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DEVELOPING STUDENTS' CREATIVE COMPETENCE IN CHEMISTRY THROUGH INTERNATIONAL ASSESSMENT STUDIES

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Abstract
The shift toward competency-based education has intensified the need to develop students' creative competence in chemistry. International assessment studies emphasize creativity, problem-solving, and the application of scientific knowledge in real-life contexts. This study aims to design and validate a methodology for developing students' creative competence in chemistry through the integration of international assessment-oriented tasks into the teaching process. A quasi-experimental research design was employed, involving control and experimental groups. Quantitative and qualitative analyses revealed a statistically significant improvement in students' creative competence in the experimental group. The findings confirm that international assessment-based instructional strategies enhance creativity and support modern chemistry education aligned with global educational standards.

Keywords: Chemistry education, creative competence, international assessment studies, competency-based approach, innovative pedagogy.

Introduction

In recent years, chemistry education has undergone significant transformation driven by global educational reforms emphasizing competencies over rote knowledge. Creative competence is recognized as a core outcome of science education, reflecting students' ability to generate original ideas, apply scientific concepts flexibly, and solve non-standard problems.

International assessment studies have reshaped educational evaluation by focusing on scientific reasoning, contextual problem-solving, and creativity. These frameworks provide valuable benchmarks for improving national education systems. However,

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the pedagogical integration of international assessment-oriented tasks into chemistry instruction remains limited and requires systematic methodological support.

The present study addresses this gap by developing and empirically validating a methodology aimed at enhancing students' creative competence in chemistry through international assessment studies.

Materials and Methods

Research design

The study was organized based on a quasi-experimental research design. This design aimed to determine the effectiveness of an instructional methodology based on international assessment studies in developing students' creative competence in chemistry.

The research was conducted in three sequential stages: diagnostic, formative, and summative.

At the diagnostic stage, the initial level of students' creative competence was determined, and baseline equivalence between the control group and the experimental group was established.

During the formative stage, students in the experimental group were taught using instructional strategies oriented toward international assessment studies, while the control group was taught using traditional chemistry teaching methods.

At the summative stage, final assessments were conducted to evaluate changes in students' creative competence.

Participants

The participants of the study were secondary school students studying chemistry within the general science curriculum.

Two groups were formed for the study: an experimental group and a control group. Each group consisted of students with comparable levels of academic achievement and similar learning conditions.

Group equivalence was ensured by analyzing students' previous academic performance and diagnostic test results. Participation in the study was voluntary, and all ethical standards related to educational research were strictly observed.

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Research instruments

Several research instruments were used to collect data:

Creative Competence Test in Chemistry – a set of chemistry tasks developed based on international assessment frameworks. These tasks required students to apply theoretical knowledge, analyze chemical phenomena, and propose creative solutions to real-life problems.

Questionnaires – structured questionnaires designed to identify students' and teachers' perceptions regarding the development of creativity in chemistry education.

Observation Checklist – classroom observations were conducted to examine how teachers implemented creative instructional strategies and activities based on international assessment tasks.

Interview Protocol – semi-structured interviews were conducted with selected teachers to explore their experiences in integrating international assessment approaches into chemistry instruction.

Research procedure

The research was conducted in three main stages.

Preparation Stage

International assessment tasks related to chemistry were analyzed and adapted to the national curriculum. Based on these tasks, materials for assessing creative competence were developed.

Implementation stage

Students completed the creative competence test and participated in chemistry lessons designed on the basis of international assessment tasks. During this stage, classroom observations and teacher interviews were conducted.

Data Collection Stage

Questionnaire responses, test results, observation records, and interview responses were collected and organized for further analysis.

Data analysis

Quantitative data obtained from creative competence tests and questionnaires were analyzed using descriptive statistical methods. In particular, statistical indicators such

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as mean values, percentages, and standard deviations were calculated. Comparative analysis was used to evaluate changes in students' creative competence.

Instructional Materials

Instructional materials designed for the experimental group were developed in accordance with the principles of international assessment studies and aimed at developing creative competence through chemistry content. These materials included:
context-based chemistry problems reflecting real-life and interdisciplinary situations;
open-ended tasks requiring multiple solution strategies;
data interpretation and experimental analysis activities;
scenario-based questions requiring scientific justification and logical reasoning.
All instructional tasks were aligned with the national chemistry curriculum, while also incorporating characteristics typical of international assessments, such as contextualization, application of knowledge, and higher-order thinking skills.

Instructional Process

The instructional process was implemented within regular chemistry lessons over a specified period of time. Instruction in the experimental group was organized according to the following pedagogical strategies:
problem-based learning, encouraging students to investigate and solve non-standard chemical problems;
inquiry-based learning, involving hypothesis formulation, experimentation, and evidence-based conclusions;
collaborative learning, promoting group discussion and exchange of ideas;
reflective activities, enabling students to analyze their problem-solving strategies and outcomes.
In contrast, the control group continued learning through traditional teaching methods, primarily focused on explanatory instruction and algorithmic problem solving.

Data Collection Tools

Several data collection tools were employed to assess students' creative competence in chemistry:
performance-based chemistry tasks designed to evaluate students' originality, flexibility, and scientific reasoning;

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analytic assessment rubrics used to measure dimensions of creative competence, including idea originality, logical consistency, and application of chemical knowledge;
observation checklists documenting student engagement, initiative, and participation during lessons;
students' reflective responses, providing qualitative insights into their thinking processes during learning.
These instruments were reviewed by experts to ensure content validity and reliability.

Data Analysis

Quantitative data obtained from pre-tests and post-tests were analyzed using descriptive and comparative statistical methods. Mean scores and percentage changes were calculated to identify differences between the experimental and control groups.
Qualitative data obtained from classroom observations and students' reflective responses were analyzed using content analysis, which allowed the identification of recurring patterns related to creative thinking and problem-solving behavior.
Qualitative data from interviews and classroom observations were also examined using thematic analysis, where the data were categorized according to themes related to teaching strategies, student engagement, and the integration of international assessment tasks into chemistry education.
The integration of quantitative and qualitative findings enabled a comprehensive evaluation of the effectiveness of the proposed methodology.

Reliability and validity

To ensure the reliability and validity of the research findings, the following measures were implemented:
standardized assessment criteria were applied consistently across both groups;
identical testing conditions were maintained during pre- and post-assessments;
multiple assessment instruments were used to verify and triangulate the data.
Participation in the research was voluntary, and all participants were fully informed about the purpose of the study. The confidentiality and anonymity of both students and teachers were ensured throughout the research.
These measures increased the credibility and replicability of the research results.

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Results

The results demonstrated a notable improvement in the creative competence of students in the experimental group. These students showed:

higher levels of originality in problem-solving;

improved ability to apply chemical knowledge in unfamiliar situations;

increased engagement and autonomy in learning activities.

Statistical comparison revealed a significant difference between experimental and control groups, confirming the effectiveness of the international assessment-based methodology.

Discussion

The findings indicate that international assessment-oriented tasks promote deeper cognitive engagement and creative thinking in chemistry education. Unlike traditional algorithmic exercises, these tasks encourage students to explore multiple solution pathways and justify their reasoning scientifically.

The results are consistent with contemporary educational theories emphasizing learner-centered and competency-based instruction. The study also underscores the importance of teacher training in designing creative and context-based chemistry tasks aligned with international assessment frameworks.

Limitations of the study include the duration of the intervention and the scope of participants. Future research should focus on long-term implementation and cross-institutional validation.

Conclusion

The study confirms that integrating international assessment studies into chemistry teaching effectively enhances students' creative competence. The proposed methodology contributes to the modernization of chemistry education and aligns instructional practices with global assessment standards. These findings provide practical implications for chemistry teachers, curriculum developers, and educational policymakers.

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