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Development Of Creative Thinking Of Students In Chemistry Lessons

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Abstract. *The research examines educational methods to boost creative thinking abilities of students studying chemistry at the secondary school level. The research adopts non-standard contextually rich tasks to teach students original flexible critical thinking skills because educational settings increasingly demand such learners. The tasks trigger cognitive interest and support imaginative thinking abilities to develop individual thinking patterns for creative thought skills. The research method uses motivational prompts followed by creative warm-up activities and real-world chemistry problems which are supported by reflection tools including metaphor-based riddles and self-assessment models. These educational practices took place in regular classrooms to support individual analysis combined with hypothesis development and group-based investigation. Students who participated in these non-traditional creative activities exhibited enhanced involvement in chemistry classes and better mastery of chemical concepts and better abilities to create distinct answers. Creative tasks integrated into curriculum support students' core cognitive development for lifelong scientific learning while sustaining their scientific understanding.*
Keywords: *creative thinking, chemistry education, non-standard tasks, student engagement, problem-solving skills, divergent thinking, pedagogical strategies.*

INTRODUCTION

The modern information society demands that schools develop creative adaptable students who demonstrate critical thinking skills because this development has become essential for survival. Modern professionals need to demonstrate both extensive knowledge and skills for lifelong learning and independent thinking and innovative problem-solving because of the rapid scientific technological and social changes. The strategic goal of educational development now focuses on creativity enhancement particularly in science subjects with chemistry at its core [1]. Current students need abilities to think independently while developing new ideas through imaginative reasoning and solving problems from various angles.The field of chemistry education now considers creative thinking to be an essential competency which promotes competence development alongside proficiency acquisition. This study bases its research approach on utilizing multiple mental processes including analysis, synthesis, induction, deduction, abstraction, concretization, comparison, generalization and conclusion drawing during content learning and problem-solving activities. The foundation of designing chemistry tasks depends on these cognitive processes which enable students to advance from memorization and procedural work [2].The authors demonstrate a method which combines purpose-built assignments to develop students' thinking abilities through flexible and deep original thought processes. According to the Latin origin of the word creativeness ("to create or make"), this paper defines creativity as the human ability to break away from established rules and patterns when finding solutions. The classroom environment shows creativity when students develop unique acceptable solutions while creating different conceptual approaches to chemical concepts and their interpretations. The educational objective to develop scientific creativity together with practical skills matches the broader teaching objective [3].he pedagogical model depends on recognizing two key cognitive orientations which include convergent thinking and divergent thinking. The process of convergent thinking uses organized algorithms to achieve optimal single solutions. The method relies on logical thinking and step-by-step reasoning and evaluative judgment. The process of divergent thinking supports learners to produce various possible solutions and connections and results through a single problem scenario. Divergent thinking serves as an essential mental skill for students to redirect familiar chemical subjects into novel approaches and discover common patterns in reactions and invent alternative experimental explanations [4].The present investigation shows divergent thinking proves most beneficial for chemistry education because it enables students to conduct comprehensive investigations along with creative problem-solving and scientific understanding to practical applications. The main purpose of divergent thinking activities is to develop four essential skills: flexibility, speed, originality and deep understanding. Modern intellectual development meets chemical education standards

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through classroom implementation of cognitive approaches which foster analytical thinking and transformative ideas [5].The purpose of this research project is to develop and assess a system of structured creative teaching methods which enhance student divergent thinking alongside creative potential. This work advances discussions about curriculum development along with cognitive skill development and STEM education in contemporary learning settings [6].

2. Materials And Methods

The research used an organized educational framework to develop creative thinking abilities in secondary school chemistry students. All teaching activities within this framework relied exclusively on content-driven motivational strategies combined with real-world contextual problems and open-ended exploratory exercises. The main educational goal focused on activating divergent thought and imaginative problem-solving in accordance with curriculum learning objectives.

2.1. Motivational Strategy Design

The lessons started with a surprising element or curiosity which the authors named "miracle effect" to activate students' cognitive interest and start their engagement. The motivational activities consisted of toys together with models and puzzles along with riddles and crosswords. The chosen tools had specific purposes to energize the learning environment while attracting student focus. The lesson introductions always began with a "bright spot" which served both as a visually arresting or conceptually intriguing point to spark students' fascination regarding the subject.Students encountered this example when learning Salt Hydrolysis during their 9th-grade chemistry class. During the lesson the teacher started with an authentic example about how people used wood ash infused water to wash their hair because soap became scarce after World War II. The technique continues to be practiced by bathhouses that draw their water supply from wells.

The students needed to provide chemical explanations about ash utilization in these situations to connect practical knowledge with theoretical comprehension.

2.2. Core Instructional Activities

The central teaching segment aimed to develop students' creative imagination together with flexible reasoning abilities. The activities supported different learning abilities while promoting self-directed goal setting as well as planning and evaluation. The program focused on teaching students four essential cognitive abilities including target definition along with independent method selection and goal achievement and problem-solving and conclusion defense and idea clarity.The creative lesson framework presented in Figure 1 demonstrates how motivational approaches unite with content planning and reflective stages to boost cognitive growth and chemical thinking abilities in education.

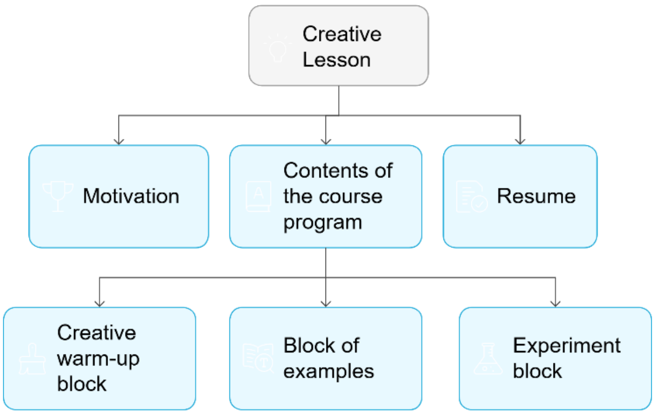

Figure 1. Structural Model of a Creative Chemistry Lesson for Developing Student Thinking

2.3. Creative Warm-up Exercises

A sequence of eight creative warm-up tasks progressed through progressive stages starting from basic to advanced levels. These included:

1. Identifying a common theme among substances: sugar, acetone, fructose; gypsum, marble, limestone.
2. Evaluating the safety and chemistry behind using aluminum dishes for cooking acidic or basic food items.
3. Imagining the global consequences if iron suddenly disappeared from Earth.
4. Designing a simple home experiment to prove the presence of carbon dioxide in bottled lemonade.
5. Proposing a method for synthesizing artificial honey using glucose and fructose.

6. Interpreting a scientific invention: a device capable of extracting oxygen from water.
7. Using phenol and formaldehyde to develop a product-based chemistry project involving new substances and applications.
8. Classifying a group of compounds and eliminating the outlier: quicklime, burnt magnesia (noting that burnt magnesia is a magnesium compound, unlike the calcium-based others).

The selected activities served both to evaluate student chemical concept comprehension and to promote imaginative thinking and analytical decision-making skills.

RESULTS

3.1. Development of Associative Thinking through Non-Standard Tasks

Non-standard tasks related to chemical context served as the basis for stimulating student associative thinking and enhancing their creativity in science lessons. The tasks required participants to put theoretical knowledge into real-life situations which resulted in developing deeper concepts and creative thinking abilities.

Task 1: The first task presented students with rusted nails that resulted from keeping them in a basement storage space incorrectly. Students needed to examine rust from a chemical point of view before suggesting removal techniques. The students successfully recognized rust as iron oxidation and provided the chemical reaction:

$2Fe + 2H_2O + O_2 = 2Fe(OH)_2$.

They explored three corrosion prevention strategies: applying surface coatings, using anti-corrosive alloys, and modifying the surrounding medium. The exercise strengthened their ability to relate textbook concepts to observable chemical degradation in daily life.

Task 2: Students in Task 2 were required to examine rust stains that developed on laundry items suspended from iron wire. Students showed their comprehension of how metal contact with wet fabrics speeds up corrosion then presented household stain removal methods which included acetic acid (CH_3COOH), citric acid ($C_6H_8O_7$) and baking soda. The assignment demonstrated how chemical reactivity relates to solving household problems.

Task 3: The examination of metallic spare parts kept in a home workshop served as the subject of Task 3. The students analyzed storage conditions as a source of oxidation while they identified different corrosion types and protective methods. The discussion focused on material science education to create economic understanding as its main objective. The students identified three educational targets which included the study of electrochemical corrosion alongside the development of observation capabilities and reasoning abilities and the formation of responsible learning habits.

3.2. Use of Riddles to Trigger Cognitive Fluency

To reinforce abstract chemical thinking through playful inquiry, riddles were integrated into the lesson structure. For instance:

- *"The shovel standing by the door unused became heavier."*(Answer: Oxidation of metal in air)
- *"Once the metal got into the acid. It boiled, hissed, and flew away with a whoosh!"* (Answer: Hydrogen)

The riddles needed students to possess understanding about chemical reactions and properties. The activity required students to access previously learned information which they then expressed metaphorically for enhanced memory and creative thinking abilities. Another example— *"It flew like a dark cloud, descended like a white bird…"*—was decoded as water, emphasizing the fusion of language, imagination, and science.

3.3. Experimental Task on Aldehyde Properties

An exploratory experiment studied aldehyde properties during the last phase of the lesson. Students analyzed structural formulas before formulating possible chemical reactions. Two hypotheses emerged:

1. The carbonyl group (C=O) of aldehydes can undergo reactions at its specific site.
2. Further reduction and oxidation reactions are possible for the aldehyde functional group.

The analysis confirmed these assumptions because students showed their capacity to apply chemical principles to forecast compound reactions. The educational use of aldehydes allowed students to build their understanding of structure–property relationships by applying logical reasoning. A visual depiction showed the chemical changes where formaldehyde turned into methanol while acetaldehyde became acetic acid to support conceptual understanding (Figure 2).

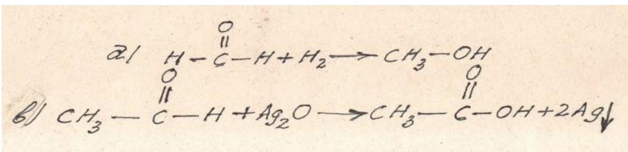

Figure 2. Oxidation and Reduction Reactions of Aldehydes Demonstrated in Classroom Experiment

DISCUSSION

The data gathered from reflective tasks and summary procedures in creative chemistry lessons demonstrates important instructional advantages to develop students' metacognitive capabilities, emotional participation, and self-directed responsibilities. The research application of reflection served as a dynamic method for students to analyze their thinking patterns and decision processes and evaluation of their performance. The use of reflection exercises during homework checks and project presentations and lesson consolidation gave students the chance to evaluate their cognitive activity stages and elements in a critical manner. This approach matches modern theories of student-centered education because it lets learners evaluate themselves while constantly seeking advancement [7]. Students who analyze their problems and methods combined with their outcomes through reflection develop better chemical understanding and stronger critical and creative thinking abilities [8].

The classroom routines incorporated three tools which introduced gamified visual metaphors through the Ladder of Success, Tree of Success, and Trailers. The tools provided concrete methods which allowed students to track their work completion alongside their errors made. Students progressed through structured challenges by using the ladder metaphor but also gained visibility into their performance through the tree metaphor that used green yellow and red colors. The visual feedback system delivered prompt formative assessment which modern schools utilize through interactive teaching methods while technology-enhanced education models also adopt this approach [8] [9]. Through the "trailers" technique students could self-track their activities which helped them understand their preferred and most difficult tasks. The customized approach simultaneously maintained student motivation while building their autonomy and ownership of tasks which are vital elements for creativity development in educational learning [10]. Student metacognitive processes gained an emotional component through assessments constructed with categories like “liked/bored” or “fun/sad” during reflective activities. The Fourth Industrial Revolution recognizes emotional states as essential learning outcomes [11] so this reflective method worked both for diagnosis and motivation. Through this process students recognized the relationship between their emotions and understanding which led teachers to develop new instructional approaches. Students gained self-monitoring skills during the summary phase when they assessed their personal and group methods followed by adaptations. Students gained autonomy through the system because they learned to recognize learning requirements while evaluating their peers' impact before changing their mental processing techniques. The educational approach follows OECD suggestions for developing creative and critical thinking in educational institutions [12]. This investigation demonstrates that both cognitive and emotional reflection serves as a fundamental instructional tool to support the development of creative thought in chemistry teaching. The approach becomes more effective when applied methodically because students evolve from knowledge consumers into meaning builders who take ownership of their learning. The study appears to support earlier work that shows how students build mental structures through assigned learning activities [13] and demonstrates why reflective practice needs purposeful implementation in classrooms.

CONCLUSIONS

The research investigates core approaches which help develop creative abilities in chemistry education through the combination of problem-based assignments and reflective instructional methods. Students achieved originality and sociability and cognitive independence through their structured participation in research-oriented and exploratory activities. Teachers lead the process of developing educational content which stimulates imagination and initiative in students. Active creative thinking development occurred when students participated in discussions and solved problems through various methods. The current study presents methods to increase student creativity yet future investigations must assess extensive effects and generate universal teaching approaches that work across multiple educational systems and scholastic fields. If anti-corrosion measures are taken at the govermment level in time, then the economic benefits of these events for the country will be enormous.

REFERENCES

[1] Beghetto, R.A., Structured uncertainty: How creativity thrives under constraints and uncertainty, in Creativity under duress in education? Resistive theories, practices, and actions, 2019, pp. 27–40. http://dx.doi.org/10.1007/978-3-319-90272-2_2

[2] García-Alberti, M., Suárez, F., Chiyón, I., and Mosquera Feijoo, J.C., "Challenges and experiences of online evaluation in courses of civil engineering during the lockdown learning due to the COVID-19 pandemic", *Education Sciences*, 11(2), 59, 2021. https://doi.org/10.3390/educsci11020059

[3] Yang, K.K., Lee, L., Hong, Z.R., and Lin, H.S., "Investigation of effective strategies for developing creative science thinking", *International Journal of Science Education*, 38(13), pp. 2133–2151, 2016. http://dx.doi.org/ 10.3390/educsci14030248

[4] Yuan, R., Liao, W., Wang, Z., Kong, J., and Zhang, Y., "How do English-as-a-foreign-language (EFL) teachers perceive and engage with critical thinking: A systematic review from 2010 to 2020", *Thinking Skills and Creativity*, 43, 101002, 2022. https://doi.org/10.1016/j.tsc.2023.101363

[5] Newton, L.D., and Newton, D.P., "Creativity in 21st-century education", *Prospects*, 44, pp. 575–589, 2014. https://doi.org/10.1007/s11125-014-9322-1

[6] Zinovkina, M., "Multilevel continuous creative education at school", *Koncept (Kirov): Scientific and Methodological e-magazine*, No. 9, p. 15, 2012. (In Russian) https://nbn-resolving.org/urn:nbn:de:0168-ssoar-320790

[7] Krylova, M.N., Philology: Scientific Researches. (In Russian) https://doi.org/10.46539/jfs.v7i2.401

[8] Bilyk, V., and Bardadym, O.V., "Introduction of interactive teaching methods in modern schools", ***Інформаційно-комунікаційні технології в освіті***, 17(2), pp. 199–209, 2023. https://eprints.cdu. edu.ua/id/eprint/5498

[9] Polat, E.S., Bukharkina, M.Y., Moiseeva, M.V., and Petrov, A.E., *New pedagogical and information technologies in the education system*, Academy, Moscow, 2001, p. 76. (In Russian) http://dx.doi.org/10.1051 /e3sconf/201913504077

[10] Isaev, D., Sobolev, A., and Pak, M., "The Program of Extracurricular Activities in Chemistry: 'Chemistry for Curious Schoolchildren'", in *EDULEARN20 Proceedings*, IATED, pp. 5787–5797, 2020. https://doi.org/10.21125/edulearn.2020.1509

[11] López, Á., and Ibáñez, E., "Challenges of education in the 4th industrial revolution", in *The Fourth Industrial Revolution and Its Impact on Ethics: Solving the Challenges of the Agenda 2030*, 2021, pp. 139–150. https://link.springer.com/chapter/10.1007/978-3-030-57020-0_11#citeas

[12] Vincent-Lancrin, S., González-Sancho, C., Bouckaert, M., De Luca, F., Fernández-Barrerra, M., Jacotin, G., et al., *Fostering Students' Creativity and Critical Thinking: What It Means in School*, Educational Research and Innovation, OECD Publishing, Paris, 2019. **ISBN:** 978-9-2646-8400-3

[13] Honcharuk, V., Zadorozhna, O., and Parakhnenko, V., "Formation of cognitive activity of students in the process of studying chemistry", *Pedagogy and Education Management Review*, 3(17), pp. 43–56, 2024 https://doi.org/10.36690/2733-2039-2024-3-43-56