NEURODIDACTIC STRATEGIES FOR INCREASING MOTIVATION AMONG HIGH SCHOOL STUDENTS IN LEARNING PSYCHOLOGY

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Abstract: *The article presents the results of a pedagogical research that capitalizes on neurodidactic strategies applied in learning Psychology in high school by creating an attractive educational environment that supports neuroplasticity and stimulates the secretion of "learning molecules" (dopamine, serotonin, noradrenaline, acetylcholine, endorphins) and that facilitates dynamic learning through activities adapted to the nervous system's functioning style. It is known that the modern instructional-educational process emphasizes the involvement and active participation of students in their own learning, with the teacher playing more of a facilitator and learning partner. Neurodidactic strategies prove their effectiveness in educational practice by being adapted to students' interests and learning styles, promoting student involvement, collaboration and leading to increased learning motivation. Motivation is considered an essential factor in learning, as it facilitates and guides student behavior. This is influenced by neurotransmitters such as dopamine, oxytocin, serotonin and endorphins, considered the "happiness chemicals". Dopamine supports motivation and reward, oxytocin promotes trust and cooperation, serotonin contributes to emotional balance and concentration, and endorphins reduce*

stress and increase well-being. Through interactive activities based on neurodidactic strategies, teachers can stimulate these chemical compounds, facilitating collaborative, engaging learning and active student participation. The research results highlight the impact of interactive activities carried out in the Psychology (high school) subject based on neurodidactic strategies on the learning motivation of 41 high school students from the city of Piteşti, Argeş County.

Keywords: *neurodidactic strategies; neuroplasticity; motivation; neurotransmitters; active learning.*

Introduction

Human development, also referred to as ontogenesis, represents a complex and continuous process characterised by the simultaneous presence of continuity and change. Continuity provides stability over time and contributes to the formation and preservation of personal identity, behavioural patterns, and individual characteristics. In contrast, change reflects developmental progress, adaptation, and transformation resulting from biological maturation, environmental influences, and learning experiences. Within this framework, child development is traditionally described through three major dimensions: growth, maturation, and learning. Among these dimensions, learning occupies a central position because it enables individuals to acquire knowledge, develop competencies, form new abilities, and adapt effectively to an increasingly complex social and cultural environment.

Education plays a fundamental role in supporting this developmental process. Its purpose extends beyond the simple transmission of information, as educational experiences contribute to the development of cognitive abilities, social competencies, attitudes, values, and personal characteristics. Through education, individuals are provided with opportunities to understand themselves and the world around them, to develop critical thinking, and to acquire skills necessary for lifelong adaptation. Consequently, contemporary educational systems increasingly emphasise learner-centred approaches that encourage active participation, autonomy, responsibility, and meaningful engagement throughout the learning process.

Teaching and learning constitute a planned, systematic, and goal-oriented educational process through which knowledge is transmitted, competencies are developed, and students' personal growth is

supported. Modern perspectives on education consider teaching and learning as a dynamic interaction rather than a unidirectional process in which teachers simply deliver information and students passively receive it. Instructional activities are expected to contribute not only to academic achievement but also to the development of attitudes, values, creativity, critical thinking, problem-solving abilities, and lifelong learning skills.

One of the defining characteristics of contemporary education is the transition from teacher-centred instruction towards learner-centred pedagogy. Within this approach, students are encouraged to become active participants in constructing their own knowledge, while teachers assume the role of facilitators who organise meaningful learning experiences and create supportive educational environments. Such educational practices promote deeper understanding, independent thinking, autonomy, and increased student engagement. Instead of perceiving learners as passive recipients of information, learner-centred approaches recognise students as active agents who interpret, organise, and apply knowledge through personal involvement.

This perspective is consistent with constructivist theories of learning, according to which knowledge is actively constructed through interaction with the environment, previous experiences, and social participation rather than passively received from the teacher. Learner-centred instruction therefore encourages students to engage in inquiry, reflection, and collaborative meaning-making, resulting in deeper conceptual understanding and long-term knowledge retention (Bruner, 1961; Vygotsky, 1978).

Instructional strategies represent a fundamental component of effective educational practice. They involve the deliberate selection, organisation, and integration of teaching methods, learning activities, educational resources, and classroom management approaches in order to achieve specific learning objectives. Effective instruction does not rely on isolated teaching techniques but requires the design of coherent learning sequences adapted to students' interests, previous knowledge, developmental characteristics, and individual learning needs. Therefore, developing appropriate instructional strategies represents a continuous professional challenge for teachers, who must constantly adapt their pedagogical approaches to the diversity of learners.

The effectiveness of contemporary teaching depends increasingly on flexibility, creativity, and responsiveness. Teachers are required to identify appropriate methods that transform learning into an active and meaningful process. In this context, active learning methods have gained considerable importance because they recognise students as participants responsible for managing and constructing their own

learning. These approaches encourage curiosity, exploration, critical thinking, problem-solving, collaboration, and reflection. Instead of passively receiving information, students actively construct knowledge through discussion, investigation, experimentation, practical application, and interaction with peers. Previous research has consistently demonstrated that active learning contributes to deeper understanding, improved knowledge retention, and enhanced academic achievement.

Within this educational framework, motivation represents one of the most important determinants of successful learning. Motivation fulfils both an activating and a directing function, providing the psychological energy required to initiate, maintain, and regulate behaviour towards meaningful educational goals. Learning motivation can therefore be understood as a set of internal processes that encourage students to acquire knowledge, develop competencies, engage with educational tasks, and persist when confronted with academic difficulties.

Educational psychology has consistently identified motivation as one of the strongest predictors of academic performance. Students who demonstrate higher levels of intrinsic motivation tend to invest greater effort in learning activities, show increased persistence, engage more deeply with educational tasks, and achieve better academic outcomes. Conversely, reduced motivation is frequently associated with disengagement, superficial learning approaches, decreased participation, and lower educational achievement (Deci & Ryan, 2000; Urhahne & Wijnia, 2023). Therefore, one of the essential responsibilities of teachers is to create learning environments capable of stimulating students' interest, maintaining attention, and supporting sustained engagement throughout the instructional process.

In addition to Self-Determination Theory, the Expectancy-Value Theory proposes that students' engagement depends on their expectations of success and the value they attribute to learning tasks (Eccles & Wigfield, 2002). Students are more likely to invest effort and persist when they believe they can succeed and perceive educational activities as personally meaningful.

Active-participatory teaching methods contribute significantly to the development of motivation because they promote curiosity, creativity, initiative, and collaboration. Through interactive activities, students become more willing to participate, communicate ideas, assume responsibility, and engage emotionally with learning tasks. Furthermore, collaborative learning contributes to the development of communication abilities, shared responsibility, interpersonal competencies, and positive relationships among students, while

simultaneously supporting academic motivation (Freeman et al., 2014; Dubinsky & Hamid, 2024).

Motivation also functions as an important mechanism of self-regulation. It influences how learners interpret educational experiences, respond to challenges, organise their efforts, and integrate new information into existing cognitive structures. Successful learning experiences can reinforce motivation through positive feedback mechanisms, creating a reciprocal relationship between achievement, confidence, and future engagement. As students experience success and perceive learning activities as meaningful, their willingness to participate and continue learning increases (Zimmerman, 2002; Sălăvăstru, 2004).

Recent advances in educational neuroscience have demonstrated that learning is influenced not only by instructional methods but also by biological mechanisms underlying attention, motivation, emotion, memory, and cognitive functioning. Neurodidactics has emerged as an interdisciplinary field combining neuroscience, psychology, and pedagogy in order to translate scientific knowledge about brain functioning into practical educational strategies. The main objective of neurodidactics is to develop teaching approaches that correspond more effectively to the way the brain processes, stores, and retrieves information (Dubinsky & Hamid, 2024).

Recent research further supports the educational relevance of neurodidactics by demonstrating that instructional models grounded in neuroscientific principles can significantly enhance students' motivation, self-regulation, and academic engagement. Brain-targeted teaching approaches create learning environments that integrate cognitive, emotional, and motivational processes, thereby promoting more meaningful and sustained learning experiences (Figueroa-Palacios et al., 2026).

Research on neuroplasticity has demonstrated that the brain remains capable of structural and functional reorganization throughout life in response to learning and experience (Doidge, 2007). These findings provide a biological rationale for educational interventions that promote active engagement, repeated practice, and emotionally meaningful learning experiences, all of which contribute to strengthening neural networks associated with long-term learning.

Recent systematic evidence further indicates that neurodidactic strategies based on spaced learning significantly support long-term memory consolidation and meaningful learning outcomes. By distributing learning activities over time and combining repetition with active engagement, these approaches facilitate durable knowledge retention and improve students' academic performance, providing

additional empirical support for neuroscience-informed instructional practices (Silva Sánchez et al., 2026).

From a neuroscientific perspective, motivational and emotional processes involved in learning are mediated by neurotransmitters. These specialised chemical messengers facilitate communication between neurons across synapses and regulate numerous physiological and psychological processes, including emotion, attention, memory, learning, sleep, motivation, and cognitive performance. Among the neurotransmitters considered particularly relevant in educational contexts are dopamine, oxytocin, serotonin, and endorphins, frequently described as "feel-good neurotransmitters" because of their contribution to psychological wellbeing. (Power, 2025)

Dopamine plays an essential role in motivation, reward processing, goal-directed behaviour, and reinforcement learning (Schultz, 2016). When students anticipate success, receive positive feedback, overcome challenges, or achieve meaningful goals, dopamine-related processes contribute to strengthening memory formation and increasing the desire to continue engaging in learning activities. Consequently, instructional strategies involving educational games, interactive challenges, achievement goals, and constructive feedback may stimulate dopaminergic activity and support sustained motivation.

Oxytocin contributes to trust, empathy, cooperation, and the development of positive social relationships. It is associated with supportive social interactions and contributes to reducing anxiety in collaborative environments. Students are more likely to participate actively when they perceive the classroom as psychologically safe and when they experience positive relationships with teachers and peers. Therefore, cooperative learning activities, teamwork, and group-based problem-solving provide favourable conditions for social connection and engagement, supporting processes associated with oxytocin activity.

Serotonin has an important role in emotional regulation, psychological wellbeing, sustained attention, and cognitive flexibility. Adequate serotonin functioning contributes to emotional stability, concentration, resilience, and the ability to manage complex learning situations. Educational environments characterised by positive feedback, recognition of students' achievements, emotional support, and a favourable classroom climate may contribute to maintaining emotional balance and cognitive readiness for learning.

Endorphins are naturally released during physical activity, laughter, enjoyable experiences, and situations requiring adaptation to stress. These neurochemicals contribute to reducing physical and emotional tension while promoting positive emotions, energy, and resilience. In

educational contexts, movement activities, creative tasks, enjoyable learning experiences, and elements of play may stimulate endorphin release, reducing anxiety and increasing students' willingness to engage with demanding cognitive tasks.

Collectively, dopamine, oxytocin, serotonin, and endorphins illustrate the biological foundations underlying effective learning experiences. When educational activities simultaneously stimulate motivation, social interaction, emotional wellbeing, and enjoyment, the learning process becomes more engaging, meaningful, and efficient. Therefore, neurodidactic strategies represent a promising approach for improving students' academic motivation and overall learning experience by integrating neuroscientific principles into everyday classroom practice.

More recent evidence also emphasizes that effective neuroeducational practice should not rely on isolated teaching techniques but rather on coherent instructional models that intentionally combine active learning, emotional regulation, collaborative experiences, and metacognitive reflection (Goset-Poblete et al., 2026). Such integrated approaches strengthen students' engagement while facilitating the transfer of neuroscientific knowledge into authentic classroom practice.

Against this theoretical background, the present study investigates the educational value of neurodidactic strategies designed to stimulate neurotransmitter-related processes in secondary school students. By integrating interactive, collaborative, and emotionally engaging learning experiences, these strategies aim to facilitate knowledge acquisition while simultaneously enhancing students' motivation, concentration, emotional wellbeing, classroom participation, and overall engagement in the learning process (Dubinsky & Hamid, 2024).

Research Methodology

Purpose

The primary aim of this study was to investigate the extent to which neurodidactic strategies based on interactive learning activities influence high school students' motivation to learn Psychology. More specifically, the research examined whether instructional activities designed to stimulate processes associated with dopamine, oxytocin, serotonin, and endorphins contribute to improvements in students' engagement, emotional wellbeing, classroom participation, and overall learning experience.

Objectives

The study pursued several specific objectives. First, it aimed to investigate students' levels of motivation and active participation

during Psychology lessons. Second, it examined the relationship between interactive neurodidactic activities and students' learning motivation. Third, it evaluated the effects of activities designed to stimulate dopamine-, oxytocin-, serotonin-, and endorphin-related processes on students' emotional states, interpersonal relationships, concentration, and classroom engagement. Finally, it sought to compare students' perceptions before and after the implementation of a neurodidactic intervention programme.

Hypothesis

Based on these objectives, the following hypothesis was formulated: the systematic integration of interactive neurodidactic activities into Psychology lessons would produce measurable improvements across all four investigated dimensions: motivation and engagement, interpersonal relationships and psychological safety, emotional balance and concentration, and stress reduction accompanied by positive emotional states.

It was expected that educational activities incorporating curiosity, collaboration, creativity, movement, challenge, positive feedback, and meaningful learning experiences would contribute to a more engaging and supportive learning environment. Furthermore, it was assumed that these strategies would enhance students' willingness to participate, strengthen social connections within the classroom, improve emotional regulation and concentration, and reduce learning-related stress.

Sample

The study involved 41 students enrolled in a Romanian technological high school from Pitești city. Participation was voluntary, and all students completed both stages of the research: the initial assessment conducted before the intervention and the final assessment conducted after the implementation of the neurodidactic programme.

The participants represented a single educational group that attended the same Psychology lessons throughout the intervention period. The use of one educational group ensured consistency regarding instructional conditions, classroom environment, teaching content, and learning activities. All students were exposed to the same intervention programme and completed the same assessment instruments before and after the intervention.

The research was conducted during regular Psychology lessons, in collaboration with the classroom teacher. At the beginning of the intervention, students had recently started the Psychology unit dedicated to Personality, allowing the implemented activities to be integrated naturally into different stages of the instructional process,

including revision, introduction of new theoretical concepts, consolidation of knowledge, and transfer of learning.

Description of the research instrument

Data collection was conducted through a structured questionnaire created and administered using Google Forms. The instrument was selected because it allowed efficient online data collection, immediate organisation of responses, automatic generation of descriptive statistical summaries, and easy administration for all participants. The digital format also ensured anonymity, accessibility, and convenience during both stages of data collection.

The first version of the questionnaire was created and administered on 22 April 2026. Students completed the questionnaire electronically by accessing the link provided by the researcher: https://forms.gle/4fMLvPSK3n2ogjmo8.

The questionnaire consisted of 16 items organised into four major dimensions. Each dimension included four indicators corresponding to one of the four neurotransmitters investigated in the study: dopamine, oxytocin, serotonin, and endorphins.

Dimension 1. Motivation and Engagement (Dopamine-related variables)

The first dimension examined variables associated with dopamine-related processes involved in motivation, reward, goal-oriented behaviour, and reinforcement learning.

The investigated indicators were:

- Interest;
- Anticipation;
- Perceived reward;
- Persistence.

This dimension evaluated students' intrinsic motivation, curiosity, willingness to participate in classroom activities, perception of achievement, and perseverance when completing challenging learning tasks.

The items were designed to identify changes in students' engagement with learning activities, their desire to participate, and their ability to maintain effort when confronted with academic challenges.

Dimension 2. Relationships and Psychological Safety (Oxytocin-related variables)

The second dimension focused on variables associated with oxytocin-related processes involved in trust, cooperation, empathy, social connection, and emotional safety.

The investigated indicators were:

- Trust;
- Cooperation;

- Sense of belonging;
- Support.

This dimension assessed students' perceptions of classroom relationships, social connectedness, collaborative learning experiences, and psychological safety. It examined whether students felt comfortable expressing ideas, working with colleagues, and receiving support from both peers and teachers.

Dimension 3. Emotional Balance and Concentration (Serotonin-related variables)

The third dimension investigated variables related to serotonin-associated processes involved in emotional regulation, attention, cognitive flexibility, and psychological wellbeing.

The investigated indicators were:

- Attention;
- Emotional stability;
- Calmness;
- Cognitive clarity.

This dimension measured students' ability to maintain concentration, regulate emotional responses, organise their thinking, and remain calm when encountering complex learning situations.

The items explored students' perceptions regarding their cognitive readiness, emotional balance, and ability to remain focused throughout educational activities.

Dimension 4. Stress Reduction and Positive Emotional State (Endorphin-related variables)

The fourth dimension examined variables associated with endorphin-related processes connected with enjoyment, stress reduction, positive emotions, and resilience.

The investigated indicators were:

- Relaxation;
- Positive energy;
- Enjoyment;
- Emotional release.

This dimension explored students' emotional wellbeing, their enjoyment of classroom activities, their perceived level of relaxation, and their overall psychological state following learning experiences.

The questionnaire was administered twice: before the intervention and after its completion. The comparison between the two administrations enabled the evaluation of changes in students' motivation, classroom engagement, emotional wellbeing,

collaborative behaviour, concentration, and perceived learning experience.

3.Research Design

The study adopted a case study research design in order to investigate the educational effects of neurodidactic instructional strategies implemented during Psychology lessons. A quantitative approach was employed through the administration of a structured questionnaire before and after the educational intervention, allowing the comparison of students' perceptions regarding motivation, classroom participation, emotional wellbeing, concentration, social relationships, and learning experience.

The research followed a pre-intervention/post-intervention design. Initially, students completed the questionnaire in order to establish their perceptions regarding the four investigated dimensions: motivation and engagement, relationships and psychological safety, emotional balance and concentration, and stress reduction accompanied by positive emotional states. Following this initial assessment, a three-week educational intervention was conducted during regular Psychology lessons.

Throughout the intervention period, a series of interactive neurodidactic activities was implemented. These activities were specifically designed to stimulate processes associated with dopamine, oxytocin, serotonin, and endorphins by promoting curiosity, collaboration, positive emotions, physical engagement, creativity, and meaningful learning experiences.

The complete collection of activities was developed as an educational booklet accompanying the research. The activities were original classroom interventions intentionally designed according to neurodidactic principles, combining cognitive challenge with emotional involvement, social interaction, and active participation. Their purpose was not only to facilitate knowledge acquisition but also to create favourable conditions for motivation, psychological safety, concentration, and positive emotional experiences.

The intervention was integrated into the Psychology unit dedicated to Personality. At the beginning of the programme, students had recently started this thematic unit; therefore, the selected activities were incorporated into different stages of the instructional process, including knowledge revision, presentation of new theoretical concepts, consolidation of information, and transfer of learning. The implemented activities are described below.

Activity 1 – "Error Detectives"

The first activity was designed as a knowledge revision strategy. Students received a series of statements based on previously studied Psychology topics, including **Primary Psychological Processes, Secondary Psychological Processes, and Processes of Activation and Stimulation**.

Each statement intentionally contained one or more conceptual errors. Students were asked to act as "detectives" and identify the inaccurate information, correct the mistakes, and provide evidence-based explanations using both their class notes and the Psychology textbook.

The activity initially involved individual analysis, followed by discussion and collaboration in small groups. Through this structure, students were encouraged to compare perspectives, justify their answers, and construct explanations together.

"Error Detectives" promoted several cognitive and emotional processes relevant to neurodidactic learning. The activity encouraged analytical thinking, retrieval practice, active processing of previously acquired knowledge, collaborative discussion, and constructive feedback. Furthermore, the challenge of identifying errors stimulated curiosity, attention, and achievement motivation, creating conditions associated with increased engagement and dopaminergic activation.

By transforming revision into an investigative task, the activity moved away from passive repetition and encouraged students to become active participants in the learning process.

Activity 2 – "Concept Theatre"

The second activity was implemented during the lesson in which new theoretical concepts related to **Personality** were introduced.

Students randomly selected cards containing different psychological concepts, including temperament types, character traits, values, and aptitudes. Each student was required to represent the assigned concept through a short dramatic performance, gestures, or role-play, while classmates attempted to identify the concept being portrayed.This activity transformed abstract psychological concepts into experiential learning experiences. Instead of simply memorising definitions, students explored concepts through creativity, communication, imagination, and social interaction.

"Concept Theatre" encouraged discovery learning by requiring students to interpret information, transform theoretical knowledge into symbolic representations, and communicate ideas in an

accessible way. The activity also promoted active classroom participation, confidence in expressing ideas, and positive interaction between students.

Through its combination of creativity, social engagement, and emotional involvement, the activity supported processes related to motivation, cooperation, and psychological safety.

Activity 3 – "The Lesson Puzzle"

The third activity was implemented during the lesson dedicated to Temperament.

At the end of the lesson, students were organised into small groups and received worksheets presenting different psychological classifications of temperament proposed by recognised psychologists, including Carl Jung, Hans Eysenck, and William Sheldon.

Each group analysed the provided information, discussed the characteristics of the different temperament models, and identified the correct relationships between classifications and theoretical descriptions.

After completing the analysis, the separate components were combined in order to reconstruct the complete conceptual framework of the lesson. Through this process, students collaboratively organised information and developed a coherent understanding of the theoretical content.

"The Lesson Puzzle" promoted collaborative problem-solving, communication, peer learning, and conceptual integration. By requiring students to actively reconstruct knowledge rather than simply reproduce information, the activity supported deeper understanding and improved retention.

Furthermore, the collaborative nature of the task contributed to the development of interpersonal relationships and a sense of shared responsibility within the classroom.

Activity 4 – "Learning in Motion"

The fourth activity was implemented during a revision lesson and combined cognitive learning with physical movement.

Students participated in a relay-style learning game involving the continuous passing of a baton around the classroom. At predetermined time intervals, the student holding the baton was required to answer a question selected from a collection of objective and semi-objective questions covering the topics Personality and Temperament.

Correct answers were rewarded with points, whereas incorrect responses resulted in the baton being passed to another student

before the next question was selected. The activity continued until all question cards had been completed.

"Learning in Motion" combined revision with physical engagement, creating a dynamic classroom environment. Beyond supporting knowledge consolidation, the activity increased classroom energy, maintained sustained attention, reduced tension associated with evaluation situations, and encouraged students to remain actively involved.

The integration of movement and play introduced elements of enjoyment and positive emotional activation, contributing to processes associated with stress reduction and endorphin release.

Activity 5 – "The Surprise Box"

The final activity was also implemented during revision lessons and consisted of a box containing unexpected learning tasks.

Students selected tasks randomly and completed challenges that varied in difficulty and required either individual responses or collaborative solutions. The tasks were designed to introduce novelty, curiosity, and an element of unpredictability into the learning process.

The random selection of activities created anticipation and encouraged students to engage with learning challenges in an enthusiastic manner. The tasks promoted healthy competition, creativity, cooperation, and problem-solving.

"The Surprise Box" successfully combined cognitive challenge with positive emotional experiences. By introducing novelty, enjoyment, and active participation, the activity supported motivation, emotional involvement, and student wellbeing.

Post-Intervention Data Collection

Three weeks after the initial administration, the questionnaire was administered for a second time in order to evaluate the impact of the neurodidactic intervention.

Students again completed the questionnaire online by accessing the following link: https://forms.gle/gzsboGw6AUwQm6wR8.

The comparison between the two administrations enabled the evaluation of changes in students' motivation, classroom engagement, emotional wellbeing, collaborative behaviour, concentration, and perceived learning experience following the implementation of the neurodidactic activities.

The obtained data were subsequently analysed according to the four investigated dimensions corresponding to dopamine-, oxytocin-, serotonin-, and endorphin-related variables.

Results

The comparison between the pre-intervention and post-intervention questionnaire responses revealed substantial improvements across all four investigated dimensions. The findings indicate that the implementation of neurodidactic strategies was associated with positive changes in students' motivation, classroom participation, emotional wellbeing, collaborative behaviour, concentration, and overall perception of the learning experience.

The results were analysed according to the four dimensions corresponding to the neurotransmitter-related variables investigated in the study: dopamine, oxytocin, serotonin, and endorphins.

Dimension 1. Motivation and Engagement (Dopamine-related Variables)

The first dimension examined changes in students' motivation and engagement through four indicators: **interest, anticipation, perceived reward, and persistence**.

The results revealed a substantial improvement following the implementation of the neurodidactic intervention. Before the intervention, the average proportion of positive responses ("Often" and "Always") across the four indicators was approximately **34.6%**, indicating a generally low to moderate level of intrinsic motivation.

At the same time, approximately **65.4%** of responses were distributed among the lower response categories ("Never", "Rarely", and "Sometimes"). This distribution suggested that, before the intervention, students demonstrated inconsistent engagement with learning activities, limited anticipation of classroom tasks, and reduced persistence when facing academic challenges.

Following the three-week intervention programme, the average proportion of positive responses increased to approximately **75.6%**, representing an improvement of more than **40 percentage points**.

This increase was accompanied by a considerable reduction in negative and neutral responses across all four indicators. Students reported greater interest in Psychology lessons, stronger willingness to participate in classroom activities, increased anticipation of learning experiences, and improved persistence when completing tasks that required effort and problem-solving.

The observed improvement suggests that the interactive neurodidactic activities successfully enhanced students' intrinsic motivation and engagement. Activities such as educational games, challenges, problem-solving tasks, and creative learning experiences created opportunities for achievement, feedback, curiosity, and active involvement.

From a neurodidactic perspective, these results are consistent with the proposed role of dopamine in motivation, reward anticipation, goal-directed behaviour, and reinforcement learning. By providing meaningful challenges and opportunities for success, the implemented strategies may have supported motivational processes associated with sustained engagement.

Overall, the findings indicate that instructional strategies designed to stimulate dopamine-related processes can substantially improve students' motivation and active participation in the learning process.*Dimension 2. Relationships and Psychological Safety (Oxytocin-related Variables)*

The second dimension investigated changes in students' social experiences within the classroom through four indicators: **trust, cooperation, sense of belonging, and perceived support**.

The results demonstrated a marked improvement after the intervention. During the initial assessment, the average proportion of positive responses across the four variables was approximately **30%**. This result reflected relatively low levels of social confidence, classroom belonging, collaborative engagement, and perceived emotional support.

Before the intervention, some students appeared to experience difficulties related to expressing their ideas freely, collaborating effectively with classmates, or perceiving the classroom as a psychologically secure environment.

Following the implementation of collaborative neurodidactic activities, the proportion of positive responses increased to approximately **71%**. Students reported feeling more confident when expressing their opinions, more willing to cooperate with classmates, and more strongly supported by both peers and the teacher. The reduction in negative responses across all items indicates that the intervention contributed to the development of a more positive classroom climate characterised by trust, cooperation, and interpersonal connectedness.

The activities included in the intervention required students to communicate, collaborate, solve problems together, and assume shared responsibility for learning outcomes. Through these

experiences, students were provided with opportunities to strengthen social relationships and develop a greater sense of belonging. These findings correspond with the proposed role of oxytocin in supporting trust, empathy, cooperation, and positive social relationships. A classroom environment characterised by psychological safety may reduce anxiety and encourage students to participate more actively in educational activities.

Overall, the results demonstrate that neurodidactic strategies incorporating cooperative learning and positive social interaction contribute substantially to students' emotional security, classroom participation, and social engagement.

Dimension 3. Emotional Balance and Concentration (Serotonin-related Variables)

The third dimension examined students' emotional regulation and cognitive functioning through four indicators: **attention, emotional stability, calmness, and cognitive clarity**.

Considerable improvements were observed following the intervention. Before the implementation of neurodidactic activities, the average proportion of positive responses across the four serotonin-related variables was approximately **24%**. This result indicated that many students experienced difficulties maintaining concentration, organising their thoughts, regulating emotional responses, and remaining calm when confronted with challenging learning situations. After the intervention, the average percentage of positive responses increased significantly to approximately **72%**, while negative responses decreased considerably.

Students reported improved concentration, greater emotional stability, enhanced ability to organise information, and increased calmness during learning activities. These changes suggest that the interactive learning environment created through the intervention supported both emotional wellbeing and cognitive readiness for learning.

Several elements of the intervention may have contributed to these improvements, including supportive feedback, collaborative learning, active participation, and the creation of a positive classroom atmosphere. By reducing tension and increasing emotional involvement, these strategies may have facilitated students' ability to maintain attention and process information more effectively.

The observed results are consistent with the proposed role of serotonin in emotional regulation, psychological wellbeing,

sustained attention, resilience, and cognitive flexibility. A balanced emotional state represents an important condition for effective learning because students who feel secure and emotionally regulated are better able to focus on complex cognitive tasks.

Taken together, these findings indicate that neurodidactic strategies can effectively support students' capacity to maintain concentration, emotional balance, and cognitive organisation throughout the learning process.

Dimension 4. Stress Reduction and Positive Emotional State (Endorphin-related Variables)

The fourth dimension investigated students' emotional experiences during learning through four indicators: **relaxation, positive energy, enjoyment, and emotional release**.

This dimension exhibited one of the most pronounced improvements following the intervention. Initially, before the implementation of neurodidactic activities, the average proportion of positive responses across the four indicators was approximately **23%**. This result suggested that students frequently perceived classroom learning as demanding, monotonous, or emotionally exhausting. Limited enjoyment and reduced positive emotional involvement may have influenced their willingness to engage actively in educational activities. Following the three-week intervention, the average proportion of positive responses increased to approximately **72%**, representing an improvement of nearly **50 percentage points**.

Students reported feeling more relaxed during lessons, experiencing greater enjoyment of classroom activities, demonstrating higher levels of positive energy, and leaving lessons with a more positive emotional state. The considerable decrease in negative responses indicates that enjoyable, dynamic, and movement-based activities effectively contributed to reducing classroom stress while promoting positive emotional experiences.

The activities that incorporated creativity, physical movement, novelty, humour, and play provided students with opportunities to experience learning as an enjoyable and meaningful process rather than merely an academic obligation. Considering the relationship between endorphin activity, stress reduction, positive emotions, and psychological wellbeing, these findings provide additional support for the effectiveness of neurodidactic teaching strategies.

Overall, the intervention transformed students' emotional experience of learning from one characterised by tension, reduced

involvement, and limited enjoyment into one associated with enthusiasm, relaxation, positive emotions, and active participation.

Discussion

The present study aimed to investigate the educational value of neurodidactic strategies based on interactive learning activities and their influence on secondary school students' motivation, emotional wellbeing, classroom participation, and learning experience. The results obtained after the intervention support the initial hypothesis, indicating significant improvements across all four investigated dimensions.

The overall increase in positive responses from approximately 28% before the intervention to over 72% after the intervention suggests that neurodidactic activities contributed to the development of a more engaging, supportive, and emotionally favourable learning environment. These findings reinforce the idea that effective learning depends not only on information transmission but also on the interaction between cognitive processes, motivation, emotions, and social experiences.

The improvement observed in the **Motivation and Engagement dimension** indicates that activities involving curiosity, challenge, feedback, and active participation can strengthen students' intrinsic motivation. The increase in dopamine-related indicators suggests that learning experiences based on novelty, achievement, and meaningful involvement may encourage persistence and sustained engagement.

The results related to **Relationships and Psychological Safety** demonstrate the importance of social interaction in learning. Collaborative activities promoted trust, cooperation, classroom belonging, and emotional support. These findings are consistent with the proposed role of oxytocin in facilitating positive social relationships and creating psychologically safe learning environments.

The significant improvement in **Emotional Balance and Concentration** highlights the relationship between emotional regulation and cognitive functioning. Supportive classroom interactions, positive feedback, and active involvement may contribute to improved attention, emotional stability, and cognitive organisation, supporting students' readiness to learn.

The **Stress Reduction and Positive Emotional State dimension** showed one of the most pronounced improvements. Activities involving movement, creativity, play, and positive emotional

engagement reduced learning-related tension and increased enjoyment. These findings correspond with the proposed role of endorphins in stress reduction and the promotion of positive emotional states.

Taken together, the results suggest that neurodidactic strategies provide an effective framework for integrating cognitive, emotional, social, and motivational factors into classroom practice. By combining active learning, collaboration, creativity, and emotional involvement, such approaches may contribute to more effective and student-centred educational experiences.

Nevertheless, several limitations should be considered. The study involved a relatively small sample of 41 students from a single educational group, and the absence of a control group limits the possibility of establishing direct causal relationships. Additionally, the research relied mainly on students' self-reported perceptions. Future studies should include larger samples, control groups, and complementary assessment methods such as classroom observations or academic performance measures.

Conclusion

The findings of this study demonstrate that the integration of neurodidactic strategies into Psychology lessons produced significant improvements in students' motivation, classroom engagement, emotional wellbeing, interpersonal relationships, concentration, and overall learning experience.

The intervention confirmed the hypothesis that interactive and emotionally engaging educational activities designed according to neurodidactic principles can positively influence multiple dimensions of learning. The increase in positive responses from approximately 28% before the intervention to more than 72% afterwards indicates substantial progress in all investigated areas.

The most notable improvements were observed in intrinsic motivation, collaborative behaviour, emotional regulation, and stress reduction. Activities based on problem-solving, creativity, cooperation, movement, and novelty created learning experiences that encouraged students to become active participants rather than passive recipients of information.

The findings highlight the importance of considering the biological and emotional foundations of learning alongside traditional pedagogical approaches. Neurodidactics offers valuable perspectives for designing educational environments that stimulate

motivation, strengthen social connections, support emotional balance, and enhance students' willingness to engage in learning. Although further research is required to validate these findings using larger samples and more complex research designs, the present study suggests that neurodidactic strategies represent a promising approach for improving the quality and effectiveness of secondary education.

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