and promote autonomous learning efficiency. By emphasizing emotional interaction in online learning environments as a starting point, effective interaction design can significantly improve the quality of online courses. This study identified the current issues and causes of low human–computer interaction levels in online courses. By integrating the unique characteristics of online learning with traditional interface interaction methods, principles for enhancing the interactivity of media interfaces in online courses were proposed. These insights can be used to guide future human–computer interaction design for online courses and improve their overall quality. In the future, the design of learning platforms must further refine gamification incentive mechanisms, exploring more optimized approaches to implement gamified interaction strategies over the long term. Practical application research should place these strategies within the context of extended learning processes. Interaction design is a critical component of online course development. Effective interaction design in online education is a key avenue for improving teaching outcomes. As information technology advances and educational informatization develops further, methods and tools for online course interaction will continue to evolve. The realization of universal education and lifelong learning is no longer an unattainable goal.

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