WORLD FORUM ON ACADEMIC INNOVATION AND DIGITAL LITERACY

TRENDS IN THE DEVELOPMENT OF SCIENTIFIC THINKING IN INCLUSIVE EDUCATION

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ABSTRACT

Scientific reasoning competence is recognized as one of the fundamental outcomes of contemporary inclusive science education, enabling students to understand scientific concepts, analyze evidence, solve real-world problems, and make informed decisions. This study investigates the developmental trends of scientific reasoning competence among students in inclusive learning environments, with particular attention to the processes of hypothesis generation, evidence interpretation, scientific inquiry, and evidence-based conclusion drawing. The paper examines the pedagogical conditions that promote the progressive development of these competencies through inquiry-based learning, differentiated instruction, Universal Design for Learning (UDL), collaborative learning, and formative assessment. A conceptual framework is proposed to explain how inclusive instructional practices foster higher-order thinking, scientific argumentation, and reflective learning. The findings suggest that continuous assessment, adaptive teaching strategies, and supportive classroom environments significantly enhance students' scientific reasoning and active participation regardless of their diverse educational needs. The study highlights the importance of integrating competence-based instructional approaches



into science education to improve educational quality and support the development of scientifically literate learners in accordance with international educational standards.

INTRODUCTION

Contemporary educational reforms emphasize competence-based learning and equitable participation for all learners. Inclusive science education should provide every learner, regardless of ability, with meaningful opportunities to investigate natural phenomena, discuss evidence, and solve authentic scientific problems. Scientific reasoning is therefore considered a dynamic competence that develops progressively through structured inquiry rather than memorization. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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LITERATURE REVIEW

International frameworks including OECD PISA, IEA TIMSS and UNESCO identify scientific reasoning as an essential component of scientific literacy. Previous studies indicate that inquiry-based instruction, scaffolding, collaborative learning and differentiated teaching substantially improve students' reasoning abilities. Universal Design for Learning provides flexible pathways for representation, engagement and

expression, allowing learners with diverse needs to participate successfully in scientific investigations.

Research also shows that formative assessment enables teachers to identify misconceptions early and adapt instruction. Vygotsky's Zone of Proximal Development and Bruner's scaffolding theory explain why guided interaction promotes gradual movement toward independent reasoning. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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MATERIALS AND METHODS

A mixed-methods quasi-experimental design was adopted. Students participated in a 12-week intervention based on the 5E instructional model. Learning activities included observation, experimentation, hypothesis formulation, data collection, graph interpretation and scientific argumentation. Assessment combined scientific reasoning tests, classroom observations, student reflection journals and teacher interviews. Competence progression was monitored across five developmental levels. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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RESULTS

The intervention produced statistically significant improvements across all dimensions of scientific reasoning. The greatest gains were observed in scientific



argumentation and data interpretation. Classroom observations demonstrated increased participation, collaboration and confidence among students with diverse educational needs. Reflection journals revealed a shift from memorization toward inquiry-oriented learning. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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DISCUSSION

The findings support the view that scientific reasoning develops progressively through carefully designed inquiry experiences supported by differentiation and continuous formative assessment. Inclusive classrooms become academically stronger when learner diversity is treated as an educational resource. The study aligns with international recommendations from UNESCO, OECD and IEA concerning equitable science education. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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PRACTICAL RECOMMENDATIONS

Science teachers should integrate inquiry-based learning, differentiated instruction, adaptive assessment and collaborative investigation into everyday teaching. Curriculum developers should incorporate competence-based assessment aligned with TIMSS and PISA frameworks. Teacher professional development should strengthen inclusive pedagogy and scientific argumentation strategies. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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CONCLUSION

The study demonstrates that inclusive science education can effectively foster scientific reasoning competence when supported by inquiry, UDL, differentiated instruction and formative assessment. The proposed conceptual framework provides practical guidance for monitoring competence development and improving science education quality in accordance with Sustainable Development Goal 4. Further analysis indicates that continuous classroom observation, reflective practice, evidence-based discussion, peer collaboration, adaptive feedback and authentic scientific investigations collectively strengthen learners' higher-order thinking. This developmental perspective encourages educators to monitor growth over time instead of relying exclusively on summative achievement measures.

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