Student-centered learning in the digital age: in-class adaptive instruction and best practices

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Article Info

ABSTRACT

Adaptive instruction is a promising solution to the limitations of traditional classroom instruction, which assumes that all students learn in the same way and at the same pace. Adaptive instruction tailors the learning experience to each student's needs and abilities. Several adaptive instruction tools and platforms exist, including intelligent tutoring systems, learning management systems, mobile apps, AI chatbots, and adaptive machine-learning programs. The Adaptive Instruction of Student Control Theoretical Framework suggests that allowing students to control their use of learning resources leads to better learning outcomes. Implementing adaptive instruction in higher education can be difficult due to faculty buy-in, technical infrastructure, and student motivation. Effective instructional design is crucial for adaptive instruction to support student control and maximize benefits. Overall, instructors must pay attention to student motivation and work to create learning environments that foster motivation, autonomy, and engagement to implement adaptive instruction successfully.

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1. INTRODUCTION

Traditional classes assume uniform learning styles and abilities, disregarding students' unique traits, such as individual learning styles, strengths, weaknesses, and prior knowledge. Consequently, some students require more time and practice to grasp concepts, while others swiftly comprehend and move ahead. Unfortunately, slower-paced learners or those with limited understanding struggle to keep pace with their peers, leading to frustration, inadequacy, demotivation, and disengagement. This situation can breed a perception of insufficient challenge or overwhelming difficulty, fueling negative attitudes toward education and hindering academic growth for students with untapped potential.

In response to this challenge, adaptive instruction or adaptive learning technologies (ALT) have emerged as a promising solution. It is an approach to teaching that tailors the learning experience to each student's needs and abilities. It is based on the idea that every student learns differently and at their own pace, so instruction should be customized to their specific learning styles, preferences, and abilities. Several

adaptive instruction tools and platforms are currently being used in English language education, including intelligent tutoring systems (ITS), learning management systems (LMS), mobile apps (speech recognition, translation, and gamification), AI chatbots, and ALEKS, which is an "adaptive machine learning designed to determine students' precise knowledge and provide them with a personalized, meaningful learning experience" [1].

For the present discussion, adaptive instruction differs from differentiated instruction, although the terms are sometimes used interchangeably. ALT refers to educational software that adjusts to the individual needs of students. ALT is based on relevant student characteristics such as achievement/readiness, prior knowledge, learning preferences, and interests and uses data analytics and algorithms to analyze a student's performance. It then adapts instruction. For example, it might provide them with personalized instruction, feedback, and support or modify the learning pace, content, product, or learning environment.

To identify areas where the student may be struggling or excelling, teachers can obtain data and analytics to adjust the content, pace, and difficulty level of the learning materials, such as quizzes, exams [2], progress tracking through a course or program [3], feedback from students [4], and each student's time spent on a particular learning activity [5]. On the other hand, differentiated instruction is a teacher-led approach that involves tailoring instruction to meet students' individual needs, and mostly applies to classroom teaching. Teachers use various strategies to modify the content, process, and/or instruction product to accommodate each student's different learning styles, interests, and abilities.

Several studies have explored the effectiveness of adaptive instruction in improving learning outcomes and motivation. A computer-based system was developed to analyze each student's strengths and weaknesses in real-time and provide customized instruction and feedback based on their needs [2]. The personalized learning system could adapt to each student's pace of learning and improve their performance in mathematics and reading. A study was also conducted to explore the effectiveness of a personalized gamified learning system in enhancing students' motivation and engagement in learning [3]. It consisted of personalized content, game elements, and a recommendation system. The students in the test group reported higher levels of motivation and engagement compared to those in a group using traditional learning. The adaptive instruction group received personalized feedback and instruction tailored to their needs [6]. Each student in the non-adaptive instruction group received the same instruction. Overall, these studies highlight the importance of considering various factors, such as instructional design and student characteristics, in designing and implementing adaptive instruction in educational settings.

Although adaptive instruction is widely known, teachers struggle to understand how to implement it in their classrooms. A study revealed that teachers from various countries rarely adjust their teaching based on individual student needs, resulting in struggling students being given tasks that are too difficult, and high-achieving students practicing already mastered skills. To improve student outcomes, more information on effective practices is necessary [7]. A recent review and meta-analysis of adaptive instruction in primary education indicated that it has the potential to improve outcomes if executed properly. This study examines the empirical evidence of within-class adaptive instruction's effectiveness in secondary education, how it is implemented in studies, and the contexts in which it is evaluated. ALT provides opportunities for students to take control of their use of learning resources and take an active role in their learning process [8]. In Kay's view, student control is an instructional technique that allows students to control various aspects of the learning process, including the pace, order, and depth of their learning. Students with control over the learning process can better construct their understanding of a learning domain [8]. Students can use their experiences, interests, and knowledge to guide their learning rather than relying solely on the instructor's guidance.

A simple diagram showing the information flow between the student, the student control tools, and the instructional materials [8]. In this diagram, the student is at the center of the learning process and is surrounded by student control tools, such as navigation, search, and annotation tools. These tools provide students with various ways to interact with instructional materials, such as searching for specific information, annotating important concepts, or navigating the materials in a non-linear fashion. Giving students more control over the learning process makes them more likely to engage with the material, feel a sense of ownership over their learning, and, ultimately, develop a deeper understanding of the domain. Additionally, students who have control over the learning process are more likely to be motivated to learn and more likely to transfer what they have learned to other contexts.

Using the perspective of self-determination theory, individuals are driven by innate psychological needs for autonomy, competence, and relatedness [9]. Autonomy involves being self-directed and having a sense of personal agency. When individuals have autonomy, they feel that their actions are self-endorsed and congruent with their own values and interests. In short, students can construct their understanding of a learning domain and become more motivated and effective.

The previous studies on adaptive instructions suggest that adaptive instructional systems and learning technologies can effectively improve learning outcomes, especially in math and science, and that educators and instructional designers should consider incorporating them into their teaching practices. For example, an expert found that adaptive instructional systems can enhance students' learning outcomes and

motivation by providing personalized feedback and guidance [10]. In a laboratory study, undergraduate students were randomly assigned to either an adaptive or non-adaptive instructional system. The adaptive system provided personalized feedback based on performance, while the non-adaptive system gave generic feedback. Learning outcomes and motivation were measured using pre-tests, post-tests, surveys, and interviews. Eye-tracking and think-aloud methods assessed cognitive and metacognitive processes like attention, comprehension, and monitoring. These methods provided insights into cognitive engagement and learning strategies. The study revealed that adaptive systems can personalize learning by adjusting content and delivery, resulting in improved outcomes and increased motivation. The adaptive system also enhanced cognitive and metacognitive processes, including attentional focus, comprehension, and monitoring.

The next study on adaptive instruction found that adaptive learning technology positively affects students' academic performance, especially in math and science. Researchers systematically reviewed the literature and identified 48 relevant studies that met their inclusion criteria [11]. These studies involved 11,676 students from various educational levels, including K-12, higher education, and professional training. The studies used a variety of ALT, such as intelligent tutoring systems, adaptive quizzes, and personalized learning environments. The meta-analysis results showed that adaptive learning technology had a significant positive effect on students' academic performance, with an average effect size of 0.45. This means that students who used adaptive learning technology performed better than those who did not. The effect was stronger in higher education and professional training settings than in K-12 settings. This study suggests that adaptive learning technology can effectively improve students' academic performance, especially in math and science. Adaptive instruction improved learning outcomes across various domains [12]. They comprehensively reviewed the literature on adaptive instructional systems, examining studies that compared the effectiveness of adaptive systems to traditional, non-adaptive instruction. After analyzing the results of the studies, they found that adaptive systems were more effective in developing higher-order thinking skills, such as problem-solving and critical thinking, and improving students' ability to transfer learning to new contexts.

Adaptive learning technologies is a useful tool to improve learning outcomes, especially in math and science subjects where students may struggle [13]. They searched various databases and identified 33 relevant studies that met their inclusion criteria. These studies involved 5,863 participants and examined the effectiveness of ALT in various subject areas. They found that the effectiveness of ALT was influenced by factors such as the type of technology used, the duration of the intervention, and the level of customization. This study suggests that educators and instructional designers should consider the type of technology used and the level of customization that would maximize effectiveness.

A study investigated the effectiveness of adaptive learning environments on students' learning outcomes and engagement by conducting a meta-analysis [14]. A meta-analysis is a statistical method that combines data from multiple studies to provide an overall estimate of the effect size of an intervention. This study systematically reviewed previous studies on adaptive learning environments and identified 40 studies that met their inclusion criteria. They then used statistical analysis to determine the overall effect size of adaptive learning environments on students' learning outcomes and engagement. The results of the meta-analysis showed that adaptive learning environments positively affect students' learning outcomes, including their academic achievement and cognitive skills. The effect size was moderate, indicating that adaptive learning environments have a meaningful impact on students' learning outcomes. Additionally, the researchers found that adaptive learning environments can enhance students' engagement in learning.

The studies found that adaptive learning and personalization can benefit students with different learning styles and abilities. A study did a systematic review to examine the impact of adaptive learning and personalization on students' academic achievement and engagement in higher education [15]. To conduct this study, the researchers searched various databases, including Scopus, Web of Science, and ERIC, and reviewed 23 studies that met their inclusion criteria. The studies published between 2010 and 2020 focused on adaptive learning and personalization in higher education. The study's findings suggest that adaptive learning and personalization positively impact students' academic achievement and engagement. Specifically, the studies reviewed found that adaptive learning and personalization resulted in improved test scores, higher course grades, and increased engagement with course materials.

Based on these studies, we conclude that using ALT and instructional systems can be an effective strategy for improving learning outcomes, especially in subjects where students may struggle. Thus, educators should consider the type of technology used and the level of customization to maximize the effectiveness of these interventions. Additionally, adaptive learning and personalization can benefit students with different learning styles and abilities. A meta-analysis was conducted to examine the impact of adaptive testing on students' motivation and learning outcomes [16]. They searched various databases, including PsycINFO and ERIC, and reviewed 41 studies that met their inclusion criteria. The studies published between 1990 and 2014 focused on adaptive testing in educational contexts. The researchers then analyzed the data from the studies and synthesized their findings to conclude the impact of adaptive testing on students' motivation and learning outcomes.

Their findings suggest that context determines the effectiveness of adaptive testing on students' motivation and learning outcomes. Specifically, they found that adaptive testing can negatively impact students' motivation and learning outcomes when the testing environment is high-stakes, students are unfamiliar with the testing format, and the adaptive testing system is not well-designed. However, the researchers also found that adaptive testing can improve students' motivation and learning outcomes when the testing environment is low-stakes and the adaptive testing system is well-designed. Consequently, educators and test developers should carefully consider the context in which adaptive testing is used.

Adaptive learning technologies have not yet fully delivered their promises of improving learning outcomes and reducing costs [17]. To conduct the study, they analyzed the results of several experiments and case studies of ALT implementation across various institutions. They also interviewed educators and administrators who had implemented ALT in their classrooms. The researchers found that while ALT has the potential to improve learning outcomes and reduce costs, the effective implementation of ALT faces several challenges, including the high cost of development, the difficulty of integrating the technologies into existing systems, and the lack of evidence-based research on their effectiveness. They found that the effectiveness of ALT depends heavily on how it is designed and implemented. The researchers emphasized that clear learning objectives should guide the use of ALT, and that educators and administrators should work closely with developers to ensure that the technologies effectively achieve those objectives.

A study examined the effectiveness of ALT in improving learning outcomes and explored the underlying issues contributing to their limited success [18]. To conduct the study, Feldstein analyzed several case studies and pilot programs of adaptive learning implementations in different institutions. The author also interviewed educators, administrators, and developers involved in implementing these technologies. He found that while ALT has been marketed as a solution to improve learning outcomes, they have not yet demonstrated significant improvements in these outcomes. Feldstein argued that the focus on technology has distracted from more fundamental educational issues, such as the need for personalized attention, effective teaching practices, and engagement. Furthermore, he argued that the adaptive learning industry has failed to address some critical challenges, including the high development and implementation costs, the lack of scalability, and the limited evidence of effectiveness. Feldstein suggested that the industry should address these challenges before investing in new technology. While ALT may have potential benefits in improving learning outcomes, their effectiveness has been overstated. Educators and administrators should be cautious in investing in ALT and consider other approaches that may be more effective in addressing underlying educational challenges.

The failure of adaptive educational technologies is often due to lack of user control, poor user experience, and inadequate feedback [19]. They aimed to identify the reasons for adaptive educational technologies' failure and explore possible solutions. To conduct the study, the researchers systematically reviewed the literature on adaptive educational technologies, focusing on studies that reported failures or limitations of these technologies. They identified 31 relevant studies and analyzed the data for common themes and patterns. The researchers found that ALT failures are often due to lack of user control, poor user experience, and inadequate feedback. Specifically, they found that users often feel that the technology is too prescriptive and does not give them enough control over their learning experience. They also found that the user experience of many ALTs is poor, with users finding the interfaces confusing, cluttered, or difficult to use. Finally, they found that many ALTs provide inadequate feedback, making it difficult for users to assess their progress and to adjust their learning strategies. Thus, the failure of adaptive educational technologies is often due to factors that can be addressed through better design and development.

Implementing ALT in higher education can be difficult due to factors of faculty buy-in, technical infrastructure, and student motivation. Specifically, faculty members were hesitant to adopt the technology due to concerns about the impact on their teaching practices, lack of training, and workload. In this case, Some researcher investigated the implementation of ALT in higher education and the challenges facing universities in adopting this technology [20]. They conducted a qualitative case study analysis by selecting six universities implementing ALT in their courses. They used data from interviews with faculty members, administrators, and students involved in implementing the technology. The interviews aimed to understand the challenges and benefits of ALT in higher education. Technical infrastructure challenges were related to integrating ALT with existing learning management systems and the need for IT support. They found that student motivation was an important factor in the success of the technology, as students who were not motivated or engaged with the technology did not see the benefits of adaptive learning. This is quite odd; it suggests that students might have been able to identify adaptive technologies because they were not integrated seamlessly into the learning experience.

Faculty and students may have differing perceptions of the effectiveness of ALT. Specifically, faculty expressed concerns about loss of control over the learning experience and perceived the technology as time-consuming and difficult to integrate into their teaching. In contrast, students reported a lack of engagement with the technology and suggested that it did not provide enough feedback or support for their

learning. Regarding this issue, a mixed-methods study was conducted study by collecting survey data from 130 faculty members and 375 students at a large, public university in the United States [21]. The survey questions were designed to assess faculty and student perceptions of ALT in the LMS, including its effectiveness, ease of use, and impact on teaching and learning outcomes. They found that faculty and students may have differing perceptions of the efficacy of ALT, with some faculty expressing concerns about loss of control over the learning experience and some students reporting a lack of engagement with the technology. This study implies that universities need to address the concerns and differing perceptions of faculty and students when implementing ALT in the LMS. Universities must provide adequate training and support for faculty members to ensure they are comfortable with the technology. If faculty members feel a loss of control of their teaching experience, they need to know when it is beneficial and when it is not. Moreover, program managers need to know whether faculty members' responses are based on good teaching practices or whether they are primarily a negative emotional reaction to change. Another more fundamental aspect is the question, "Who is the teacher?" This loss of faculty control reflects a role shift. The educational technologists and program designers take over part of the teaching role, while faculty members are somewhat reduced to tutors for materials that others have developed.

From the previous studies, we learn that educators must carefully consider the context in which adaptive testing is used. In high-stakes testing environments or when students are not familiar with the testing format, adaptive testing may not be the best option. While ALT has the potential to improve learning outcomes and reduce costs, their effectiveness depends heavily on how they are designed and implemented, and their effectiveness has been overstated [22]. The adaptive learning industry has encountered significant challenges that hinder its progress towards achieving optimal outcomes. By harnessing the power of innovative design and development practices, we can strategically address these obstacles and pave the way for transformative advancements. Implementing these recommendations will not only mitigate current shortcomings but also unlock new dimensions of engagement, personalization, and learning efficacy, revolutionizing the educational landscape.

2.   RESEARCH METHOD

The authors conducted a comprehensive review of in-class adaptive instruction using a best evidence synthesis method. The authors excluded solely organizational adaptations, and interventions that did not implement planned ALT. They systematically searched specific keywords related to the intervention, population, and outcomes of interest, limiting the results to studies published in academic journals between 2012 and 2022. They also performed an additional search using more specific keywords related to ALT and used informal approaches, such as cross-referencing selected papers, consulting experts, and utilizing personal knowledge. Only newly identified papers from reputable journals indexed in online databases were used to avoid selecting low-quality sources.

The authors emphasized the importance of using strict pre-defined criteria to select studies and combining meta-analysis with detailed descriptions of the included studies to enhance result interpretability. They noted that the best evidence synthesis method is especially useful for topics like adaptive instruction, where the literature is expected to be limited and varied. It is important to extract as much knowledge as possible from each study rather than simply averaging quantitative outcomes and study characteristics. The inclusion criteria were as:

i)   The paper must be written in English.
ii)   The study includes education from primary school to college.
iii) The study must focus on the effect of in-class ALT.
iv)   ALT implementation must be practical for teachers and not require excessive training, coaching, or external teachers in the classroom.
v)   The study must compare students in an adaptive instruction intervention condition to those in control using standard practice or an alternative intervention.
vi)   The study design could be randomized, quasi-experimental, or matched. Large-scale survey designs that retrospectively link within-class adaptive instruction to academic outcomes were also eligible.

3.   RESULTS AND DISCUSSION
3.1.   Factors affecting the success of student control
3.1.1. Student motivation

Motivated students with a sense of ownership over their learning are more likely to effectively utilize student control options. Motivation plays a vital role in the success of these options as it drives students to engage with the material, explore different choices, and actively participate in the learning

process. This active involvement leads to better utilization of student control options and increased achievement of learning outcomes. Conversely, students lacking motivation may be less inclined to use student control options or engage meaningfully with the material. They may feel overwhelmed by the available options or fail to see the material's relevance to their goals and interests.

Another study found that highly motivated students were more likely to take advantage of the student control options in a web-based learning environment [23]. These students were more likely to engage with the learning material, to explore different options, and to achieve higher learning outcomes. Researchers found that student motivation was a critical factor in the success of student control options, particularly in mobile learning [24]. They found that highly motivated students were more likely to use student control options effectively, actively participate in their learning process, and achieve higher learning outcomes. Another researchers also found that student motivation was a key factor in the effectiveness of a student control tool designed to support inquiry-based learning in science education [25]. They found that highly motivated students were likelier to use the tool effectively, engage in inquiry-based learning activities, and achieve higher learning outcomes.

Three studies all provide evidence that student motivation is a critical factor in the success of student control options [23], [25], [26]. Highly motivated students were more likely to engage with the learning material, explore and experiment with different options, and take an active role in their learning process. Additionally, highly motivated students were more likely to achieve higher learning outcomes when using student-control options. These studies suggest that student motivation may be particularly important in specific contexts, such as web-based and mobile learning environments or inquiry-based learning in science education. Therefore, instructors should pay attention to their students' motivation level and work to create learning environments that foster motivation, autonomy, and engagement. By doing so, students may be more likely to use student control options and effectively achieve higher learning outcomes.

This suggests that ALT itself might not motivate students, and that motivation must come from other sources. It also suggests that, poorly done, ALT reduces student motivation when students feel overwhelmed or confused. Table 1 summarizes selected papers on the relationship between student motivation and the success of student control in online learning. The findings consistently suggest that highly motivated students are more likely to utilize student control options, engage actively with the learning material, explore different options, and achieve higher learning outcomes in web-based learning environments.

Table 1. Summary of papers on the relationship between student motivation and control in online learning

Paper	Country	Participants or sample	Procedures	Study design	Effect of student motivation on student control in online learning
[23]	United States	20 students who took the GPS course in Fall of 2003. There were 4 female and 16 male participants (M=23.13 years, SD=2.9).	Three SMEs were provided with written instructions to review the prototype, offer design comments, and recommendations, along with the user profile, taking approximately two hours for each expert to evaluate the WD2 L environment prototype.	Experimental design	Highly motivated students in a web-based learning environment demonstrated greater utilization of student control options, actively engaging with the material, exploring various options, and achieving higher learning outcomes.
[24]	United States	Students and faculty members	This article examines communication technologies, such as online interaction tools, that focus on SWOT analysis (strengths, weaknesses, opportunities, and threats), and compares external data for SWOT analysis across universities in different countries and cultures.	Qualitative research design	Highly motivated students in a web-based learning environment effectively utilized student control options, actively engaging with the material, exploring different options, participating in their learning process, and achieving higher learning outcomes
[26]	United States	K-12 students, undergraduates and graduate's student	The literary review provides a summary, evaluation, and explanation of research relevant to understanding student perception of m-learning, followed by an examination of 18 studies that focus on the type of technology used, interaction supported, learning tasks, measured perceptions, and outcomes.	Experimental and non-experimental design	Student motivation is a critical factor in the success of student control options. Highly motivated students were more likely to engage with the learning material, explore and experiment with different options, and take an active role in their learning process.

3.1.2. Student experience

Student experience, in this case, is related to their familiarity with control options, such as search, navigation, or annotation tools. Those familiar with them may be more likely to use and benefit from them effectively. Meanwhile, students who have prior experience with these control options may be more likely to use them effectively and benefit from them [27]. Student experience, in this case, is related to their familiarity with control options. Those familiar with them may be more likely to use and benefit from them effectively [27].

A technological novice might encounter several useful features that could truly increase understanding. Yet, that student may perceive the helps negatively because they are seen as distracting or overwhelming. To state the point generally, students might see certain features but fail to see them as advantageous simply because they do not understand or perceive the benefit of the feature. Thus, students fail to recognize the opportunities given to them [28]. This inability to identify opportunities may be exacerbated by the fact that students in online environments tend to rush to complete a task rather than consider the task a time to explore. If students see student control as empowering, important, and useful, then the chance to use the tools increases. Even when the given controls are not associated with the learning outcome, students often perceive the program more positively and, in turn, perform better [29]–[31]. Students with prior experience with self-regulated learning (SRL) strategies, such as goal setting and self-monitoring, were more likely to benefit from a student-controlled video-based instructional program [32]. The study suggests that students with prior experience with SRL strategies may be better equipped to take advantage of the control options provided by the instructional program.

In a previous study, students with prior experience using search engines were more likely to use the search function within an online course to locate specific information [33]. The study found that students familiar with search engines were more efficient in finding information than those who were not, suggesting that prior experience with search tools can enhance the effectiveness of student control options. Another study found that students who had experience with using annotation tools, such as highlighting and note-taking, were better able to recall information from a digital text than those who did not have prior experience with these tools [34]. The study suggests that students familiar with annotation tools may be better able to use them to enhance their learning experience. These studies collectively suggest that students with prior experience with specific student control options, such as SRL strategies, search engines, and annotation tools, are more likely to use and benefit from these options effectively in instructional contexts. These findings for instructional designers imply that they should consider the students' prior experience and familiarity with these control options when designing instructional programs.

Table 2 provides a comprehensive overview of several research papers exploring the effects of student motivation on the success of student control in online learning. Conducted in different countries including the United States, South Korea, and Europe, they highlight the significance of student experience and familiarity with control options such as search, navigation, and annotation tools. Highly motivated students were found to be more likely to engage actively with learning materials, explore various options, and achieve better learning outcomes when given control over their learning process.

3.1.3. Instructional design

The instructional design should be carefully crafted to support student control, with clear navigation options, easily searchable content, and appropriate support materials to help students make sense of the material. Instructional design plays a crucial role in the success of adaptive instruction. Effective instructional design ensures that the content and activities are appropriately aligned with the learning objectives and that the instructional program is designed to facilitate learning and knowledge retention. Adaptive instruction, in particular, requires careful instructional design to support student control and maximize its benefits.

Another principal concern is the need to control content. Some theorists suggest carefully building language curriculum around relevant themes. For example, concrete lists for themes have been created with linguistically diverse students in mind [35], [36]. Freeman [37] suggested that by carefully choosing content, English students more easily develop academic language because certain terms repeat naturally during the theme study. Furthermore, pre-selecting content matching an English as a second language (ESL) student's background is often seen as key to motivation and learning. By adjusting the purposes for learning English to the kinds, types, and genres of English, students are more likely to advance in their areas of need and expertise. As Brown points out [38], many current titles in ESL, especially when students move beyond basic levels, offer theme-based courses. English for special purposes (ESP) is a growing field that addresses that precise belief, with hundreds of offerings such as nursing, aviation, business, and academic coursework. This also suggests that the software itself can give students some level of motivation.

Some other studies have also stressed the importance of instructional design on the effectiveness of ALT as presented in Table 3. Clear learning objectives, appropriate content selection, feedback, and

scaffolding were crucial for ALT's success [39]. Finally, clear learning objectives, proper content selection, and interactive support materials were essential to ALT success for English vocabulary learning [40]. Clear learning objectives, appropriate content selection, and interactive feedback and support materials are crucial components in designing effective adaptive learning systems. Student control, including clear navigation options and searchable content, is also important. Furthermore, feedback and scaffolding help students monitor their progress and adjust their learning strategies.

Table 2. Summary of papers on the effects of student experience on the success of student control in online learning

Paper	Country	Participants or sample	Procedures	Study design	Effect of student experience on student control in online learning
[28]	United States	Eight groups of 40 Ss were balanced for sex	Each S gave oral arguments on 2 issues; responses were scored for overall quality, number of lines of argument, and other factors. Analysis disclosed a borderline statistically significant impact of high school, college, and graduate school	Qualitative research design	Students, particularly technological novices, may fail to recognize the advantageous features and opportunities that could enhance their understanding due to perceiving them as distracting, overwhelming, or lacking comprehension of their benefits
[29]	United States	One control group and 4 Experimental group	Elementary school children in 1 control and 4 experimental conditions worked with educational computer activities designed to teach arithmetic order of operations rules. In the control condition, this material was presented abstractly. In the experimental conditions, identical material was presented in meaningful and appealing learning contexts, in either generic or individually personalized form.	Experimental design	If students see student control as empowering, important, and useful, then the chance to use the tools increases. Even when the given controls are not associated with the learning outcome, students often perceive the program more positively and, in turn, perform better.
[30]	New York		Choice can be motivating when the options meet the students' need for autonomy, competence, and relatedness.	Qualitative, descriptive	
[32]	South Korea	Participants from two universities in South Korea.	The procedures for this study involved recruiting participants, randomly assigning them to experimental and control groups, implementing the interventions, collecting data through surveys, and analyzing the data to investigate the effects of learner-centered practices on students' online learning experiences.	Experimental design	Students with prior experience with self-regulated learning (SRL) strategies, such as goal setting and self-monitoring, were more likely to benefit from a student-controlled video-based instructional program.
[33]	North America, Europe, and Asia	No participants involved. The paper provides a comprehensive review and synthesis of existing research studies	The procedures for this paper involved a systematic and rigorous review of the literature on the topic of learner control and guidance in online learning environments, using established methods for identifying and selecting relevant research studies and synthesizing their findings.	Systematic search of relevant literature using online databases.	Students familiar with search engines were more efficient in finding information than those not, suggesting that prior experience with search tools can enhance the effectiveness of student control options.
[34]	United States	219 undergraduate students from a large university in the Midwestern region of the United States	The procedures for this study involved recruiting participants, collecting data on their Facebook use and academic performance, analyzing the data, and investigating the relationship between Facebook use and academic performance among undergraduate students	Correlational design	Students who had experience with using annotation tools, such as highlighting and note-taking, were better able to recall information from a digital text than those who did not have prior experience with these tools.

Table 3. Summary of papers on the effects of instructional design on student control in online learning

Paper	Country	Participants or sample	Procedures	Study design	Effect of instructional design on student control in online learning
[35]	United States	Students	Three SMEs were given written instructions for the task by asking them to review and provide design comments or recommendations that would help revise the prototype. The user profile specified in the Requirement Specification Document was also given to help the SMEs have a better understanding of the target user group. It took about two hours for each expert to complete the evaluation of the WD2L environment prototype.	Experimental design	By carefully choosing content, English students more easily develop academic language. Furthermore, pre-selecting content matching an ESL student's background is seen as key to motivation and learning.
[36]	Not explicitly reported		The procedures described in the article involve using thematic planning to integrate language and content instruction, setting both language and content objectives, using multimodal instruction, and designing integrated assessments to measure student learning.	Literature review and conceptual framework	Integrating language and content instruction through thematic planning can provide numerous benefits for students and can help teachers create more meaningful and effective instruction.
[37]	United States		"ESL/EFL Teaching: Principles for Success" provides a comprehensive and practical guide for effective ESL/EFL teaching, emphasizing the importance of understanding learners, creating a supportive learning environment, and focusing on communication and authentic materials and contexts.	The book does not report on any specific research study or provide empirical procedures.	Understanding learners, creating a supportive learning environment, and focusing on communication and authentic materials and contexts positively contribute to effective ESL/EFL teaching.
[38])	United States	Students	Content-based ESL instruction integrates language instruction with content areas to meet both the linguistic and academic needs of English learners.	Qualitative research design	Many current titles in ESL, especially when students move beyond basic levels, offer theme-based courses. Content-based ESL instruction offers a more meaningful path to academic language acquisition.
[39]	United States	Elementary school students	The literary review summarized, evaluate, and explain the research applicable to understanding student perception of m-learning. Then examine 18n studies paying particular attention to the type of technology used, the interaction the technology was used to support, learning task, perceptions, and outcomes measured.	Experimental and non-experimental design	Some other studies have stressed the importance of instructional design on the effectiveness of ALT. Found that clear learning objectives, appropriate content selection, feedback, and scaffolding were crucial for ALT's success
[40]		30 eligible journal articles published from 1998 to 2017	Project-based learning has a medium to large positive effect on students' academic achievement compared with traditional instruction. In addition, the mean effect size was affected by subject area, school location, hours of instruction, and information technology support, but not by educational stage and small group size.	Experimental design	Clear learning objectives, proper content selection, and interactive support materials were essential to ALT success for English vocabulary learning. Student control, including clear navigation options and searchable content, is also important. Furthermore, feedback and scaffolding help students monitor their progress and adjust their learning strategies.

3.1.4. Task complexity

A study explored the impact of student control on the effectiveness of a multimedia learning program [41]. The researchers found that the level of student control significantly affected the learning outcomes, but the complexity of the learning task moderated the effect. Specifically, when the task was complex, students with more control over their learning experienced lower cognitive load levels and better learning outcomes than those with less control. However, when the task was less complex, there was no significant difference in learning outcomes between students with high and low levels of control.

The complexity of the learning task can also affect the success of student control. If the task is too complex, students may struggle to navigate the materials effectively and may benefit from more guidance and structure from the instructor. The complexity of the learning task refers to the difficulty level involved in

the learning material or activity. Student control refers to the degree to which students can control their learning experience, such as selecting the order of content, choosing learning strategies, and pacing their own learning. When the learning task is too complex, students may find it difficult to navigate the materials effectively and may require more guidance and structure from the instructor.

Another study explored the effectiveness of student control in an online learning environment [42]. They found that while student control can benefit learning, it may be less effective under certain conditions. Specifically, students who lack prior knowledge or experience in the subject matter may struggle with too much student control and may benefit from more guidance and structure from the instructor. Similarly, when dealing with complex tasks or materials, students may benefit from additional support and guidance to help them make sense of the material.

These studies suggest that instructional designers and instructors must consider various factors that support student control when designing ALT. They must balance student control and instructional support [43], providing appropriate levels of guidance and structure to help students navigate the materials effectively and make sense of the content. By doing so, they can develop more effective ALT programs that help students to achieve optimal learning outcomes.

3.1.5. Student feedback

Providing students with feedback on their use of control options can help them improve their use of these tools and make better use of them in the future. Student feedback is essential to ALT, particularly when supporting student control. When students are given control over their learning experience, they need to be able to reflect on their use of the available tools and resources to make the most of them. Providing feedback to students on using student control options can help them understand how to use these tools more effectively and make better use of them in the future.

A study found that providing feedback on students' use of an ALT system helped improve their learning outcomes [44]. In this study, students were given control over their learning path, and feedback was provided on their choices' effectiveness. The results showed that students who received feedback performed better on assessments than those who did not. In another study, students were given control over the difficulty level of math problems in an ALT system [45]. Others found that providing students with feedback on their performance and progress helped them better use the adaptive system and improve their math skills. A previous study examined the effects of feedback on student control in an adaptive English writing system [46]. The researchers found that providing students with feedback on their writing performance and progress helped them become more engaged with the adaptive system and effectively use its features.

3.1.6. Instructor support

While students can have greater control over the learning process, instructors still play a critical role in supporting students, helping them navigate materials effectively, and helping them make the most of student control option. Providing guidance, answering questions, and monitoring progress can all help students succeed with student control options. Students may still need instructor guidance and support to navigate the materials effectively, particularly if the learning task is complex or challenging. Instructors can provide students with guidance and support by answering questions, offering explanations, and monitoring progress.

Instructor support positively influenced students' motivation and satisfaction in an ALT environment [47]. The study showed that students who received more instructor support reported higher motivation and satisfaction with the learning experience. Another study found that instructor guidance was essential for students to effectively use self-directed learning strategies in an ALT environment [48]. The study indicated that students who received more guidance from instructors could use self-directed learning strategies and achieve their learning goals better. Researchers found that instructor feedback and guidance were particularly important for students with low prior knowledge in an ALT environment [49]. The study showed that students with low prior knowledge who received more instructor feedback and guidance were better able to improve their learning outcomes.

3.2. Teaching strategies to deliver adaptive instructions
3.2.1. Instructional design should be carefully crafted to support student control

First, for students to make sense of the material, they need easily searchable content, appropriate support materials, and easy-to-use intuitive navigation tools that allow them to move through the content easily [50], [51]. The search feature and good navigation tools help students save time and effort that would otherwise be spent browsing through the entire material to find specific information. They also prevent students from getting lost or confused while accessing or navigating the material. Moreover, the program should allow students to access content and support materials in various formats, such as videos, images, text, or diagrams, to cater to students' learning preferences and learning styles [52]. By providing clear navigation

options, easily searchable content, and appropriate support materials, ALT can help students engage with the material more effectively, leading to better learning outcomes.

3.2.2. Student feedback is an essential component of adaptive instruction

Secondly, student feedback is essential. English teachers should build feedback mechanisms into their ALT programs that allow students to reflect on using student control options. These feedback mechanisms should enable students to reflect on their use of student control options, which allow students to control their learning experience.

In ALT, systems have several ways to implement feedback can be implemented to help students improve their performance. One way is through immediate feedback, where students receive instant feedback on their performance after completing a learning activity or assessment [48], [53]. For example, if students answer a question, they will immediately receive feedback on whether their response is correct or incorrect. This type of feedback helps students identify areas where they need improvement and adjust their learning strategies accordingly. Another type of feedback is self-assessment feedback. In this case, students are prompted to complete self-assessment surveys or checklists to reflect on their learning and identify areas where they need improvement [54]. For example, students may be asked to rate their confidence in a particular topic or skill. Based on their responses, the adaptive system may provide additional learning resources or adjust the difficulty level of future learning activities. Lastly, personalized feedback is a type of feedback that is tailored to each student's needs and performance [55]. Students who struggle with a particular topic or skill may receive more targeted feedback and resources to help them improve. This type of feedback ensures that students receive the support they need to succeed and progress in their learning [56].

3.2.3. English teachers need to support and help students navigate the materials effectively

Finally, while student control is designed to give students greater control over the learning process, English teachers still play an important role in supporting students and helping them navigate the materials effectively. Teachers can use several different strategies. First, they can provide students with guidance and support by answering questions, offering explanations, and monitoring progress [33]. Teachers are uniquely positioned to provide personalized feedback and help students identify areas they need to improve. By providing this kind of support, teachers can help students stay motivated and engaged with the subject matter, ultimately leading to greater success in learning English. Second, they can create online discussion forums or communities where students can ask questions and receive answers from their peers and teachers. Third, teachers can create videos or audio recordings that clearly and concisely explain difficult concepts. Fourth, they can also use interactive multimedia resources like simulations or games to help students visualize abstract concepts and deepen their understanding [57].

Some other kinds of support are in the realm of program developers. Chatbots can answer some types of questions. They can use online ALT platforms that use artificial intelligence to adapt instruction to each student's needs [4]. For example, these platforms can adjust the difficulty level of exercises or recommend resources based on students' strengths and weaknesses.

4. CONCLUSION

In conclusion, adaptive learning technologies (ALT) is a family of technologies that can adjust the learning experience to the characteristics of each student. Research so far has shown that it can be effective, but this conclusion comes with various caveats. First, ALT is more effective for some students than others. Having greater control over their learning mainly benefits students with the skills to use online tools. Students who lack those skills find the interface frustrating and demotivating. Students do better if they already have experience with self-regulated learning (SRL) strategies. Then, highly motivated students made better use of the online features. That it works better for some students than others indicates a performance gap in ALT; it is to adapt to the needs of the individual. Second, assessment can also be adaptive, improving students' motivation and learning outcomes when the testing environment is low-stakes. Third, ALT depends heavily on how well it is designed and implemented, with some implementations being more effective than others. Some failures were due to users feeling they lacked control, received inadequate feedback, and had poor user experience of the software; some interfaces were confusing, cluttered, or difficult to use. The positive version also tended to be true; students were more likely to do better when they felt in control of their learning experience, received helpful feedback, and had a good experience with the software. Fourth, instructor support was usually essential, especially when materials were complex. In these cases, student control became a hindrance. This has particular implications for applying ALT to Massive Online Open Courses (MOOCs), which tend to optimize the use of automated software in learning experiences. Fifth, ALT faces challenges at an institutional level. Some faculty felt they lost some control over the learning

experience, but this is probably because the technology partly displaced their teaching role. ALT has high development costs and is difficult to integrate into existing systems. Some versions are reportedly not scalable. The future of ALT is bright, but it is not without some challenges, especially in refining the characteristics that would make a more effective and enjoyable learning experience for all students.

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