ISEJ Indonesian Science Education Journal

ISSN Online: 2716-3350
Vol. 4 No. 1 January 2025 Pages 19-27
https://siducat.org/index.php/isej/
Published by Yayasan Darussalam Bengkulu

Development of Assessment to Measure Creative Thinking Skills of Junior High School Students on the Topic of Chemicals in Daily Life

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Abstract
This study aims to develop an assessment instrument to measure junior high school students' creative thinking skills in learning about chemical materials in daily life. The research employed the Borg and Gall research and development (R&D) model, adapted into eight stages: needs analysis, data collection, product design, expert validation, design revision, small-scale trial, product revision, and implementation trial. The study was limited to the small-scale trial phase. Validation instruments consisted of questionnaires administered to experts in assessment, subject matter, and language, as well as to one science teacher and 10 seventh-grade students. Data were analyzed using descriptive statistics by calculating the percentage of achievement in each component. Results indicated high validity: 87.69% (assessment expert), 95.5% (language expert), and 82% (material expert), categorized as "very feasible." Student responses also showed high acceptance, ranging from 72% to 90% across components. These findings confirm that the developed assessment instrument is valid and feasible to be used as a learning tool in science education, with potential to enhance creative thinking in junior high school students.
Keywords: **Assessment; Chemicals in Daily Life; Creative Thinking; Science Education**

INTRODUCTION

Education constitutes one of the most critical pillars for sustaining national development and shaping individuals who are intellectually capable, socially responsible, and morally grounded. In the Indonesian context, education is not merely viewed as the transmission of knowledge but also as a deliberate investment in human capital that can foster holistic growth encompassing cognitive, affective, psychomotor, and spiritual dimensions (Ningsih et al., 2022; Noor Kamila, 2022; Rahmayani et al., 2024; Rothomi, 2023). Global frameworks such as OECD (2018), UNESCO (2021) and World Bank (2018) have similarly emphasized that education must go beyond rote memorization to cultivate higher-order skills, adaptability, and creativity, which are indispensable for participation in the 21st-century knowledge economy. Education in the current era is thus increasingly framed as an enabler of transformation, equipping learners with the dispositions and competencies required to solve complex, real-world problems.

The 21st century is characterized by rapid technological advancement, digital connectivity, and global interdependence, all of which redefine the competencies students must acquire. Scholars widely agree that 21st-century skills can be grouped into three domains: (a) life and career skills, including adaptability, initiative, and responsibility; (b) learning and innovation skills, such as problem-solving, communication, collaboration, and creative thinking; and (c) information, media, and technology skills, including digital and information literacy (Bauwens et al., 2020; Martin, 2018). Within this framework, creative thinking emerges as one of the most vital capacities, allowing learners to generate novel solutions, connect disparate ideas, and approach problems from multiple perspectives. Empirical evidence confirms that students equipped with creative thinking skills perform better in academic tasks, demonstrate resilience in unfamiliar contexts, and show higher levels of engagement (Almulla, 2023; Ayasrah et al., 2023; Karunarathne & Calma, 2024).

Creative thinking has long been recognized as a cognitive dimension of creativity and is defined

as the ability to generate ideas or products that are both novel and useful (Beghetto & Kaufman, 2014; Corazza, 2016; Sternberg, 2018). Alabbasi et al., (2022) and Almeida et al., (2008) operationalized this construct into four widely adopted indicators: fluency, flexibility, originality, and elaboration. These indicators remain the foundation for assessing students' creative abilities across disciplines, particularly in science education, where learners are encouraged to pose questions, design investigations, and interpret phenomena critically (Almeida et al., 2008; Dufva & Dufva, 2016; Karunarathne & Calma, 2024). In practical terms, creative thinking enables students to formulate new hypotheses, reframe problems in innovative ways, and integrate prior knowledge into novel contexts. Research in diverse settings has consistently shown that fostering creative thinking enhances problem-solving skills, strengthens conceptual understanding, and increases motivation in science classrooms (Kind & Kind, 2007; Pinar et al., 2025; Rothomi, 2023).

Despite its recognized importance, the integration of creative thinking into science learning and assessment remains challenging, particularly in Indonesia. Observations in junior high schools, including SMPN 7 Seluma, indicate that the assessments predominantly used by teachers focus on recall-based items that do not capture students' ability to think creatively or apply knowledge to real-life problems. Similar issues have been reported across Indonesian schools, where traditional evaluation practices often emphasize factual knowledge while neglecting higher-order thinking skills (Dahlan et al., 2020; Dwi Utami et al., 2019; Zana et al., 2024). Consequently, students may struggle to transfer abstract scientific concepts into practical applications, limiting their readiness for future learning and careers. This gap underscores the need for assessments that authentically measure creative thinking and provide meaningful feedback to both teachers and students.

Science education offers a particularly strategic platform for cultivating creativity. Topics such as "Chemicals in Daily Life" are inherently relevant to students' experiences, as they bridge textbook concepts with everyday practices, such as the use of cleaning agents, preservatives, or fuels. When assessments are contextualized within daily life, they not only enhance understanding but also stimulate curiosity and critical reflection on the role of science in society (Rizki et al., 2022; Wijaya et al., 2018). Moreover, project-based and performance-based assessments have been shown to provide rich opportunities for learners to demonstrate creative problem-solving, communication, and collaboration (Mallari & Tayag, 2022). These approaches align with global calls for authentic and competency-based assessment that captures what students can do, rather than merely what they can recall.

Several studies in Indonesia have attempted to design creative-thinking-oriented instruments in science, yet most have concentrated on physics or mathematics topics (Ernawati et al., 2019; Salirawati et al., 2024; Wahyuni & Irwandani, 2024). While valuable, these efforts have not adequately addressed the chemical concepts embedded in students' everyday contexts, which arguably provide more tangible and relatable entry points for fostering creativity. In addition, many prior instruments have not undergone systematic validation involving assessment experts, subject matter specialists, and language experts, raising concerns about their reliability and classroom applicability (Ad'hiya & Laksono, 2018; Mulyono et al., 2023). Furthermore, large-scale psychometric testing, such as Rasch modeling or item analysis, is rarely employed in local studies, limiting the generalizability of findings.

Against this backdrop, the present study seeks to address these limitations by developing and validating an assessment instrument specifically designed to measure junior high school students' creative thinking skills in the topic of "Chemicals in Daily Life." Unlike previous studies, this research adopts the Borg and Gall research and development model, integrates expert validation from multiple domains, and conducts empirical trials with students. The novelty of this study lies in its focus on contextualized chemistry learning, systematic validation procedures, and the explicit alignment of assessment items with Torrance's four indicators of creative thinking. The ultimate goal is to produce a feasible, valid, and practical instrument that can support teachers in fostering 21st-century competencies while enhancing the authenticity of science learning in Indonesian classrooms.

METHODS

This study employed a research and development (R&D) approach, adapted from the Borg and Gall model, which is widely applied in educational innovation research to design, validate, and refine instructional products systematically. The model was selected because it emphasizes iterative testing and expert validation, ensuring that the resulting product is both theoretically sound and practically applicable in classroom settings. Although the full Borg and Gall framework consists of ten stages, the present research was conducted up to the small-scale trial stage, which is considered sufficient for establishing initial feasibility. The stages included needs analysis, data collection, product design, expert validation, design revision, small-scale trial, and final product refinement.

The study was conducted at SMPN 7 Seluma, Bengkulu Province, Indonesia, with participants comprising three university lecturers who served as expert validators (one assessment expert, one material expert, and one linguist), one science teacher, and ten seventh-grade students. The experts were selected purposively based on their academic background and professional experience in assessment development, subject matter content, and linguistic clarity. The science teacher was involved to evaluate the instrument's classroom relevance, while the students participated in the small-scale trial to provide empirical evidence on usability and acceptance. This multi-perspective design aligns with best practices in assessment development, ensuring both content validity and contextual appropriateness.

The instrument developed in this study was an assessment tool designed to measure creative thinking skills in science learning, specifically on the topic "Chemicals in Daily Life." The assessment items were constructed to align with Torrance's four indicators of creative thinking: fluency, flexibility, originality, and elaboration. Items included open-ended questions and problem-solving tasks contextualized in daily chemical applications, such as the use of cleaning agents, preservatives, or combustion processes, thereby promoting authentic assessment of students' higher-order thinking skills. To evaluate the quality of the instrument, expert validators assessed its content accuracy, language clarity, and structural feasibility using a Likert-scale validation sheet ranging from 1 (very poor) to 5 (excellent).

Data were collected using expert validation sheets, teacher evaluations, and student response questionnaires. The validity of the instrument was analyzed descriptively by calculating the percentage of achievement for each criterion using the formula:

$$P = \frac{m}{N} \times 100\%$$

where P represents the percentage score, m the total score obtained, and N the maximum possible score. The results were interpreted based on established feasibility criteria: ≥ 81% (very feasible), 61–80% (feasible), 41–60% (moderately feasible), 21–40% (less feasible), and ≤ 20% (not feasible). This approach allowed for rigorous examination of both expert judgments and student responses.

The small-scale trial was conducted with 10 students, who completed the instrument and subsequently responded to a questionnaire assessing clarity, interest, and relevance of the items. Their responses were analyzed using percentage scores to identify strengths and weaknesses of the assessment product. In addition, feedback from the science teacher was integrated to refine the practicality and classroom alignment of the instrument. The triangulation of expert, teacher, and student perspectives enhanced the reliability and ecological validity of the findings.

The stages of the research and development process are summarized in Table 1, which illustrates the sequence of activities, participants involved, and outputs generated at each stage.

Table 1. Research and Development Stages of the Assessment Instrument

Stage	Activities Performed	Participants Involved	Output Produced
Needs Analysis	Identification of problems through interviews with teachers and students	Science teacher, students	Problem formulation
Data Collection	Review of curriculum, literature, and classroom practices	Research team	Database of references and item specifications
Product Design	Development of draft assessment instrument aligned with creative thinking indicators	Research team	Prototype instrument

Stage	Activities Performed	Participants Involved	Output Produced
Expert Validation	Evaluation of content, language, and structure	Assessment expert, material expert, linguist	Validity scores and feedback
Design Revision	Refinement of items based on expert feedback	Research team	Revised instrument
Small-Scale Trial	Implementation with 10 seventh-grade students	Students	Empirical usability data
Final Product	Integration of feedback and finalization of assessment tool	Research team	Feasible assessment instrument

This methodological design ensured that the developed instrument underwent systematic validation and refinement, integrating theoretical grounding with empirical evidence. By combining expert evaluations, teacher perspectives, and student responses, the study generated an assessment product with strong potential to measure creative thinking reliably and to be applied effectively in science learning contexts.

RESULTS AND DISCUSSION

Expert Validation Result

The validation process by three experts confirmed the high feasibility of the developed creative thinking assessment instrument. The assessment expert rated it at 87.69%, the language expert at 95.5%, and the material expert at 82%. Collectively, these results demonstrate that the instrument achieved "very feasible" status in terms of conceptual soundness, clarity, and curricular alignment. Figure 1 presents a comparison of validation results from experts, the science teacher, and aggregated student responses. It shows that expert evaluations consistently exceeded 80%, whereas teacher evaluation was slightly lower at 72%, indicating the need for practical refinements.

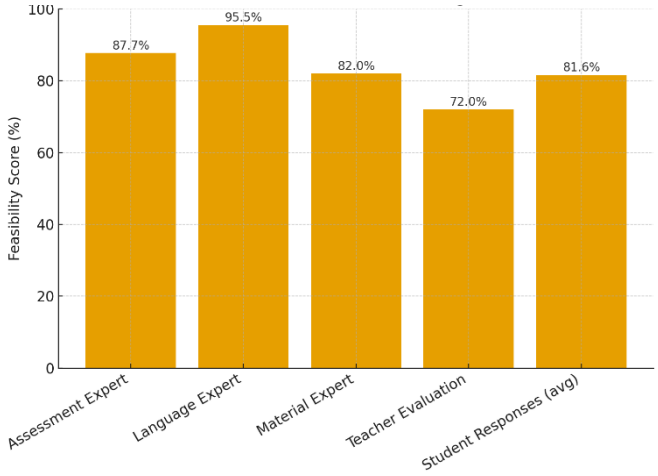

Figure 1. Validation Results by Experts, Teacher, and Students (average)

These findings are in line with previous studies demonstrating that expert validation is an indispensable step in ensuring assessment quality. Rahyu Setiani et al., (2024) emphasized that multi-expert validation increases the robustness of assessment tools in science learning. Similarly, Mulyono et al., (2023) argued that linguistic precision and contextual relevance are critical for ensuring accessibility to junior high school students. The results here confirm these claims, while also showing that integrating assessment, content, and language perspectives produces a more comprehensive validation process.

Teacher Evaluation

The science teacher's evaluation, which resulted in a feasibility rating of 72%, revealed that the instrument is generally aligned with curriculum objectives but requires refinement in several key areas. Specific concerns were raised regarding the clarity of instructions, explicitness of scoring rubrics, and contextual adaptation of items to student realities. These insights are valuable because

they emphasize the role of teacher feedback in bridging theoretical validation with classroom applicability. In practical terms, teacher input ensures that the instrument is not only valid in design but also user-friendly, manageable within the constraints of classroom time, and motivational for learners.

Table 2. Summary of Teacher Feedback and Revisions

Aspect Evaluated	Before Revision	Suggested Revision/Improvement	Expected Impact in Classroom
Clarity of Instructions	Instructions were perceived as too abstract and lengthy.	Simplify language, provide step-by-step directions, and use student-friendly terms.	Enhances student comprehension and reduces misinterpretation.
Scoring Rubrics	Rubrics lacked detailed performance descriptors and differentiation of levels.	Add clear, criterion-based rubrics with explicit performance indicators for each score range.	Increases transparency, fairness, and consistency in evaluation.
Contextual Relevance	Some items were considered insufficiently connected to daily student experiences.	Redesign items to include familiar examples (e.g., food preservatives, detergents, fuels).	Boosts engagement and facilitates transfer of abstract concepts.
Time Efficiency	Several tasks were too time-consuming for classroom conditions.	Adjust task length and complexity to fit within one learning session.	Ensures feasibility of implementation without overburdening lessons.

These revisions are consistent with prior findings that teacher involvement enhances ecological validity and practicality of instruments (Marphatia & Edge, 2015). Moreover, integrating teacher suggestions not only improves instrument usability but also increases teacher ownership and likelihood of adoption, as confirmed by studies on participatory approaches to assessment development (Areljung et al., 2021).

Student Responses

The small-scale trial involving 10 seventh-grade students yielded highly encouraging results, with response scores ranging between 72% and 90% across ten measured components. Students consistently rated the instrument positively in terms of clarity, engagement, and contextual relevance, confirming its accessibility and perceived usefulness in supporting their learning. The highest scores were obtained in dimensions such as *usefulness*, *motivation*, and *applicability to daily life*, suggesting that the instrument not only served as a tool for evaluation but also as a meaningful learning aid. By embedding assessment tasks within contexts familiar to students such as cleaning products, food preservation, and combustion processes the instrument succeeded in bridging abstract chemical principles with daily experiences, thereby enhancing both cognitive and affective engagement.

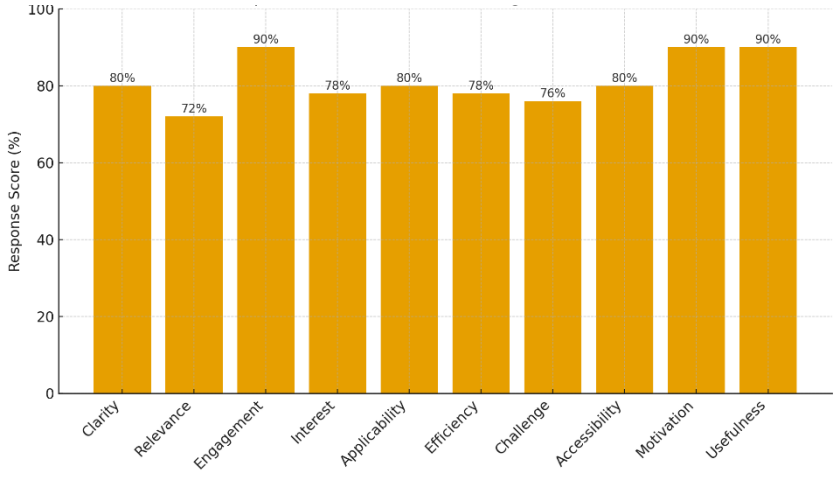

Figure 2. Student Responses Across Assessment Dimensions

These findings reinforce the argument that contextualized and authentic assessment practices foster deeper student involvement in science learning. Rahyu Setiani et al., (2024) demonstrated that

problem-based assessments improved both creativity and conceptual mastery, particularly when tasks were situated within realistic scenarios. Luzyawati et al., (2023) similarly reported that embedding scientific literacy in everyday contexts stimulated students' motivation and facilitated comprehension. Our results extend these observations to the chemistry domain, where connecting learning materials to household and environmental phenomena has demonstrably increased students' willingness to engage with complex concepts.

Furthermore, the strong student responses align with theoretical perspectives on meaningful learning, which emphasize that students construct knowledge more effectively when new information is anchored to prior experiences (Nainggolan et al., 2021). The positive reception of this assessment tool suggests that contextual authenticity not only motivates learners but also enhances the transferability of abstract concepts to real-life applications. This is particularly important in chemistry education, which is often criticized for being overly abstract and disconnected from students' realities.

Comparatively, studies by Rahayuningsih et al., (2023) have shown that inquiry-based approaches combined with authentic tasks significantly improve students' creative thinking skills. The present findings corroborate these results while also demonstrating that well-designed assessments can function as both evaluative and instructional tools, actively stimulating higher-order thinking processes. This dual function underscores the pedagogical value of formative assessments that go beyond measurement to also enhance learning.

Taken together, the student response data reveal not only high levels of acceptance but also provide empirical evidence that creativity-oriented assessments contextualized in everyday chemistry can increase students' motivation, relevance perception, and engagement. These outcomes imply that such instruments hold strong potential for addressing persistent challenges in Indonesian science education, such as low student interest and difficulties in applying abstract concepts to real-world problems. By leveraging students' lived experiences, assessments of this nature can transform evaluation from a summative judgment into a formative, motivating, and empowering learning experience.

The comparative findings of this study reinforce and extend existing evidence on the role of inquiry-based and contextual learning in fostering creative thinking. While earlier research has demonstrated the effectiveness of guided inquiry, discovery learning, and problem-based strategies across mathematics, biology, and physics (Ad'hiya & Laksono, 2018; Areljung et al., 2021; Nainggolan et al., 2021; Rahayuningsih et al., 2023; Rahyu Setiani et al., 2024), the present study contributes by introducing a validated instrument specifically contextualized to chemistry in daily life. By embedding Torrance's creative thinking indicators fluency, flexibility, originality, and elaboration into tasks grounded in authentic, real-world experiences, the instrument bridges the gap between abstract science content and students' everyday realities. This not only affirms the broader pedagogical value of contextualization but also demonstrates that creativity can be meaningfully assessed within chemistry education, an area often perceived as overly abstract and disconnected from daily experience.

Overall, the results confirm that the developed assessment instrument is valid, feasible, and positively received by experts, teachers, and students alike. Its design integrates conceptual soundness with practical usability, thereby addressing both academic rigor and classroom relevance. In doing so, the study situates itself at the intersection of theory, practice, and policy, offering an empirically grounded approach to measuring creative thinking in Indonesian junior high schools. These outcomes provide a strong foundation for scaling creativity-oriented assessments into broader science curricula, ensuring that evaluation practices do not merely measure knowledge acquisition but also foster higher-order thinking and engagement consistent with 21st-century educational demands.

Novelty and Implications

The novelty of this research lies in three main aspects. First, it focuses specifically on the topic "Chemicals in Daily Life," which is rarely addressed in prior Indonesian assessment development studies. This focus enhances both curricular alignment and contextual relevance, making the instrument more authentic for students. Second, the study employed a triangulated validation process—combining expert, teacher, and student feedback thus producing an instrument that is both academically rigorous and practically applicable. Third, the instrument was explicitly designed around Torrance's four creative thinking indicators (fluency, flexibility, originality, elaboration), ensuring

alignment with international standards for creativity assessment.

The implications of this research are significant. For educators, the instrument provides a ready-to-use tool to measure and foster creative thinking in science classrooms, thereby complementing traditional knowledge-based assessments. For policymakers, the findings demonstrate the feasibility of integrating 21st-century competencies into assessment practices, aligning with global educational reform agendas (OECD, 2018; UNESCO, 2021; World Bank, 2018). For researchers, the study offers a framework for further development of contextualized assessments across other science domains.

Limitations

This study has several limitations. The small-scale trial was restricted to 10 students, limiting the generalizability of results. The research did not extend to a large-scale implementation phase, preventing psychometric analyses such as Rasch modeling or item response theory from being applied. Additionally, while the instrument was validated by experts and a teacher, broader validation across diverse school contexts would strengthen external validity. Future research should therefore focus on large-scale trials, advanced psychometric testing, and cross-institutional validation to establish stronger generalizability and reliability.

CONCLUSION

The present study confirmed the successful development and validation of an assessment instrument designed to measure junior high school students' creative thinking skills in the context of "Chemicals in Daily Life." Validation from experts yielded very high feasibility ratings, teacher evaluation categorized the instrument as feasible, and student responses indicated strong acceptance across clarity, motivation, and contextual relevance. These results establish the instrument's academic validity and practical applicability, highlighting its novelty in contextualizing chemistry-based learning through Torrance's creative thinking indicators and in employing a triangulated validation process that integrated expert, teacher, and student perspectives. The findings imply that the instrument can serve as an effective tool for embedding 21st-century competencies into science education, offering practical benefits for teachers, valuable insights for policymakers, and a foundation for further scholarly inquiry. However, the small-scale trial and limited psychometric testing constrain the generalizability of results, underscoring the need for future studies to conduct large-scale implementation and advanced statistical analyses to strengthen reliability and broaden applicability across diverse educational contexts.

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