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Original

The influence of the educational platform Rain Classroom on emotional intelligence, creativity, academic independence, and concentration of Chinese students: An empirical study

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A R T I C L E I N F O

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A B S T R A C T

The aim of this study is to evaluate the impact of an educational model based on the theory of embodied interaction on the development of *emotional intelligence*, *creativity*, *academic independence*, and *attention concentration* among students. The study involved 300 students from a Chinese university who were divided into experimental and control groups. In the experimental group, the Rain Classroom platform, which integrates digital technologies into the traditional educational process, was utilized, while the control group continued their studies under the standard curriculum. The results revealed that students in the experimental group exhibited significant improvements across all measured parameters—*emotional intelligence*, *creativity*, *academic independence*, and *attention concentration*—whereas no such changes were observed in the control group. The scientific novelty of the research lies in its comprehensive approach to examining the influence of the embodied approach and digital educational platforms on the development of students' cognitive and emotional competencies. The study's practical significance is reflected in the proposal of a new approach for educators and educational administrators aimed at enhancing the effectiveness of teaching through the use of digital educational platforms.

La influencia de la plataforma educativa Rain Classroom en la inteligencia emocional, la creatividad, la independencia académica y la concentración de estudiantes chinos: un estudio empírico

Palabras clave:
Capacidad dinámica
Cognición encarnada
Educación encarnada
Emoción encarnada
Generación emocional
Enseñanza interactiva

R E S U M E N

El objetivo de este estudio es evaluar el impacto de un modelo educativo basado en la teoría de la interacción encarnada en el desarrollo de la inteligencia emocional, la creatividad, la independencia académica y la concentración de la atención entre los estudiantes. El estudio ha involucrado a 300 estudiantes de una universidad china, quienes han sido divididos en grupos experimental y de control. En el grupo experimental, se ha utilizado la plataforma Rain Classroom, que integra tecnologías digitales en el proceso educativo tradicional, mientras que el grupo de control ha continuado sus estudios bajo el plan de estudios estándar. Los resultados han revelado que los estudiantes del grupo experimental han mostrado mejoras significativas en todos los parámetros medidos—*inteligencia emocional, creatividad, independencia académica* y *concentración de la atención*—, mientras que no se han observado tales cambios en el grupo de control. La novedad científica de la investigación radica en su enfoque integral para examinar la influencia del enfoque encarnado y las plataformas educativas digitales en el desarrollo de las

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competencias cognitivas y emocionales de los estudiantes. La relevancia práctica del estudio se ha reflejado en la propuesta de un nuevo enfoque para docentes y administradores educativos, orientado a mejorar la efectividad de la enseñanza mediante el uso de plataformas educativas digitales.

Introduction

The rapid development of educational technologies has significantly altered the landscape of contemporary learning. Digital platforms are now integrated into many pedagogical strategies, offering students and educators new tools for engagement, assessment, and communication (McGivney et al., 2024). Among these tools, interactive educational platforms like Rain Classroom provide not only access to information but also opportunities for real-time interaction, feedback, and personalized learning experiences. Despite the proliferation of digital education research, limited attention has been given to the emotional and psychological dimensions of learning within these digital environments (Filsinger, 2024; Sadka & Antle, 2022). Modern education increasingly recognizes the importance of emotional and cognitive skills, such as *emotional intelligence*, *creativity, academic independence*, and *attention concentration*, in promoting meaningful and sustainable learning outcomes (Chen et al., 2020; Goleman, 2001; Kabri et al., 2024). These competencies contribute to students' ability to adapt, innovate, and thrive in rapidly changing academic and professional landscapes. However, studies often examine these skills in isolation, without accounting for their interconnected nature or the potential of digital technologies to foster their integrated development. This theoretical framework explores how interactive educational technologies, particularly embodied and emotionally engaging platforms, influence the development of these core competencies. By synthesizing research from educational psychology, cognitive science, and digital pedagogy, we aim to establish a comprehensive understanding of how such platforms contribute to student growth.

Interactive technologies and embodied learning

Interactive educational technologies represent a transformative approach in modern pedagogy, allowing for the integration of immersive experiences, real-time feedback, and personalized instruction. Embodied cognition emphasizes the crucial role of the body in the cognitive process, asserting that cognition emerges from the interaction and integration of the brain, body, and environment (Macrine & Fugate, 2021). This necessitates the concept of embodied interactive learning, which posits that learning is a holistic process where cognitive development is inseparable from emotional and physical experience (Emihovich et al., 2020). The theory of emotional genesis, grounded in the "construction of meaning," explores the dynamic role of emotions in cognition, asserting their connection with physical activity and environmental adaptation (Sullivan, 2018). This theory supports the role of interactive learning as a medium to ignite and regulate emotions that drive cognitive development and *creativity* (Bylieva et al., 2021; Järvenoja et al., 2020). The integration of emotional and physical experiences is fundamental in embodied learning, especially in immersive formats. Educational platforms, including Rain Classroom, represent digital solutions that support learning through online tools and interactive environments. These platforms allow for increased accessibility, real-time feedback, and more engaging learning experiences (Glushchenko & Inei, 2024; Zhu et al., 2024). They can take many forms, including online courses, immersive simulations, and AI-assisted environments (Asad et al., 2021; Mystakidis et al., 2021). Immersive experiences have been shown to elicit specific emotional responses in learners (Drigas et al., 2023), although findings remain mixed (Lin & Yu, 2023; Paramita et al., 2023). Challenges remain in their implementation, such as expensive equipment, poorly adjusted curricula (Ioannou & Ioannou, 2020), lack of funding, and insufficient training (Aida et al., 2022; Marks & Thomas, 2022; Zhong et al., 2023). Importantly, digital learning may reduce direct emotional interaction, requiring researchers to focus on compensatory strategies (Filsinger, 2024; Wang et al., 2023). Nonetheless, emotionally enriched digital learning environments can foster essential emotional competencies depending on program structure, learner characteristics, and teacher-student interaction (Liu et al., 2022; Shao et al., 2020).

Emotional and creative development

The concept of teaching the generation of emotions treats emotions as a central component of learning rather than a byproduct. It enhances cognitive development, motivation, and social skills (Shapiro & Stolz, 2019). As bodily experiences, emotions are tied to embodied interaction (Yu et al., 2020). *Emotional intelligence* (EI), defined as the ability to recognize, manage, and influence emotions, plays a key role in effective learning (Delhom et al., 2020; Goleman, 2001; Mayer et al., 2001). Emotion generation, influenced by both external stimuli and internal processing, impacts memory and decision-making (Estrada et al., 2021; Wang et al., 2021). Research has connected higher EI with better academic regulation and lower incidents of maladaptive behavior. For example, one study found that students with higher EI reported less violent behavior and better academic outcomes (Ubago-Jiménez et al., 2023). Instructors' emotional competencies have also been associated with better classroom leadership and communication (Gülbahar & Sıvacı, 2019; Khani & Ghasemi, 2019). *Creativity*, defined as generating novel ideas, is crucial to innovation in education (Kabri et al., 2024). Active and interactive learning methods promote *creativity* (Mohammad & Yasin, 2015), particularly when paired with immersive tools such as VR or AR (AlAli & Al-Barakat, 2022). Creative pedagogical practices are enhanced when educators embrace innovative models and assessments (Alam, 2022). Finding novel solutions during the learning process leads to positive emotions, which reinforce motivation and learning (Kabri et al., 2024).

Self-regulated learning and concentration

Academic independence and self-directed learning involve the ability to plan, monitor, and evaluate one's own learning. These skills are vital for academic and professional development (Chen et al., 2020; Rahmatullah et al., 2022). Educational platforms foster self-regulation by enabling personalized learning paths and allowing learners to work at their own pace (González-Pérez & Ramírez-Montoya, 2022; Rahman & Yunus, 2020). The ability to concentrate — sustain attention over time — is another fundamental skill. It is strongly linked to comprehension, retention, and academic performance (Le, 2021). Focus and flexible thinking also help mitigate academic stress and improve learning outcomes (Jamil et al., 2023; Sun et al., 2020). Interactive features such as quizzes, feedback, and gamification can help learners stay engaged and reduce distractions (Kay, 2022; Soon et al., 2023). Studies have shown that students with higher concentration and autonomy experience lower anxiety and greater confidence (Hsu & Goldsmith, 2021; Ma, 2022). Virtual environments, such as flipped classrooms and interactive STEM settings, have been proven to enhance self-efficacy and concentration (Lee et al., 2024; Li & Cao, 2020). By combining emotional engagement, personalized pacing, and immersive learning, platforms like Rain Classroom support the simultaneous development of *emotional intelligence*, *creative thinking, autonomy,* and *focused attention* in learners.

Comparative analysis and evaluation of the current state of the problem

Contemporary research emphasizes the importance of implementing interactive educational technologies based on the theory of embodied cognition for the development of *emotional intelligence*, *creativity, attention concentration,* and *academic independence* among students (Emihovich et al., 2020; Macrine & Fugate, 2021). However, one study predominantly addresses these aspects in isolation, failing to provide a comprehensive view of their interrelation (Lee et al., 2024). A significant contribution to the study of embodied cognition has been made by authors who have proposed a theoretical justification for the importance of bodily experience in the learning process. They argue that cognitive activity is enhanced through physical interaction with the learning material and environment, yet they fail to provide empirical evidence of this concept in digital educational settings (Macrine & Fugate, 2021). A similar approach is presented in research that highlights the significance of interactive environments for improving the learning process; however, the impact of digital platforms on the emotional sphere of students remains insufficiently explored (Emihovich et al., 2020). At the same time, researchers emphasize the importance of emotions and bodily experience in education. However, theoretical conclusions are not supported by experimental validation of the application of specific digital tools in the educational process (Shapiro & Stolz, 2019). In contrast, another study investigated the development of *emotional intelligence* through the use of digital technologies, confirming that interactive learning fosters empathy and self-control. One study empirically confirmed the positive impact of virtual and augmented reality on students' academic performance; however, the focus was solely on the cognitive aspects of learning, while issues related to *emotional intelligence*, *concentration,* and *independence* were not adequately addressed (Lee et al., 2024). Similarly, another study on VR technologies confirmed the effectiveness of using VR for students' cognitive and cultural development without addressing emotional development and creative thinking (Li & Cao, 2020; Turgumbayeva et al., 2019).

A specific educational platform, Rain Classroom (2024), was selected, the effectiveness of which was empirically tested using validated instruments such as C-AES, TTCT-F, SRSSDL, and CQ. The study involved 300 students, allowing for more robust and reliable conclusions regarding the platform's impact on students, compared to the smaller sample sizes used in other studies (e.g., Lee et al., 2024; Mohammad & Yasin, 2015). The main advantages of this study are its interdisciplinary nature, the justification of the sample, and a thorough empirical analysis of the results using standardized diagnostic tools. Unlike other studies, which often rely on theoretical or narrowly focused experimental approaches (Emihovich et al., 2020; Macrine & Fugate, 2021; Shapiro & Stolz, 2019), this study offers a clear experimental comparison of the control and experimental groups, thereby significantly enhancing its scientific significance.

Overall, the analysis of existing research shows that the impact of interactive educational platforms on the development of key academic and emotional competencies among students remains insufficiently explored. Although numerous studies emphasize the benefits of digital technologies for enhancing *student engagement, self-regulation*, and *creativity*, most of them address these aspects in isolation without considering their complex interactions. Previous research has demonstrated the effectiveness of interactive learning elements, such as virtual reality, digital platforms, and gamification. However, their limitation lies in the fact that they often do not explore the integration of these tools into unified educational models. Furthermore, insufficient attention has been paid to the empirical verification of the impact of digital technologies on students' *emotional intelligence* and *academic independence*. This study fills this gap by offering a comprehensive approach that combines emotional and cognitive learning components. Unlike previous works, it not only evaluates the impact of the interactive environment on cognitive skills but also analyzes its effect on students' emotional regulation. The results obtained demonstrate that the integration of the Rain Classroom platform leads to significant changes in the development of *emotional intelligence*, *creative thinking, attention concentration,* and *self-directed learning*.

The present study

The present study aims to empirically assess the impact of the Rain Classroom educational platform on the development of key academic and emotional competencies among students, including *emotional intelligence*, *creativity*, *academic independence,* and *attention concentration*. It also examines how the integration of interactive digital technologies affects students' motivation, engagement in the learning process, and the effectiveness of self-regulated learning. This research distinguishes itself from previous studies by offering a comprehensive and interdisciplinary approach. While most existing works focus on isolated cognitive outcomes or engagement metrics, this study simultaneously addresses both cognitive and emotional dimensions. Furthermore, it applies an educational model based on the theory of embodied interaction, thereby contributing new insights into the mechanisms through which educational technologies influence not only academic performance but also emotional regulation and student autonomy. Based on these objectives, the following hypotheses were formulated: (1) The use of Rain Classroom has a positive impact on students' *emotional intelligence* compared to traditional teaching methods; (2) The application of interactive educational technologies fosters the development of *creativity*; (3) The digital educational environment positively influences the development of academic independence and enhances students' self-learning skills; and (4) The use of the Rain Classroom platform enhances students' attention and focus compared to traditional teaching methods.

To test these hypotheses, a quasi-experimental research project was implemented, consisting of three stages: (1) measurement of students' *emotional intelligence*, *creativity*, *academic independence,* and *attention concentration* prior to the intervention; (2) implementation of an interactive educational program using Rain Classroom in the experimental group, while the control group followed the regular curriculum; (3) post-intervention assessment and comparison of the target variables in both groups.

Method

Participants

The study involved 300 undergraduate students from a university located in Eastern China. This is a public institution offering full-time undergraduate programs across several disci-

Table 1
Data on study participants

Groups	Total	Male	Female	Mean age	*SD*
Control	150	72	78	18.48	0.17
Rain Classroom	150	69	81	18.59	0.24
Total/Mean	300	141	159	18.53	0.20

plines, including education, arts, science, and engineering. For more details, see Table 1.

The sample consisted of 150 students in the experimental group and 150 students in the control group, all of whom were enrolled in general education courses. Participation was voluntary, and students did not receive any academic incentives. A stratified sampling method was employed to ensure diversity across academic disciplines and gender balance. In terms of socio-economic status, the majority of participants came from middle-income families, with 68% reporting a monthly family income ranging from 5,000 to 12,000 yuan (approximately 700–1,700 USD). Around 22% were from low-income families (less than 5,000 RMB/month), while 10% were from high-income families (more than 12,000 RMB/month). Approximately 60% of the students were from urban areas, and 40% were from rural regions. All participants had prior experience using digital learning platforms, but none had previously participated in structured studies involving Rain Classroom. No participant reported any cognitive or psychological disorders that might have affected their participation in the study.

Instruments

This study employed four validated instruments: the Chinese version of the *Assessing Emotions Scale* (C-AES), the *Torrance Test of Creative Thinking – Figural* (TTCT-F), the *Self-Rating Scale of Self-Directed Learning* (SRSSDL), and the *Concentration Questionnaire* (CQ).

The C-AES (Ko & Siu, 2014) is a 33-item measure of *emotional intelligence* that includes four subdimensions: *appraisal of emotions* (AE, 7 items; α = .86, CR = .87, ω = .86, AVE = .61), *facilitation of thought* (FT, 5 items; α = .85, CR = .86, ω = .85, AVE = .60), *regulation of emotion* (RE, 6 items; α = .84, CR = .85, ω = .84, AVE = .58), and *facilitation of relationships* (FR, 6 items; α = .87, CR = .88, ω = .87, AVE = .63). Items are rated on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree, and total scores are calculated as the average across the four subscales. CFA confirmed the scale's construct validity: CFI = 0.92, TLI = 0.91, RMSEA = 0.05.

The TTCT-F (Wang & Ismail, 2023) is a 31-item test that evaluates *creativity* through three subscales: *originality* (12 items; α = .89, CR = .91, ω = .90, AVE = .72), *fluency* (9 items; α = .87, CR = .88, ω = .88, AVE = .68), and *flexibility* (10 items; α = .90, CR = .91, ω = .91, AVE = .71). Each subscale is scored from 40 to 160 points, and an overall *creativity* score is calculated by averaging the subscale scores. The TTCT-F showed strong psychometric properties: overall α = .91, CR = .93, ω = .92, AVE = .74. CFA values indicated excellent model fit: CFI = 0.93, TLI = 0.92, RMSEA = 0.04.

The SRSSDL (Williamson, 2007) measures self-directed learning using 60 items across five dimensions: *awareness* (α = .84, CR = .85, ω = .85, AVE = .60), *learning strategies* (α = .83, CR = .84, ω = .84, AVE = .58), *learning activities* (α = .86, CR = .87, ω = .86, AVE = .61), *evaluation* (α = .85, CR = .86, ω = .86, AVE = .59), and *interpersonal skills* (α = .82, CR = .83, ω = .83, AVE = .57). Each dimension includes 12 items rated on a 5-point Likert scale (1 = never to 5 = always). Final scores are obtained by summing across all items. As no validated Chinese version existed, the SRSSDL was translated into Chinese using a back-translation procedure: two bilingual experts independently translated the scale, followed by back-translation and review by a panel of educational psychologists. A pilot test confirmed conceptual and linguistic clarity. Psychometric indicators were satisfactory: overall α = .85, CR = .86, ω = .87, AVE = .59. CFA confirmed adequate model fit: CFI = 0.90, TLI = 0.90, RMSEA = 0.05.

The CQ (Bhatia, 2011) is a 20-item questionnaire assessing *attention concentration*, including three subdimensions: *attention stability* (9 items; α = .86, CR = .87, ω = .86, AVE = .66), *attention distribution* (7 items; α = .85, CR = .86, ω = .85, AVE = .64), and *attention shifting* (4 items; α = .83, CR = .84, ω = .83, AVE = .62). Responses are binary (yes/no), with each "yes" scored as 1. Total scores range from 0 to 20, with lower scores reflecting higher concentration. Thresholds used for interpretation were low concentration (< 30), moderate (30–50), and high (> 50). As no prior Chinese version existed, the CQ was translated using the same method described for the SRSSDL. The scale demonstrated strong reliability: overall α = .88, CR = .90, ω = .89, AVE = .68. CFA supported good construct validity: CFI = 0.91, TLI = 0.90, RMSEA = 0.04.

Procedure

All participants voluntarily expressed their willingness to participate and provided informed consent by signing the appropriate documentation. They were assured of anonymity and the confidentiality of their personal data. All participants identified as ethnically Chinese. To minimize the influence of extraneous factors, stratified randomization was used, which allowed for the even distribution of participants across the control and experimental groups, taking into account demographic characteristics such as gender, academic level, and field of study. The research procedure consisted of three sequential stages: the initial collection of demographic data and baseline measurements of the key parameters, the implementation of the educational program using Rain Classroom in the experimental group, and post-testing to assess changes in the key indicators. Before the main phase of the study, an analysis of differences between the control and intervention groups was conducted during the pre-testing stage to ensure their initial statistical homogeneity.

The study began with the recruitment of university students in autumn 2023. The C-AES, TTCT-F, SRSSDL, and CQ were preliminarily administered at the end of September. The students were then randomly allocated to either an intervention group (n = 150) who received interactive learning experiences through an educational platform Rain Classroom interaction or a control group (n = 150) who continued their usual curriculum. Teachers in the intervention group underwent special three-month training to be able to implement Rain Classroom. Students in both groups studied the same curriculum, and the length of the training was also the same. The intervention lasted six months (October 2023 to March 2024). The participants were again asked to complete the C-AES, TTCT-F, SRSSDL, and CQ tests in early April 2024 to estimate their post-intervention levels of *emotional intelligence*, *creativity, academic self-directedness,* and *learning concentration*.

Before data collection commenced, the study received approval from the university's ethical committee. All participants were provided comprehensive information regarding the study's aims and procedures, after which they signed an informed consent form. Participation was voluntary, with the option to withdraw at any time without any negative consequences. The study adhered to the ethical standards set forth in the Helsinki Declaration, including the assurance of anonymity, confidentiality, and the responsible handling of personal data, and received approval from the ethics committee of the participating university.

Intervention

Rain Classroom is an educational platform designed for full integration with PowerPoint and WeChat to enhance engagement and interaction in the classroom. The standard curriculum relies solely on lecture-based instruction without any incorporation. Particularly, students in the control group attended lectures in lecture halls and practical classes in specially equipped classrooms. Students in the intervention group, on the other hand, had the opportunity to participate in an academic course that integrates conventional learning with the educational platform Rain Classroom.

Rain Classroom integrates cloud-based services for storing and distributing educational materials and analytical tools for tracking student progress in real time. A key technical feature of the platform is its capability to create interactive slides that include polls, quizzes, and tasks with instant feedback. These functions are supported by built-in data analysis tools that automatically process student responses and generate reports for instructors. Notably, the platform supports both synchronous and asynchronous learning, including access via mobile devices, enabling students to engage with materials at their own pace. Additionally, Rain Classroom features automatic lecture recording and subsequent publication in cloud storage, which is particularly beneficial for revisiting complex topics. The platform's technical infrastructure also facilitates group projects and collaborative work through virtual rooms, allowing students to develop interaction and teamwork skills—an essential component of the educational process. Chart 1 presents a brief description of the modified curriculum's core components.

Chart 1

Core components of the proposed Rain Classroom-assisted education program

Learning activities	Skills	Pathways for skills development	Usage examples of Rain Classroom
Introduction sessions on integrating Rain Classroom into academic courses for beginners	Self-directed learning skills	Independent exploration of subject-specific modules	Academic research in Rain Classroom
Collaborative Rain Classroom projects	*Emotional intelligence*, communication, empathy	Participation in project-related group activities	Collaborative experiments and group-based student projects in Rain Classroom
Rain Classroom-assisted seminars on stress management strategies	Self-regulation	Familiarization with stress reduction methods suitable for implementation in the virtual environment	Exposure-based training with simulations of stress-inducing scenarios
Interactive Rain Classroom games for improving decision-making skills	Cognitive control	Immersion in game-based scenarios where one has to make prompt choices based on fluid conditions	Learning through Rain Classroom-powered games
Creation projects	Creative thinking	Original designing of tasks and projects	Modeling and animation
Rain Classroom-based visualization	Concentration	Problem-solving within the environment	Problem visualization

The interactive education program was designed in a manner that promotes the development of *emotional intelligence* in students, enhances their creative abilities and concentration, and improves academic self-directedness. The equipment required to implement the intervention program and a technical specialist was present in the classroom during lessons to provide technical assistance, if needed.

Data analysis

In accordance with contemporary standards for psychological and educational test evaluation (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1985), the study collected diverse sources of evidence to substantiate the interpretation of results derived from the employed questionnaires. All analyses were conducted separately for each of the four instruments and their corresponding subscales. Reliability was assessed using various internal consistency coefficients: Cronbach's alpha (α), composite reliability (CR), and McDonald's omega (ω). These indices reflect the degree of inter-item consistency within each scale. Threshold values of α and $\omega \geq 0.70$, as well as $CR \geq 0.60$, were considered acceptable according to established benchmarks (Nunnally & Bernstein, 1994). Additionally, average variance extracted (AVE) was computed as evidence of convergent validity, with a minimum acceptable value set at 0.50.

Evidence pertaining to the internal structure of the instruments was obtained through confirmatory factor analysis (CFA), which aimed to evaluate the degree to which the empirical data conformed to the theoretical model underlying each scale. Model fit was assessed using the following indices: Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA). CFI and TLI values ≥ 0.95 and $RMSEA \leq 0.08$ were interpreted as indicative of good model fit (Hu & Bentler, 1999). To evaluate the equivalence of the experimental and control groups at the pretest stage, independent-samples t-tests were conducted for key variables: *emotional intelligence*, *creativity, academic autonomy,* and *attentional focus*. The results revealed no statistically significant differences ($p > 0.05$), indicating baseline comparability and thereby mitigating (though not eliminating) the risk of bias in subsequent between-group comparisons. To assess the effectiveness of the intervention, paired t-tests were performed within each group to compare pre- and post-test scores. Additionally, effect sizes (Cohen's d) were calculated for both between-group and within-group changes, enabling an assessment of the magnitude of the observed effects. All statistical tests were conducted with a significance level of $p < .005$, and for multiple comparisons, the Bonferroni correction was applied to control the Type I error rate. This choice aligns with contemporary recommendations for enhancing the reliability of empirical data (Benjamin et al., 2018) and is crucial for confirming the absence of changes in the control group and ensuring the reliable interpretation of intervention effects.

All statistical data processing and reliability assessments were conducted using IBM SPSS Statistics 25. Confirmatory factor analysis (CFA), as well as the computation of composite reliability (CR), McDonald's omega (ω), and average variance extracted (AVE), were performed using IBM SPSS Amos 23 and JASP 0.16.0. These software packages support structural equation modeling and advanced psychometric analysis.

Results

The first objective of the study was to examine the indicators of *emotional intelligence*, *creativity*, *self-regulation*, and *attention con-*

Table 2
Descriptive statistics of the pre-test and post-test C-AES scores in the control and Rain Classroom groups

Groups		AE (pre-test)	AE (post-test)	FT (pre-test)	FT (post-test)	RE (pre-test)	RE (post-test)	FR (pre-test)	FR (post-test)
Control	Mean	19.30	19.43	28.83	29.46	18.37	18.41	21.50	20.69
	Std. Deviation	2.790	2.955	3.110	3.225	2.855	2.917	2.511	2.657
	p	.673		.084		.912		.011	
	d	0.05		0.20		0.01		0.33	
Rain Classroom	Mean	19.53	22.98	29.23	32.43	18.55	22.99	20.99	22.47
	Std. Deviation	2.944	2.058	3.212	1.680	2.946	1.506	2.670	1.670
	p	**< .001**		**< .001**		**< .001**		**< .001**	
	d	1.11		0.94		1.50		**0.67**	

Note. AE = appraisal of emotions; FT = facilitation of thought; RE = regulation of emotion; FR = facilitation of relationships.

Table 3
Descriptive statistics of the pre-test and post-test TTCT-F scores in the control and Rain Classroom groups

Groups		Originality (pre-test)	Originality (post-test)	Fluency (pre-test)	Fluency (post-test)	Elaboration (pre-test)	Elaboration (post-test)	Abstractness of titles (pre-test)	Abstractness of titles (post-test)	Resistance to premature closure (pre-test)	Resistance to premature closure (post-test)
Control	Mean	89.31	89.89	83.21	83.49	81.72	81.72	75.97	76.45	84.25	83.65
	Std. Deviation	5.844	6.430	4.912	4.534	4.640	4.585	4.229	3.932	3.179	3.175
	p	.374		.587		.999		.339		.123	
	d	0.10		0.06		0.00		0.11		0.19	
Rain Classroom	Mean	90.78	101.55	83.53	88.98	82.15	84.79	75.88	81.02	84.23	88.41
	Std. Deviation	6.181	2.197	4.720	1.431	4.585	2.930	4.422	2.638	2.968	1.719
	p	**< .001**		**< .001**		**< .001**		**< .001**		**< .001**	
	d	1.52		1.22		0.65		1.14		1.43	

Note. TTCT-F = Torrance Test of Creative Thinking – Figural.

Table 4
Descriptive statistics of the pre-test and post-test SRSSDL scores in the control and Rain Classroom groups

Groups		Awareness (pre-test)	Awareness (post-test)	Learning strategies (pre-test)	Learning strategies (post-test)	Learning activities (pre-test)	Learning activities (post-test)	Evaluation (pre-test)	Evaluation (post-test)	Interpersonal skills (pre-test)	Interpersonal skills (post-test)
Control	Mean	29.95	29.67	32.65	32.57	31.39	31.69	32.83	33.25	30.23	30.38
	Std. Deviation	3.031	3.187	2.314	2.324	2.944	2.588	2.648	2.533	2.993	2.847
	p	.410		.740		.335		.159		.636	
	d	0.09		0.03		0.11		0.16		0.05	
Rain Classroom	Mean	30.06	34.61	32.63	34.94	31.33	35.71	33.16	36.75	30.42	34.86
	Std. Deviation	3.356	1.733	2.336	2.034	2.910	2.295	2.588	1.727	2.961	2.033
	p	**< .001**		**< .001**		**< .001**		**< .001**		**< .001**	
	d	1.35		0.99		1.14		1.01		1.17	

Note. SRSSDL = Self-Rating Scale of Self-Directed Learning.

centration among students in both the control and experimental groups at the pre-test and post-test stages. The second objective was to calculate the significance level of within-group differences. For clarity, the data regarding the four studied variables are presented sequentially, with the significance levels of within-group differences (p-values) and effect sizes (Cohen's d) provided for each group. Table 2 presents descriptive statistics for scores on the C-AES subscales obtained before and after the intervention. The control group's level of *emotional intelligence* changed little from pre- to post-test, whereas the Rain Classroom group demonstrated significant improvements in all C-AES subscales ($p < .001$, d ranging from 0.67 to 1.11).

Table 3 presents descriptive statistics for the *creative thinking* abilities exhibited by students in the control and Rain Classroom groups. The results demonstrate that, compared to the control group, the intervention group experienced significant improvements ($p < .001$, d ranging from 0.56 to 1.52).

Table 4 shows that students who participated in Rain Classroom-assisted learning activities became significantly more self-directed than their peers in the control group. The intervention group showed improvements in all subscales ($p < .001$, d ranging from 0.75 to 1.14).

Table 5
Descriptive statistics of the pre-test and post-test *CQ* scores in the control and Rain Classroom groups

Groups		Pre-test	Post-test
Control	Mean	8.673	8.713
	Std. Deviation	1.7628	1.6316
	p	.830	
	d	0.02	
Rain Classroom	Mean	8.393	6.533
	Std. Deviation	1.6624	1.1332
	p	**< .001**	
	d	0.63	

Note. CQ = Concentration Questionnaire.

Table 5 presents data on *attention concentration*. While the control group did not demonstrate any significant change ($p = .830$, $d = 0.02$), the Rain Classroom group improved significantly ($p < .001$, $d = 0.63$).

Table 6
Results of the *t*-test for the C-AES, TTCT-F, SRSSDL, and CQ scores of the control and Rain Classroom groups

Subscale	*t*	*df*	*p*	Mean Difference	95% CI Lower	95% CI Upper	Cohen's *d*
C-AES							
Appraisal of Emotions (AE)	−12.064	298	< .001	−3.547	−4.125	−2.968	1.04
Facilitation of Thought (FT)	−9.993	298	< .001	−2.967	−3.551	−2.382	1.00
Regulation of Emotion (RE)	−17.085	298	< .001	−4.580	−5.108	−4.052	1.06
Facilitation of Relationships (FR)	−6.946	298	< .001	−1.780	−2.284	−1.276	0.98
TTCT-F							
Originality	−21.004	298	< .001	−11.653	−12.745	−10.562	0.68
Fluency	−14.133	298	< .001	−5.487	−6.251	−4.723	0.66
Elaboration	−6.903	298	< .001	−3.067	−3.941	−2.192	0.61
Abstractness of Titles	−11.830	298	< .001	−4.573	−5.334	−3.813	0.64
Resistance to Premature Closure	−16.147	298	< .001	−4.760	−5.340	−4.180	0.66
SRSSDL							
Awareness	−16.700	298	< .001	−4.947	−5.530	−4.364	0.78
Learning Strategies	−9.411	298	< .001	−2.373	−2.870	−1.877	0.72
Learning Activities	−14.257	298	< .001	−4.027	−4.583	−3.471	0.76
Evaluation	−13.954	298	< .001	−3.493	−3.986	−3.001	0.74
Interpersonal Skills	−15.685	298	< .001	−4.480	−5.042	−3.918	0.75
CQ							
Concentration	13.440	298	< .001	2.180	1.861	2.499	0.63

The third objective of the study was to calculate the significance level of between-group differences in post-test *emotional intelligence*, *creativity, self-regulation,* and *attention concentration* among students in the control and experimental groups. The data are presented in Table 6. The present findings suggest that integrating educational platforms such as Rain Classroom into the learning process has a contributory effect on the development of academic skills.

In addition, effect sizes (Cohen's *d*) were calculated, revealing large effects for *emotional intelligence* (on average on the scale $d = 1.02$) and *academic independence* (on average on the scale $d = 0.75$) and moderate effects for *creativity* (on average on the scale $d = 0.65$) and *attention concentration* ($d = 0.63$). These results indicate that Rain Classroom not only provided statistically significant improvements but also had a substantial impact on the development of key academic and emotional competencies.

Discussion

The present study aimed to assess the impact of the Rain Classroom platform on four key educational and psychological constructs: *emotional intelligence*, *creativity*, *self-regulated learning,* and *attention concentration*. All four hypotheses formulated prior to the intervention were supported by empirical data. Specifically, students in the experimental group demonstrated significantly greater improvements across all target variables compared to the control group. These results suggest that the integration of Rain Classroom into university education fosters significant improvements in both the cognitive and emotional development of students. The incorporation of technologies was reported to improve the learning outcomes of students taking the university course in Finance (Hvorecký et al., 2025). A similar effect was observed among students enrolled in Marketing but the results were found to be inconsistent. The present study shows that educational platforms can affect specific skills and competencies, such as *emotional intelligence*, *creativity, concentration,* and *academic self-directedness*. Note that although promising, this quality of learning requires further research, as the effects it provokes may vary depending on the academic context. The technology was reported to impact the affective and motivational dimensions of learning, including students' emotional well-being and confidence (McGivney et al., 2024). Even though the evidence of change in learners' self-efficacy is lacking, the reported easing of negative emotions supports the current study's findings regarding the connection between interactive learning and *emotional intelligence*. Some researchers highlight the need to consider the emotional aspects of educational platform-assisted learning and ethical issues (Mystakidis et al., 2021), which, in light of the overlooked challenges of integrating educational platform tools into teaching and learning, is relevant to the current analysis. As a pedagogical tool, the educational platform has multiple uses (Asad et al., 2021; Glushchenko & Inei, 2024), including the facilitation of self-directed learning, creative thinking, and *emotional intelligence*, as evidenced by the results of the present study.

A meta-analysis of the educational platform's learning effects highlighted its substantial impact on student engagement (Lin & Yu, 2023). According to some other studies, learning with modern tools contributes to the development of *emotional intelligence* skills, such as self-control and self-awareness, and it affects learners' emotions (Kay, 2022). These findings are consistent with the current study, the results of which show that the use of Rain Classroom in the classroom results in increased confidence and higher *emotional intelligence*. Learning-related emotions are linked to technology acceptance, which mediates the relationship between learning-related emotions and interactive learning engagement (Lin et al., 2024). Examining the multifaceted nature of emotional valence, some researchers determined that positive emotions heighten one's desire to use modern technologies (Soon et al., 2023). These findings, among other things, highlight the importance of attending to affect when introducing new technologies into the classroom. The educational platform can provide emotionally engaging learning situations (Knaus, 2023). The present study echoes this statement with evidence of positive change in learners' *emotional intelligence* after exposure to immersive instructions.

Furthermore, the results of the current article reveal significant connections between research on embodied cognition and embodied learning. For instance, one study by Macrine and Fugate (2021) examines the impact of embodied cognition on classroom learning, which is reflected in our research through the enhancement of *emotional intelligence* and autonomy in the learning process. Similar themes are evident in another study by Emihovich et al. (2020), where embodied learning is linked to interactive environments, corroborated by current data on the positive effects of educational platforms on student skill development. Other authors, Shapiro and Stolz (2019), emphasize the importance of embodied cognition for education, which aligns with our findings on the role of *emotional intelligence* and *creativity* in educational technologies.

Comparison of the findings from the present study with previous research highlights several key aspects that distinguish this investigation from earlier work and address existing gaps in the scholarly literature. Prior studies have consistently confirmed that digital educational technologies enhance student engagement and improve cognitive learning outcomes (Lin & Yu, 2023; McGivney et al., 2024). For instance, research focused on the implementation of virtual and augmented reality technologies indicates that interactive tools foster a deeper understanding of instructional content and promote the development of critical thinking skills (Asad et al., 2021; Lee et al., 2024). However, the majority of these studies primarily concentrate on cognitive outcomes while largely overlooking the emotional dimensions of learning, such as the development of *emotional intelligence* and *self-regulation skills* (Filsinger, 2024; Sadka & Antle, 2022). In contrast, the present study substantiates not only the cognitive benefits of a digital learning environment but also demonstrates its substantial impact on students' emotional regulation and motivation—domains that have received insufficient empirical attention in previous research (Drigas et al., 2023; Kay, 2022). Another notable limitation of earlier investigations lies in their fragmented approach to analyzing the interplay of diverse educational factors. While some studies have explored the influence of digital technologies on *creativity* or *attentional focus* (AlAli & Al-Barakat, 2022; Ma, 2022), few have considered their cumulative effects. The current study reveals that the Rain Classroom platform simultaneously fosters the development of several core competencies, thereby underscoring its potential as a comprehensive tool for supporting the learning process (Glushchenko & Inei, 2024; Rain Classroom, 2024).

Moreover, many previous studies have employed limited methodological approaches, including small sample sizes and the absence of control groups, which have hindered the objective interpretation of observed effects (Emihovich et al., 2020; Turgumbayeva et al., 2019). In contrast, the present study adopts a quasi-experimental design with a clear division between experimental and control groups, thereby enhancing the reliability of the data and allowing for a more precise identification of differences in learning outcomes. This study, therefore, addresses significant gaps in the existing literature by validating not only the cognitive but also the emotional-regulatory effects of interactive learning environments (Liu et al., 2022; Ubago-Jiménez et al., 2023). It further expands current understanding of the mechanisms through which digital educational platforms influence students, emphasizing their role in the development of both academic and personal competencies. The findings provide a foundation for future research aimed at exploring the long-term effects of digital learning technologies and their adaptation across diverse academic contexts.

Limitations

The study has several limitations. First, the sample is confined to students from a single university, which may limit the generalizability of the results to a broader population. While the studied group is sufficiently representative within the context of higher education, the impact of the Rain Classroom platform on students with diverse academic levels, cultural backgrounds, and educational conditions requires further investigation. Second, the study was conducted over a 10-week period, allowing for the assessment of short-term effects of implementing the digital educational platform, but it does not allow for conclusions regarding its long-term impact. The long-term influence of interactive learning on *emotional intelligence*, *creativity*, and *academic independence* remains an open question for future research. Third, the primary data were collected through self-report methods such as C-AES, TTCT-F, SRSSDL, and CQ, which may introduce an element of subjectivity in the assessment of results. Although the instruments used are validated and widely applied in scientific research, incorporating additional objective psychophysiological or behavioral methods could enhance the reliability of the data obtained. Furthermore, the influence of external factors, such as individual student characteristics, prior levels of digital literacy, or learning preferences, was not fully considered, which may affect the perception and effectiveness of using Rain Classroom.

Conclusions

The results demonstrate that the use of the Rain Classroom educational platform has a significant positive impact on the development of *emotional intelligence*, *creativity, academic independence,* and *attention concentration* among students. A quasi-experimental study found that participants in the experimental group, who were trained using the interactive features of the platform, showed statistically significant improvements across all measured parameters compared to the control group, which was taught using traditional methods. The scientific novelty of the study lies in the comprehensive analysis of the impact of interactive learning, based on the theory of embodied interaction, on key educational competencies of students. Unlike previous studies that examined these aspects separately, this work provides a holistic view of their interconnection and the dynamics of changes under the influence of a digital educational environment. The practical significance of the study is that the results can be used to enhance teaching methods based on interactive digital technologies. The implementation of such educational platforms promotes increased student engagement in the learning process, the development of independent learning skills, and emotional regulation, which is especially relevant in the context of the digitalization of higher education. The findings also highlight the need for further research focused on the long-term effects of interactive educational technologies on academic success and students' emotional well-being. Future studies could include a wider range of educational disciplines, analyze the impact of other digital platforms, and apply additional methods for assessing outcomes, including neurophysiological and behavioral indicators.

CRediT authorship contribution statement

Weiwei Jiang: conceptualization, data curation, formal analysis, funding acquisition investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft, writing – review & editing.

References

Aida, S., Ainur, Z., Ardak, A., Madina, A., Perizat, K., & Gulnara, R. (2022). Formation of professional competencies of a future foreign language teacher in the field of distance education. *World Journal on Educational Technology: Current Issues*, *14*(1), 268–281. https://doi.org/10.18844/wjet.v14i1.6724

AlAli, R., & Al-Barakat, A. (2022). Using Structural equation modeling to assess a model for measuring creative teaching perceptions and practices in higher education. *Education Sciences*, *12*(10), 690. https://doi.org/10.3390/educsci12100690

Alam, A. (2022). Mapping a sustainable future through conceptualization of transformative learning framework, education for sustainable development, critical reflection, and responsible citizenship: An exploration of pedagogies for twenty-first century learning. *ECS Transactions*, *107*(1), Article 9827. https://doi.org/10.1149/10701.9827ecst

American Educational Research Association. (1985). *American Psychological Association, & National Council on Measurement in Education*. Standards for educational and psychological testing. American Educational Research Association.

Asad, M. M., Naz, A., Churi, P., & Tahanzadeh, M. M. (2021). Virtual reality as pedagogical tool to enhance experiential learning: A systematic literature review. *Education Research International*, *2021*, Article 7061623. https://doi.org/10.1155/2021/7061623

Benjamin, D. J., Berger, J. O., Johannesson, M., Nosek, B. A., Wagenmakers, E.-J., Berk, R., Bollen, K. A., Brembs, B., Brown, L., Camerer, C., Cesarini, D., Chambers, C. D., Clyde, M., Cook, T. D., De Boeck, P., Dienes, Z., Dreber, A., Easwaran, K., Efferson, C., Fehr, E., . . . Johnson, V. E. (2018). Redefine statistical significance. *Nature Human Behaviour*, *2*(1), 6–10. https://doi.org/10.1038/s41562-017-0189-z

Bhatia, P. (2011). *Concentration Questionnaire*. https://www.academia.edu/36819755/Concentration_Questionnaire

Bylieva, D., Hong, J. C., Lobatyuk, V., & Nam, T. (2021). Self-regulation in e-learning environment. *Education Sciences*, *11*(12), Article 785. https://doi.org/10.3390/educsci11120785

Chen, J., Zhou, J., Wang, Y., Qi, G., Xia, C., Mo, G., & Zhang, Z. (2020). Blended learning in basic medical laboratory courses improves medical students' abilities in self-learning, understanding, and problem solving. *Advances in Physiology Education*, *44*(1), 9–14. https://doi.org/10.1152/advan.00076.2019

Delhom, I., Satorres, E., & Meléndez, J. C. (2020). Can we improve emotional skills in older adults? Emotional intelligence, life satisfaction, and resilience. *Psychosocial Intervention*, *29*(3), 133–139. https://doi.org/10.5093/pi2020a8

Drigas, A., Papanastasiou, G., & Skianis, C. (2023). The school of the future: The role of digital technologies, metacognition and emotional intelligence. *International Journal of Emerging Technologies in Learning*, *18*(9), 65–85. https://doi.org/10.3991/ijet.v18i09.38133

Emihovich, B., Xu, X., & Arrington, T. L. (2020). S.P.E.C.I.a.L. – a conceptual framework to support learning in immersive environments. *International Journal of Smart Technology and Learning*, *2*(2/3), 182–197. https://doi.org/10.1504/IJSMARTTL.2020.112149

Estrada, M., Monferrer, D., Rodriguez, A., & Moliner, M. Á. (2021). Does emotional intelligence influence academic performance? The role of compassion and engagement in education for sustainable development. *Sustainability*, *13*(4), Article 1721. https://doi.org/10.3390/su13041721

Filsinger, M. (2024). Bringing emotions in: How anger shapes the relationship between social isolation and populist attitudes. *American Behavioral Scientist*, *69*(5), 583–603. https://doi.org/10.1177/00027642241241133

Glushchenko, V. V., & Inei, Y. H. A. (2024). Theoretical aspects of creating a scientific and educational platform for information and trading systems. *ASEAN Journal of Educational Research and Technology*, *3*(2), 135–146.

Goleman, D. (2001). Emotional intelligence: Issues in paradigm building. In C. Cherniss, & D. Goleman (Eds.), *The emotionally intelligent workplace* (pp. 13–26). Jossey-Bass.

González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of education 4.0 in 21st century skills frameworks: Systematic review. *Sustainability*, *14*(3), Article 1493. https://doi.org/10.3390/su14031493

Gülbahar, B., & Sıvacı, S. Y. (2019). The effect of emotional intelligence on in-class leader teaching and in-class effective communication skills: A structural equation modeling study. *International Journal of Languages' Education and Teaching*, *7*(1), 23–39.

Hsu, J. L., & Goldsmith, G. R. (2021). Instructor strategies to alleviate stress and anxiety among college and university STEM students. *CBE—Life Sciences Education*, *20*(1), Article es1. https://doi.org/10.1187/cbe.20-08-0189

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Hvorecký, J., Rozehnal, P., Funioková, T., & Gurný, P. (2025). 3D desktop virtual reality as a facilitator of the learning quality and of strengthening students' results. *Interactive Learning Environments*, *33*(1), 154–169. https://doi.org/10.1080/10494820.2024.2341692

Ioannou, M., & Ioannou, A. (2020). Technology-enhanced embodied learning. *Educational Technology & Society*, *23*(3), 81–94.

Jamil, N., Belkacem, A. N., & Lakas, A. (2023). On enhancing students' cognitive abilities in online learning using brain activity and eye movements. *Education and Information Technologies*, *28*(4), 4363–4397. https://doi.org/10.1007/s10639-022-11372-2

Järvenoja, H., Malmberg, J., Törmänen, T., Mänty, K., Haataja, E., Ahola, S., & Järvelä, S. (2020). A collaborative learning design for promoting and analyzing adaptive motivation and emotion regulation in the science classroom. *Frontiers in Education*, *5*, 111. https://doi.org/10.3389/feduc.2020.00111

Kabri, K., Harapan, E., & Purwanto, M. B. (2024). 21st century English learning: A revolution in skills, critical thinking, creativity, and visual communication. *Asian Journal of Applied Education*, *3*(1), 43–54. https://doi.org/10.55927/ajae.v3i1.7841

Kay, R. (2022). Examining the role of emotions in learning with technology. *Journal of Digital Life and Learning*, *2*(2), 12–26. https://doi.org/10.51357/jdll.v2i2.211

Khani, R., & Ghasemi, F. (2019). EFL teachers' emotional intelligence, emotional support, and their classroom leadership: A structural equation modeling approach. *International Journal of Research in English Education*, *4*(3), 1–20. https://doi.org/10.29252/ijree.4.3.1

Knaus, T. (2023). Emotions in media education: How media based emotions enrich classroom teaching and learning. *Social Sciences & Humanities Open*, *8*(1), Article 100504. https://doi.org/10.1016/j.ssaho.2023.100504

Ko, F. S. L., & Siu, A. M. H. (2014). Validation of a Chinese version of the Assessing Emotions Scale for measuring the emotional intelligence of Chinese adolescents. *International Journal on Disability and Human Development*, *13*(1), 79–88. https://doi.org/10.1515/ijdhd-2013-0017

Le, H. V. (2021). An investigation into factors affecting concentration of university students. *Journal of English Language Teaching and Applied Linguistics*, *3*(6), 7–12. https://doi.org/10.32996/jeltal.2021.3.6.2

Lee, T., Wen, Y., Chan, M., Azam, A. B., Looi, C.-K., Taib, S., Ooi, C., Huang, L., Xie, Y., & Cai, Y. (2024). Investigation of virtual & augmented reality classroom learning environments in university STEM education. *Interactive Learning Environments*, *32*(6), 2617–2632. https://doi.org/10.1080/10494820.2022.2155838

Li, X.-D., & Cao, H.-H. (2020). Research on VR-supported flipped classroom based on blended learning: A case study in "Learning English through News.". *International Journal of Information and Education Technology*, *10*(2), 94–98. https://doi.org/10.18178/ijiet.2020.10.2.1347

Lin, Y., & Yu, Z. (2023). A meta-analysis of the effects of augmented reality technologies in interactive learning environments (2012–2022). *Computer Applications in Engineering Education*, *31*(4), 1111–1131. https://doi.org/10.1002/cae.22628

Lin, X., Yu, J., Wang, Q., Limniou, M., Huijser, H., & Gu, H. (2024). Role of learning-related emotions, emotion regulation, and technology acceptance in learner engagement with online professional development. *Australasian Journal of Educational Technology*, *40*(2), 1–18. https://doi.org/10.14742/ajet.9060

Liu, S., Liu, S., Liu, Z., Peng, X., & Yang, Z. (2022). Automated detection of emotional and cognitive engagement in MOOC discussions to predict learning achievement. *Computers & Education*, *181*, Article 104461. https://doi.org/10.1016/j.compedu.2022.104461

Ma, X. (2022). Influence study of learners' independent learning ability on learning performance in online learning. *International Journal of Emerging Technologies in Learning*, *17*(9), 201–213. https://doi.org/10.3991/ijet.v17i09.30925

Macrine, S. L., & Fugate, J. M. B. (2021). Translating embodied cognition for embodied learning in the classroom. *Frontiers in Education*, *6*, Article 712626. https://doi.org/10.3389/feduc.2021.712626

Marks, B., & Thomas, J. (2022). Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory. *Education and Information Technologies*, *27*(1), 1287–1305. https://doi.org/10.1007/s10639-021-10653-6

Mayer, J. D., Salovey, P., Caruso, D. R., & Sitarenios, G. (2001). Emotional intelligence as a standard intelligence. *Emotion*, *1*(3), 232–242.

McGivney, E., Forshaw, T., Medeiros, R., Sun, M., & Grotzer, T. (2024). Addressing emotions and beliefs for vulnerable jobseekers with virtual reality. *Education and Information Technologies*, *29*, 5541–5570. https://doi.org/10.1007/s10639-023-11923-1

Mohammad, N., & Yasin, R. M. (2015). Creative teaching in design and technology curriculum: Using structural equation modeling. *Procedia-Social and Behavioral Sciences*, *204*, 240–246. https://doi.org/10.1016/j.sbspro.2015.08.146

Mystakidis, S., Berki, E., & Valtanen, J. P. (2021). Deep and meaningful e-learning with social virtual reality environments in higher education: A systematic literature review. *Applied Sciences*, *11*(5), Article 2412. https://doi.org/10.3390/app11052412

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory*. McGraw Hill, Inc.

Paramita, P. E., Zulkifli, Z., Aziz, F., & Supendi, D. (2023). Analysis of the influence of gadgets on children's emotional intelligence. *Jurnal Scientia*, *12*(1), 132–137. https://doi.org/10.58471/scientia.v12i01.1057

Rahman, Q., & Yunus, T. (2020). Study of metacognitive skills development and reflection of self-learning in education. *Education and Development*, *10*(20), 28–27.

Rahmatullah, A. S., Mulyasa, E., Syahrani, S., Pongpalilu, F., & Putri, R. E. (2022). Digital era 4.0: The contribution to education and student psychology. *Linguistics and Culture Review*, *6*(S3), 89–107. https://doi.org/10.21744/lingcure.v6nS3.2064

Rain Classroom. (2024). *Official site*. https://www.yuketang.cn/en

Sadka, O., & Antle, A. (2022). Interactive technologies for emotion regulation training: A scoping review. *International Journal of Human-Computer Studies*, *168*, Article 102906. https://doi.org/10.1016/j.ijhcs.2022.102906

Shao, K., Nicholson, L. J., Kutuk, G., & Lei, F. (2020). Emotions and instructed language learning: Proposing a second language emotions and positive psychology model. *Frontiers in Psychology*, *11*, Article 2142. https://doi.org/10.3389/fpsyg.2020.02142

Shapiro, L., & Stolz, S. A. (2019). Embodied cognition and its significance for education. *Theory and Research in Education*, *17*(1), 19–39. https://doi.org/10.1177/1477878518822149

Soon, P.-S., Lim, W. M., & Gaur, S. S. (2023). The role of emotions in augmented reality. *Psychology & Marketing*, *40*, 2387–2412. https://doi.org/10.1002/mar.21884

Sullivan, J. V. (2018). Learning and embodied cognition: A review and proposal. *Psychology Learning & Teaching*, *17*(2), 128–143. https://doi.org/10.1177/1475725717752550

Sun, M., Wang, M., & Wegerif, R. (2020). Effects of divergent thinking training on students' scientific creativity: The impact of individual creative potential and domain knowledge. *Thinking Skills and Creativity*, *37*, Article 100682. https://doi.org/10.1016/j.tsc.2020.100682

Turgumbayeva, A., Aimaganbetova, O., Kassymova, R., Yeralina, E., & Bakirova, Z. (2019). The motivation of Russian and Kazakhstani faculty members in the cross-cultural context. *The Open Psychology Journal*, *12*(1), 174–180. https://doi.org/10.2174/1874350101912010174

Ubago-Jiménez, J. L., Corral-Robles, S., Ortega-Martín, J. L., & Melguizo-Ibáñez, E. (2023). The interplay between academic performance, emotional intelligence, and self-concept as predictors of violent behavior in higher education: A multi-group structural equation modeling. *Frontiers in Psychology*, *14*, Article 1124712. https://doi.org/10.3389/fpsyg.2023.1124712

Wang, L., & Ismail, J. (2023). A study to evaluate the effectiveness of art creativity in China: Torrance test creative thinking. *Malaysian Journal of Social Sciences and Humanities*, *8*(10), Article e002488. https://doi.org/10.47405/mjssh.v8i10.2488

Wang, Q., Zheng, X., & Zhang, S. (2023). Digital compensation: Smartphone use in the emotion socialisation of left-behind children in rural China. *New Media & Society*, *27*(4), 2434–2454. https://doi.org/10.1177/14614448231213954

Wang, Z., Wang, X., & Zeng, Z. (2021). Memristive circuit design of brain-like emotional learning and generation. *IEEE Transactions on Cybernetics*, *53*(1), 222–235. https://doi.org/10.1109/TCYB.2021.3090811

Williamson, S. (2007). Development of a self-rating scale of self-directed learning. *Nurse Researcher*, *14*(2), 66–83. https://doi.org/10.7748/nr2007.01.14.2.66.c6022

Yu, J., Huang, C., Han, Z., He, T., & Li, M. (2020). Investigating the influence of interaction on learning persistence in online settings: Moderation or mediation of academic emotions? *International Journal of Environmental Research and Public Health*, *17*(7), Article 2320. https://doi.org/10.3390/ijerph17072320

Zhong, B., Su, S., Liu, X., & Zhan, Z. (2023). A literature review on the empirical studies of technology-based embodied learning. *Interactive Learning Environments*, *31*(8), 5180–5199. https://doi.org/10.1080/10494820.2021.1999274

Zhu, H., Pongtornkulpanich, A., & Chankoson, T. (2024). Development model of factors influencing the adoption of online education platforms for promoting educational equity in Chinese higher education. *Educational Administration: Theory and Practice*, *30*(4), 5738–5752. https://doi.org/10.53555/kuey.v30i4.2279