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USING MODERN PEDAGOGICAL TECHNOLOGIES IN TEACHING MATHEMATICALLY GIFTED STUDENTS

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Abstract. This theoretical and methodological article examines the pedagogical conditions and modern technologies that support the identification and systematic development of mathematically gifted school students. The study is based on analysis, comparison, synthesis, and pedagogical modeling of research on gifted education, differentiated instruction, mathematics teaching, digital learning, and formative assessment. The analysis shows that isolated methods do not provide sustainable results; an effective system combines continuous multi-criteria identification, an individual learning trajectory, curriculum enrichment, problem- and project-based learning, STEM integration, computational thinking, dynamic mathematics software, dialogic cooperation, and formative assessment. Particular attention is paid to the teacher's role in selecting intellectually demanding tasks, providing timely scaffolding, maintaining psychological safety, and balancing individual and collaborative work. A practical implementation cycle is proposed: diagnostic profiling, differentiated planning, enriched instruction, evidence-based monitoring, and reflective adjustment. The article concludes that modern technologies become pedagogically productive only when they are aligned with clear learning goals and the learner's current level of readiness, interest, pace, and socio-emotional needs.

Keywords: mathematical giftedness, gifted education, differentiated instruction, problem-based learning, project-based learning, STEM education, computational thinking, digital mathematics, formative assessment, individual learning trajectory

INTRODUCTION

Rapid scientific and technological development has increased the need for individuals who can reason abstractly, recognize patterns, construct models, and generate nonstandard solutions. Mathematics is central to these capacities because it connects logical reasoning, quantitative analysis, spatial imagination, and evidence-based decision-making. Consequently, the early identification and purposeful development of students with high mathematical potential is not only an educational task but also a strategic investment in a country's scientific and technological future.

Contemporary gifted education treats giftedness as a developing potential rather than a fixed label. Outstanding achievement emerges through the interaction of domain-specific ability, creativity, motivation, task commitment, opportunity, and sustained support [1, 2]. Therefore, mathematical giftedness should not be reduced to speed in solving routine exercises. It is more accurately reflected in the ability to generalize, detect hidden relationships, move flexibly between representations, formulate hypotheses, justify solutions, and persist when facing complex problems.

A standard curriculum may underchallenge such learners and gradually weaken their motivation. At the same time, simply increasing the quantity of exercises is not sufficient. Gifted students require qualitatively richer tasks, intellectual autonomy, access to advanced resources, interaction with peers, and constructive feedback. The purpose of this article is to systematize modern pedagogical technologies for working with mathematically gifted students and to propose an integrated framework for their classroom and extracurricular development.

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MATERIALS AND METHODS

The article has a theoretical and methodological character. The research methods included analysis of pedagogical and psychological literature, comparison of instructional approaches, synthesis of evidence-based recommendations, and pedagogical modeling. The technologies were examined according to six criteria: intellectual challenge, responsiveness to individual differences, development of learner agency, transfer to authentic situations, quality of feedback, and feasibility in school practice. No empirical sample was used; therefore, the conclusions are presented as a conceptually grounded framework and a set of practical recommendations that require contextual adaptation and further experimental verification.

RESULTS AND DISCUSSION

Continuous identification and an individual learning trajectory

Identification should be continuous, multi-criteria, and development-oriented. A single test or one-time competition result cannot capture the full structure of mathematical potential. Useful evidence includes performance on nonroutine problems, originality of strategies, depth of explanations, speed of conceptual transfer, teacher observations, student questions, project products, portfolios, and persistence during demanding tasks. This approach makes it possible to recognize students whose potential may be masked by low confidence, limited prior opportunities, or uneven development [1, 2].

The diagnostic profile should lead to an individual learning trajectory. Differentiation may involve curriculum compacting when previously mastered content is confirmed, tiered tasks with increasing levels of abstraction, enrichment through open-ended problems, and selective acceleration when it is pedagogically justified. Differentiation does not mean lowering common educational standards; it means providing different pathways, degrees of support, and levels of complexity so that each learner works within a productive zone of challenge [3].

Differentiated and problem-based instruction

In differentiated mathematics instruction, students can work with the same core concept through tasks that vary in complexity, openness, representation, and required independence. For example, while the class studies quadratic functions, a mathematically gifted student may compare families of functions, investigate parameter effects, formulate a conjecture, and prove a general relationship. Such tasks promote depth rather than premature movement through disconnected topics.

Problem-based learning is particularly valuable because it places students in situations where a ready-made procedure is unavailable. Learners identify what is known, formulate hypotheses, select mathematical tools, test solutions, and evaluate the reasonableness of conclusions. Research on problem-based learning emphasizes the development of flexible knowledge, problem-solving skills, self-directed learning, collaboration, and intrinsic motivation [4]. However, intellectual independence should not be confused with the absence of teacher support. Carefully timed questions, partial examples, visual prompts, and feedback are necessary forms of scaffolding, especially when a task contains unfamiliar concepts. NCTM likewise identifies reasoning, problem solving, purposeful questioning, mathematical discourse, and productive struggle as central practices of effective mathematics teaching [5].

Project-based learning, STEM integration, and computational thinking

Project-based learning connects mathematical ideas with authentic inquiry. Projects such as “Geometry in Architecture,” “Mathematical Models of Population Change,” “Optimization of School Resources,” or “Probability in Everyday Decisions” require students to collect data, select

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assumptions, construct models, interpret results, and communicate conclusions. Successful project work combines student autonomy with clear milestones, teacher guidance, collaboration, and assessment criteria [6].

The STEM approach broadens the meaning of mathematics by integrating it with science, technology, and engineering. Engineering design tasks allow gifted learners to experience mathematics as a tool for constructing, predicting, optimizing, and testing rather than as a set of isolated formulas [7]. Programming in Python, C++, or block-based environments can further develop computational thinking through data practices, modeling and simulation, algorithmic problem solving, and systems thinking [8]. For mathematically gifted students, code should not replace mathematical reasoning; it should make patterns testable, provide rapid feedback, and create opportunities to move from numerical experiments to proof and generalization.

Digital mathematics environments and the flipped classroom

Dynamic mathematics environments such as GeoGebra and Desmos, computer algebra systems, spreadsheets, and interactive simulations can make abstract relationships visible and manipulable. Learners can vary parameters, observe invariants, compare graphical and symbolic representations, and test conjectures. A meta-analysis of GeoGebra-supported mathematics learning reported a substantial positive overall effect, while also showing that outcomes depend on implementation conditions, access to devices, and the duration of instruction [9]. Therefore, digital tools should be selected for a clear cognitive purpose and followed by explanation, justification, and reflection.

The flipped classroom can be used when gifted learners are ready to encounter introductory explanations before class through concise videos, readings, or interactive notes. Classroom time is then reserved for advanced problems, discussion, modeling, and teacher consultation. A quasi-experimental study in high-school mathematics found positive effects on concept learning and motivation [10]. Nevertheless, pre-class materials must be short, accessible, and accompanied by accountability mechanisms; otherwise, the model may simply transfer lecture time from school to home.

Dialogic, cooperative, and game-based technologies

Heuristic conversation and Socratic dialogue strengthen the ability to defend a claim, detect hidden assumptions, and revise an argument. Instead of confirming only the final answer, the teacher asks students to explain why a method works, compare alternative solutions, and identify the conditions under which a statement remains valid. This transforms mathematical communication into a form of reasoning.

Although some gifted students prefer individual work, cooperative learning is important for developing communication, leadership, conflict resolution, and collective problem solving. Small groups should be organized around demanding tasks that genuinely require distributed roles, such as modeler, verifier, data analyst, and presenter. Mathematical battles, intellectual tournaments, quests, and logic games may increase emotional engagement, but competition should remain psychologically safe and should reward reasoning, creativity, and improvement rather than speed alone.

Formative assessment and socio-emotional support

Traditional marks often fail to show the qualitative growth of a gifted learner. Formative assessment makes student thinking visible and enables instruction to be adjusted during learning. Effective tools include analytic rubrics, learning journals, portfolios, self-assessment, peer feedback, oral defense of solutions, and teacher conferences. Research on classroom assessment demonstrates

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that feedback is most useful when it clarifies the learning goal, identifies the current level, and indicates the next attainable step [11].

The learning environment should also respond to socio-emotional needs. Gifted students may experience perfectionism, fear of failure, boredom, or isolation. The teacher should normalize productive error, recognize effort and strategy, establish realistic goals, and create opportunities for mentorship and peer interaction. Universal Design for Learning principles can support access, participation, and learner agency by providing multiple means of engagement, representation, and action without reducing intellectual rigor [12].

Table 1. Pedagogical technologies for developing mathematical giftedness

Approach	**Primary purpose**	**Illustrative task**	**Critical implementation condition**
Differentiated instruction	Match challenge, pace, and support to readiness	Tiered open-ended problems; curriculum compacting	Use diagnostic and formative evidence; avoid fixed labels
Problem-based learning	Develop flexible knowledge and independent problem solving	Prove or refute a conjecture arising from a real situation	Provide timely scaffolding and require justification
Project-based and STEM learning	Connect mathematics with authentic design and inquiry	Model an architectural, economic, or engineering problem	Use clear milestones, roles, and assessment criteria
Digital mathematics and flipped learning	Visualize relationships and reserve class time for advanced reasoning	Explore parameter changes in GeoGebra before formal proof	Technology must serve a cognitive goal, not novelty
Dialogic and cooperative learning	Strengthen argumentation, communication, and collective intelligence	Compare several solutions and defend the most efficient one	Ensure genuine interdependence and psychological safety
Formative assessment	Monitor growth and guide the next step	Portfolio, rubric, learning log, oral defense	Feedback must be specific, actionable, and timely

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PRACTICAL RECOMMENDATIONS

1. Create a dynamic diagnostic profile for each potentially gifted learner by combining achievement data, nonroutine tasks, observation, portfolio evidence, and student self-reflection.

2. Plan an individual trajectory that includes curriculum compacting, enrichment, mentoring, olympiad preparation, research tasks, and selective acceleration where appropriate.

3. Include at least one open-ended or investigative problem in each thematic unit and assess the quality of reasoning, not only the correctness or speed of the answer.

4. Integrate digital tools with prediction, experimentation, explanation, and proof; require students to interpret every graph, model, or computational result.

5. Balance independent work with structured cooperation, mathematical dialogue, project defense, and peer review so that intellectual and social competencies develop together.

6. Use formative assessment and socio-emotional support continuously; help students view error as information, set realistic goals, and maintain motivation during difficult work.

CONCLUSION

Working with mathematically gifted students is a systematic and multidimensional process. The most productive approach is not the use of one fashionable method but the purposeful integration of differentiation, problem and project inquiry, STEM and computational thinking, digital mathematics, dialogue, cooperation, formative assessment, and psychological support. These technologies allow students to move beyond routine performance toward abstraction, modeling, proof, creativity, and independent research.

The decisive factor is the teacher's professional competence. A teacher must recognize potential, design sufficiently complex tasks, regulate cognitive load, provide precise feedback, and create a classroom culture in which intellectual risk is safe. The proposed framework can guide school practice, extracurricular clubs, and olympiad preparation. Future studies should empirically examine its effectiveness across age groups and educational contexts using measurable indicators of mathematical reasoning, creativity, motivation, and transfer.

REFERENCES

1. Subotnik, R. F., Olszewski-Kubilius, P., & Worrell, F. C. (2011). Rethinking giftedness and gifted education: A proposed direction forward based on psychological science. Psychological Science in the Public Interest, 12(1), 3–54. https://doi.org/10.1177/1529100611418056
2. Renzulli, J. S. (1978). What makes giftedness? Reexamining a definition. Phi Delta Kappan, 60(3), 180–184, 261.
3. Tomlinson, C. A. (2014). The Differentiated Classroom: Responding to the Needs of All Learners (2nd ed.). Alexandria, VA: ASCD.
4. Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3
5. National Council of Teachers of Mathematics. (2014). Principles to Actions: Ensuring Mathematical Success for All. Reston, VA: NCTM.
6. Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. Improving Schools, 19(3), 267–277. https://doi.org/10.1177/1365480216659733

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http://houghtonstreetreview.com/index.php/hsr

7. English, L. D. (2016). STEM education K–12: Perspectives on integration. International Journal of STEM Education, 3, Article 3. https://doi.org/10.1186/s40594-016-0036-1
8. Weintrop, D., Beheshti, E., Horn, M. S., Orton, K., Jona, K., Trouille, L., & Wilensky, U. (2016). Defining computational thinking for mathematics and science classrooms. Journal of Science Education and Technology, 25(1), 127–147. https://doi.org/10.1007/s10956-015-9581-5
9. Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., & Wijaya, T. T. (2021). A meta-analysis of GeoGebra software decade of assisted mathematics learning: What to learn and where to go? Heliyon, 7(5), e06953. https://doi.org/10.1016/j.heliyon.2021.e06953
10. Bhagat, K. K., Chang, C. N., & Chang, C. Y. (2016). The impact of the flipped classroom on mathematics concept learning in high school. Educational Technology & Society, 19(3), 134–142.
11. Black, P., & Wiliam, D. (1998). Assessment and classroom learning. Assessment in Education: Principles, Policy & Practice, 5(1), 7–74. https://doi.org/10.1080/0969595980050102
12. CAST. (2024). Universal Design for Learning Guidelines, Version 3.0. Wakefield, MA: CAST.