DESIGNING PROJECT-BASED LEARNING AND PROBLEM-BASED LEARNING ACTIVITIES IN NATURAL SCIENCE SUBJECT TO PROMOTE GROWTH MINDSETS FOR SECONDARY SCHOOL STUDENTS

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ABSTRACT

This research addresses the pedagogical necessity of transitioning from traditional didactic instruction toward student-centered paradigms—specifically Project-Based Learning (PBL) and Problem-Based Learning—to cultivate a growth mindset within the Natural Science curriculum. The study proposes a systematic five-step design framework that operationalizes the integration of mindset interventions into scientific inquiry. This framework guides educators through a structured progression: identifying specific cognitive mindset goals, engineering authentic complex tasks, and developing formative assessment rubrics that prioritize iterative learning processes over summative content acquisition. By integrating the biological principles of neuroplasticity into the "Living Things" curriculum unit, the study provides a physiological basis for cognitive malleability. This allows students to engage in multi-dimensional inquiry where errors are analyzed as informative data points rather than terminal failures. The findings suggest that the synthesis of student-centered instruction and neuroscientific education fosters both disciplinary scientific competencies and the adaptive resilience required for navigating contemporary technological environments.

KEYWORDS

Project-Based Learning, Problem-Based Learning, growth mindset, natural science, secondary school students

1. INTRODUCTION

Contemporary educational reforms increasingly underscore the necessity of cultivating learners' competencies for the twenty-first century, particularly their capacity for critical thinking, collaborative problem-solving, and adaptability in dynamic scientific and technological contexts (Rusmin et al., 2024) [1]. Within this paradigm, the promotion of a growth mindset—the belief that intellectual abilities can be developed through deliberate effort, effective strategies, and constructive feedback—has emerged as a pivotal objective in enhancing students' long-term academic engagement and resilience (Kate M. Xu, 2025)[2]. Empirical research consistently indicates that students who internalize a growth mindset demonstrate higher levels of motivation, persistence in the face of difficulties, and openness to challenging learning tasks, all of which are essential for successful engagement with scientific inquiry (Ramadhona et al., 2025) [3]. The findings indicate that adopting a growth mindset enhances students' self-efficacy and their ability

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to regulate effort, thereby contributing to better academic achievement—particularly among learners in rural schools (Ba et al., 2025) [4].

2. GROWTH MINDSET

The concept of growth mindset originated from research on individuals' implicit theories of intelligence—specifically, their beliefs regarding the malleability of cognitive abilities. In her seminal work, Dweck (2006) [5] differentiated these beliefs into two categories: the fixed mindset and the growth mindset. Individuals who adopt a growth mindset view intelligence and talent as qualities that can be developed through sustained effort, deliberate practice, and continuous learning. Since its introduction, the construct has rapidly gained prominence in educational and psychological research. Various theoretical perspectives, including positive psychology, self-determination theory, and learned helplessness, have been employed to further expand and enrich the conceptual foundations of the growth mindset. The growth mindset, commonly defined as the belief that intelligence and abilities can be developed through effort and learning, contributes not only to academic achievement and mental well-being but also to advancing educational equity, economic productivity, and social mobility (Haimovitz and Dweck, 2017; Dweck and Yeager, 2019) [6], [7].

A substantial body of empirical studies has provided evidence for the positive effects of a growth mindset on students' academic and socio-emotional development (Sousa & Clark, 2025) [8]. In recognition of its critical role in shaping learners' motivation and achievement, researchers have increasingly examined the antecedents and conditions that support its development (Sungur&Senler, 2010) [9]. Several contributing factors—such as parental beliefs, student grit, and teachers' formative feedback—have been identified as positively associated with the cultivation of a growth mindset (Jin et al., 2025) [10]. Past research underscores how the interplay between **expectancy and value** defines student motivation in math, while also confirming that a **growth mindset** consistently improves outcomes across the board. Conversely, the success of specific teaching strategies seems to rely on the surrounding environment, implying that mathematics educators should tailor their methods to align with the local cultural context. (Jeong et al., 2025) [11]. Our earlier research demonstrated, both theoretically and through empirical analysis, a clear association between the features of the 5E instructional model and experiential learning with students' corresponding expressions of self-efficacy and motivation in biology learning.

The natural science curriculum, which encompasses core domains of physics, chemistry, biology, and earth science, provides fertile ground for pedagogical innovation aimed at cultivating these dispositions (Ministry of Education, 2018) [12]. However, instructional practices in many educational settings remain predominantly teacher-centered, often emphasizing content transmission over inquiry, exploration, and reflective reasoning (Alam, 2023) [13]. Such approaches may limit opportunities for students to meaningfully engage with complex scientific problems, to revise their conceptions based on evidence, and to experience the iterative nature of scientific knowledge construction—conditions widely recognized as conducive to the development of a growth mindset (Morris, 2025) [14]. Teaching about neuroplasticity can enhance both students' motivation and their neural engagement, with perceived competence playing a key mediating role in this link (Blanchette Sarrasin et al., 2025) [15].

Against this backdrop, project-based learning and problem-based learning have garnered substantial attention as instructional methodologies capable of fostering deeper conceptual understanding and higher-order cognitive processes (Su et al., 2025) [16]. Both approaches situate learning within authentic, often interdisciplinary, problem contexts that require sustained inquiry, collaborative engagement, evidence-based reasoning, and continuous reflection (Manalo

& Chua, 2020) [17]. These characteristics closely align with theoretical constructs underpinning growth mindset development, including productive struggle, persistence, adaptive strategy use, and valuing feedback as a tool for improvement (Wolcott et al., 2020) [18]. In the Vietnamese context, focusing on how science is applied and why it matters for future careers is a powerful driver for student interest in STEM [19]. This approach aligns with growth mindset principles by demonstrating that abilities are developed through purposeful practice and that academic challenges are meaningful steps toward a long-term professional identity.

Despite the documented strengths of project-based learning and problem-based learning, there remains a notable gap in the literature regarding the intentional design of such learning activities to explicitly promote students' growth mindset within the natural science discipline. Existing studies largely prioritize cognitive or performance-oriented outcomes, while the systematic integration of mindset-supportive elements—such as structured opportunities for reflection, normalized experiences of challenge, and explicit emphasis on learning processes—has received limited attention. Addressing this gap is of particular importance for educational systems seeking to simultaneously strengthen scientific competencies and nurture adaptive learner dispositions.

This study seeks to contribute to this emerging field by developing and analyzing a framework for designing project-based learning and problem-based learning activities in natural science that explicitly embed principles of growth mindset pedagogy. The research aims to elucidate design features that support students' adaptive beliefs about learning, enhance their engagement with scientific inquiry, and promote resilience in the face of academic challenges. These results aim to provide a blend of theoretical frameworks and actionable strategies for teachers, curriculum designers, and officials dedicated to fostering mindset-focused science programs.

3. METHODOLOGY

This research uses a theoretical research method to analyze the benefits of promoting growth mindset in problem-based learning and project-based learning activities in the 2018 General Education Curriculum for Natural Sciences at the lower secondary level in Vietnam, aiming to identify teaching activities that promote growth mindset in students. The research process was conducted as follows:

1) Literature search: The first step of the research was to search for literature related to project-based learning, problem-based learning, and the general education curriculum for natural sciences, especially documents specifying the objectives, content, teaching methods, and assessment of the program. Literature related to teaching theories aimed at promoting growth mindset, models, and processes for constructing teaching activities was also collected and reviewed.

2) Sources: The main sources include research papers, documents, etc., on the 2018 General Education Curriculum. Professional materials: Textbooks, reference books, and scientific articles in the field of pedagogy and teaching oriented towards promoting growth mindset.

3) Document Analysis: The collected materials were systematically analyzed into groups: the benefits of problem-based learning and project-based learning; the content of topics in the curriculum that can be used to organize teaching that promotes growth mindset; and the orientation for designing teaching activities.

4) Analysis and Synthesis: The study conducts an analysis to identify teaching activities that promote growth mindset, thematic content, and the ability to organize teaching oriented towards promoting growth mindset. From this, the study synthesizes and proposes a process for building

teaching activities to enhance growth mindset through the subject, specifically illustrated in the natural science subject.

4. RESULTS AND FINDINGS

4.1. Learning Activities to Promote Students' Growth Mindset in Natural Science Subject

Problem-Based Learning

Problem-based learning is a student-centered teaching strategy where learning occurs through the process of solving real-world, complex problems that often do not have a single, clear answer. Instead of being given information first and then solving the problem, students begin with the problem and then seek and acquire the necessary knowledge to solve it.

Table 1. Opportunities for fostering a growth mindset through problem-based learning activities

Project-based learning activities	**Opportunities to foster a growth mindset.**
Presenting the problem: The teacher introduces an open-ended, complex, and practically significant problem that relates to life and the community.	Developing complex problem-solving skills: Students face real-world situations that require multi-dimensional thinking, experimentation, and adaptation. Each time they encounter a deadlock and find a solution, their thinking skills are strengthened. Enhancing learning motivation: Practical, relatable problems make learning more meaningful and engaging, thereby increasing enthusiasm for learning.
Identifying necessary knowledge: Students, often working in groups, analyze the problem, identifying what they already know and what they need to learn further to solve it.	Promoting critical thinking and analysis: To solve problems, students must know how to ask questions, analyze information, and evaluate the logic and reliability of solutions. Encouraging collaboration and communication skills: Students learn to listen, share ideas, persuade, and overcome obstacles together.
Planning and information gathering: Students independently direct their learning, seeking information from various sources (textbooks, the internet, interviews, surveys, etc.), analyzing and synthesizing the information.	Enhancing autonomy and responsibility: Students take responsibility for their own learning process, managing their time and resources to find solutions. This helps them feel that their abilities are recognized.
Solution development and evaluation: Teams propose feasible solutions, present supporting arguments and evidence, and then self-evaluate and critique the solutions.	Believing in the possibility of improvement: Students find that the quality of their solutions improves with effort and revision. Learning from mistakes: Self-assessment and critical thinking help them view mistakes as learning opportunities. Evidence-based thinking: Reasoning and finding evidence cultivate a habit of learning and self-improvement. Developing perseverance: Trial and error and improvement help form the habit of not giving up.
Presentation and Evaluation: Groups present their solutions, receive feedback, and reflect on their learning process and the skills they have developed.	Learning to accept feedback: Students view feedback as opportunities for improvement rather than criticism, thereby developing a positive attitude towards learning. Recognizing the value of effort: The process of presenting solutions helps students realize that success comes from research, experimentation, collaboration, and perseverance. Reflecting on the learning process: Students analyze what they did

	well and what they did not, learn to adjust their learning strategies, and understand that abilities can be developed through practice.

Project-Based Learning

Project-based learning is a teaching method in which students work for a significant period of time (several weeks or an entire semester) to investigate, respond to, and solve a complex and engaging problem, question, or challenge. Typically, these projects culminate in a tangible deliverable or a public showcase designed for immediate real-world use.

Table 2. Opportunities to promote growth thinking through project-based learning activities.

Characteristics of project-based learning	**Opportunities to foster a growth mindset.**
Interdisciplinary nature: Projects often require students to apply knowledge and skills from various disciplines. Authenticity/Reality: Projects often relate to real-world problems or situations or have significance for the community.	Developing skills in synthesizing and applying knowledge: Students are required to connect pieces of knowledge from multiple subjects to complete the project, thereby seeing the meaning and applicability of what they have learned.
There is a specific product: Students create a tangible or intangible product (report, video, model, event, etc.).	Increased engagement with learning goals: When students have a clear goal of creating a specific and meaningful product, their motivation to learn will be much higher.
Challenging: The project requires research, creativity, and problem-solving; there are no ready-made answers.	Stimulating creativity and innovation: Projects often lack a fixed format, encouraging students to come up with unique ideas and create products with their own personal touch. Mistakes in the creative process are seen as opportunities for learning and improvement.
Collaboration and autonomy: Students work in teams, manage their own processes, and take responsibility for the results.	Strengthening teamwork, communication, and presentation skills: Working on a long-term project helps students develop skills in listening, critical thinking, task delegation, conflict resolution, and effectively presenting ideas. Enhancing self-learning and time/project management abilities: Students independently plan, delegate tasks, manage progress, and allocate resources. These skills are crucial for future success.

Some learning activities that promote a growth mindset in natural sciences subject

By synthesizing growth mindset benefits from active learning models with the requirements of the natural science curriculum, we have developed the following activities focused on living things:

Table 3. Some learning activities aimed at promoting a growth mindset in natural science (living things section)

Topic/Content	**Learning activities that foster a growth mindset**
Grade 6	
Cells – the basic units of life	Project: “3D Cell World” – Students design cell models (animal/plant) using recycled materials; present the function of each organelle. Problem-based learning: “What would happen if cells didn’t have membranes/chloroplasts/mitochondria?” – Students reason and explain.

Diverse habitats	Project: "Building a local dichotomy key" – Students collect samples/photos of local organisms and create a classification key. Problem-based learning: "Why is it necessary to classify organisms?"
Viruses – Bacteria – Fungi	Project: "Applications of microorganisms in practice" – Students learn about the process of creating fermented products using microorganisms and create yogurt, vinegar, fermented pork sausage, etc. Students propose ideas for creating products using microorganisms, research to implement the project, and if successful, adjust the steps and repeat the process according to the adjusted procedure. Problem-based learning: "Why does food spoil easily? How can we limit spoilage?"
Grade 7	
Metabolism & Energy – Photosynthesis	Project: "Scientific Gardening" – Students plant trees under different light conditions, measure height, number of leaves, etc. Problem-based learning: "Why are indoor plants often weaker than outdoor plants?"
Cellular respiration	Project: "Seed Germination – Where Does the Energy Come From?" – Observing germinating seeds, measuring temperature, comparing conditions. Problem-Based Teaching: "Why do seeds spoil easily when stored in moist conditions?"
Gas exchange – water exchange	Project: "Where does water go in plants?" – Students explore and experiment to design an experiment on water transport using food coloring and stomata models. Problem-based learning: "Why do plants wilt in the sun?"
Growth and development	Project: "Growing Every Day" – Tracking the growth of plants or small animals (such as earthworms). Problem-based learning: "What makes plants grow faster?"
Reproduction in organisms	Project: "Is plant propagation easy or difficult?" – Cuttings, layering, comparing success rates. Problem-based learning: "Why do farmers prefer using clonal varieties in cultivation?"
Grade 8	
Digestive and Nutritional System	Project: "Developing a Healthy School Menu" – Students analyze nutrition and design a one-week menu. Problem-Based Learning: "Why does eating too much greasy food easily cause illness?"
Sensory nervous system	Project: "The ability to learn new skills, the plasticity of the nervous system" Problem-based teaching: "Why do we react quickly to hot objects?"
Grade 9	
From genes to proteins	Project: "Applications of DNA analysis in paternity testing and crime investigation". Problem-based teaching: "Why do some people carry gene mutations but not show symptoms, while others show severe symptoms? What determines whether a gene is 'expressed' as a protein?": Developing a growth mindset by understanding: Genes don't determine everything, the body has compensatory mechanisms, and phenotypes can change depending on the environment and habits.
Chromosomal inheritance	Project: "Creating a teaching model of the process of mitosis and meiosis": Students propose ideas for designing diagrams and models using materials or electronic learning resources, experiment with different methods and redo them if they don't meet the requirements, and exchange ideas and discuss to improve the steps involved.
Applying genetic technology to daily life.	Project: Application of genetic technology in medicine, forensic science, environmental cleanup, agriculture, and biosafety.

4.2. Procedure of Designing Learning Activities for Comprehensive Growth Mindset for Students in Teaching Natural Science

The general principles in designing teaching and learning activities that promote critical thinking in students in Natural Sciences are: student-centered learning, focusing on exploration, application, and critical thinking; learning situations must be practical, with problems or product requirements; students must go through a thinking process: asking questions → searching for information → analyzing → proposing solutions → critical thinking → refining; encouraging multiple correct answers and developing competencies such as problem-solving, creativity, collaboration, communication, and information technology use.

4.2.1.General Procedure

Based on the content of the secondary school natural science curriculum and the goal of promoting growth mindset, we propose the following 5-step process for designing teaching and learning plans:

Step 1. Identify project topics that have the opportunity to promote growth mindsets based on the learning objectives of the content topic in the curriculum.

Project topics should be linked to the lesson/chapter content and related to practical problems. Topics should have the potential to create products (models, posters, videos, scientific reports, initiatives).

Step 2. Identifying growth mindsets goals

To define the lesson objectives, it is necessary to base them on the learning objectives of the content topic in the natural science curriculum and the goals of promoting growth mindset such as analytical and evaluative skills, critical thinking, creative thinking, the ability to solve real-world problems, natural science competence (understanding - exploring nature - applying knowledge), effort, overcoming difficulties and challenges, etc.

Step 3. Determine the content, methods, and teaching equipment of the lesson.

Based on the lesson objectives, the teacher selects appropriate content, methods, and teaching equipment.

Step 4. Design the learning activity process to promote a growth mindset.

This includes the stages of project-based learning:

1. Introduction – Assigning Tasks

Present a real-world scenario (video, picture or data), students propose questions and the teacher is working on the project.

Develop guiding questions: Guiding questions should be open-ended, offer multiple solutions, and guide students to independently explore the knowledge.

2. Planning: Group work, assigning roles, determining timeframes, and defining the product to be created.

3. Project Implementation: Research materials, conduct experiment and surveys, collect and analyze data, and develop a project methodology.

- Completing the product: Model, poster, video, research report.

4. Presentation – Critique: Students present their results; groups critique each other, and the teacher supplements the information with accurate scientific knowledge.

5. Evaluation – Self-evaluation – Lessons learned: Evaluation rubrics assess the process, product, and thinking skills.

Step 5. Design evaluation tools to assess teaching and learning outcomes to promote cognitive development after the lesson.

Evaluation tools that promote cognitive development in natural science can include multiple-choice questions, learning journals, product/project evaluation rubrics, self-evaluation through checklists, etc.

4.2.2. Illustration for Designing Learning Activities to Enhance Growth Mindset for Students in Teaching Natural Science Grade 8 (Section Of Living Things)

Topic: The nervous system

Duration: 2 lessons

I. Objectives

1. Competencies

* Natural science competencies: observation, data collection, model interpretation, conclusion presentation.

- Describe the structure and role of the nervous system in controlling bodily functions.

- Understand the concept of neuroplasticity and factors that help the brain learn better.

- Analyze situations demonstrating the nervous system's ability to change and adapt.

* General Competencies: Problem-solving & Creative Skills: Designing project products; proposing ways to enhance brain function.

Communication & Collaboration Skills: Teamwork, project reporting.

* Growth Mindset:

- Developing observation, analysis, and information synthesis skills.

- Recognizing the plasticity of the nervous system: how the brain develops when faced with challenges.

- Explaining, based on science, the benefits of a growth mindset.

2. Qualities

- Diligence: Consciously protects and cares for the health of the nervous system.

- Honesty: Provides accurate feedback on completed tasks, confidently asks questions, and requests support when encountering difficulties in completing learning tasks.

- Growth Mindset: Recognizes that the brain can change and become stronger through practice, thereby developing a growth mindset; accepts mistakes as learning opportunities; cultivates perseverance and overcoming difficulties during project completion.

II. Teaching aids and materials: pictures, videos, models of the nervous system structure, nerve plasticity

II. Teaching and Learning Process

Warm-up

Game: Quick reflexes (drop a ruler to measure reaction time → students measure and compare).

Question: “Why do each person have different reflexes? Which part controls that?”

Forming New Knowledge

Activity 1: Exploring the Structure of the Nervous System

- The educator partitions the class into teams of 4–6 members and delegates the following responsibilities:

Observe the video and discuss the following content, presenting it in the form of a mind map:

+ Learn about the structure and function of the nervous system. Give illustrative examples of the nervous system's activity.

+ How does the human brain function when performing a new task? What is neural plasticity?

- The teacher shows a video about the structure of the nervous system and nerve plasticity.

- Groups discuss and present their findings using mind maps on A4 paper.

- Representatives from two groups present their discussion results; other groups add comments and suggestions, and ask questions.

- The teacher supports and encourages students to actively participate in the discussion, complete the task, and express their opinions. The teacher summarizes and evaluates the results.

Activity 2: Project “Enhancing Brain Power: Neuroplasticity in Learning and Life”

Project topic proposal and selection

The teacher poses the guiding question: “How can we help the brain become smarter and learn better based on the plasticity of the nervous system?”

Students present project ideas based on the teacher's given problem, for example:

- An analysis of nervous system components—both central and peripheral—their physiological functions, and the mechanisms of neuroplasticity demonstrated through case studies.

- Small scientific research: Designing a simple experiment to test reflexes, information processing speed, or memory; recording data, describing, and explaining.

- Designing communication products: Video "How to make your brain stronger?", a poster promoting neuroplasticity; the handbook "10 habits to boost brain power" and a 3D model of the nervous system with annotations on neuroplasticity.

Promoting the growth mindset: Teachers assign open-ended tasks, giving students the opportunity to propose ideas, approach problems from different perspectives, and connect them to real-world situations.

Developing project plans: Groups create plans and assign tasks for project implementation.

Promoting the growth mindset: Teachers emphasize that “mistakes are also learning opportunities”; students are encouraged to generate many ideas, even if they are incomplete, focusing on effort and progress, and connecting them to local realities.

Project implementation: Groups implement the project according to plan, gathering information, designing the product, discussing and providing feedback within the group to refine the product plan.

Promoting the growth mindset: Teachers support, guide, and create opportunities for students to explore and discover. If the product is not good, students are encouraged to discuss in groups to find errors, try improvements, and try again. Students learn to turn challenges into creative opportunities. When the initial product is not satisfactory, they must find ways to improve it, experiment with new materials and techniques. This fosters perseverance, breakthrough thinking, and belief in their ability to create value.

Product report

Each group presents for 3–5 minutes. Other groups ask critical questions.

The teacher provides feedback.

Promoting a growth mindset: Students draw the conclusion: “Our brains can always improve. Failure is just a signal that helps the nervous system learn.”

The teacher emphasizes: The brain develops through practice; mistakes are opportunities to learn, and effort in learning helps the brain create new neural connections. The teacher encourages students to keep a journal: “What challenges did I overcome today?”

Evaluating the outcome

- Students self-assess their group and individual progress, sharing what they have learned (Teacher suggests the question: "How has your thinking changed today?")

- Regular assessment: Observing group activities, question-and-answer sessions, experiment reports

Table 4. Rubric for evaluating project products and the level of growth mindset demonstrated

Criteria	**Level 1**	**Level 2**	**Level 3**	**Level 4**
1.Scientific content	Many errors; incomplete.	Relatively correct, but incomplete.	Accurate, there are illustrative examples.	Very accurate, expands knowledge beyond what's in the textbook.
2.Explain neuroplasticity.	Stated very generally	State the basic concept	Explain clearly, with examples.	In-depth explanations, relevant to learning and life.
3. Experiment – Data Analysis	Incomplete documentation, lack of analysis.	Measurements were taken, but the analysis was limited.	The analysis is quite clear and includes comparisons.	Conduct in-depth analysis, draw logical conclusions, and relate it to neuroplasticity.
4.Product Innovation	Simple, few ideas	There are 1–2 creative points.	Attractive, with investment	Unique, showcasing innovative thinking.
5.Teamwork skills	Less involvement or conflict	Assignment of tasks, but not yet effective.	Active cooperation and mutual respect.	Working together seamlessly and supporting each other to overcome difficulties.
6. Presentation – Communication	Confused, lacking confidence	Easy to understand, but still disjointed.	Present clearly and logically.	Persuasive, using engaging illustrations.
7.Growth mindset	Students do not yet demonstrate a growth mindset; they are afraid of making mistakes; they are reluctant to experiment; and they believe that their abilities are fixed.	Students are willing to try but easily give up when they encounter errors; they have an initial awareness of neuroplasticity but have not yet applied it.	Students demonstrates perseverance and a willingness to correct mistakes; believes that practice leads to improvement; and knows how to apply neuroplasticity to improve the product.	Students demonstrates a high level of growth thinking: proactively learning from mistakes; suggesting ways to improve; using growth mindset language (“I didn’t succeed, but I’ll try again”); and encouraging peers to progress together.

5. Conclusions

This research highlights the necessity of shifting away from teacher-centered instruction toward student-centered models, such as project-based and problem-based learning, to foster a growth mindset within the natural science curriculum. These approaches place learners in authentic, complex situations that require multi-dimensional thinking, persistent inquiry, and collaborative problem-solving. To support this transition, the study offers a systematic five-step design framework that guides teachers through identifying mindset goals, planning activities, and creating evaluation tools that emphasize the learning process over simple content transmission.

Furthermore, by integrating lessons on neuroplasticity, the study demonstrates how students can be shown scientific evidence that their cognitive abilities are malleable and can be strengthened through effort. Applying these principles to the “Living things” section of the curriculum allows students to reframe mistakes as feedback rather than failures, encouraging them to persist when facing academic challenges. Ultimately, this pedagogical shift ensures that students develop both core scientific competencies and the resilient, adaptive dispositions needed for success in a dynamic technological landscape.

To advance the field of growth mindset pedagogy in natural science, future research should move beyond the current focus on biological topics to explore how the proposed design framework can be adapted for physical and chemical sciences. Longitudinal studies are needed to determine if the mindset shifts fostered by these inquiry-based activities persist as students encounter more rigorous academic environments. Additionally, investigating the role of teacher professional development is crucial, as the successful shift from traditional methods to mindset-oriented instruction depends heavily on educators’ own implicit beliefs. Further exploration into the integration of educational technologies, such as virtual reality to visualize neuroplasticity , and the development of more robust, quantitative assessment tools to complement qualitative rubrics would provide a more comprehensive understanding of student progress. Finally, expanding this research to include diverse learner populations and home-school partnerships will ensure that these interventions effectively promote educational equity and long-term academic resilience.

REFERENCES

[1] L. Rusmin, Y. Misrahayu, F. Pongpalilu, R. Radiansyah, and D. Dwiyanto. (2024). "Critical Thinking and Problem-Solving Skills in the 21st Century," *Join: Journal of Social Science*, vol. 1, pp. 144-162.

[2] J. L. Kate M. Xu, Lisette Wijnia. (2025). "A review of the relationship between student growth mindset and self-regulated learning," *Front. Educ.*, vol. 10 - 2025

[3] R. Ramadhona, H. Sutrisman, S. Padua, A. Sicat, B. Kusumo, and R. Simanjuntak, (2025). "The Effect of Growth Mindset on Student Academic Resilience: Comparative Studies in Indonesia and Malaysia," *Darussalam: Journal of Psychology and Educational*, vol. 3, pp. 107-122, 04/24 2025.

[4] Y. Ba, W. Ming, and H. Zhang. (2025). "Unlocking academic success: How growth mindset interventions enhance student performance through self-belief and effort regulation," *Acta Psychologica*, vol. 256, p. 104977, 2025/06/01/ 2025.

[5] C. S. Dweck. (2006).*Mindset: The new psychology of success, Mindset: The new psychology of success.* Random House

[6] C. S. D. Kyla Haimovitz. (2017). "The Origins of Children's Growth and Fixed Mindsets: New Research and a New Proposal," *Child Development*, vol. 88, no. 6, pp. 1849–185,

[7] C. Dweck and D. Yeager. (2019). "Mindsets: A View From Two Eras," *Perspectives on Psychological Science*, vol. 14, p. 174569161880416

[8] B. J. Sousa and A. M. Clark. (2025). "Growth mindsets in academics and academia: a review of influence and interventions," *Journal of Higher Education Policy and Management*, vol. 47, no. 1, pp. 38-56.

[9] S. Sungur and B. Senler. (2010). "Students' achievement goals in relation to academic motivation, competence expectancy, and classroom environment perceptions," *Educational Research and Evaluation*, vol. 16, pp. 303-324.

[10] X. Jin, J. Guan, and T. Li. (2025). "The influencing factors of growth mindset: A systematic literature review," *Educational Research Review*, vol. 49, p. 100735.

[11] D. Jeong, S. G. Kim, and M. Bong. (2025). "Gender, mindset, and teacher support predict students’ math motivation profiles: Evidence from five countries in PISA 2022," *Contemporary Educational Psychology*, vol. 83, p. 102428.

[12] Vietnam Ministry of Education. (2018). *General Education Curriculum*. Available: https://moet.gov.vn/tintuc/pages/tin-hoat-dong-cua-bo.aspx?ItemID=5755

[13] M. Alam. (2023). "FROM TEACHER-CENTERED TO STUDENT-CENTERED LEARNING: THE ROLE OF CONSTRUCTIVISM AND CONNECTIVISM IN PEDAGOGICAL TRANSFORMATION," vol. 11, pp. 154-167

[14] D. Morris. (2025). "Rethinking Science Education Practices: Shifting from Investigation-Centric to Comprehensive Inquiry-Based Instruction," *Education Sciences,* vol. 15, p. 73.

[15] J. Blanchette Sarrasin *et al.* (2025). "Effects of teaching neuroplasticity on motivation, inhibitory control and task performance, and the role of mindset theory," *Trends in Neuroscience and Education,* vol. 40, p. 100257.

[16] T. Su, J. Liu, L. Meng, Y. Luo, Q. Ke, and L. Xie. (2025). "The effectiveness of problem-based learning (PBL) in enhancing critical thinking skills in medical education: a systematic review and meta-analysis," *Frontiers in Education,* vol. 10.

[17] F. Manalo and E. Chua. (2020). "Collaborative Inquiry Approaches and Level of Thinking and Reasoning Skills: Basis for Sustainable Science Education," *International Multidisciplinary Research Journal,* vol. 2, pp. 91-98.

[18] M. Wolcott *et al.* (2020). "A review to characterize and map the growth mindset theory in health professions education," *Medical education,* vol. 55.

[19] Ho Thi Hong Van, Le Ngoc Hoan and Dinh Quang Bao(2018). "Effect of Teaching Approaches in Stem Career Orientation for Students Through Biology Learning in Vietnam," *International Journal of Education (IJE),* vol. 6, No. 4.

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