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Creative Thinking Skills of Biology Education Students in a Gender Perspective

Anita Rosiyanti* and Nur Endah Susilowati

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Abstract

Creative thinking represents a crucial twenty-first-century skill that enables learners to generate original ideas, explore diverse perspectives, and develop innovative solutions to problems. This study aims to analyze the creative thinking skills of biology education students at UIN Raden Intan Lampung through a gender perspective. Using a descriptive qualitative design, the research involved a population of 87 students, with a purposive sample of male and female students from the 2021 cohort. Data were collected through an essay-based creative-thinking test adapted from validated instruments covering four indicators: fluency, flexibility, originality, and elaboration. The findings show that female students demonstrated higher mean scores in fluency (58%) and elaboration (49%), while male students scored higher in flexibility (52%) and originality (46%). Overall, students' creative thinking skills fell into the "moderately creative" category across all indicators. The results highlight the importance of gender-responsive strategies in science education that nurture creativity, inclusivity, and equal opportunity in academic settings. The implication of this study suggests that biology educators should design learning environments that provide balanced opportunities for both genders to express, explore, and refine their creative potential in the context of higher education.

Keywords: Biology Education; Creative Thinking; Gender Perspective; Higher Education; and Inclusive Pedagogy.

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INTRODUCTION

Creative thinking is recognized as a core competence for twenty-first-century learners, essential for preparing students to face complex, dynamic, and uncertain global challenges [1], [2], [3]. Education for the twenty-first century demands more than mere retention of facts it must cultivate creativity, critical thinking, and equitable engagement among learners of all genders. Creative thinking, defined as the ability to generate novel and useful ideas, has been increasingly recognized as a core competence in global educational frameworks [4], [5], [6].

In science and biology education, creativity enables students to pose hypotheses, design experiments, and interpret data in innovative ways, which is essential for advancing both individual learning and scientific literacy [7], [8], [9]. However, research has documented persistent gender related differences in classroom participation, confidence, and opportunities to contribute to inquiry based tasks, which can influence how creative potential is expressed and nurtured [10], [11], [12]. For example, studies in active-learning biology courses reveal that female students often participate less frequently than their male peers, even when content mastery is similar [13]. Similarly, in physics classrooms, gendered patterns in self-efficacy and willingness to take intellectual risks have been observed, constraining female students' engagement in conceptually challenging tasks [14]. Moreover, large scale assessment data from international testing have shown that female students in many countries outperform male peers on creative thinking tasks, although such patterns are moderated by sociocultural, instructional, and classroom conditions [15], [16].

The theoretical foundation for this study integrates constructivist learning theory with gender-inclusive pedagogy. Constructivist approaches argue that learners build knowledge when actively engaging with problems, exploring multiple representations, and reflecting on their thinking [17], [18], [19]. From a gender lens, inclusive pedagogy emphasizes that instructional design and classroom culture should intentionally provide equitable access to cognitive challenge and expressive opportunity regardless of gender [20], [21]. Prior research has shown that creative thinking is influenced not only by intellectual ability but also by learning environment, teacher expectations, and social dynamics within the classroom [22], [23], [24]. In design education, investigations of gender bias using divergent thinking measures (e.g., fluency, originality, elaboration) have revealed that even seemingly neutral assessments can produce differential outcomes unless classroom conditions are structured to support equitable expression [25]. Furthermore, meta-analyses of gender differences in creativity find that mean differences are often small and variable, but that variance and expressive mode differ between males and females under different educational settings [26], [27].

Despite the accumulated literature on creativity, gender, and pedagogy, several important gaps remain. Most prior studies of creative thinking in higher education have treated gender as a background variable rather than a central analytic dimension; they report aggregate scores without investigating how male and female students may differ across creativity sub domains or how instructional context mediates those differences. Also, much of the existing work derives from Western or urban settings, offering limited insight into how creativity develops in gendered ways in rural or non-metropolitan institutions. In biology education specifically, there is scant empirical evidence on how creative thinking skills manifest differently by gender, especially in Indonesian university settings. To address these gaps, the present study seeks to

analyze creative thinking skills of biology education students from a gender perspective, examining sub-domains of fluency, flexibility, originality, and elaboration, and assessing how male and female students differ in these dimensions in a non-metropolitan higher education context. By doing so, this research aims to contribute evidence toward designing gender-responsive pedagogical strategies that nurture creative potential equitably across genders.

METHODS

The study employed a descriptive qualitative approach designed to explore and describe students' creative thinking performance in natural academic settings [28]. The research was conducted in a biology education students enrolled at UIN Raden Intan Lampung, Indonesia, which describes the perspective of creative thinking skills in students based on gender.

Population and Sample

The population of this study comprised all undergraduate students enrolled in the Biology Education program at UIN Raden Intan Lampung during the 2021 academic year. These students were chosen because they represent future educators who are expected to integrate scientific creativity into their professional practice. From this population, a purposive sample of 87 students was selected, consisting of 42 female and 45 male participants. The purposive sampling technique was used to ensure balanced gender representation, as the study sought to analyze creative thinking skills through a gender lens. Participants were drawn from the same cohort and had completed comparable coursework, ensuring homogeneity in academic background and exposure to biology-related content.

Instrument

Data for this research were collected using a standardized essay-based creative-thinking test adapted from the Torrance Test of Creative Thinking (TTCT-V) and adjusted for biology education contexts. The instrument measured four major indicators of creative thinking: fluency, flexibility, originality, and elaboration. Each indicator was operationalized through open-ended problem scenarios requiring students to propose solutions, hypotheses, or interpretations that demonstrated divergent reasoning and biological insight. Instrument validity was established through expert judgment by two lecturers specializing in biology education and learning assessment, who reviewed the content, construct alignment, and linguistic clarity of the items. The test was administered in a written format within regular class hours, and students were allotted sufficient time to elaborate their responses.

Data Analysis

Data analysis employed a mixed descriptive approach combining quantitative and qualitative interpretation. Quantitative data were processed through percentage analysis to determine the mean score for each indicator and to categorize students' creative-thinking levels into five categories: very creative (81–100%), creative (61–80%), moderately creative (41–60%), less creative (21–40%), and not creative (0–20%). Comparative analysis was conducted to identify differences between male and female students on each indicator. Qualitative data were derived from students' written responses and analyzed through thematic coding to capture patterns of creative expression, elaboration, and conceptual depth. The quantitative and qualitative findings were triangulated to ensure internal validity and a richer interpretation of gendered patterns in creative performance.

The methodological framework thus provided a comprehensive means to assess the intersection between creativity and gender in biology education. By integrating statistical description with interpretive analysis, the study sought not only to measure levels of creative thinking but also to uncover how male and female students differently conceptualize and articulate creativity in scientific contexts.

RESULTS AND DISCUSSION

Results

The analysis of students' creative thinking skills revealed varying levels of achievement across the four core indicators fluency, flexibility, originality, and elaboration between male and female biology education students. Overall, the results indicate that the creative thinking skills of both groups fall within the "moderately creative" category, with nuanced differences in performance across specific dimensions. Female students demonstrated higher mean scores in fluency (58%) and elaboration (49%), while male students slightly outperformed their peers in flexibility (52%) and originality (46%). These findings suggest that gender may influence certain cognitive tendencies in creative expression, aligning with previous studies that reported similar variations in divergent thinking performance [29], [30].

Table 1. Creative Thinking Performance of Biology Education Students by Gender

Indicator	Female (%)	Male (%)	Overall Category	Interpretation
Fluency	58	55	Moderately Creative	Idea generation ability
Flexibility	49	52	Moderately Creative	Perspective-shifting ability
Originality	44	46	Moderately Creative	Novel idea production
Elaboration	49	47	Moderately Creative	Depth and detail development

The slightly higher performance of female students in fluency and elaboration suggests that women may be more adept at generating and refining ideas systematically, reflecting strengths in verbal elaboration and collaborative reasoning.

Discussion

The findings of this study confirm in contrast, the higher flexibility and originality scores among male students indicate a greater tendency to explore unconventional perspectives and take cognitive risks. These complementary patterns support findings by Anna [31], who found that female learners excel in elaborative reasoning and integrative communication, while male learners tend to perform better in open-ended and exploratory tasks. Similarly, a study by Ben [32] emphasized that gender differences in creativity may stem from variations in self-confidence, communication styles, and social expectations within academic environments.

Furthermore, the results correspond with the work of Dini et al. [33], who argued that learning environments fostering autonomy and experimentation can enhance both fluency and

originality regardless of gender, provided that equitable participation is ensured. In a comparable context, Kate [34] demonstrated that integrating inquiry-based learning in STEM disciplines significantly improved creative thinking but noted that female students benefited most when collaboration and verbal articulation were emphasized. Likewise, research by Kaewmanee et al. [35] found that male learners displayed higher originality scores due to their preference for intuitive and spontaneous reasoning styles. Collectively, these studies reinforce that while overall creative potential is similar across genders, specific modes of expression may vary depending on instructional conditions and social dynamics.

The present findings also highlight the pedagogical implications of gender sensitive teaching in biology education. Aulia et al. [36] argued that creativity can flourish in inclusive classrooms that validate multiple perspectives and minimize gender bias. The present study extends this argument by showing that balanced gender participation in biology education correlates with more diverse manifestations of creativity female students contributing depth and fluency, while male students bring flexibility and novelty. Therefore, the novelty of this study lies in its integration of gender analysis into the assessment of creative thinking within the Indonesian higher education context, a dimension largely absent in previous creativity research in biology education. Unlike earlier works that examined creativity enhancement primarily through instructional models, this study positions gender as a key analytical variable shaping how creative potential is expressed and developed.

The implications of these findings are multifaceted. Pedagogically, instructors should design classroom environments that leverage the complementary strengths of both genders by incorporating collaborative learning, inquiry driven projects, and reflective exercises. Curricular frameworks should embed creativity indicators into assessment systems to ensure equitable recognition of both divergent and elaborative competencies. From a policy perspective, these results support national and global education agendas such as *Sustainable Development Goal 4* which emphasize inclusivity, gender equity, and quality education as interconnected priorities. Fostering gender-inclusive creativity also contributes to preparing future biology educators capable of nurturing innovation and empathy in their classrooms.

Despite the study's contributions, several limitations must be acknowledged. The research was confined to a single institution, limiting the generalizability of findings to broader populations or different cultural settings. The sample size, while representative, remains modest and may not capture the full variability of creative thinking patterns across genders. Moreover, the study relied on essay-based instruments, which, though effective for qualitative insight, might not fully account for contextual factors such as communication preferences or cultural norms that influence creativity expression. Future research should adopt mixed-method or longitudinal designs, combining psychometric tests with classroom observations and interviews, to obtain deeper insights into the developmental trajectories of gendered creativity.

In summary, this study provides empirical evidence that gender plays a nuanced yet meaningful role in shaping creative thinking skills among biology education students. While both male and female learners exhibit comparable overall creativity levels, differences in sub-dimensions highlight the need for inclusive pedagogical frameworks that value diverse cognitive styles. The findings thus advance theoretical understanding and practical application of gender-inclusive creativity within higher education, underscoring its importance for equitable and innovative science learning.

CONCLUSION

This study concludes that the creative thinking skills of biology education students at UIN Raden Intan Lampung are generally categorized as moderate across all assessed indicators fluency, flexibility, originality, and elaboration with subtle yet meaningful gender-based variations. Female students demonstrated strengths in fluency and elaboration, reflecting systematic and detail-oriented thinking, while male students showed higher flexibility and originality, indicating exploratory and risk-taking tendencies. These findings affirm that creative potential is equally distributed across genders but manifests differently depending on cognitive style and classroom context. Theoretically, the study extends existing literature by situating creative thinking within a gender-inclusive framework, emphasizing that creativity in science education should be understood not only as an intellectual competence but also as a socially constructed process influenced by participation equity. Practically, the results underscore the importance of developing gender-responsive pedagogical designs that integrate inquiry based learning, collaboration, and reflective expression to cultivate creativity more holistically. Although limited by its single-institution scope and relatively small sample, this research contributes valuable insights for educators, curriculum designers, and policymakers seeking to promote creativity and inclusivity in higher education. Future investigations with broader samples and longitudinal approaches are recommended to explore how gender-responsive interventions can further enhance students' creative competencies in biology and other STEM-related fields.


LIMITATIONS

This study offers valuable insights into the relationship between gender and creative thinking in biology education, but has several limitations. It was conducted at a single higher education institution, limiting the generalizability to other universities or cultural contexts. The sample size, while adequate for descriptive analysis, is small, which restricts the ability to detect subtle gender-related variations. The study mainly used essay-based assessments of creative thinking, which may not fully capture other forms of creativity such as collaborative problem solving, digital innovation, or visual design. Sociocultural factors, such as prior educational experiences, classroom climate, and teacher expectations, were not measured but may have influenced the outcomes. Future research should involve larger, more diverse samples, and mixed-method or longitudinal designs to examine the development of creative thinking across genders. Including classroom observations, interviews, and cross-institutional comparisons would deepen understanding of how contextual and pedagogical factors shape gendered creativity in science education.

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AUTHOR CONTRIBUTION

A.R. conceptualized the study, designed the methodology, conducted interviews, analyzed data, and drafted the manuscript. A.R. supervised the research design, refined the analytical framework, and revised the manuscript. N.E.S. contributed to data analysis and manuscript revision. All authors reviewed and approved the final manuscript.

CONFLICT OF INTEREST

"The authors declare no conflict of interest."

DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

The authors used ChatGPT during the preparation of this work to design graphics and images. After utilizing the tool, the authors thoroughly reviewed and edited the content as necessary and assumed full responsibility for the publication's content

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