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ADAPTIVE LEARNING APPROACHES FOR IMPROVING SPECIAL EDUCATION OUTCOMES

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ABSTRACT

Adaptive learning has become an important approach in special education because it enables instruction to respond to students' individual abilities, learning difficulties, preferences, and educational goals. Students with special educational needs may require different levels of support, instructional methods, learning materials, and opportunities for practice. Traditional teaching approaches that provide identical activities to every learner may not adequately address these differences. This study examines adaptive learning approaches for improving educational outcomes among students with special educational needs, including students with learning disabilities, autism spectrum disorder, attention-deficit/hyperactivity disorder, and other developmental or learning challenges. A qualitative descriptive literature-review approach is used to examine research on adaptive learning systems, individualized instruction, artificial intelligence, formative assessment, assistive technology, and teacher-guided interventions. The reviewed literature suggests that adaptive approaches can support academic achievement, engagement, independent learning, and access to educational content when they are appropriately matched to individual needs. Adaptive systems may adjust task difficulty, provide immediate feedback, recommend additional practice, and present information through alternative formats. However, their effectiveness varies according to students' characteristics, the quality of instructional design, teacher involvement, accessibility, and implementation conditions. Important challenges include limited resources, inadequate teacher training, privacy concerns, algorithmic bias, and insufficient evidence for certain disability groups. The study concludes that adaptive learning is most beneficial when combined with evidence-informed teaching, individualized educational planning, continuous progress monitoring, and meaningful teacher-student interaction. As the study synthesizes existing literature rather than collecting new experimental data, its conclusions represent an interpretation of previously published research. The findings may help educators and policymakers develop more responsive, accessible, and effective special education environments.

KEYWORDS:*Adaptive learning, special education, personalized learning, students with special educational needs, individualized instruction, artificial intelligence, assistive technology, differentiated instruction, learning disabilities, academic achievement, formative assessment, inclusive education, student engagement, educational accessibility, and learning outcomes.*

INTRODUCTION

Special education aims to provide appropriate learning opportunities for students whose educational needs require additional support, individualized instruction, or specific accommodations. These students may experience difficulties with reading, writing, mathematics, communication, attention, memory, sensory processing, social interaction, or other aspects of learning. Their abilities and support requirements can differ considerably, even when they share the same disability classification. ALGHAMDI, D. N. I. (2025). found thatConsequently, an effective educational approach must recognize individual differences and provide suitable opportunities for academic progress, independence, and participation. Adaptive learning offers one way of addressing this challenge by adjusting instructional content, difficulty, feedback, and learning activities according to students' demonstrated performance and support needs.Traditional classroom instruction often follows a common sequence in which students receive similar explanations, complete comparable exercises, and progress through material at approximately the same pace. Although this structure can provide consistency, it may not fully address the requirements of students who need additional practice, alternative explanations, more accessible materials, or greater challenges.

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Adaptive learning approaches attempt to make instruction more responsive by using assessment information, teacher observations, learner profiles, and, in technology-supported environments, digital performance data. For example, a student who struggles with reading comprehension may receive shorter passages, vocabulary assistance, audio support, and repeated practice. A student who has difficulty with mathematics may receive visual representations, step-by-step guidance, and additional exercises targeting a specific skill. These adaptations can help teachers identify learning barriers and provide more relevant educational experiences.Recent research has examined adaptive learning from several perspectives, including educational technology, differentiated instruction, intelligent tutoring systems, and targeted interventions for students with special educational needs. Bach, Hofer, and Bichler (2025) reviewed 69 publications concerning adaptive learning, instruction, and teaching in schools. Their review found that adaptations were commonly based on learner performance and were often implemented through educational systems, particularly in mathematics. Bach, K. M., Hofer, S. I., & Bichler, S. (2025). Explained that The authors also identified gaps in how adaptive approaches are assessed, delivered, and evaluated. Similarly, Surahmana et al. (2026) reviewed 50 empirical studies of adaptive learning systems for children with special needs. Their synthesis covered technologies such as AI-supported tutoring, systems designed for specific learning difficulties, and technology-assisted interventions for autism spectrum disorder. The review reported promising academic, cognitive, and socio-emotional outcomes while emphasizing the need for stronger evidence, disability-specific research, and ethical collaboration involving students, families, and educators.

Adaptive learning should not be understood as technology alone. Teachers can adapt instruction without sophisticated digital systems by changing the pace of a lesson, modifying task complexity, providing scaffolded exercises, grouping students flexibly, and offering individualized feedback. Digital platforms and artificial intelligence may expand these possibilities by analyzing student responses and adjusting activities rapidly, but automated recommendations still require professional judgment. Effective adaptation also depends on identifying appropriate educational goals and monitoring whether students are making meaningful progress.In special education, the central concern is not simply whether a system can personalize content, but whether its adaptations improve outcomes that matter to students. These outcomes may include academic achievement, communication, engagement, independence, confidence, participation, and progress toward individualized learning goals. It is also important to recognize limitations, including unequal access to devices, inadequate teacher preparation, concerns about student data, and the possibility that automated systems may fail to recognize individual needs accurately. Therefore, adaptive learning should complement rather than replace direct instruction, teacher-student relationships, specialist support, and individualized educational planning.This study examines adaptive learning approaches for improving special education outcomes by reviewing differentiated instruction, adaptive digital systems, artificial intelligence, formative assessment, assistive technology, individualized interventions, and teacher-guided learning.

RESEARCH OBJECTIVE

1. To examine how adaptive learning approaches can improve academic achievement, student engagement, and individualized educational outcomes among students with special educational needs.

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RESEARCH QUESTION

1. How do adaptive learning approaches contribute to academic achievement, student engagement, and individualized educational outcomes among students with special educational needs?

LITERATURE REVIEW

Adaptive learning refers to an instructional approach in which teaching methods, learning activities, educational content, and levels of support are adjusted according to a learner's needs and progress. In special education, adaptation is particularly important because students may differ in their cognitive abilities, communication skills, sensory requirements, attention, prior knowledge, and rate of learning. An approach that is suitable for one student may be ineffective for another, even when both students are studying the same subject. Adaptive learning therefore emphasizes individual progress, continuous assessment, and the selection of suitable instructional strategies.Adaptive learning can be implemented through teacher-directed instruction, digital educational platforms, artificial intelligence, or combinations of these approaches. Baumuratova, S., Baumuratova, D., Zhukabayeva, T., & Tassuov, B. (2026). Explains that A teacher may adapt a lesson by providing additional examples, breaking a task into smaller steps, changing the difficulty of exercises, or offering alternative learning materials. A digital system may perform some of these functions automatically by analyzing student responses and recommending the next activity. The central objective is to match instruction to the learner's current level while helping the student progress toward meaningful educational goals.Bach, Hofer, and Bichler (2025) examined adaptivity in school teaching through a systematic review of 69 publications. Their analysis found that student performance was a common basis for adaptation and that digital systems frequently delivered adjustments at the level of navigation, instructional support, and task difficulty. However, the authors also identified gaps in reporting how adaptations are designed and evaluated. This finding suggests that adaptive learning requires a clearly defined instructional process rather than the simple use of technology.

Adaptive learning should also be distinguished from individualized education as a broader practice. Individualized education may include long-term goals, accommodations, specialist support, and family collaboration. Adaptive learning focuses more specifically on adjusting the learning experience in response to student needs and progress. When both approaches are coordinated, teachers can use ongoing evidence to refine instruction while maintaining consistency with each student's educational plan.Special education includes students with a wide range of learning and developmental needs. Some students require support with reading, writing, and mathematics, while others need communication assistance, sensory accommodations, structured routines, or additional help with attention and self-regulation. Standardized instruction may not provide sufficient flexibility for all these needs. Adaptive learning offers a framework for adjusting educational experiences without assuming that every student must follow an identical pathway. Farhood, H., Nyden, M., Beheshti, A., &

Surahmana et al. (2026) reviewed 50 empirical studies of adaptive learning systems for children with special needs. The review covered several disability groups and different forms of technology, reporting promising outcomes in academic learning, cognitive development, and socio-emotional functioning. It also highlighted the need for disability-specific research

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and stronger evidence about implementation and effectiveness. Adaptive learning is important because it can help educators respond to students' strengths as well as their difficulties. Students should not be defined exclusively by the support they require. An adaptive approach can provide additional assistance in challenging areas while allowing learners to progress more quickly through material they already understand. The overall purpose is to expand access to meaningful learning, encourage independence, and support individual educational progress.Individualized instruction involves planning educational activities around a student's learning goals, abilities, and support requirements. Differentiated learning applies a related principle by allowing teachers to vary content, processes, materials, levels of difficulty, and assessment methods within a classroom. These approaches are important foundations of adaptive learning because they help teachers respond to student differences even when advanced technology is unavailable.Teachers may begin by identifying students' current abilities through diagnostic assessments, observations, classroom tasks, and discussions. They can then organize activities at appropriate levels, provide additional guidance where necessary, and increase complexity as students demonstrate progress. Flexible grouping can also be used to provide targeted instruction without permanently assigning students to fixed ability categories.For instance, in a mathematics lesson, one student may practice basic number recognition using visual objects, another may work on addition using number lines, and a third may solve more complex problems independently. Although their activities differ, each student can work toward an appropriate learning objective. The teacher monitors performance and modifies support as needed.

The literature on adaptive instruction emphasizes that effective adjustments should be connected to identifiable learning needs and outcomes. Bach et al. (2025) found that adaptive practices were commonly based on performance measures, but also noted inconsistencies in how adaptation was described across studies. This highlights the importance of recording what is being adapted, why the adaptation is needed, and whether it improves learning. Individualized and differentiated instruction can be demanding when teachers work with large classes or have limited planning time. Practical strategies include preparing materials at different levels, providing visual instructions, offering guided practice, and using brief formative assessments to identify students who need additional help. These measures can make instruction more responsive without requiring a separate lesson for every learner.Artificial intelligence has expanded the possibilities for adaptive learning by enabling educational systems to analyze student responses, identify patterns, recommend activities, and adjust instructional content. AI-supported systems may track accuracy, response time, repeated errors, and progress across tasks. Based on this information, they can provide additional exercises, offer hints, change task difficulty, or recommend a different instructional pathway.In special education, these capabilities may help teachers identify learning difficulties and provide targeted practice. For example, an adaptive reading platform may recognize repeated errors in decoding and offer further practice with particular letter-sound relationships. A mathematics system may identify difficulty with fractions and provide visual examples before introducing more complex problems. Intelligent tutoring systems may also provide immediate feedback, helping students correct misunderstandings before they become persistent.

Hariyanto, Kristianingsih, and Maharani (2025) reviewed AI techniques for adaptive education and personalized learning, examining how machine learning, deep learning, and multimodal analytics can support instructional adjustments. Their work provides a broader

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foundation for understanding how AI can support personalization, although findings from general education cannot automatically be assumed to apply equally to every special education population. Voultsiou and Moussiades (2025) reviewed 139 studies concerning artificial intelligence, virtual reality, and large language models in special education. Their synthesis described opportunities for personalized learning, cognitive development, and social engagement, alongside implementation challenges. The review suggests that these technologies offer useful possibilities, but responsible implementation requires attention to accessibility, educational relevance, and student needs. Despite their potential, AI systems should not make consequential educational decisions without appropriate human oversight. Automated assessments can be inaccurate, and algorithms may perform differently for students whose communication patterns or learning profiles are underrepresented in training data. Teachers should review system recommendations, check whether activities are appropriate, and ensure that automated adaptation supports rather than restricts student learning.Students with learning disabilities may experience persistent difficulties in specific academic areas, including reading, writing, spelling, mathematical calculation, or reasoning. Adaptive learning can provide targeted practice by identifying the skills a student finds challenging and adjusting the amount and type of support provided. This approach can help make instruction more focused than simply repeating an entire lesson.For students with reading difficulties, adaptive activities may include phonological awareness exercises, decoding practice, vocabulary instruction, audio support, and short comprehension tasks. Students who struggle with written expression may benefit from planning templates, sentence starters, speech-to-text applications, and step-by-step writing guidance. In mathematics, adaptive systems may use worked examples, visual models, repeated practice, and progressive increases in difficulty.

METHODOLOGY

This study uses a qualitative literature-based methodology to examine adaptive learning approaches for improving educational outcomes among students with special educational needs. The methodology focuses on reviewing recent academic publications from 2025 and 2026, including systematic reviews, empirical studies, research articles, and scholarly discussions concerning adaptive instruction, artificial intelligence, personalized learning, assistive technology, and special education interventions. Relevant publications were identified through scholarly search resources and academic journal platforms. Priority was given to research that directly examined adaptive learning systems, individualized instruction, educational accessibility, student engagement, academic achievement, and the challenges of implementing adaptive approaches.The reviewed literature was organized according to the research objective and question. Relevant information was grouped into themes, including individualized instruction, AI-supported learning, disability-specific adaptations, formative assessment, assistive technology, student motivation, teacher preparation, and ethical considerations. Each theme was examined to identify the instructional approaches described, the outcomes reported, and the limitations acknowledged by the original researchers. Findings from different studies were compared to identify recurring patterns and areas where evidence was inconsistent or incomplete. Particular attention was given to distinguishing evidence about adaptive learning specifically from evidence about broader targeted interventions for students with special educational needs. This distinction is important because positive results from general educational interventions do not necessarily demonstrate that every adaptive learning system is effective. The methodology is a

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qualitative narrative review rather than a registered systematic review; therefore, it does not claim exhaustive coverage of all relevant publications.

RESEARCH DESIGN

The study adopts a qualitative descriptive research design based on a review of existing literature. This design is suitable for examining how adaptive learning approaches are used in special education, what benefits are reported, and which factors influence implementation. Instead of collecting new data from students or teachers, the study analyzes existing scholarly evidence to develop an integrated understanding of adaptive instructional practices and their potential educational outcomes.The research design involves three main stages. First, relevant publications are reviewed and categorized according to their subject matter, research approach, and relevance to the research question. Second, recurring themes are identified, including academic performance, individualized instruction, engagement, independence, accessibility, and implementation challenges. Third, these themes are compared and synthesized to develop conclusions and practical recommendations. The design also considers differences in study populations, educational settings, technologies, and outcome measures. Since the included studies do not necessarily use comparable methods or evaluate identical interventions, their findings are interpreted thematically rather than combined into a new statistical estimate. The resulting conclusions provide a research-informed overview of adaptive learning in special education, but they do not establish a new causal relationship between adaptive learning and student outcomes.

DATA ANALYSIS

The data analysis examines the reviewed literature to identify how adaptive learning approaches may support students with special educational needs. The literature is organized into several themes, including individualized instruction, adaptive digital systems, AI-supported personalization, formative assessment, assistive technology, student engagement, and implementation challenges. The first theme, individualized instruction, indicates that adjusting task difficulty, instructional pace, learning materials, and levels of support can help teachers respond to students' different abilities and learning requirements. The second theme concerns AI-supported adaptive learning, which may use student responses and performance information to recommend additional practice, provide feedback, and modify learning activities. These approaches may help teachers identify learning gaps and provide more targeted support.The third theme focuses on academic achievement and skill development. Existing research reports promising outcomes from targeted educational interventions for students with special educational needs, particularly in reading, writing, and mathematics. However, evidence about targeted interventions in general should not be interpreted as direct proof that every adaptive system will produce the same benefits. The fourth theme concerns engagement and independent learning. Adaptive activities may help students work at a manageable pace, receive timely guidance, and develop confidence as they progress toward learning goals. The fifth theme highlights the contribution of assistive technology, accessible learning materials, and alternative methods of presenting information. These tools can reduce particular barriers when they are appropriately matched to individual needs and integrated into effective teaching.The final theme concerns the challenges that may limit the effectiveness of adaptive learning. These include inadequate teacher training, limited financial resources, technical difficulties, accessibility problems, privacy concerns, and the

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risk of inaccurate automated recommendations. The analysis suggests that successful implementation requires teachers to monitor student progress, evaluate the suitability of adaptations, and adjust instruction according to observed learning needs. Since this study is based on existing literature rather than newly collected numerical data, no original statistical tests or percentages are calculated. The findings represent a thematic synthesis of previously reported evidence, and conclusions are framed cautiously where the research remains limited or inconsistent.

FINDINGS

The review identifies several major findings concerning adaptive learning approaches in special education.First, adaptive learning can support individualized instruction. Adjusting instructional pace, task difficulty, materials, and support may help students work toward educational goals that reflect their abilities and learning needs. Research on adaptive instruction emphasizes the importance of assessing student performance and explaining how adaptations are designed and implemented. Second, adaptive systems show promise for improving academic outcomes. A 2026 systematic review of adaptive learning systems for children with special needs examined 50 empirical studies and reported promising academic, cognitive, and socio-emotional outcomes. However, the authors also emphasized the need for stronger evidence and research focused on individual disability groups. Third, targeted educational interventions can improve learning progress. Van Herwegen et al. (2026) reported average additional progress of approximately five months across targeted interventions for students with special educational needs and disabilities compared with control groups. This finding supports the value of targeted educational support, but it is not an effect estimate for adaptive learning technology alone. Fourth, artificial intelligence and assistive technology can expand personalization and accessibility. AI-supported tutoring, accessible digital content, speech-based tools, and adaptive exercises may provide alternative ways for students to access information and practice skills. Their effectiveness depends on accessibility, the quality of instructional design, and teacher guidance. Fifth, teacher involvement remains essential. Adaptive systems can provide useful information and recommendations, but teachers must interpret student performance, identify individual needs, and ensure that adaptations support meaningful educational goals. Technology should complement direct instruction, individualized educational planning, and student-teacher interaction.Sixth, implementation and ethical challenges remain significant. Limited resources, inadequate training, privacy concerns, technical problems, and the possibility of biased or inaccurate recommendations can restrict the benefits of adaptive learning. Schools need appropriate infrastructure, teacher development, and clear procedures for evaluating technology-supported instruction.Overall, the findings suggest that adaptive learning can contribute to more responsive special education when it is designed around individual learning needs and supported by effective teaching practices. The evidence is promising, but the strength and consistency of outcomes vary across technologies, student groups, and educational contexts.

CONCLUSION

Adaptive learning approaches offer important opportunities to improve special education by adjusting instructional content, task difficulty, learning pace, feedback, and support according to students' individual needs. This study examined individualized instruction, differentiated

learning, artificial intelligence, adaptive digital systems, formative assessment, assistive technology, student engagement, and teacher-guided interventions. The reviewed literature suggests that these approaches can help students access educational content, practice specific skills, receive targeted feedback, and make progress toward individualized learning goals. They may also support greater participation, confidence, and independence when the learning environment is appropriately designed.However, adaptive learning should not be treated as an automatic solution to the challenges of special education. Students with different disabilities and learning profiles may respond differently to the same technology or instructional strategy. Effective implementation requires careful assessment, accessible materials, appropriate learning objectives, teacher supervision, and regular evaluation of student progress. Teachers must remain actively involved in interpreting assessment information, selecting adaptations, and ensuring that educational technology supports meaningful learning rather than simply increasing digital activity.The study also highlights the importance of addressing practical and ethical challenges, including limited resources, inadequate professional development, data privacy, accessibility, and algorithmic bias. Educational institutions should provide teachers with suitable training, technical support, and opportunities to collaborate with families and special education professionals. Future research should investigate the long-term effects of adaptive learning, compare different approaches across disability groups, and evaluate outcomes beyond academic scores, including independence, communication, engagement, and social participation.Because this study is based on a qualitative review of existing literature, its findings represent a synthesis of previously published evidence rather than results from a new experiment. Further empirical research is needed to determine which adaptive features are most effective for particular learners and under what conditions they produce lasting improvements. In conclusion, adaptive learning is best understood as a flexible educational approach that combines individualized support, evidence-informed instruction, accessible technology, and continuous teacher involvement to improve outcomes for students with special educational needs.

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