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Evaluating the Creative Abilities of Teacher Trainees at a Higher Education Institution in the Eastern Cape of South Africa

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ABSTRACT
Creativity is the skill to create new, unique, suitable, and practical things. Evaluating creativity skills includes assessing an individual's capacity for innovative thinking, creation of original ideas, and unique problem-solving abilities. Evaluating creativity in a classroom can be difficult yet fulfilling. This study evaluates creativity skills through a science model, which includes originality, fluency, flexibility, and elaboration in thinking and expression. The investigation is founded on the Guilford Model of Intellect. The research was carried out utilising quantitative methods. The study specifically selected 120 students taking the Life Sciences course to participate. The project had a deadline of 3 months for completion. A rubric was provided to students to help them understand how they will be assessed. The study showed that the assessment of creativity skills of students enhances academic performance in Life Sciences. It also showed that teachers can evaluate and encourage creativity in the classroom, creating a setting where students are inspired to explore, develop, and express their creativity. The Teaching and Learning Committee will receive guidance to emphasise the significance of evaluating students with models in science classes. This will boost students' success and enthusiasm in science classes.

Keywords: Creativity Skill, Guilford Model of Intellect, Classroom, Life Sciences, Thinking

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INTRODUCTION
Creativity is a multifaceted construct that has been the subject of extensive research across various disciplines, including psychology, education, and organisational behaviour. Creativity is the ability to produce novel and valuable ideas or products, a definition widely adopted in both academic and practical contexts.[1] This definition emphasises two critical components: originality and effectiveness, which are often seen as essential criteria for assessing creative outputs.[2] The creativity of students is connected to the creativity of teachers. Teachers' creativity is linked to their perception of students' creative qualities. Moreover, scientific innovation involves a blend of scientific understanding, procedural abilities, and creative thinking, problem-solving using both specialised and general knowledge in the field and

[1] Zi Yan et al., "Enhancing Students' Self-Efficacy in Creativity and Learning Performance in the Context of English Learning: The Use of Self-Assessment Mind Maps," *Frontiers in Psychology* 13 (May 11, 2022), https://doi.org/10.3389/fpsyg.2022.871781.
[2] Mark A. Runco and Ahmed M. Abdulla Alabbasi, "Interactions among Dimensions of Divergent Thinking as Predictors of Creative Activity and Accomplishment," *Thinking Skills and Creativity* 53 (September 2024): 101583, https://doi.org/10.1016/j.tsc.2024.101583.

scientific procedural skills. Scientific creativity is distinguished from artistic and linguistic creativity as it is based on scientific knowledge and process skills, emphasises creative science experiments, and addresses creative scientific problem-solving. Juanengsih, et.al., stress the importance of creativity as a critical ability to improve education quality for promoting creativity.[3] Evaluating the creative skills of teacher trainees in higher education institutions, particularly in the Eastern Cape, is a critical area of research that intersects pedagogy, creativity, and teacher preparation. Creativity in teaching is essential for fostering an engaging and effective learning environment, and it is increasingly recognised as a vital component of teacher education programs.[4] The evaluation of creative abilities among teacher trainees can be approached through various pedagogical frameworks. In the context of South Africa, the challenges faced by teacher trainees are compounded by systemic issues such as overcrowded classrooms and resource limitations, which can stifle creativity.[5] The Eastern Cape, in particular, has been noted for its educational challenges, including inadequate infrastructure and support for innovative teaching methods.[6] Therefore, when evaluating the creative abilities of teacher trainees, they must also consider these contextual factors that influence their capacity to implement creative pedagogies effectively. The study aimed at assessing the creative skills of teacher trainees at a higher education institution (HEI) is designed to fill a significant gap in understanding how creativity is perceived, developed, and assessed within teacher education programs. Creativity is increasingly recognised as a crucial competency for educators, enabling them to engage students effectively and foster innovative thinking in the classroom.[7] However, there is a notable lack of empirical research focused on the specific creative abilities of teacher trainees, particularly in the context of South African higher education, hence this research.

One of the primary motivations for this study is the recognition that teacher trainees often enter the profession with varying degrees of creative skills and beliefs about creativity. Research indicates that teachers' beliefs about creativity significantly influence their teaching practices and their ability to nurture creativity in students.[8] The study, therefore, seeks to address the challenges faced by teacher trainees in the Eastern Cape, where educational resources and support systems may be limited. The context of South African education, particularly in under-resourced areas, presents unique challenges that can impact the development of creativity among future educators.[9] By evaluating the creative abilities of teacher trainees, the study aims to identify specific areas where support and training can be improved, thereby enhancing the overall quality of teacher education in the region. One of the primary objectives is to assess the creative competencies of teacher trainees. This involves measuring their ability to generate original ideas and apply innovative problem-solving skills in educational contexts. Using established assessment tools, the study aims to quantify the level of creativity among trainees and identify specific strengths and weaknesses in their creative abilities.[10]

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[3] Nengsih Nengsih Juanengsih, Wulan Apriani, and M. Ahmad Danial, "Assessing Creativity of Senior High School Students in Learning Biology Using Online Portfolio Assessment on Facebook," in *Proceedings of the International Conference on Education in Muslim Society (ICEMS 2017)* (Paris, France: Atlantis Press, 2018), https://doi.org/10.2991/icems-17.2018.17.

[4] Ilona Valantinaite and Zivile Zivile Sedereviciute-Paciauskiene, "The Dimension of Textile Use in the Expression of Verbal Creativity," *European Scientific Journal, ESJ* 18, no. 6 (February 28, 2022): 1, https://doi.org/10.19044/esj.2022.v18n6p1.

[5] Corinne Meier and Joyce West, "Overcrowded Classrooms–the Achilles Heel of South African Education?," *South African Journal of Childhood Education* 10, no. 1 (2020): 1–10.

[6] Zingiswa Mybert Monica Jojo, "Creating an Innovative Primary School Mathematics Teaching Environment: The Case of Eastern Cape Province," *Journal of Research in Mathematics Education* 12, no. 2 (June 24, 2023): 173–91, https://doi.org/10.17583/redimat.11278.

[7] Shakhnoza Khaydaraliyevna Pozilova, "Developing Professional Creativity of Teachers Based on Problem Based Learning (PBL)," *Acta Pedagogia Asiana* 2, no. 2 (June 25, 2023): 106–14, https://doi.org/10.53623/apga.v2i2.237.

[8] Serene Chan and Mantak Yuen, "Creativity Beliefs, Creative Personality and Creativity-Fostering Practices of Gifted Education Teachers and Regular Class Teachers in Hong Kong," *Thinking Skills and Creativity* 14 (December 2014): 109–18, https://doi.org/10.1016/j.tsc.2014.10.003; Sue Hyeon Paek and Sarah E. Sumners, "The Indirect Effect of Teachers' Creative Mindsets on Teaching Creativity," *The Journal of Creative Behavior* 53, no. 3 (September 12, 2019): 298–311, https://doi.org/10.1002/jocb.180.

[9] Jacek Gralewski and Maciej Karwowski, "Are Teachers' Implicit Theories of Creativity Related to the Recognition of Their Students' Creativity?," *The Journal of Creative Behavior* 52, no. 2 (June 29, 2018): 156–67, https://doi.org/10.1002/jocb.140; Dan Davies et al., "The Roles and Development Needs of Teachers to Promote Creativity: A Systematic Review of Literature," *Teaching and Teacher Education* 41 (July 2014): 34–41, https://doi.org/10.1016/j.tate.2014.03.003.

[10] Jojo, "Creating an Innovative Primary School Mathematics Teaching Environment: The Case of Eastern Cape Province."

Another significant objective is to explore the beliefs and attitudes of teacher trainees regarding creativity in teaching. Understanding how these beliefs influence their teaching practices is crucial, as research indicates that teachers' perceptions of creativity can significantly affect their ability to foster creativity in their students.[11] This objective seeks to uncover the underlying factors that shape trainees' views on creativity and its role in education. The study also aims to identify the contextual challenges faced by teacher trainees in the Eastern Cape, particularly those that may hinder the development and expression of creativity. Factors such as resource limitations, classroom dynamics, and educational policies can impact the ability of trainees to implement creative teaching strategies.[12]

According to Lille and Romero, creativity encompasses cognitive and socioemotional abilities, enabling the generation and implementation of valuable and unique ideas.[13] Creativity is shown when people develop an original and helpful answer to deal with a potentially tricky situation that a particular group values in a specific setting. According to Conradty et.al., creativity is a combination of talent, knowledge, skill, internal drive, and individual traits, which are influenced by external factors.[14] The main research question underlying the study was: *What is the connection between students' scientific creativity skills and academic performance?*

LITERATURE REVIEW

Al-Makhalid and Ben-Motreb's research in 2022 revealed that freshman students show greater creativity than critical thinking, while seniors display higher levels of critical thinking than creativity.[15] This study significantly adds to the limited research on enhancing students' mathematical learning abilities. According to Kasirer and Shnitzer-Meirovich, the findings provide valuable information on encouraging creativity and critical thinking in math instruction.[16] Teachers frequently make the mistake of connecting creativity with high levels of intelligence and well-behaved students, according to Jónsdóttir, who stresses the significance of agency in creativity, referring to the capacity to generate novel and innovative ideas or products through action.[17] Moreover, this prompts the learner to explore various methods in addressing a problem, to seek inspiration from multiple sources for direction, and ultimately to select a solution considering the unique circumstances of the issue. He asserts that creativity depends on a blend of factors like proficiency in certain areas, influences on the creative process, and social and environmental factors that foster a supportive environment for students to feel self-assured, driven, and open to taking chances. According to Egana-delSol, engaging in challenging artistic and cultural activities can positively impact students' academic performance and creativity.[18] Agustiana, Agustini, et.al., suggest that teaching creativity, the ability to think creatively, is a skill acquired through training rather than being inherently natural, allowing for development over time.[19] An individual's creative ability can be affected by various factors such as the work environment, stimuli received, and interactions with others.

[11] Chan and Yuen, "Creativity Beliefs, Creative Personality and Creativity-Fostering Practices of Gifted Education Teachers and Regular Class Teachers in Hong Kong."

[12] Gralewski and Karwowski, "Are Teachers' Implicit Theories of Creativity Related to the Recognition of Their Students' Creativity?"

[13] Benjamin Lille and Margarida Romero, "Creativity Assessment in the Context of Maker-Based Projects," *Design and Technology Education: An International Journal* 22, no. 3 (2017): 32–47.

[14] Cathérine Conradty, Sofoklis A. Sotiriou, and Franz X. Bogner, "How Creativity in STEAM Modules Intervenes with Self-Efficacy and Motivation," *Education Sciences* 10, no. 3 (March 13, 2020): 70, https://doi.org/10.3390/educsci10030070.

[15] K. A. M. Al-Makhalid and K. S. Ben-Motreb, " Creativity and Critical Thinking in Learning Mathematics among Saudi Students: Comparison between Freshmen and Seniors," *Journal of Positive Psychology and Wellbeing* 6, no.1 (2022): 1–12.

[16] Anat Kasirer and Shlomit Shnitzer-Meirovich, "The Perception of Creativity and Creative Abilities among General Education and Special Education Teachers," *Thinking Skills and Creativity* 40 (June 2021): 100820, https://doi.org/10.1016/j.tsc.2021.100820.

[17] Svanborg R. Jónsdóttir, "Narratives of Creativity: How Eight Teachers on Four School Levels Integrate Creativity into Teaching and Learning," *Thinking Skills and Creativity* 24 (June 2017): 127–39, https://doi.org/10.1016/j.tsc.2017.02.008.

[18] Pablo Egana-delSol, "The Impacts of a High-School Art-Based Program on Academic Achievements, Creativity, and Creative Behaviors," *Npj Science of Learning* 8, no. 1(September 16, 2023):39, https://doi.org/10.1038/s41539-023-00187-6.

[19] I. Gusti Ayu Tri Agustiana et al., "The Effect of OPPEMEI Model on Students' Creative Thinking Skill and Cognitive Learning Achievement," in *Proceedings of the International Joint Conference on Science and Engineering (IJCSE 2020)* (Paris, France: Atlantis Press, 2020), https://doi.org/10.2991/aer.k.201124.040.

Assessment of Creativity in a Science Classroom

Valdez-García et.al., propose that assessment has three main functions: guiding and inspiring future learning with formative assessment, ensuring quality care for the community by identifying competent physicians, and selecting candidates for advanced training through summative assessment.[20] Nguyen et.al., suggest that creativity plays a crucial role in acquiring, disseminating, and applying knowledge in academic settings, ultimately contributing to the growth of a vibrant and prosperous national economy.[21] Integrating innovation into science education provides a more sustainable approach to presenting and structuring knowledge.[22] Nevertheless, creativity is crucial in science education because having only factual knowledge is insufficient to enhance skills and develop new scientific ideas. On the other hand, it is increasingly evident that sticking to a strict "linearity, conformity, and standardisation" system hinders the development of more flexible, diverse, and organic communities. Juanengsih, et.al., highlight the significance of assessing creativity in education to improve the learning process and achieve learning goals in promoting creativity.[23] The research discovered that students exhibited greater creativity while designing posters than when composing practicum reports. This might be because students have greater flexibility to design posters creatively, unlike the standardised format of practicum reports. Furthermore, they argue that creativity requires both originality and effectiveness. Teaching approaches that foster creativity provide students with ample freedom to take risks, make choices, and autonomously determine their own actions and goals. Educators must decide when to give students independence to create their learning strategies and when to step in to support, clarify, aid, elaborate, or challenge to nurture student imagination.

Teachers may sometimes struggle to enable students to take charge of their learning.[24] Long, Kerr, et.al., argue that meticulously designed assessments of creativity in the academic setting are essential for understanding the fundamental aspects of creativity and innovative educational experiences.[25] Evaluations of this kind can predict the expected outcomes of creativity in education and identify factors that aid students in developing their creative skills. According to Oh, educators help curriculum developers in detailing the inclusion of creativity in education, enabling teachers and parents to grasp students' creativity through their unique points of view and experiences.[26] Incorporating human subjective beliefs in understanding scientific facts suggests that values arising from human subjectivity are inherently involved. Scientists often use these values to determine the most reliable scientific theories about the world. For example, scientists are cognitively significant because they contribute to gaining scientific knowledge about the world. However, teachers may sometimes struggle with enabling students to take charge of their learning.[27] Long et.al., proposed that thorough assessments of creativity in education are essential for understanding the fundamental aspects of creativity and creative educational experiences.[28] Evaluations such as these may identify the expected outcomes of creativity in education and identify factors that support students in developing their creative skills. Curriculum developers help define how creativity is incorporated into education, enabling teachers and parents to grasp students' creativity from their unique viewpoints and backgrounds. Oh suggests that understanding scientific facts involves considering human subjective beliefs, showcasing the inevitable inclusion of values rooted in human subjectivity.[29] Scientists often use these values to determine the most

[20] Jorge Eugenio Valdez-García, Mildred Vanessa López Cabrera, and Elena Ríos Barrientos, "Principles of Assessment and Effective Feedback," *Annals of Eye Science* 2 (2018): 42–42, https://doi.org/10.21037/aes.2017.06.10.

[21] Hiep Duc Nguyen, Le Thi Mai, and Duc Anh Do, "Innovations in Creative Education for Tertiary Sector in Australia: Present and Future Challenges," *Educational Philosophy and Theory* 52, no. 11 (September 18, 2020): 1149–61, https://doi.org/10.1080/00131857.2020.1752190.

[22] Susanne Beck et al., "The Open Innovation in Science Research Field: A Collaborative Conceptualisation Approach," *Industry and Innovation* 29, no. 2 (February 7, 2022): 136–85, https://doi.org/10.1080/13662716.2020.1792274.

[23] Nengsih Juanengsih, Apriani, and Ahmad Danial, "Assessing Creativity of Senior High School Students in Learning Biology Using Online Portfolio Assessment on Facebook."

[24] Jónsdóttir, "Narratives of Creativity: How Eight Teachers on Four School Levels Integrate Creativity into Teaching and Learning."

[25] Haiying Long et al., "A Critical Review of Assessments of Creativity in Education," *Review of Research in Education* 46, no. 1 (March 14, 2022): 288–323, https://doi.org/10.3102/0091732X221084326.

[26] Jun-Young Oh, "Understanding the Scientific Creativity Based on Various Perspectives of Science," *Axiomathes* 32, no. 6 (December 24, 2022): 907–29, https://doi.org/10.1007/s10516-021-09553-8.

[27] Jónsdóttir, "Narratives of Creativity: How Eight Teachers on Four School Levels Integrate Creativity into Teaching and Learning."

[28] Long et al., "A Critical Review of Assessments of Creativity in Education."

[29] Oh, "Understanding the Scientific Creativity Based on Various Perspectives of Science."

trustworthy scientific theories about the world. For example, scientists have cognitive significance since they are involved in gaining a scientific grasp of the world. However, they have ethical or social relevance. These values are referred to as non-cognitive values. The claim that values should not impact scientific facts underscores the significance of preserving the neutrality of scientific facts. Bhandari et.al., confirm that the appraisal of the app's interface aesthetics will impact different evaluations of mobile applications.[30] An enhanced sense of positivity stems from elevated classical aesthetics, leading to a greater perception of practicality and pleasure. On the other hand, a more emotional interface impacts excitement levels, leading to a higher drive to download. This indicates that valence is mainly related to practicality, affecting the user's judgment of a design's attractiveness and resulting in higher ratings for perceived practical quality.

THEORETICAL FRAMEWORK

This paper is significantly informed by the Guilford Model of Intellect, particularly its emphasis on divergent thinking as a critical component of creativity. Gulford's model posits that intelligence is multifaceted, comprising several dimensions, including convergent and divergent thinking.[31] Divergent thinking is characterized by the ability to generate multiple solutions to open-ended problems, essential for fostering creativity in educational contexts.[32] One of the study's primary objectives is to assess the level of divergent thinking among teacher trainees, as this cognitive ability is closely linked to their potential for creative problem-solving and innovation in teaching practices.[33] Research indicates that educators with strong divergent thinking skills are more adept at developing higher-order thinking skills (HOTS) assessments and creating engaging learning environments.[34] This aligns with findings that suggest a positive correlation between divergent thinking and creativity, highlighting the importance of nurturing these skills in teacher education programs.[35]

The paper also explores how perceived support from educators influences the development of divergent thinking among trainees. Previous research has shown that supportive teaching environments can enhance students' creative potential, suggesting that teacher trainees who feel supported are more likely to effectively engage in divergent thinking tasks.[36] This exploration is crucial for understanding how institutional factors can impact the creative development of future educators. Furthermore, the study seeks to identify pedagogical strategies that cultivate divergent thinking within teacher training curricula. By evaluating current teaching methods and their effectiveness in promoting divergent thinking, the research aims to provide recommendations for enhancing creativity in teacher education.[37] This is particularly relevant in South Africa, where educational challenges necessitate innovative approaches to teaching and learning.[38]

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[30] Upasna Bhandari, Klarissa Chang, and Tillmann Neben, "Understanding the Impact of Perceived Visual Aesthetics on User Evaluations: An Emotional Perspective," *Information & Management* 56, no. 1 (January 2019): 85–93, https://doi.org/10.1016/j.im.2018.07.003.

[31] Joy Paul Guilford, "The Structure of Intellect," *Psychological Bulletin* 53, no. 4 (1956): 267–93, https://doi.org/10.1037/h0040755.

[32] Gil Gonen-Yaacovi et al., "Rostral and Caudal Prefrontal Contribution to Creativity: A Meta-Analysis of Functional Imaging Data," *Frontiers in Human Neuroscience* 7 (2013), https://doi.org/10.3389/fnhum.2013.00465.

[33] I Wayan Widana and Gede Ratnaya, "Relationship between Divergent Thinking and Digital Literacy on Teacher Ability to Develop HOTS Assessment," *Journal of Education Research and Evaluation* 5, no. 4 (September 22, 2021): 516, https://doi.org/10.23887/jere.v5i4.35128.

[34] Widana and Ratnaya, "Relationship between Divergent Thinking and Digital Literacy on Teacher Ability to Develop HOTS Assessment."

[35] Zhichen Xia, Hong Yu, and Fan Yang, "Benevolent Leadership and Team Creative Performance: Creative Self-Efficacy and Openness to Experience," *Frontiers in Psychology* 12 (January 21, 2022), https://doi.org/10.3389/fpsyg.2021.745991.

[36] Meng Sun, Minhong Wang, and Rupert Wegerif, "Using Computer-based Cognitive Mapping to Improve Students' Divergent Thinking for Creativity Development," *British Journal of Educational Technology* 50, no. 5 (September 28, 2019): 2217–33, https://doi.org/10.1111/bjet.12825.

[37] Isabelle C. de Vink et al., "Supporting Creative Problem Solving in Primary Geometry Education," *Thinking Skills and Creativity* 48 (June 2023): 101307, https://doi.org/10.1016/j.tsc.2023.101307.

[38] Gralewski and Karwowski, "Are Teachers' Implicit Theories of Creativity Related to the Recognition of Their Students' Creativity?"

METHODOLOGY

This study utilised the positivist paradigm. According to Kamau, positivism emphasises objectivity, hypothesis testing, and statistical analysis, making it particularly suitable for quantitative studies.[39] A research paradigm serves as a foundational framework that shapes the entire research process, encompassing beliefs and assumptions about the nature of reality (ontology), the nature of knowledge (epistemology), and the methods used to gather and analyse data (methodology).

Research Approach

This study used a quantitative approach, emphasising objective measurements and structured tools such as surveys, tests, and questionnaires to collect numerical data.

Research design

A correlational research design was employed in this study, which is valuable for examining relationships and patterns, providing researchers with insights into how changes in one variable may be linked to changes in another.

Participant Selection

The population for this study consisted of 120 specifically selected students taking the Life Sciences course. The research used quantitative methods in the Oliver Tambo (OR) District of Education of the Eastern Cape Province, South Africa. The authors used the stratified sampling technique to select Life Science students who participated in the study.

Data Collection Procedures

The data collection instrument for this inquiry was a questionnaire. Correlation analysis assessed the strength and direction of relationships between two continuous variables. The project work took place for approximately 3 months. Throughout this 3-month timeframe, students and their teams convened with instructors for direction. The science creativity test evaluated four components as detailed in Figure 1.

Ethical Considerations

All the necessary ethical considerations were addressed before the study was carried out. The participants were informed of the details of the study, and their consent was sought before the study began.

Rubric for a science model

Module name:_____

Student No_____

Table 1: Rubric for a model

Scale	Originality (6)	Creativity skill (6)	Visual Appeal (4)	Scientific concept (4)	Score (20)
1	Inappropriate materials were selected and contributed to a product that performed poorly.	Deficiency in creativity	Construction appears careless.	The student shows a minimal understanding.	
2	Most of the materials selected were appropriate	Some moderate creativity is displayed	Construction demonstrated some effort	The student shows a minimal understanding.	

[39] Gabriel Ndung'u Kamau, "ICT4D Research in Developing Countries: A Call for Pragmatism Approach," *International Journal of Computer and Information System (IJCIS)* 3, no. 2 (June 14, 2022): 51–55, https://doi.org/10.29040/ijcis.v3i2.67.

3	Appropriate materials were selected	There was an attempt to use materials creatively.	Construction was careful and accurate for the most part, but a few details could have been added.	The student demonstrates a proficient understanding.	
4	Appropriate materials were selected.	They were creatively portrayed, enhancing their understanding of the subject matter.	Great care was taken in the construction process to make the model neat and attractive.	The student demonstrates excellence in understanding.	

Achievement scores of participants

This score shows how creative students are in originality, creativity, product aesthetic, and scientific understanding. The data was reviewed and structured, and is presented in Table 1.

Table 2: Achievement scores of students

Participant	Originality (6)	Creativity (6)	Visual Appeal (4)	Scientific concept (4)	Achievement Score (20)
A	4	5	3	4	16
B	5	3	4	3	16
D	4	4	3	4	15
E	5	4	3	3	16
F	3	2	2	1	11
G	2	3	3	2	12
H	2	2	3	2	11
I	4	3	3	3	14
J	5	4	3	4	16
K	4	3	3	3	14
L	2	2	2	2	10
M	4	4	3	3	15
N	5	4	3	4	16
O	5	4	2	3	16
P	4	3	2	3	13
Q	4	4	3	3	15
R	3	4	3	4	14
T	3	4	3	3	14

PRESENTATION OF FINDINGS AND DISCUSSION

Originality

The diagram presented below is a **Pareto chart**, combining both a **bar graph** and a **cumulative line graph** to analyse the distribution of originality grades across different categories labeled by letters (B, O, E, J, N, A, D, I, K, M, P, Q, F, R, T, G, H, L).

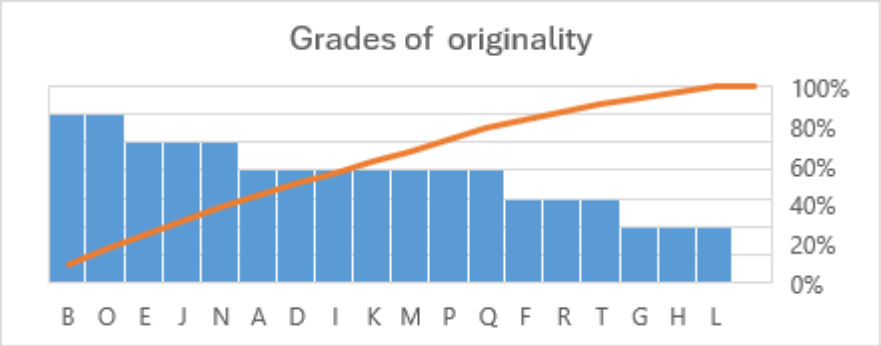

Figure 1: Grades of originality

The chart provides two dimensions of analysis: the absolute grades of originality (depicted by the blue bars) and the cumulative percentage contribution of these grades (depicted by the orange line). The blue bars represent individual grades of originality for each item labelled with the corresponding letter. Each blue bar's height shows that specific item's originality value, with values on the left-hand y-axis (from 0% to 100%). Items toward the left, such as B, O, E, etc., likely have higher individual originality grades based on their taller blue bars. Movement towards the right (items like F, R, T, etc.) causes the originality grades to decrease, as the shorter blue bars indicate. The orange cumulative line shows that summing up the originality of each item from left to right, the total contribution approaches 100%, meaning that originality is more concentrated in the earlier items on the x-axis. Runco et al propose that divergent thinking often leads to originality, which is crucial for creativity, although performing well in a divergent thinking assessment does not always guarantee creative actions.[40] Based on Figure 1, two participants got 90%, three reached 70%, seven got 60%, three scored 40%, and three achieved 30% for their originality. Being truly innovative often hinges on the crucial aspect of originality in creativity. Originality is having unique, inventive, or imaginative ideas, creations, or expressions. Introducing a novel concept or experience that has not been seen or felt before is necessary.[41]

Interpretation of the Bar Graph (Grades of Originality)

The blue bars indicate the individual originality grades assigned to each letter category. A clear trend emerges:

- B exhibits the highest originality grade, followed closely by O and E.
- Categories J, N, A, D, I, K, M, P, Q maintain a middle range of originality scores, with slight variations, but overall moderate performance.
- Categories F, R, T, G, H, and L show lower originality scores, suggesting lesser degrees of originality compared to the earlier categories.

This uneven distribution suggests that originality is concentrated in a few categories (B, O, E) and declines significantly as one moves toward the later categories.

The orange cumulative line represents the cumulative percentage contribution to overall originality. The curve shows:

- A steep initial incline between categories B and E, indicating that a small number of categories contribute significantly to the total originality output.
- A gradual rise thereafter, with middle categories contributing moderately to the cumulative originality percentage.

[40] Mark A. Runco, Selcuk Acar, and Nur Cayirdag, "A Closer Look at the Creativity Gap and Why Students Are Less Creative at School than Outside of School," *Thinking Skills and Creativity* 24 (June 2017): 242–49, https://doi.org/10.1016/j.tsc.2017.04.003.

[41] Selcuk Acar, Cyndi Burnett, and John F. Cabra, "Ingredients of Creativity: Originality and More," *Creativity Research Journal* 29, no. 2 (April 3, 2017): 133–44, https://doi.org/10.1080/10400419.2017.1302776; Giovanni Emanuele Corazza, "Potential Originality and Effectiveness: The Dynamic Definition of Creativity," *Creativity Research Journal* 28, no. 3 (July 2, 2016): 258–67, https://doi.org/10.1080/10400419.2016.1195627; Carsten Deckert, "On the Originality-Effectiveness Duality of Creativity: Tensions Concerning the Components of Creativity," *Business Creativity and the Creative Economy* 2, no. 1 (2016): 70–82, https://doi.org/10.18536/bcce.2016.10.2.1.07.

- A flattening of the curve towards the end (categories G, H, L), suggesting diminishing marginal contributions to the overall originality by these categories.

This pattern follows the Pareto Principle (80/20 rule), where a small proportion of categories (around 20–30%) account for most of the original output.
The diagram suggests several key academic insights:

- Concentration of High Originality: A few categories (B, O, E) are responsible for the majority of the creative or original outcomes. This has implications for resource allocation, talent development, and educational strategies, suggesting a focus on nurturing and replicating the practices associated with these higher-performing groups.
- Equity and Inclusivity Concerns: The substantial drop in originality grades across other categories suggests potential underutilization of creative capacities in the broader population. Educational interventions should aim to democratise opportunities for developing originality across all groups.
- Strategic Focus for Improvement: By identifying categories with lower originality (e.g., G, H, L), targeted support programmes can be designed to stimulate creativity, critical thinking, and innovative problem-solving among these groups.
- Curriculum Design: Findings reinforce the importance of embedding differentiated instructional strategies that foster originality, particularly among learners who traditionally score lower in originality assessments.

The "Grades of Originality" diagram illustrates a classic Pareto distribution where a minority of categories contribute disproportionately to overall originality. This finding highlights the need for strategic educational interventions to foster creativity across all categories, with a particular focus on those underperforming. It also reinforces the importance of promoting environments where innovative thinking is systematically nurtured rather than isolated within a select few groups.

Creativity skill

Creativity includes developing new ideas, which can happen spontaneously or with proper preparation.[42] The research emphasized the abilities of the individuals, with one person achieving 85%, nine achieving 70%, five achieving 50%, and three achieving 40% (Figure 2).

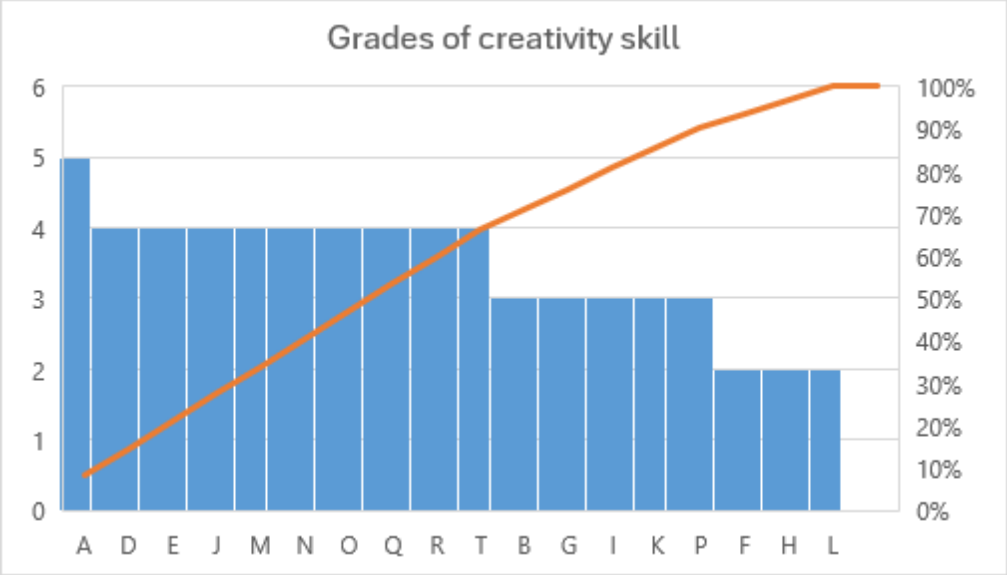

Figure 2. Grades of creativity skill

[42] Yoga Budi Bhakti and Irnin Agustina Dwi Astuti, "The Influence Process of Science Skill and Motivation Learning with Creativity Learn," *Journal of Education and Learning (EduLearn)* 12, no. 1 (January 2, 2018): 30–35, https://doi.org/10.11591/edulearn.v12i1.6912; S Astutik et al., "HOTS Student Worksheet to Identification of Scientific Creativity Skill, Critical Thinking Skill and Creative Thinking Skill in Physics Learning," *Journal of Physics: Conference Series* 1465, no. 1 (February 1, 2020): 012075, https://doi.org/10.1088/1742-6596/1465/1/012075.

Visual appeal of the model

One person scored 90%, while 13 people got 70%, and four got 50%. Jeffries, et.al., concur with Welke, et.al., on the idea that visual charm in creativity comprises various components that enhance visual creations' charm, influence, and efficiency.[43] Achieving beautiful and engaging designs relies on the careful balance of aesthetics, composition, originality, feelings, and technical ability. Overall, the participants' models display a visual appeal that suggests they put effort into their work.

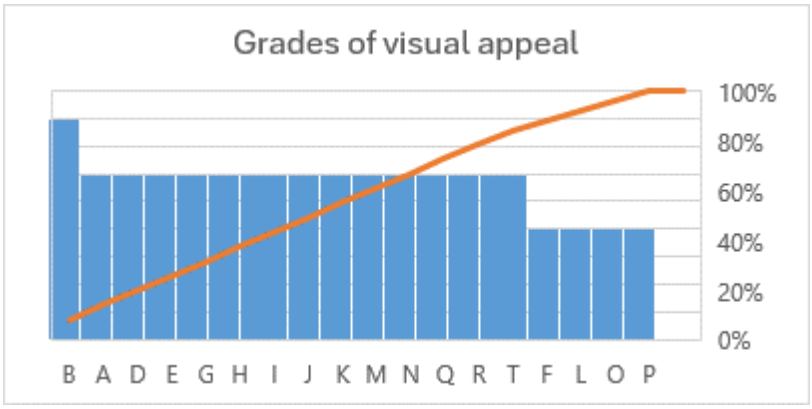

Figure 3: Grades of visual appeal

An Aspect of a Scientific Concept

Five people earned a 90% score, nine got a 70% score, three received a 50% score, and 1 person scored 20%. According to the data in Figure 5, five people scored 90%, nine scored 70%, three scored 50%, and one scored 20%. Altogether, 80% of the participants exhibited scientific creativity in their models. Students' creativity in science involves critical thinking, inventive problem-solving, and creating fresh ideas in scientific research. It involves more than just memorising information; it also consists of utilising knowledge creatively to investigate, test, and discover.[44]

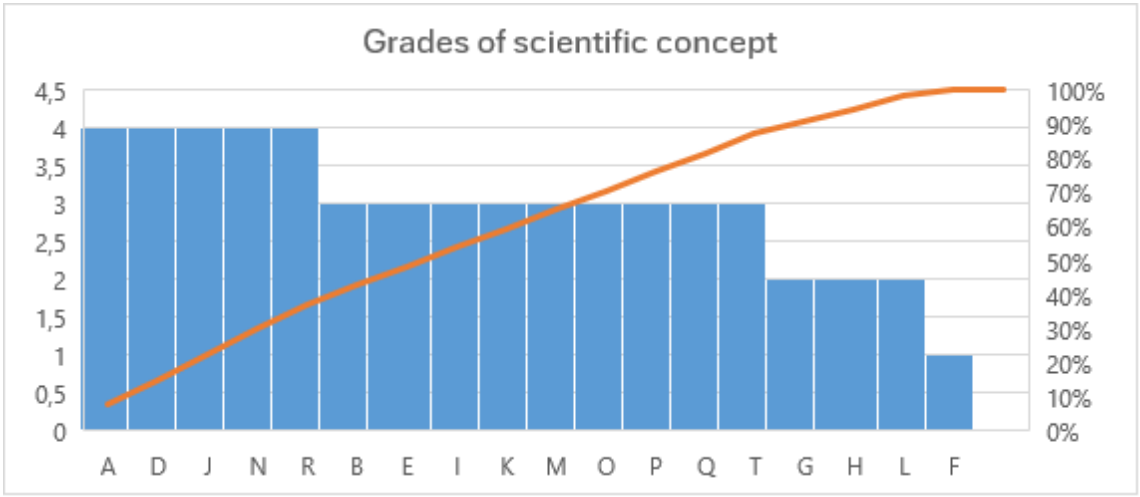

Figure 4: Grades of scientific concept

[43] Karl K Jeffries, Theodore Zamenopoulos, and Alison J K Green, "Design Creativity, Technical Execution and Aesthetic Appeal: A CAT with Caveats (Part 2)," *International Journal of Design Creativity and Innovation* 6, no. 1–2 (2018): 66–79; Dominik Welke, Isaac Purton, and Edward A. Vessel, "Inspired by Art: Higher Aesthetic Appeal Elicits Increased Felt Inspiration in a Creative Writing Task," February 20, 2020, https://doi.org/10.31234/osf.io/rdsbv.

[44] Oh, "Understanding the Scientific Creativity Based on Various Perspectives of Science."; Erdoğan Usta and Çiğdem Akkanat, "Investigating Scientific Creativity Level of Seventh Grade Students," *Procedia - Social and Behavioral Sciences* 191 (June 2015): 1408–15, https://doi.org/10.1016/j.sbspro.2015.04.643.

Overall Achievement Score of Participants on Creativity

In Figure 5, six participants obtained a 90% score, three got 85%, four achieved 80%, one got 75%, one reached 70%, two scored 65%, and one obtained 60%.

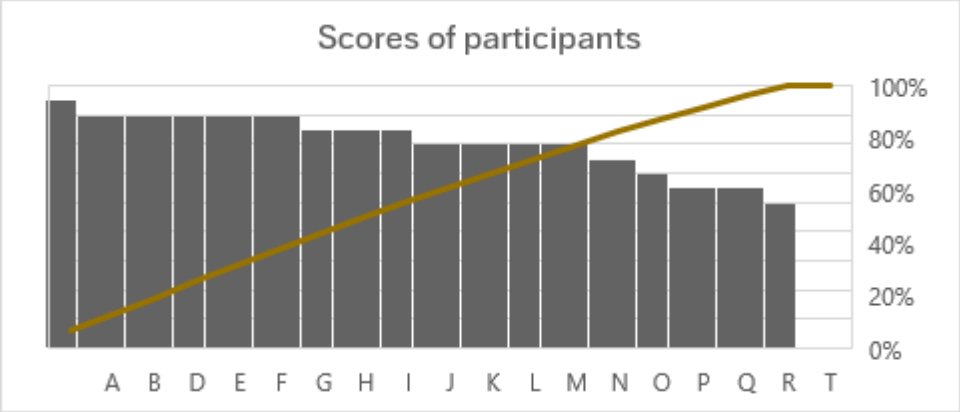

Figure 5: Achievement score of participants

The findings suggest that teachers have the ability to assess and promote creativity in the school environment, fostering an atmosphere that motivates students to experiment, invent, and showcase their creative skills. The research reveals that students achieved scores above 50%, displaying significant creativity in their projects, highlighting their strong scientific creativity. Studies show that students demonstrate a variety of thought processes about their creativity skills. The problem is that education usually doesn't encourage creativity; teachers and assessors generally think students require factual knowledge. Encouraging creativity is vital in education for individuals to develop into innovative thinkers. Encouraging student creativity is crucial in education to prepare young people for possible challenges. Most of the models displayed a high degree of creativity. In addition, their ratings for attractiveness were exceptional. Teachers can help students improve their understanding of their creativity by providing constructive feedback on their strengths and areas needing improvement. Educators, teachers, and policymakers are advised to use the Guilford Model of Intellect and divergent thinking in education to improve creative abilities. A creative person showcases their creativity through their actions, which result from thinking unconventionally. The education system should promote critical thinking, a growth mindset, creative behaviour, and logical reasoning. Matraeva, et.al. and Gallagher and Grimm suggest that divergent thinking, which includes fluency, elaboration, flexibility, and originality, is essential for creativity.[45]

RECOMMENDATIONS

The recommendation is for teachers and assessors to promote creativity among students and help students improve their understanding of their creativity by providing constructive feedback. Suggestions include integrating creative pedagogical strategies in teacher training programs, enhancing technology and collaborative learning, and fostering an environment encouraging experimentation with innovative ideas. Institutions should offer workshops and training that focus on developing creative teaching strategies. Collaboration with experienced teachers and mentors should be integrated into the evaluation process. Trainees should be encouraged to experiment with unconventional methods and be evaluated on the outcomes, including both successes and lessons learned. Regular observation of trainees in their teaching environment, focusing on how they implement creative approaches, is also suggested. After attending workshops, trainees should be evaluated on how well they apply newly learned creative techniques in their classrooms.

[45] Alena D. Matraeva et al., "Development of Creativity of Students in Higher Educational Institutions: Assessment of Students and Experts," *Universal Journal of Educational Research* 8, no. 1 (January 2020): 8–16, https://doi.org/10.13189/ujer.2020.080102; Daniel Gallagher and Lisa R. Grimm, "Making an Impact: The Effects of Game Making on Creativity and Spatial Processing," *Thinking Skills and Creativity* 28 (June 2018): 138–49, https://doi.org/10.1016/j.tsc.2018.05.001.

CONCLUSION

The study evaluates the creative abilities of teacher trainees at a higher education institution in the Eastern Cape of South Africa. Creativity in education is considered crucial for fostering critical thinking, problem-solving, and innovative teaching approaches. The study examines the extent to which teacher trainees exhibit creative abilities and how these skills are nurtured during their training. The evaluation focuses on various aspects of creativity, including originality, flexibility, and the ability to think divergently. It also considers how the institutional curriculum, teaching methods, and available resources support the development of creativity. Data is collected through a combination of surveys, creative performance assessments, and interviews with teachers. Factors such as the influence of socio-cultural background, prior educational experiences, and the role of mentorship are explored. The findings suggest that while there is a potential for creativity among the trainees, the formal education system tends to prioritize conventional teaching methods, which may limit opportunities for creativity. This study provides insights into how higher education institutions in South Africa can better prepare future teachers to become creative, adaptable teachers.

Further research

The research could be carried out by employing different factors that may impact creativity within the same group.

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