A METHODOLOGY FOR DIAGNOSING LEARNING OUTCOMES BASED ON A NEURODIDACTIC APPROACH

Azamat Ahmadali-o'g'li Boydavlatov
azamatboydavlatov77@mail.com
Namangan davlat pedagogika instituti

Abstract: This thesis examines the theoretical foundations, criteria, and methodological stages of diagnosing learning outcomes through a neurodidactic approach. It explores methods for assessing students' cognitive activity, attention, memory, motivation, and learning progress, as well as opportunities for providing individualized educational support.

Keywords: neurodidactics, learning outcomes, diagnostics, cognitive activity, attention, memory, motivation, formative assessment, individualized learning, pedagogical monitoring

INTRODUCTION. In today's educational system, identifying students' knowledge, skills, and competencies, taking into account their individual developmental characteristics, and improving educational effectiveness are among the key pedagogical priorities. In traditional assessment systems, the primary criterion is often the student's final performance, that is, the extent to which a task has been completed correctly. However, this approach does not always fully reveal the processes underlying the formation of learning outcomes, including cognitive processes such as information perception, attentional control, memory retention, reasoning, and the application of knowledge in new situations. Consequently, a neurodidactic approach to the study of learning outcomes is gaining particular significance in contemporary pedagogy.

Neurodidactics is an interdisciplinary field grounded in the scientific connections between neurobiology, cognitive psychology, and pedagogy. It investigates the characteristics of the human brain involved in learning and their implications for the organization of educational processes. This field helps account for learners' attention, memory, motivation, emotional states, cognitive load, and the consolidation of knowledge. The OECD publication *Understanding the Brain: The Birth of a Learning Science* also emphasizes the potential for integrating scientific knowledge about brain function into educational practice, as well as the importance of grounding this process in scientific evidence [1].

Diagnosing learning outcomes through a neurodidactic approach involves more than assessing the knowledge students have acquired. It entails the systematic identification of their cognitive activity during learning, information-processing strategies, patterns of errors, ability to monitor their own performance, and learning trajectories. Within this framework, diagnosis is not regarded as a means of assigning students to rigid categories, but rather as a mechanism for identifying their educational needs and informing the planning of subsequent pedagogical interventions. The relevance of this topic stems from the fact that students completing tasks involving identical content may achieve different outcomes. Such differences may be influenced by factors including prior knowledge, attentional control, working memory capacity, learning motivation, task complexity, and learning conditions. Therefore, rather than relying exclusively on scores or grades, it is essential to examine the processes that contribute to learning outcomes when conducting diagnostic assessments.

MAIN BODY

Theoretical Foundations of the Neurodidactic Approach

The theoretical foundations of the neurodidactic approach comprise the functioning of the human brain during learning, the interrelationships among cognitive processes, and the psychological

and pedagogical principles governing knowledge acquisition. When learners receive new information, they connect it with their existing knowledge, identify its salient features, retain it in memory, and retrieve it when necessary. The effectiveness of these processes depends on the structure of the learning task, the amount of information presented, the sequencing of repetition, feedback, and the learner's active engagement.

Within neurodidactics, particular importance is attached to attention, memory, executive functions, motivation, and emotional states. Attention helps learners focus on the salient aspects of learning material. Working memory is essential for temporarily maintaining and manipulating information. Long-term memory enables knowledge and experiences to be retained over extended periods. Executive functions are associated with goal setting, activity planning, behavioral regulation, and the adaptation of strategies in response to task requirements [2]. These processes may influence learning outcomes both directly and indirectly. For example, even when a student knows the correct answer to a question on a given topic, they may make an error in a complex task because they are unable to sustain attention for an extended period. Another student, although initially unable to complete a task, may arrive at the correct solution after receiving additional explanations and responding to guiding questions. Such situations demonstrate the need to analyze final performance without separating it from the processes through which the outcome is achieved.

One of the key features of the neurodidactic approach is its emphasis on individual differences among learners. However, it is inappropriate to interpret these differences as fixed or predetermined characteristics. A learner's performance may vary depending on their level of knowledge, the type of task, the learning environment, fatigue, motivation, and the pedagogical support provided. Therefore, diagnostic findings should be interpreted as evidence pertaining to a particular point in time and a specific set of conditions.

When applying neuroscientific research to education, it is essential to exercise caution regarding claims that lack sufficient scientific evidence. For example, the assumption that every learner can be classified exclusively as a "visual," "auditory," or "kinesthetic" learner, and that instruction should be tailored solely to the corresponding category, lacks adequate empirical support. The OECD report draws particular attention to the problem of "neuromyths," which arise from the misinterpretation of scientific information about the brain [1]. Accordingly, neurodidactic assessment should be grounded not in assumptions or popular beliefs, but in observable outcomes, repeated measurements, and scientifically validated pedagogical methods.

The nature and principles of diagnosing learning outcomes from a neurodidactic perspective

The diagnosis of learning outcomes is a systematic process aimed at determining the extent to which learners have achieved educational objectives, analyzing existing difficulties, and identifying appropriate subsequent instructional actions. Within a neurodidactic approach, the defining feature of this process is the observation of factors associated with learning, alongside the assessment of academic outcomes.

When developing this methodology, it is advisable to adhere to the following principles.

- First principle: Scientific validity. Diagnostic instruments should be aligned with pedagogical objectives, clearly understandable, and as reliable as possible. Conclusions regarding attention or memory should not be based solely on the results of a single task.
- Second principle: Continuity. Learning outcomes should be examined not through a one-time assessment, but by integrating initial, ongoing, and final assessments. This approach helps identify the dynamics of learners' development over time.
- Third principle: Individualization. Diagnostic findings should be interpreted with due consideration for learners' prior knowledge, task complexity, and the level of support provided. While

educational objectives should remain clearly defined for all learners, the methods of support may be differentiated according to individual needs.

• Fourth principle: Assessment for learning. The purpose of diagnosis is not merely to identify shortcomings, but also to determine ways of addressing them. Research by P. Black and D. Wiliam has established the importance of formative assessment and effective feedback in improving the learning process [3].

• Fifth principle: Reliance on evidence from multiple sources. Conclusions about a learner should be drawn through the combined analysis of test results, written assignments, oral responses, practical tasks, observational data, and self-assessment.

Thus, neurodidactic assessment serves to analyze learners' knowledge, their approaches to applying that knowledge, and the difficulties that emerge during the learning process as an integrated whole.

Key criteria and indicators of neurodidactic assessment

In a methodology for diagnosing learning outcomes, it is essential to define assessment criteria precisely. Without clearly specified measurable indicators, assessment may become subjective. Within the scope of this study, the following diagnostic domains are proposed.

1. Criterion of Cognitive Outcomes. This criterion determines the extent to which learners have acquired knowledge and can apply it effectively. The indicators include explaining concepts, recalling facts, applying rules, solving problems, and providing justification for conclusions.

2. Criterion of Attention and Task Engagement. This domain examines learners' ability to understand task instructions accurately, identify relevant information, follow directions throughout task performance, and complete tasks in the presence of potential distractions. Pedagogical observation and records of the task-performance process may be used for this purpose. Such observations should not be used as a basis for clinical or neurological conclusions.

3. Criterion of Memory and Knowledge Consolidation. This criterion examines learners' ability to recall newly acquired information immediately and after a certain period, connect it with prior knowledge, and apply it in new situations. Appropriate methods include brief tasks at the end of a lesson, retrieval questions at the beginning of the following lesson, and delayed assessments.

4. Criterion of Reasoning and Problem-Solving. This criterion encompasses learners' abilities to analyze, compare, generalize, identify cause-and-effect relationships, select appropriate strategies, and explain their solutions.

5. Criterion of Metacognitive Activity. Metacognition refers to learners' ability to understand, monitor, and evaluate their own thinking and learning processes. Indicators of this criterion include developing a plan before undertaking a task, modifying strategies when difficulties arise, identifying errors, and explaining their own performance.

6. Criterion of Motivation and Emotional State. This criterion involves observing learners' interest in tasks, willingness to participate in learning activities, persistence after making errors, and responses to seeking assistance. Such indicators should be interpreted cautiously, as observable behavior alone does not fully reflect a learner's internal motivation or emotional state.

7. Criterion of Learning Progress. Learners' initial performance, intermediate results, and final outcomes are compared. Improvements or declines in performance are analyzed in conjunction with task complexity, learning conditions, and the level of support provided.

A diagnostic table can be developed based on these criteria.

Table 1.

Main criteria of neurodidactic diagnostics and corresponding tools

Diagnostic direction	Key indicator	Recommended tool
Knowledge and understanding	Correct answer, explanation, and applying knowledge	Test, written and practical assignment
Attention	Following instructions, extracting key information	Observation, recording the task process
Memory	Information retrieval and delayed recall	Short questions, repeated check
Thinking	Analysis, comparison, and justifying the solution	Problem-based tasks
Metacognition	Planning, error identification, and self-assessment	Reflection sheet, interview
Motivational activity	Participation, persistence, and making use of help	Participation, persistence, and making use of help
Development dynamics	Difference between initial and subsequent results	Diagnostic work portfolio

This table does not replace a universal psychological test. Rather, it provides teachers with a methodological framework for monitoring learning outcomes from multiple perspectives and making evidence-informed instructional decisions.

Methodology for diagnosing learning outcomes based on a neurodidactic approach. It is recommended that the diagnosis of learning outcomes within a neurodidactic framework be organized into a sequence of interrelated stages. The effectiveness of this methodology depends on the clarity of the diagnostic objectives, the appropriate selection of assessment instruments, and the use of the findings to inform pedagogical practice.

Stage 1: Defining Objectives and Diagnostic Planning

The first step is to determine the subject, topic, or competency for which learning outcomes are to be assessed. For example, when studying the comparison of fractions in mathematics, the diagnostic objective should extend beyond determining whether students know the relevant rule. It may also encompass their ability to compare fractions, justify their solutions, and identify errors. At this stage, the expected outcomes, assessment criteria, number of tasks, and conditions for task completion should be specified. Instructions given to learners should be simple and comprehensible, while task complexity should correspond to the subject matter being studied.

Stage 2: Initial Assessment

Initial assessment is conducted to identify learners' prior knowledge and existing difficulties related to the topic. Short tests, open-ended questions, practical tasks, or problem-solving scenarios may be used. For example, before introducing a new topic, students may be asked to explain a rule learned in the previous lesson and apply it to a simple example. Analysis of their responses helps determine which areas of knowledge are well established and which concepts require further explanation. Rather than serving primarily as a basis for assigning a final grade, initial assessment should inform the effective planning of instruction.

Stage 3: Observation of the Learning Process

At this stage, the teacher observes how learners approach tasks, which strategies they employ, how they respond to difficulties, and how effectively they use the assistance provided.

During observation, the teacher seeks answers to the following questions:

- Has the learner correctly understood the task instructions?
- Can the learner independently plan a solution?
- At which stage does the learner make an error?
- Can the learner identify the error independently?
- Does the learner's performance improve after additional guidance?

Observation findings are recorded on a previously prepared observation sheet. Although teachers can assess observable learner behavior, such observations should not be used to draw medical conclusions about brain function or memory.

Stage 4: Formative Assessment and Feedback

Formative assessment enables teachers to determine learners' levels of understanding during a lesson and adjust instructional methods when necessary. Short questions, exit tickets, pair work, error-identification tasks, peer assessment, and self-assessment can be used effectively for this purpose. Research by P. Black and D. Wiliam indicates that formative assessment becomes meaningful when the information obtained is used to modify teaching and learning activities [3]. Therefore, diagnosis should not end with data collection; it should inform subsequent pedagogical decisions. Feedback should be specific, comprehensible, and oriented toward improvement. For example, instead of making a general statement such as "You do not understand the topic," it is more appropriate to provide targeted guidance: "You correctly identified the denominators in the first example, but you need to review the step of finding a common denominator when comparing the fractions."

Stage 5: Final Assessment

Final assessment is conducted to determine the extent to which the intended learning objectives have been achieved. Tasks should be selected to allow comparison with initial assessment results without merely requiring learners to reproduce memorized answers. The final assessment may encompass recall, application, analysis, and the transfer of knowledge to new situations. Differences between initial and final results provide an indication of learning progress. However, additional evidence is necessary before attributing improvements exclusively to the effect of a single instructional method.

Stage 6: Analysis of Results and Planning Individualized Educational Support. The collected data are synthesized according to the established criteria to identify learners' strengths and the skills requiring further development. Where necessary, teachers may provide additional exercises, brief review sessions, step-by-step guidance, tasks differentiated by complexity, and opportunities for independent practice. At this stage, learners should not be assigned to fixed categories such as "capable" and "incapable." Diagnostic findings reflect performance at a particular point in time, and this performance may change in response to appropriate instructional support, practice, and feedback. In summary, neurodidactic assessment can be organized according to the following logical sequence:

Defining objectives → Initial assessment → Observation of the learning process → Formative feedback → Final assessment → Analysis of results and planning educational support.

This sequence transforms diagnosis from an isolated assessment event into a continuous pedagogical process.

Diagnostic instruments and their applications. Within a neurodidactic framework, it is advisable to employ a combination of complementary methods rather than rely on a single universal instrument.

First, diagnostic tests make it possible to assess knowledge and skills within a relatively short period. Test items should assess not only factual recall but also comprehension and the application of knowledge.

Second, problem-solving tasks help examine learners' reasoning strategies, their ability to identify cause-and-effect relationships, and their capacity to justify solutions. Learners should be asked not only to provide an answer but also to explain how they arrived at it.

Third, observation checklists enable the systematic recording of behaviors manifested during learning activities. Observers should rely on specific, observable evidence rather than subjective impressions.

Fourth, self-assessment and reflection develop learners' ability to recognize their own knowledge, articulate difficulties, and establish subsequent learning goals. For example, at the end of a lesson, students may be asked: "What did I learn today?", "Which step was difficult for me?", and "What will I pay attention to next time?"

Fifth, delayed retrieval tasks help assess the extent to which previously learned information can be recalled after a certain period. This method provides additional evidence concerning knowledge retention rather than relying exclusively on immediate test performance.

Sixth, portfolios and longitudinal monitoring enable comparisons of learners' work across different points in time. A portfolio may contain initial assignments, revised tasks, self-assessment sheets, and teacher recommendations.

When selecting diagnostic instruments, teachers should consider their alignment with learning objectives, suitability for learners' developmental levels, clarity, and capacity to support meaningful comparisons of results. If the objective is to assess mastery of a particular topic, medical or sophisticated neurophysiological measurements are generally unnecessary. Methods such as electroencephalography (EEG), which measures aspects of brain activity, require specialized research or clinical settings, appropriately qualified professionals, and specific ethical safeguards.

An example of applying neurodidactic assessment in educational practice

To illustrate the proposed methodology more concretely, consider the learning process associated with the topic "Comparing Common Fractions" in a mathematics lesson at a general education school. The following example is a methodological illustration and should not be interpreted as the result of an empirical study.

Initially, the teacher establishes the diagnostic objective: students should understand the rules for comparing fractions, apply those rules, explain their reasoning, and identify their own errors.

At the first stage, students are given brief diagnostic tasks. For example, they may be asked to compare the fractions (1/4) and (3/4), compare fractions with unequal denominators, and explain their chosen solution. The results are used to identify prior knowledge and difficulties related to the topic.

At the second stage, students are observed while completing independent tasks. The teacher records indicators such as understanding the task instructions, planning a solution, carrying out intermediate steps, and checking the answer. When a student provides an incorrect answer, the teacher attempts to identify the stage at which the error occurred.

At the third stage, brief feedback is provided. For example, a student who has difficulty comparing fractions with different denominators may be offered a visual model, a number line, or step-by-step guidance. Visual materials are used as a means of supporting understanding of the topic, rather than being treated as a single mandatory method for all learners.

At the fourth stage, students complete tasks that are similar in content but differ in numerical values and conditions. They are expected not only to obtain the correct answer but also to explain their reasoning and check for errors.

At the fifth stage, initial and final results are compared. The analysis takes into account the number of correct answers, the quality of explanations, the degree of independent task completion,

and the ability to identify errors. If a student begins to provide correct answers but remains unable to explain the solution, additional explanations and independent practice are recommended.

This example demonstrates that the purpose of neurodidactic assessment is not merely to assign a score. Its primary function is to identify learning difficulties, select appropriate forms of support, and monitor changes in learning outcomes over time.

Evaluation and interpretation of diagnostic results

When analyzing diagnostic results, it is advisable to use clearly defined criteria and comprehensible performance levels. The following illustrative four-level scale may be applied:

- Advanced level: The learner applies knowledge independently, justifies solutions, and identifies errors.
- Proficient level: The learner completes the core tasks but requires limited support in certain complex situations.
- Developing level: The learner has partially mastered the fundamental concepts but requires guiding questions or additional practice to complete tasks.
- Beginning level: The learner requires a review of foundational concepts and structured, step-by-step pedagogical support.

These levels should not be interpreted as definitive judgments about a learner's personal characteristics or intellectual abilities. Rather, they indicate the level of achievement attained in relation to a specific learning objective and the type of pedagogical support required.

To improve assessment reliability, tasks should be evaluated according to predefined criteria. Where appropriate, the same competency should be assessed through different tasks, and learners' performance should be compared over time. A low score on a single assessment does not establish the existence of a persistent learning difficulty. Performance may also be influenced by task complexity, the clarity of instructions, fatigue, and learning conditions. Feedback provided to learners should ideally address three questions: What did the learner do successfully? What needs to be improved? What should the next step be? This approach transforms assessment from a punitive process into a means of promoting learning and development.

Pedagogical conditions and limitations of implementing neurodidactic assessment. The effectiveness of neurodidactic assessment also depends on the conditions under which it is implemented.

First, teachers should acquire knowledge of neuroscientific concepts from scientifically reliable sources and distinguish evidence-based findings from popular but unverified claims. Neuroscientific knowledge offers opportunities to improve education; however, it cannot fully replace pedagogical experience or psychological knowledge [1; 4].

Second, a safe and supportive learning environment should be established throughout the diagnostic process. It is important to treat errors as a natural part of learning, avoid unfavorable comparisons between students, and encourage learners to seek assistance when needed.

Third, information about learners should be kept confidential, and diagnostic findings should be used exclusively for educational purposes. Public disclosure of individual assessment results or their use to label students is inconsistent with pedagogical ethics.

Fourth, diagnostic procedures should be integrated naturally into classroom activities wherever possible. Complex tests are not necessary in every lesson. Short questions, observation, reflection, and brief practical tasks can also provide teachers with valuable information.

Fifth, before implementing the proposed methodology in practice, it should be adapted to the relevant age group, subject area, and learning conditions and, where necessary, evaluated through a small-scale pilot study. Drawing scientifically valid conclusions about its effectiveness requires

systematic data collection, the selection of appropriate comparison criteria, and consideration of alternative explanations for the observed results.

Thus, neurodidactic assessment is not merely the introduction of a new assessment technique. It is a methodological approach aimed at developing a deeper understanding of learning outcomes, adapting instructional processes, and continuously improving educational quality.

CONCLUSION

Diagnosing learning outcomes through a neurodidactic approach makes it possible not only to assess learners' knowledge and skills but also to examine, from a pedagogical perspective, the cognitive processes involved in the development of these outcomes. Attention, memory, reasoning, metacognitive activity, motivation, and learning progress are considered interrelated indicators. The analysis leads to the following conclusions.

First, neurodidactic assessment is based on an approach that extends beyond final scores to take the learning process itself into account. This is important for identifying learners' difficulties and organizing targeted educational support. Second, the effectiveness of diagnosis depends on clearly defined criteria, complementary assessment instruments, and repeated observations. Combining tests, problem-solving tasks, delayed retrieval activities, observation, and reflection provides a more comprehensive understanding of learning outcomes. Third, the diagnostic process should ideally comprise initial assessment, observation of the learning process, formative feedback, final assessment, and analysis of results. This sequence helps translate the information obtained into practical pedagogical decisions. Fourth, implementing a neurodidactic approach requires scientific rigor, consideration of individual differences, respect for learners' dignity, and careful interpretation of diagnostic findings. Definitive conclusions about learners' abilities should not be drawn on the basis of popular neuromyths or isolated observations. Fifth, the practical value of this methodology lies in identifying the pedagogical measures necessary to improve learning outcomes. Based on diagnostic findings, teachers can adapt learning tasks, provide additional exercises, reinforce previously acquired knowledge, improve feedback practices, and develop learners' independent learning skills.

In conclusion, the methodology for diagnosing learning outcomes through a neurodidactic approach represents a promising direction in pedagogy. It can contribute to adapting instruction to learners' needs, strengthening the formative function of assessment, and improving the educational process on a scientific basis. At the same time, its effectiveness depends on reliance on scientific evidence, empirical evaluation of the methodology in practice, and the judicious use of diagnostic findings.

References

1. OECD. Understanding the Brain: The Birth of a Learning Science. Paris: OECD Publishing, 2007. Asarda miya faoliyati haqidagi bilimlarni ta'limga tatbiq etish imkoniyatlari va neyromiflardan ehtiyot bo'lish zarurati yoritilgan.

2. Diamond A. Executive Functions. Annual Review of Psychology. 2013. Vol. 64. P. 135–168. Maqolada ijro funksiyalari, jumladan, o'zini nazorat qilish, ishchi xotira va kognitiv moslashuvchanlikning nazariy asoslari bayon etilgan.

3. Black P., Wiliam D. Assessment and Classroom Learning. Assessment in Education: Principles, Policy & Practice. 1998. Vol. 5, No. 1. P. 7–74. Mualliflar shakllantiruvchi baholash va teskari aloqaning ta'lim jarayonidagi rolini tahlil qilgan.

4. Howard-Jones P. A. Neuroscience and Education: Myths and Messages. Nature Reviews Neuroscience. 2014. Vol. 15. P. 817–824.

5. Tokuhama-Espinosa T. Mind, Brain, and Education Science: A Comprehensive Guide to the New Brain-Based Teaching. New York: W. W. Norton & Company, 2011.

6. Horvath J. C., Donoghue G. M. A Bridge Too Far — Revisited: Reframing Bruer’s Neuroeducation Argument for Modern Science of Learning Practitioners. Frontiers in Psychology. 2016. Vol. 7. Article 377. DOI: https://doi.org/10.3389/fpsyg.2016.00377.