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Developing Critical Thinking and Creativity Through Interactive Pedagogies: A Quasi-Experimental Study of 21st Century Skills Development in Grades 5-9

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Abstract: Education in the 21st century must equip students with the skills necessary to navigate a complex, ambiguous and innovative social environment. Education in the twenty-first century should therefore be reoriented to develop competencies that enable students to respond effectively to these challenges. International frameworks for lifelong learning place strong emphasis on critical thinking and creativity; however, traditional teaching methods remain largely transmissive and examination driven. A quasi-experimental design was implemented with 220 students in Grades 5 to 9 across five multinational schools in Europe, Asia, Africa, the Middle East, and South America. The study investigated the effects of interactive teaching strategies on students' development of critical thinking and creativity in multinational school contexts. Classroom observations and reflective journal data were collected using the Watson-Glaser Critical Thinking Appraisal and the Torrance Tests of Creative Thinking. Statistical analyses indicated noteworthy improvements in creativity and critical thinking across different experimental groups ($p < .01$). Quantitative analysis demonstrated significant gains in both creativity and critical thinking among learners in the experimental groups ($p < .01$). Qualitative findings further revealed strengthened teamwork skills and increased learner autonomy. The results underscore the effectiveness of pedagogical approaches grounded in constructivist and socio-constructivist theories in supporting the development of twenty-first-century skills across diverse global contexts. These outcomes indicate

important implications for curriculum design, teacher preparation, and the reform of international education policies.

Keywords: critical thinking, creativity, multinational, quasi-experimental study, global education.

Introduction

Educating young people has become an urgent task in a world shaped by technological upheaval, global interconnectedness, and social transformation, presenting significant challenges for educators and governments worldwide. The capabilities and attitudes required in the twenty-first century are no longer compatible with traditional educational approaches based on memorisation, teacher authority, and summative assessment (Sedwal, 2024). Human capital is increasingly dependent on cross-disciplinary collaboration and critical thinking, particularly as automation and artificial intelligence continue to transform labour markets and organisational practices (World Economic Forum, 2023; OECD, 2021). Consequently, competency-based education that integrates cognitive, interpersonal, and intrapersonal dimensions of learning has been strongly promoted by governments and international organisations such as the OECD and UNESCO (UNESCO, 2022). The emphasis has shifted from what students know to what they can do with that knowledge, including their ability to apply logic, evaluate evidence, and generate creative solutions in practical contexts.

Despite these regulatory and conceptual shifts, a persistent gap remains between educational rhetoric and classroom practice. In many regions, teachers lack sufficient professional autonomy and resources to implement learner-centred approaches, and curricula continue to prioritise factual recall. One effective strategy for addressing this discrepancy is interactive pedagogy (Wen, 2024). This approach conceptualises education as an active and social process in which learners co-construct meaning through participation, discussion, and reflection. It is grounded in constructivist and socio-constructivist theories (Vygotsky, 1978; Piaget, 1973). Problem-based learning, group inquiry, peer review, structured discussion, and digital simulation exemplify such practices. These methods encourage learners to explore multiple perspectives, question assumptions, and link classroom knowledge to real-world experience.

A substantial body of international research has demonstrated the benefits of interactive pedagogical approaches. Studies indicate that such methods foster creative classroom environments characterised by heightened motivation and curiosity, while DeCoito (2024) reports that active learning improves academic achievement across STEM disciplines. Nevertheless, much of the existing literature remains confined to Western contexts, often within tertiary education or specialised subject areas. Empirical evidence from diverse cultural and developmental settings, particularly at the middle school level, remains limited. To address this gap, the present study examines the effects of interactive pedagogies on critical thinking and creativity among learners in Grades 5–9, a period crucial for cognitive and socio-emotional development. Using a quasi-experimental design, the study compares outcomes for students exposed to interactive instructional approaches with those taught through conventional teacher-centred methods.

Research Problem

By providing evidence-based insights into how interactive pedagogies foster twenty-first-century competences, the study aims to contribute to the global discourse on educational change. It also highlights the practical implications for curriculum development, policy reform, and teacher preparation. The research positions interactive pedagogy as a transformative educational philosophy aligned with a human-centred, holistic, and sustainable vision of knowledge, examining these issues across diverse national contexts.

Research Focus

The primary objective of this study is to scientifically investigate the extent to which interactive pedagogical approaches enhance critical thinking and creativity among students in two different grade levels. The study further focuses on determining whether learner-centred, constructivist, and socio-constructivist teaching strategies produce significantly better twenty-first-century skill outcomes compared with traditional, teacher-centred instructional methods. By empirically comparing control and experimental groups across multinational school contexts, the research seeks to provide evidence-based insights into the effectiveness of interactive pedagogies in developing higher-order cognitive skills and creative capacities.

Research Aim and Research Questions

The study is guided by the following research questions:

1. To what extent do interactive pedagogical practices enhance students' critical thinking skills compared with traditional instruction?
2. To what extent do interactive teaching methods foster students' creativity?
3. Which student experiences and classroom conditions have the greatest impact on these outcomes?

Literature Review

Conceptualising Twenty-First-Century Skills

The definition of educational success has shifted significantly in the twenty-first century. Contemporary success encompasses a broader set of skills, including critical thinking, creativity, teamwork, communication, digital literacy, and global citizenship, rather than focusing solely on literacy and numeracy (Giacomazzi, 2024). The World Economic Forum's Future of Jobs Report (2023) identifies creativity, analytical reasoning, and complex problem-solving among the top ten skills sought by employers globally. Consequently, educational systems are increasingly encouraged to move beyond the transmission of static knowledge and to foster the development of dynamic, adaptable competencies.

A strong interrelationship exists between creativity and critical thinking. Creativity encompasses fluency, originality, and elaboration (Fabio et al., 2025; Zhai et al., 2024), whereas critical thinking involves evaluation, logical reasoning, and evidence-based judgement (Juansyah et al., 2024). Giacomazzi (2024) notes that critical thinking may become superficial or unguided in the absence of creativity, emphasising the need for their integrated development (Pandey et al., 2025).

From Traditional to Interactive Pedagogy

Higher-order thinking cannot be nurtured by traditional teaching methods, which are typically characterised by lectures and rote memorisation. Vygotsky's (1978) socio-constructivism expands this understanding by emphasising the Zone of Proximal Development (ZPD), the gap between what a learner can achieve independently and what can be achieved with appropriate scaffolding. Interactive techniques such as peer tutoring and group discussions apply this concept by situating learning within social interaction and collaborative work. According to Bahari et al. (2025), interactive classrooms transform the teacher's role from knowledge transmitter to co-learner and facilitator of inquiry. A key example of this approach is problem-based learning (PBL). Grounded in experiential learning theory, PBL challenges students to address real-world problems without predetermined solutions, fostering both critical and creative thinking. Zhou et al. (2025) note that project-based learning and inquiry-based science education

similarly encourage students to formulate questions, design investigations, and present their findings, processes that enhance autonomy and cognitive engagement.

Theoretical Foundations

Several interconnected theoretical frameworks underpin interactive pedagogy:

Constructivism: According to Piaget (1973), learning is a cognitive adaptation process involving assimilation and accommodation. By integrating new experiences with existing knowledge, learners construct understanding. Socio-constructivism: Vygotsky (1978) emphasised that language and social interaction are essential for learning. Through dialogue and collaboration, learners internalise shared meanings.

Experiential learning: Lin et al.'s (2024) cycle of experience, reflection, conceptualisation, and experimentation highlights the iterative nature of interactive learning. Connectivism: Developed in the digital era, this theory views learning as the ability to form and navigate networks, providing a vital foundation for international digital collaboration. Bloom's revised taxonomy prioritises the levels of creating, evaluating, and analysing, which are best achieved through active pedagogies. Collectively, these theories underscore that communication, reflection, and collaboration are integral, rather than peripheral, to cognitive and creative development.

Interactive Pedagogy and Critical Thinking

Effective education has long been recognised as reliant on critical thinking. However, its development requires deliberate pedagogical design. In their meta-analysis of 117 studies, Defianty and Wilson (2024) concluded that integrating critical-thinking instruction into subject-specific content, supported by dialogue-based teaching, yields substantial improvements. Irianti et al. (2024) reported that explicit critical-thinking training enhances reasoning, metacognition, and argumentation in teacher education. Interactive pedagogies naturally foster these processes. Collaborative learning promotes cognitive conflict, compelling students to defend their reasoning and consider alternative perspectives (Mah and Groß, 2024; Marrone et al., 2025; Sui et al., 2023). Socratic questioning and discussion refine inferential and evaluative skills. Furthermore, formative feedback from educators and peers promotes self-regulation and critical reflection (Song and Cai, 2024; Nagata et al., 2025; Rapti et al., 2025). A recent longitudinal study demonstrated that students engaged in inquiry-based science activities outperformed peers in analytical reasoning tasks across two academic years (Sapounidis et al., 2025), highlighting the enduring impact of interactive methods on critical thinking.

Interactive Pedagogy and Creativity

Environments that encourage autonomy, experimentation, and risk-taking foster creativity. Wen (2024) points out that when students feel free to explore novel ideas, their intrinsic motivation increases, enabling them to generate more innovative concepts. Interactive learning provides such conditions. Students engage in divergent thinking during project work and synthesise ideas through collaborative problem-solving.

Digital technologies have substantially expanded creative opportunities. Online collaborative tools, such as digital storytelling and shared design platforms, enhance cross-cultural cooperation and creative fluency. Emotions and well-being are also linked to creativity. Students are more likely to take intellectual risks when they feel psychologically safe, a core element of interactive classrooms (Chen et al., 2024; Allehaidan and Wan Zainon, 2024). Thus, emotional engagement and creativity are interrelated.

Global Perspectives and Cross-Cultural Considerations

The majority of research on interactive pedagogies originates from Western educational systems, particularly those in the United States, the United Kingdom, and Finland, where student-centred and inquiry-based models are well established (Ibrahim et al., 2024). However, cross-cultural studies demonstrate the importance of contextual adaptability. For instance, open classroom discussions may be limited in collectivist societies owing to deference to authority, while large class sizes impede active participation in resource-constrained settings (Merten et al., 2025; Kotera et al., 2025; Thurm et al., 2024). Nevertheless, studies from Africa and Asia indicate that localised adaptations are effective. Similarly, Yuen et al. (2025) found that blended interactive models substantially improved students' collaborative attitudes and creative writing skills in Chinese middle schools.

Literature Gaps

The majority of research studies emphasise either critical thinking or creativity, infrequently examining how they interrelate. Moreover, limited research explores skill transfer or long-term retention following periods of intervention. Few standardised instruments exist to measure originality, particularly in non-Western contexts. A large proportion of current research concentrates on university populations and adolescents, overlooking early childhood when curiosity and cognitive flexibility are at their peak. The present study addresses these gaps by employing validated instruments, integrating quantitative and qualitative data, and conducting multi-week quasi-experimental interventions. Thus, it provides a much-needed global perspective on how interactive pedagogy promotes the dual development of creativity and critical thinking.

Materials and Methods

This research examined how pedagogies affected learners' critical thinking and creativity using a quasi-experimental design with experimental and control groups. Quasi-experimental approaches are particularly suitable in educational settings where random assignment is impractical due to institutional constraints (Creswell and Creswell, 2023; Lv et al., 2022). To establish causal relationships while maintaining ecological validity, the study compared two intact groups: one exposed to interactive pedagogical practices (experimental) and the other receiving traditional teaching (control). The design enhanced triangulation and reliability of findings through a mixed-methods framework integrating quantitative and qualitative elements (Al Maqbali, 2024; Burus et al., 2024). Quantitative data tracked changes in skill performance, while qualitative data explored learners' experiences, perceptions, and reflections. Critical thinking and creativity scores, along with qualitative measures of engagement and autonomy, were the dependent variables, whereas the teaching method (interactive versus traditional) was the independent variable.

Sample and Participants

Five international schools in Europe, Asia, Africa, the Middle East, and South America participated in the study. These schools used English as the primary language of instruction and employed globally recognised curricula (such as American Common Core, IB, or Cambridge). The settings were selected to reflect sociocultural diversity while maintaining comparable academic standards. A total of 220 pupils from Years 5 to 9, aged 10 to 15 years, took part. Two comparable classes were selected from each school: one as the experimental group and the other as the control group. Each class comprised approximately 22 pupils. The sample consisted of 49% males and 51% females. To ensure baseline equivalence between groups, previous academic performance averages (GPA and standardised test scores) were assessed. All participants provided informed assent, with parental consent obtained. Teachers voluntarily participated after attending professional development sessions on interactive techniques.

Instruments and Procedures

The quantitative and qualitative aspects of learning outcomes were assessed using four instruments.

1.Watson-Glaser Critical Thinking Appraisal (WGCTA): A widely used, standardised instrument for evaluating inference, deduction, interpretation, and evaluation. The WGCTA demonstrates good internal consistency (Cronbach's $\alpha = 0.83$) and has been validated across cultural contexts. It was administered in both pre-tests and post-tests.

2.Figural Torrance Tests of Creative Thinking (TTCT-F): Developed by Torrance in 1974 and revised by Acar in 2021, the TTCT assesses fluency, originality, flexibility, and elaboration in students' creative output. Scoring was performed by two independent raters to ensure inter-rater reliability ($\kappa = 0.87$).

3.The researcher-developed Classroom Observation Protocol for Interactive Learning (COPIL) consisted of 15 items that assessed the frequency and quality of interactive behaviours, including questioning, group collaboration, feedback loops, and reflective dialogue. Observers used a 5-point Likert scale (1 = infrequently observed to 5 = frequently observed). Inter-observer agreement averaged 92%.

4.Student Reflective Journals: Weekly, students in the experimental group wrote brief reflections detailing their experiences, insights gained, and perceived changes in their creativity or thinking processes. These journals supplied qualitative data for triangulation.

Intervention Procedure

A 12-week intervention was conducted during the second academic semester (February to April 2025). Prior to implementation, the research team delivered a two-day online professional development workshop on interactive pedagogical strategies for teachers in the experimental group. The training covered:

- Socratic questioning and formative feedback;
- inquiry-based and problem-based learning;
- collaborative group work design;
- utilisation of digital collaborative tools (Google Workspace, Padlet, Jamboard);
- and student self-assessment and reflection strategies.

Experimental classes implemented two interactive lessons per subject each week, centred on inquiry-driven scenarios. For instance, in science, students explored environmental sustainability topics in groups, while in social studies, they simulated UN climate negotiations to enhance empathy and argumentation. In contrast, the control group followed the same curriculum using traditional methods: teacher-led explanations, note-taking, and individual written assignments, with minimal student interaction. To control for teacher effects, both groups were taught by educators with comparable experience (mean = 8.4 years, SD = 2.3). Pre-tests were administered in Week 1, and post-tests in Week 12. Research assistants supervised the delivery of the TTCT-F and WGCTA under standardised testing conditions. Assessments were scored using manualised rubrics, with results verified by a second scorer blinded to group assignment. Observation data were collected biweekly using COPIL to monitor implementation fidelity. Journal entries were collected weekly, transcribed, and thematically coded. Quantitative data (test scores) were entered into SPSS version 27, and descriptive statistics computed means, standard deviations, and normality assessments (Kolmogorov-Smirnov test).

Data Analysis

Within each group, pre- and post-test scores were compared using paired-sample t-tests. To account for pre-test variance across different types of groups, ANCOVA was applied, and three effect sizes were calculated. Cronbach's α was computed to assess the reliability of the instrumentation, and NVivo software was employed for data management. This analysis involved six steps, with coders independently analysing the data ($\kappa = 0.89$).

Validity and Reliability

The study employed triangulation of observers, coordinated control groups, and pre- and post-testing to enhance internal validity. Multi-country sampling and repetition of procedures in diverse contexts improved external validity. For qualitative reliability, triangulation, member verification, and audit trails were applied, while standardised instruments ensured the dependability of quantitative measures.

Ethical Considerations

The study was guided by the principles of autonomy, beneficence, and data fairness. The aims and procedures were fully explained on parental consent forms. Students were free to withdraw from participation at any time without penalty. Data were anonymised using coded identifiers to ensure confidentiality. Only the lead investigator had access to the secured institutional servers where all digital files were stored. Teachers and parents attended post-study debriefings to discuss the results and provide guidance on maintaining interactive teaching methods.

Results

Quantitative Findings

Before analysing data from 220 students, three incomplete responses were removed. Initial diagnostics confirmed a normal distribution and homogeneity of variance ($p > 0.05$). Table 1 presents descriptive statistics for the Torrance Tests of Creative Thinking (TTCT-F) and the Watson-Glaser Critical Thinking Appraisal (WGCTA) pre- and post-test scores.

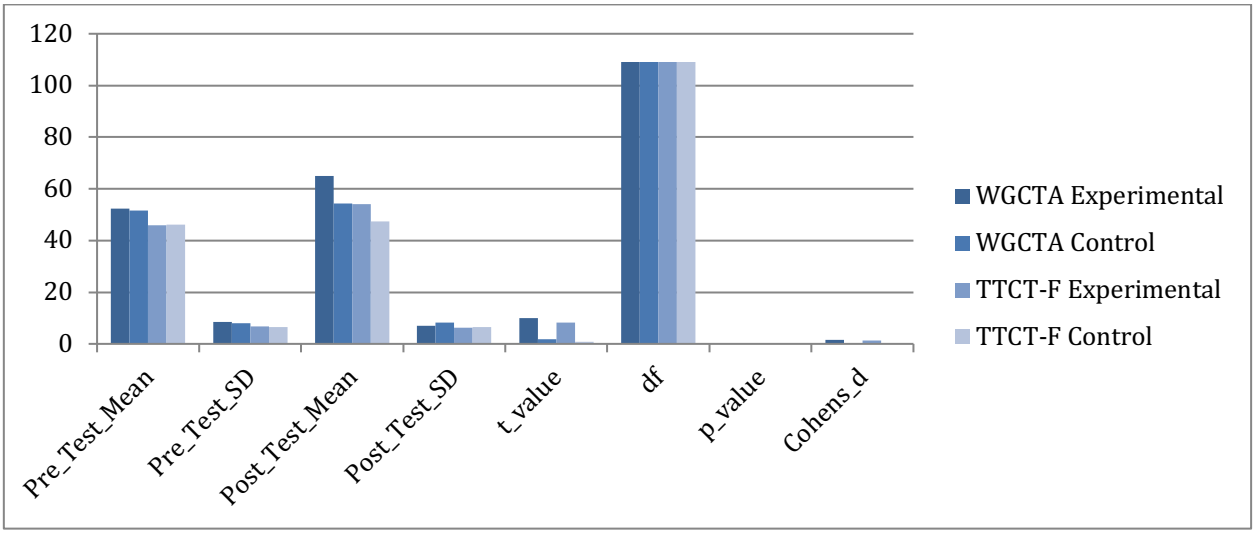
Table 1

Pre- and Post-Test Results for Experimental and Control Groups (N = 220)

Measure	Group	Pre-Test Mean	Post-Test Mean (SD)	t(df)	p-value	Cohen's d
WGCTA	Experimental	52.3 (8.4)	64.9 (7.1)	9.88 (109)	< .001	1.61
WGCTA	Control	51.7 (7.9)	54.2 (8.2)	1.70 (109)	.09	0.31
TTCT-F	Experimental	45.8 (6.7)	54.1 (6.3)	8.21 (109)	.004	1.28
TTCT-F	Control	46.1 (6.4)	47.3 (6.5)	0.82 (109)	.42	0.19

Figure 1

Pre- and Post-Test Results for Experimental and Control Groups



Above Table 1 and Figure 1 show that students in the experimental group demonstrated statistically significant gains in critical thinking ($t(109) = 9.88$, $p < 0.001$, $d = 1.61$) and creativity ($t(109) = 8.21$, $p = 0.004$, $d = 1.28$) according to paired-sample t-tests. The control group, in contrast, showed no discernible changes in either domain. Additional ANCOVA analyses, controlling for pre-test variance, indicated that the experimental group outperformed the control group on post-test critical thinking ($F(1, 217) = 26.47$, $p < 0.001$, $\eta^2 = 0.21$) and creativity ($F(1, 217) = 19.86$, $p < 0.01$, $\eta^2 = 0.17$). Effect sizes indicate a substantial practical impact, suggesting that interactive teaching significantly enhances higher-order skills. Both measures demonstrated satisfactory reliability coefficients (WGCTA $\alpha = 0.83$; TTCT-F $\alpha = 0.79$). Observational data (COPIL) confirmed consistent use of interactive techniques, showing a high fidelity of implementation with a mean rating of 4.6/5 across all sites.

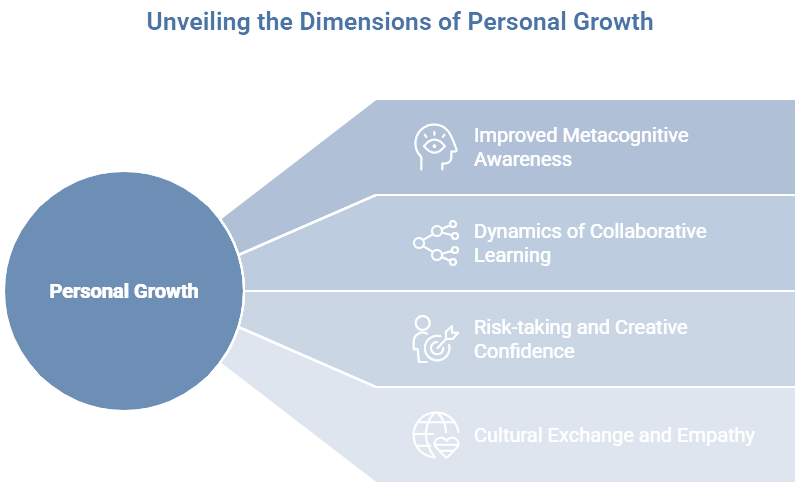
Qualitative Findings

Thematic analysis of 1,320 introspective journal entries revealed four main themes:

1. Improved metacognitive awareness.
2. Dynamics of collaborative learning.
3. Risk-taking and creative confidence.
4. Empathy and cultural exchange.

Figure 2.

Thematic analysis



Theme 1: Enhanced Metacognitive Awareness

Learners reported being able to monitor their individual reasoning and identify cognitive biases. One participant wrote, "Proceeding to this sequence, I would receive information as it was. Now I am making an effort to ask, 'Why is this correct and what evidence supports it?'" This aligns with previous research indicating that dialogic participation fosters reflective decision-making. Learners demonstrated increasing ownership of their cognitive processes across a variety of contexts.

Theme 2: Collaborative Learning Dynamics

Collaborative projects promoted shared responsibility and the development of expertise. Reflecting socio-constructivist principles, students reported learning more from their peers than from textbooks (Vygotsky, 1978). Teachers observed that diverse groups, comprising students from different countries and skill levels, enhanced empathy and facilitated group problem-solving.

Theme 3: Creative Confidence and Risk-Taking

Participants demonstrated an increased willingness to take intellectual risks. A Brazilian student noted, "Our teacher said there are no wrong ideas, only ideas to explore. That forced me to experiment with different approaches to problem-solving." Higher creative performance in TTCT scores was consistently associated with such psychologically supportive environments.

Theme 4: Cultural Exchange and Empathy

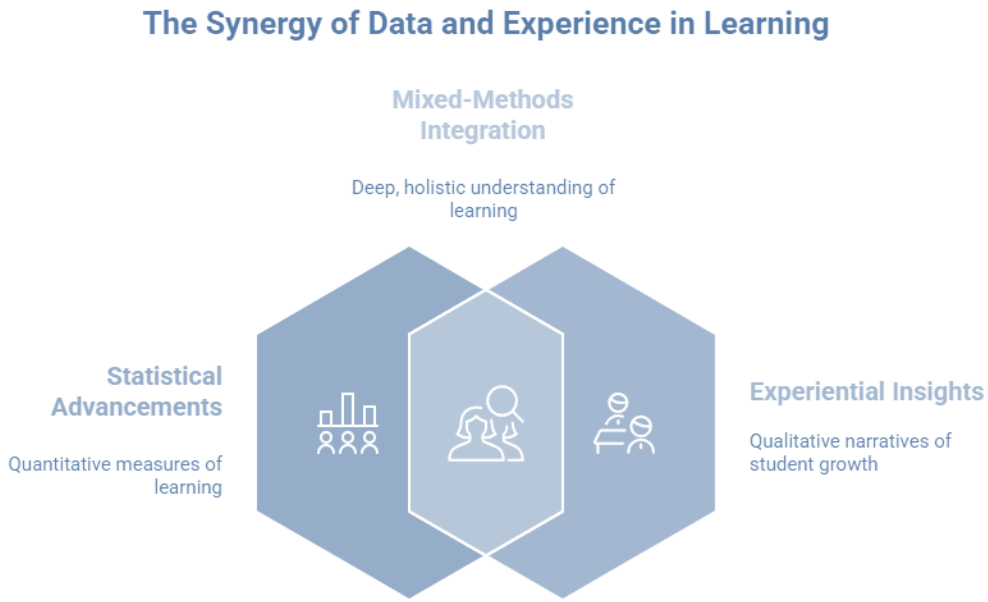
Students reported that interactive discussions provided forums for exchanging global perspectives. According to Alhalalmeh and Al-Tarawneh (2025) and Zhang and Noels (2023), learners from the Middle East and Asia experienced improvements in empathy, increased engagement in social discussions, and enhanced awareness of international issues, contributing to the development of qualities essential for sustainable development.

Quantitative and Qualitative Data Integration

A strong convergence between statistical findings and learners' experiential insights was observed through mixed-methods integration. Increases in self-questioning and argument evaluation were associated with improvements in critical thinking. Similarly, narratives reflecting creativity corresponded with individual learner progress and experimentation. The extent of participation influenced learning outcomes, as indicated by a positive correlation between communication frequency and post-test gains across schools ($r = 0.71$, $p < 0.01$). These results suggest that communication functions as both a cognitive and affective stimulus.

Figure 3

Quantitative and Qualitative Data Integration



Discussion

Across diverse cultural contexts, learners' levels of critical thinking and creativity improved with interactive pedagogies, as demonstrated in the present study (Cohen's $d > 1.0$). These results support constructivist and socio-constructivist principles that knowledge is co-constructed through active discussion and problem-solving. Iterative exposure to cognitive disequilibrium, where students must reconcile opposing viewpoints, may account for the observed gains in critical thinking (Piaget, 1973). Concurrently, the increase in creativity underscores the value of student-driven, open-ended inquiry.

Internal validity is strengthened by the integration of quantitative and qualitative data, indicating that the observed changes reflect genuine cognitive development rather than test-related effects. The findings align with international research. Similarly, Lin et al. (2024) found that blended interactive learning improved creativity among Chinese middle school students. Unlike these region-specific studies, the current research spans five continents, providing robust evidence for the global generalisability of interactive pedagogies.

Liu et al. (2024) emphasise that interactive learning requires professional development for tutors; teachers need targeted training and competence in applying diverse strategies. Furthermore, this study

indicates that learners of different ages actively participate and demonstrate strong cognitive engagement when supported by appropriate pedagogical approaches. The OECD (2021) highlights the need for assessment frameworks to adapt, ensuring evaluations align with varying capabilities through peer assessment and reflective portfolios. Digital technologies were employed to enhance creative exploration, facilitate interventions, and support teamwork. According to Marrone et al. (2025), real-time brainstorming across geographical regions was enabled by multiple platforms, including Google Docs, reflecting a connectivist perspective. UNESCO (2022) reported that increased access to digital tools and interactive platforms allowed learners to visualise levels of creativity and contribute to shared knowledge. However, field surveys also identified differences in digital literacy and disparities in data access. The global scope of the present study enhances engagement and improves generalisability, but several limitations should be noted. The quasi-experimental design was not fully randomised, and short-term interventions may not capture long-term retention effects. Non-native speakers may be disadvantaged if assessments rely exclusively on English-language tests. Future research should employ longitudinal follow-ups and culturally sensitive instruments. Moreover, although high-ranking journals provide valuable information, self-reported measures remain a potential source of bias.

Conclusions

The present research study provides valid evidence that interactive pedagogies significantly enhance learners' levels of critical thinking as well as creativity across a wide range of national and international educational contexts. Learners demonstrated both qualitative and quantifiable improvements in standardised assessments and revealed clear metacognitive and creative engagement in qualitative reflections through joint inquiry-based learning, group discussion, and reflective practice. The results indicate that interactive pedagogy can transform classroom cultures from passive knowledge reception to active knowledge construction. In addition to cognitive skills, learners also developed persistence, curiosity, and open-mindedness, which are essential qualities for success in everyday situations characterised by rapid change and increasing complexity.

The findings of the present study have substantial policy implications. International organisations and ministries of higher education should allocate funding for tutor professional development that prioritises technology-mediated collaboration and higher-order thinking skills. Training modules that enable pre-service tutors to practise interactive instructional design, peer feedback, and formative evaluation should be systematically integrated into tutor education programmes. To recognise creativity and critical thinking as measurable learning outcomes, educational systems must update their curricula and assessment frameworks. More authentic learning indicators can be achieved by combining project-based rubrics, digital portfolios, and performance-based assessment methods. Furthermore, educational institutions should establish professional learning communities in which educators collaboratively evaluate student work, exchange pedagogical strategies, and adapt interactive approaches to their specific contexts.

The study also underscores the global applicability of interactive pedagogy. Active, student-centred approaches were positively received by learners across all five continents, despite variations in culture and infrastructure. This suggests that curiosity, social interaction, and creative expression represent universal human motivations. Nevertheless, contextual adaptation remains essential, as effective implementation depends on available technological resources, class size, and cultural sensitivity.

Suggestions for future research

Future research should examine teacher belief systems, employ longitudinal designs to evaluate sustainability, and explore discipline-specific applications of interactive pedagogy, such as STEM and humanities contexts. Comparative research on hybrid online and offline approaches would enhance

understanding of the post-pandemic educational environment. In addition, future studies should link interactive learning outcomes to resilience, emotional intelligence, and well-being, which are increasingly recognised as essential components of holistic education (OECD, 2021). Longitudinal and cross-linguistic research is also required, as indicated by the limitations of the present study, including its quasi-experimental design, reliance on English-language assessments, and relatively short duration. Further investigation is needed to determine how interactive pedagogy influences other twenty-first-century competencies, including ethical reasoning, teamwork, and resilience. Overall, this study contributes to the growing global body of evidence demonstrating that interactive, constructivist learning environments foster the creative and intellectual capacities required for sustainable development. Education can effectively prepare global citizens capable of shaping a fair, innovative, and inclusive future when educators, learners, and policy makers adopt interactivity as a guiding educational principle rather than a transient trend.

Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki (2013). As the research involved routine educational practices with minimal risk and anonymised data, formal IRB approval was not required under institutional regulations. However, comprehensive ethical safeguards were implemented. Institutional permissions were obtained from all participating schools. Written parental consent and child assent were obtained for all 220 participants after full explanation of study aims, procedures, and rights to withdraw. The research was guided by principles of autonomy, beneficence, and justice. No conflicts of interest existed, and no compensation was provided to participants.

Data availability statement

The datasets are not publicly available due to ethical restrictions protecting participant confidentiality. However, aggregated anonymised datasets are available from the corresponding author upon reasonable request, subject to appropriate ethical approval. All summary statistics are reported in this article.

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Conflict of interest

The author declares no competing financial interests or personal relationships that could have influenced this work.

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