Phineas Sebopelo

ADAPTIVE LEARNING STRATEGIES IN OPEN AND DISTANCE LEARNING

OPPORTUNITIES AND CHALLENGES FOR QUALITY ASSURANCE

Alumni.in eBooks

Phineas Sebopelo

ADAPTIVE LEARNING STRATEGIES IN OPEN AND DISTANCE LEARNING

OPPORTUNITIES AND CHALLENGES FOR QUALITY ASSURANCE

Alumni.in eBooks

EDITORIAL TEAM

Adaptive Learning Strategies in Open and Distance Learning: Opportunities and Challenges for Quality Assurance
Phineas Sebopelo

Edition:
Alumni.In Publishing
Technical Review:
Altieres de Oliveira Silva and Diego dos Santos Janes
Cover and Typesetting:
Isabel Kubaski

ISBN – 978-65-987295-8-5
DOI: https://doi.org/10.37497/alumni.inbooks.3

Cataloging-in-Publication Data (CIP) – Brazil

Sebopelo, Phineas

Adaptive Learning Strategies in Open and Distance Learning: Opportunities and Challenges for Quality Assurance / Phineas Sebopelo — São Paulo: Alumni.In Publishing, 2025.

Includes bibliographical references

ISBN 978-65-987295-8-5

Open and Distance Learning
Learning Technologies
Artificial Intelligence in Education I. Title

DDC 371.334

HOW TO CITE: ABNT APA ISO Vancouver

Editora Alumni.In
CNPJ: 42.065.021/0001-35 – São Paulo, Brasil
Alumni.In Books e-ISSN: 3085-8569

Indexing by EBSCO eBooks Google Scholar SEMANTIC SCHOLAR

SUMMARY

ADAPTIVE LEARNING STRATEGIES IN OPEN AND DISTANCE LEARNING: OPPORTUNITIES AND CHALLENGES FOR QUALITY ASSURANCE

Phineas Sebopelo PhD[1]
https://orcid.org/0000-0001-9594-778X

CHAPTER HIGHLIGHTS

The chapter is premised on the ever-changing landscape of distance learning and the infusion of the e-learning aspect into the teaching and learning strategies. The adoption of adaptive learning strategies necessitated institutions to deliver custom learning experiences that address the unique needs of individual students.

The chapter points to the importance of institutions adopting a variety of adaptive learning strategies such as personalized learning, automated feedback, visualized learning, to enhance the student learning experience rather than assuming a one-fits-all-all experience. The book chapter highlights challenges that impede institutions in adopting adaptive Learning Strategies.

The chapter underscores the point that at the core of Higher education institutions is the need to address challenges and threats to the quality of education by adopting efficient instructional strategies for Adaptive learning. The book also suggests strategies to mitigate against challenges that impede the adoption of adaptive learning strategies.

[1] Research Director of Botswana College of Distant and Open Learning – Botswana Open University – P/bag BO 189, Bontleng, Gaborone – Botswana – E-mail: *psebopelo@staff.bou.ac.bw*

1. INTRODUCTION

The sudden rise and growth of internet technologies in recent years coupled with the increased availability of high bandwidth infrastructures, and advances in mobile and wireless technologies have created new opportunities in education. The application of AI in the education sector has brought new prospects for the design and development of better technology-enhanced learning systems [1]; [2] With the more intense application of Artificial intelligence (AI) in education, adaptive learning has become a topical issue and a new research hotspot in online education. Most distance learning institutions have adopted a learner-centered approach in which individualised learning is a commonly followed model of teaching and learning support for students. However, personalisation of learning can only be achieved using various methods available, and one of those methods is adaptive learning which has been made possible by the advent of intelligent learning systems which can integrate learner preferences by analysing learner needs and experiences data [3] For many years education has been dominated by administrators and tutors who set expectations that students had to meet. However, with the latest technological advancements, there is a shift towards a concept of learning that is necessitated by the changing desires of learners [4]. The shift adjusts the training process to suit students better. According to [5], the acceptance of a constructionist view of learning led to advocacy of the learner-centered approach in education as a more effective and successful instructional method in which approaches, and content are focussed on individual learners. The true potential of adaptive learning has put the learner in the middle of the learning process thereby taking a radical departure from the old teacher-centred instructional paradigm [6]. Adaptive learning technologies aim to provide students with the means to acquire information according to their needs and cognitive differences [7], thus ensuring that individual learners

experience the learning process individually [8]. Education technology becomes an enabler when students gain control over their learning journey regarding pace, format, or other specific needs. Since every student learns differently, they need a system that allows for their individuality, in the absence of such a system learning outcomes will differ for different students regardless of being exposed to the same learning experiences [9]. Adaptive learning systems dynamically adjust to student interactions and performance levels.

The concept of Adaptive learning

The concept of adaptive learning can be traced back to the 1960s and 1970s when researchers began to explore the potential of computer-assisted learning to deliver tutor-made experiences to individual students [10]. Early pioneers in the field of adaptive learning included Patrick Supess, who developed a computer-based system for teaching mathematics [11], and Gordon Pask who created a program called SAKI that could adapt its teaching style based on students' performance [12], attributed the arrival of adaptive learning on the educational scene in the 1950s, to the works of behaviouralist Skinner who invented the teaching machine that focussed on effectively teaching new concepts rather than reinforcing memorization. These pioneers laid the groundwork for the development of more sophisticated adaptive learning systems in the modern-day era. Today's adaptive learning systems can now be used to deliver highly personalised learning experiences. Although adaptive learning experts have settled the definition question, there remains debate around the meaning of adaptive learning with many rank-and-file educators still maintaining the interchangeable use of personalised and adaptive to denote the same concept. One of the reasons for the sustained differences in the definition is that some authorities in education refer to technologies that dynamically adjust the level or type of

course content based on individual abilities or attainment, in ways that accelerate a learner's performance with both automated and or instructor interventions [13]. This approach uses a computer to organize, and plan training in the most appropriate way to the learning needs of a student taking into consideration the different needs of each student [14]. It uses the differing individual characteristics of learners as a focus of differentiated instruction. According to [15], adaptive learning works as a simple concept in which the coursework should progress in coherence with student learning capabilities.

Influence of COVID-19 on the adoption of adaptive learning strategies

Covid 19 dramatically influenced students' and staff's learning and teaching experiences and approaches [16]. According to [17], the pandemic forced the digitization of most universities before which they largely operated using a face-to-face mode of teaching. The shutting of campuses and inadequate admittance to substitute lecture rooms forced many students and teachers into unfamiliar education environments [18]. The pandemic forced drastic changes in teaching methodologies, shifting from in-person to online platforms. The shift came in the shape of the unprecedented global crisis in 2020 when classrooms across the world went online to enable continuous learning. Technological platforms came to the rescue to support teachers in delivering effective learning solutions. Adaptive learning technologies became more prevalent and more relied upon. According to [19], the pandemic forced institutions to shift from traditional learning to flexible learning which paved the way for the creation of content that was tailor-made to the needs of students ensuring the efficacy of teaching and learning processes. During the COVID-19 pandemic educational institutions transitioned to remote learning [20]. These methodologies sought to provide personalised approach and keep

students engaged in lecture sessions [21]. The COVID-19 pandemic necessitated the adoption and use of adaptive learning methods to ensure continuity of education and protection of learners during the pandemic. This was achieved through the training of teachers and non-teaching personnel to handle new learning methods for the smooth implementation of adaptive systems. With the COVID-19 pandemic use of adaptive learning systems has become increasingly popular placing digital technology in the forefront. The use of adaptive learning technologies was limited before the pandemic, with its implementation limited mainly to traditional face-to-face classroom settings. But with the advent of the pandemic, many institutions shifted to hybrid learning mode and increasingly adopted the use of adaptive learning technologies to support individualised needs of learners. The pandemic highlighted the efficacy of adaptive learning systems and that they are the future of education. The use of adaptive learning systems made learning appealing as it personalized courses for each learner.

Adaptive learning and artificial intelligence

The education sector is challenged to deliver engaging, effective, and personalised content that meets the growing expectations of diverse learners who are increasingly shaped by digital interactions. Integrating AI in education, particularly through adaptive learning tools holds great promise to meet these challenges [22]. However, a transition to adaptive learning is not basic and simple, it comes with its complexities and challenges that require understanding technology and its implementation. Over the years students have been subjected to rigid learning systems that prioritised predefined outcomes over naturing individual development. However, in recent times there has been an emergence of more advanced AI-enabled learning systems which are gaining more traction due to their ability to

deliver learning content and adapt to the individual needs of students [23]. The emergence of artificial intelligence has been credited for challenging and breaking barriers to personalised learning. This is achieved application of AI adaptive learning which focuses on addressing the distinct needs of each learner by employing personalised teaching techniques [24]. Artificial intelligence and Machine learning enable the analysis of vast amounts of learner data, including performance, interactions, and practices. By processing these data, adaptive learning systems can create learner profiles and identify individual needs and strengths [25]. AI-powered adaptive learning systems consist of components that work together to deliver a personalised learning experience. Through AI adaptive learning tools, learner modeling involves creating and maintaining learner profiles, as well as collecting data such as assessment scores, learning preferences, progress tracking, and even the collection of socio-emotional factors [26]. AI-powered adaptive learning is an advanced educational approach that leverages AI in education to personalise the learning experience for each student, this approach caters to the diverse requirements of each student. This innovative method uses data analytics and machine learning algorithms to assess student strengths, weaknesses, and learning patterns [27] Based on the analysis the system dynamically adjusts the educational material content according to the learner's needs and abilities. AI-powered adaptive learning is poised to shape the future of education in the digital age by enabling learners and educators to achieve optimal outcomes [28]. Adaptive learning with AI not only offers individualised study plans but also instantaneous assessment and feedback. Periodic assessments and evaluations, which are commonly used in traditional training approaches, may not accurately represent the learners' development. Learners may see where they stand regarding their progress and make real-time adjustments with the help of AI-powered technologies. The use of adaptive learning tools enables timeous feedback which facilitates

the consolidation of acquired knowledge and acquisition of acquired new abilities.

Adaptive Learning strategies and their influence on the quality of education

In an ever-changing world of technology, AI has become a game changer, particularly in the field of quality assurance [29]. With its ability to learn, adapt, or predict, AI is not just a buzzword but a pivotal tool in enhancing the efficiency of quality assurance processes. With greater reliance on technology digital platforms, it is therefore the right time to invest in quality assurance for educational applications to ensure optimal learning experiences. The importance of quality assurance was highlighted during the COVID-19 pandemic when students were heavily dependent on digital applications to access educational resources and engage with content. During that era, the experience was that technical glitches or issues related to the usability of educational applications could disrupt the learning process and ultimately hinder educational outcomes [30]. The other thing is the adoption of adaptive learning platforms which offer tailored content and personalised learning through educational applications and software. These applications cater to individualised student needs and learning styles. The increase in several educational institutions has created a challenge for maintaining the quality of education [31]. To address this problem many efforts have been put in place such as the establishment of common quality standards, qualification frameworks, and accreditation systems. With institutions resorting to the use of digital platforms, such technology is being adopted for use for self-evaluations, collaboration, and continual improvement. Most institutions are adopting the use of adaptive learning algorithms to personalise learning experiences for learners [32]. These platforms assess individual strengths and weaknesses by dynamically adjusting

content and instructional strategies to meet the unique needs of each learner [33]. Adaptive learning platforms optimize student outcomes, self-paced learning and provide targeted support and remediation when needed. By harnessing the power of technology, particularly the use of adaptive learning platforms institutions can enhance their educational practices, provide personalized and engaging learning experiences, and prepare students for a rapidly evolving world [34]. The journey towards quality education through technology is an ongoing process and by taking a leading role in technological advancements, institutions can achieve excellence and empower students to succeed in this digital era [35].

Theories behind adaptive learning

It is essential to know that there are theories attached to the concept of adaptive learning. These theories determine how adaptive learning platforms interact with different learners. Theories that power adaptive learning include meta-cognitive theory, deliberate practice theory, theory of fun for game design, and Ebbinghaus curve. Building adaptive learning algorithms in these theories helps offer a personalised learning experience among students. If these four theories are built into their driving algorithms, adaptive platforms make learning incredibly personalized, and that creates vastly superior learning campaigns. Learners get the kind of dynamic experience they might have with a one-on-one tutor, even with massive, diverse teams spread across the globe.

Meta-cognitive theory

John Flavell of Stanford University is regarded as the founding researcher behind meta-cognition theory [36]. In the original conceptualization, he used meta-memory to refer to the understanding of the individual's ability to manage and monitor

the input, storage, search, and retrieval of his/her memory [37]. According to [38], metacognition refers to the knowledge and regulation of one's cognitive processes. He based his reasoning on the idea that individuals possess knowledge of their cognitive processes. He also believed that further to that some individuals are better capable of regulating these processes than others. Metacognition theory integrates one's knowledge about cognition and regulation of cognition [39] while knowledge of cognition means what individuals know about their cognition or cognition in general [40]. Recognition of cognition refers to metacognitive activities that help control one's thinking or learning [41]. The theory is about knowledge of knowledge that is interested in how humans can actively monitor and regulate their thought processes [42]. It is the capacity to reflect on which cognitive skills individuals use to succeed in each task. It is therefore about processes involved in regulating how we think. The theory focuses on how to help learners understand their style of learning; hence it also goes by the name self-awareness meta-cognitive theory, and learners are provided with processes that enable them to unlock their potential and become more productive. Meta-cognition is the most effective way to improve students' academic performance and can help their academic potential [43]. Supporting the development of metacognition is a powerful way to promote student success since students with strong metacognitive skills are positioned to learn more and perform better than their peers, who are still developing their metacognition [44]. Teaching metacognitive strategies can greatly enhance learning for all students in all subject areas [45]. According to [46], introducing metacognition tutoring to teach learners how to be aware of their knowledge enables deeper learning. Learners with metacognitive ability are more capable of self-regulating their learning [47]. Self-regulation empowers students to take control of their learning experiences thereby fostering independence and responsibility [48]. By fostering metacognitive awareness learners become more conscious of

their learning strategies, and comprehension abilities and can take charge of their educational journey for enhanced outcomes.

Deliberate practice theory

Psychologist Anders Ericson coined the term Deliberate Practice while researching how people become experts [49]. Studying experts from several fields he dismantled the myth that expert performers have unusual innate talents [50]. In his seminal work Peak, Ericson explained that for pretty much everyone willing to endure the hardship of years of practice, "deliberate Practice", can produce expert performance. As defined by Ericson and his colleagues' Deliberate Practice "is the individualised training activities specially designed by a coach or teacher to improve specific aspects of an individual performance through repetition and successive refinement" [51]. It focuses on a student's individual skill threshold, emphasizes interactive rehearsal for skill acquisition, aims for high levels of sustained effort, and uses homework to advance clinical ability [52]. Deliberate Practice refers to a special type of practice. It has the power to transform an amateur into a professional. According to [53], it refers to targeted and task-centred training programs based on instructions. It involves highly structured repetitive practices for purposes of improving very specific narrowly defined aspects of performer ability and skills. It is a systematic approach based on careful observation of what the best performers in a particular field are doing [54] provided evidence that Deliberate Practice improved students' ability to build the necessary knowledge and skills to become better problem solvers. While regular practice might include mindless repetitions, deliberate practice requires focused attention, and it is conducted with the specific goal of improving performance [55]. This theory emphasizes the importance of learners to understand their weaknesses. Based on this theory adaptive learning system offers learners

new content by modifying the existing one according to their weaknesses. According to [56], one of the benefits of this theory is that adaptive learning utilizes it to challenge learners by pulling them out of their comfort zones. This builds and enhances the confidence needed to tackle their learning challenges and make them successful. In education, deliberate practice involves putting effort into improving students' or teachers' performance [57]. It is a way of training designed to bring students to high levels of skill efficiently. The idea is to transform novice habits, movements, and ways of thinking. Linking student practice to well-defined aspects of expert performance ensures that the student is practicing the right skills and is moving towards expertise. Without doing this the student might get better at doing something but doing it wrongly. According to [58], deliberate practice is designed to increase teacher effectiveness. It demands the teacher to be highly focussed on the process of repetition and constant feedback [59]. Despite its suggested merits, some argue that it is highly exaggerated in its praise and that it is poorly defined [60]. They observe that it is only useful for skills that can be drilled and copied but not for more sophisticated coaching or teacher education elements.

Theory of Fun for Game Design

The Theory of fun for game design was developed by Koster. The theory features a novel way of teaching interactive designers how to create and improve their designs by incorporating a degree of fun. It promises to give insight into the major cultural forces used in games to inspire people to do better than current designers. It is predicated on the notion that fun and learning are the same activity of the brain [61]. This theory is about the exploration of fun and why games matter. Game designers usually become influenced by existing game concepts and add their flair with new elements to their game concepts. This theory balances the notion of deliberate practice by suggesting that learners can achieve a maximum

level of engagement when they feel challenged to some extent. According to this theory, play creates a space of low-pressure learning allowing for failure as a learning opportunity too [62]. Players who enjoy challenging games frequently face failure and must demonstrate persistence to succeed through failure, although difficult to learn as a skill that is valuable across many aspects of life [63]. By incorporating the theory of fun for game design into its algorithm, adaptive learning can engage learners and make them feel less overwhelmed when challenges get out of hand. The idea behind fun and games is that the combination of education and entertainment increases learner motivation through increased learner engagement [64]. Most of the time children use electronic devices to play games without them noticing that they are learning something [65]. This implies that having fun through playing games is another way of learning. According to [66], games can facilitate learning. Adaptive game design approaches borrow from this theory to create new frameworks to engage students in learning experiences that are linked in some way. The adaptive learning design is therefore geared towards the kind of learning experience needed and having fun(Learning) through playing. According to [67], the intrinsic motivation in game-based learning is learning through fun. It involves game mechanics that are related to game design aspects [68]. In game-based learning, adaptability is based on the capability of the game to engage each learner in a way that reflects his or her specific situation [69]. This can range from currently acquired knowledge to cognitive abilities to the learner's emotions or a range of other variables [70]. A further argument propounded by [71] is that it allows for graceful failure. instead of describing failure as an undesirable outcome, failure is by design expected and sometimes a necessary step in the learning process [72]. The game-based learning invites risk-taking and exploration as well as the freedom to interact with the game environment and co-players [73]. In game-based learning,

co-players are critical because they assure others of their capacity to repair their [74].

Ebbinghaus forgetting curve

This theory was introduced by Hermann Eddingbus in 1885. The forgetting curve hypothesizes the decline of memory retention over time. The curve shows that information is lost over time if there is no effort to retain it. The theory posits that humans start losing memory of their learned knowledge over time in a matter of days and weeks unless the acquired knowledge is reinforced [75]. This theory suggests that for students to truly learn something they must commit it to long-term memory and that the peak time to do so is just when students are about to forget it. Adaptive learning platforms incorporate this theory in that at the exact moment when students are about to forget a concept or information, the platform will reintroduce it before it vanishes thereby securing it in the long-term memory [76]. This theory powers personalisation behind adaptive learning by suggesting that learners must aim for long-term memory at the time they are about to forget. By so doing they can learn and acquire new knowledge. The ideal forgetting curve should adapt learning materials as well as user meta-features. According to [77] in the context of intelligent tutoring systems, the forgetting curve for each user and knowledge component should enable us to develop revision strategies to counteract memory decay and ensure long-term retention. The theory is used to explain why learning is hard, if humans did not have a forgetting curve, they would remember everything they have learned thereby making them super geniuses. The curve is used to describe the natural rate of forgetting without any strategic intervention. The forgetting curve is usually depicted as a down-curving graph showing the amount a typical learner forgets over time [78]. The curve drops steeply at first, indicating that learners forget quite a bit of what they learned

quickly. The curve flattens but only after the learner has forgotten most of the content. The theory of the forgetting curve is accused of oversimplifying the understanding of long-term retention. This limitation has undermined developers' and designers' ability to create memorable thinking. So instead of gaming forgetting curve training professionals should focus on coming up with strategies that lead to strong knowledge acquisition and retention.

Adaptive Learning Strategies in Education

In an adaptive learning strategy, the educator will decide what to teach, manage, and how to engage the student. The students will get learning activities that suit their intelligence [79]. Certain learning strategies can be employed to improve student learning. These strategies include active retrieval of information, gamification, interleaved practice, and special practice.

Active retrieval and testing strategy

The active retrieval and testing strategy is a study method used to actively retrieve information from memory. It encourages students to engage with material in an active way rather than passively. Using this strategy helps students bring information to mind thereby enhancing and boosting their learning. According to [80], retrieval practice is not a singular activity, but it takes several forms and different types of retrieval strategies and has varied effects on the student's long-term retention of information. Active retrieval of previously learned information leads to substantial long-term retention. Retrieval practice is a powerful evidence-based teaching strategy that can be easily incorporated into existing courses [81]. Educators rely heavily on learning activities that encourage elaborative studying whereas activities that require students to practice retrieving and constructing knowledge are used less frequently. However [82] proved that practicing retrieval

produces greater gains in meaningful learning than elaborative studying with concept mapping. This shows that retrieval practice enhances learning by retrieval-specific mechanisms rather than by elaborative study processes. According to [83]. Retrieval practice is about recalling facts, concepts, and events from memory to enhance learning. The very act of retrieving something from one's memory strengthens the connections holding it there. According to [84] retrieved practice is a superior method for long-lasting memory updating. This makes it more likely that the student will retrieve the recalled information in the future. Retrieval practice should be viewed as a learning strategy rather than an assessment strategy. It is about the students trying to recall information without having it in front of them [85]. It is more effective in increasing long-term retention. This is an important strategy that improves student learning through active retrieval of information, testing contributes by helping the students to repeatedly learn concepts ahead of an examination [86]. This helps students to have an accurate assessment of their understanding and identify their knowledge gaps. It is well-established that activities that rely on retrieving information from memory promote meaningful learning and facilitate transfer to related concepts [87].

Interleaved practice

It is a form of retrieval practice that helps students to incorporate existing knowledge and skills with new ones. Interleaved practice is the process where students mix or interleave, multiple subjects or topics while they study to improve their learning. According to [88], this practice boosts learning by mixing up closely related topics which encourages students to develop the ability to distinguish between multiple concepts. It requires students to choose a strategy based on the problem itself, as they must do when they encounter a problem during a comprehensive examination or subsequent course. The interleaved

practice is a feasible intervention that requires little or no teacher training, although teacher buy-in requires that teachers understand the logic underlying interleaved practice [89]. The interleaved practice provides students with the opportunity to practice the very skill they are expected to learn. When applied strategically interleaved practice challenges students to learn in a smart adaptive way instead of relying on rote learning muscle memory [90]. Interleaved practice does not limit students to one skill at a time but allows them to store information more deeply, challenging them to lease out patterns and form connections [91]. It forces the brain to work hard to recall prior learning and determine which strategies or skills to use to resolve them. Interleaved practice is a promising approach that fosters the adaptive use of subtraction strategies. By intermixing strategies, comparison processes are evolved which prompts more task-based strategy use [92]. The interleaved practice of different tasks leads to superior long-term retention despite poor initial acquisition of performance [93]. The interleaved practice can confer learning advantages even for more complex problems [94]. According [95], interleaved practice leads to better performance blocking on categorization tasks with novel exemplars. For learning content to enter and remain in a learner's long-term memory, the learner needs multiple exposures to the [96]. Long-term encoding needs opportunities for rehearsal and repetition [97]. However, the levels of processing suggest that in the long run, repetition is not sufficient. As such, students need to encode information semantically by relating it to other ideas and knowledge. This encodes information on a deep level, and it is an effective studying technique. The ability to remember information depends on the number of times the learner encounters it and the interval between repetitions [98]. According to [99], the interleaving strategy dramatically improves learning.

Mastering

Although the movement to adopt mastering-based approaches in education gained momentum only in recent decades, the concept is not new. Its practice was first outlined by Benjamin Bloom in the 1960s stating that students can master any task given the right conditions [100]. Bloom's learning for mastery evolved and was subsequently implemented in primary and secondary schools. Mastering in education is a method where students achieve mastery of a subject they are learning about before moving on to new material [101]. This technique signifies the art of becoming skilled in a particular field or area by acquiring knowledge in a subject of interest and mastering it. The approach is like conventional learning, but the difference is that students receive feedback on their tests and continue the same content until they master the subject matter. In mastering the student seeks help in learning to learn better [102]. It emphasizes that instruction should be tailored to the time needed for each student to master the content. According to [103]. students who practice mastering outperform conventional students. It helps students to keep track of completing the learning objectives of a particular subject and allows teachers to provide a form of individualized learning to all students without taking away from the overall teaching goals of the group. Adaptive learning uses the concept of mastering to adjust the complexity of content according to each learner's ability. Adaptive learning systems can assist students in mastering content by recognizing and fulfilling specific learning gaps. According to [104], an adaptive learning format aids learners in mastering content. In mastering a student takes charge of his or her learning and that makes them develop excellent skills in self-directed and lifelong learning.

Scaffolding

The theory of scaffolding was first proposed as an educational theory by Jerome Bruner in the 1960s. Bruner and other psychologists used the term scaffolding to describe how preschool teachers helped with a particular problem by giving extensive explanations before gradually withdrawing so that students had a chance to work independently. Bruner recommended teachers use language, actions, and images to convey information using a variety of techniques [105]. Teachers must be flexible enough and willing to try a variety of teaching techniques that result in meaningful learning. Bruner believes that instruction should also include a variety of appropriate materials that would enable students to represent their knowledge through actions and works [106]. Scaffolding refers to a method where teachers offer a particular kind of support to students as they learn and develop a new concept or skill. In the institutional scaffolding model, a teacher may share information or demonstrate a problem and then gradually step back to allow the students to practice on their own [107]. The idea behind scaffolding is that when students are given the support they need while learning something new, they stand a better chance of using that knowledge independently. In education, scaffolding is a teaching strategy that involves providing support and guidance to students as they learn new concepts or skills. The scaffolding approach differs from the traditional independent learning model in which a teacher asks students to read an article as homework without providing additional structured support [108]. Through this theory, instructors deliver lessons in distinct segments providing less and less support as students master new concepts and material. It is a sustained interactive process that involves the fading of assistance or gradual modification of the tasks by an expert. This supportive framework lets students feel comfortable taking the next step in their learning [109] This involves the removal of guidance and support as students learn and become more competent. The

theory promotes a positive learning environment since students feel supported throughout their learning journey. The support is helpful to the student because it encourages them to become more responsible for their learning in turn creating their own goals and can monitor their levels of engagement.

Feedback

Feedback is an important component of the education system which is designed to influence, reinforce, and change behaviors, concepts, and attitudes in learners [110]. Feedback strategy is a coordinated plan that integrates clear and decisive statements including at least under which situational and individual conditions of the instructional context should be provided. In the instructional context, the term feedback refers to all post-response information that informs the learners of his/her actual state of learning or performance to regulate the further learning process of learning [111]. Feedback involves the provision of information about aspects of understanding and performance and can be given by practitioner's peers, and oneself and from oneself to practitioners. It is no secret that feedback is an important component of effective learning since it improves learners' confidence, motivation, and ultimately their achievement. The main purpose of feedback is to improve the student, not the work. Work can always be improved but most importantly it is the learner who needs to make meaningful progress. According to [112], the only thing that matters in feedback is the reaction of the recipient. No matter how well-designed the feedback is, if the student does not act upon it, time would have been wasted preparing it. Feedback is a key element of the incremental process of ongoing learning and assessment. Providing frequent and consistent feedback is therefore a significant means of improving achievement in learning. This involves the provision of information about aspects of understanding and can be given by practitioners, peers, oneself, and from learners to practitioners. Teacher feedback

whether combined with peer discussions improves learning outcomes [113]. This means that it is important to view it as a top choice when it comes to improving student outcomes. This learning strategy is effective since it focuses on processes of student learning such as effort and strategic behavior in addition to the learning outcomes. Effective feedback assists the learner in reflecting on their learning and their learning strategies so they can adjust and make better progress in learning. Effective feedback is elaborate, and meaningful, and provides students with corrective advice to monitor and optimize learning activities and behaviours. Although providing constructive feedback can be challenging is a learnable skill. Feedback is more than just post-assignment commentary, but rather a guide for students to learn their weaknesses and strengths. When properly employed feedback can impact students on a variety of levels. Feedback is more effective for cognitive and physical outcome measures than motivational and emotional criteria [114]. It can help direct what students should do with their time, how they should feel about their efforts, whether their motivation level is appropriate, and whether they are meeting [115]. Providing frequent and ongoing feedback is a significant means of improving achievement in learning. According to [116], teachers need to provide instant feedback, and the information should be provided consistently and on-demand in immediate response to a learner's action and the flow of learning.

BENEFITS OF ADAPTIVE LEARNING STRATEGIES FOR QA IN ODEL

Personalised instruction

The emergence of personalised adaptive learning is due to the rise in big data technology, in which data is being generated in a

faster and more fast way [117]. Personalised learning is in demand due to new technologies involving big data and learning analytics. Under the influence of data-intensive science, personalised learning has become the fifth-generation educational technology) [118], Based on this big data Adaptive learning has become one of the most important digital learning environments. The rise in big data makes it possible to record and interpret students' characteristics and real-time state in all learning aspects [119]. Adaptive learning personalises learning by continuously evaluating each student's performance in real-time and creating an everchanging individualised learning path as directed by artificial intelligence and machine learning thus increasing student engagement [120]. The goal of personalised learning is to help each student achieve academic success by first understanding the learning needs of the students. [121] noted that personalised learning requires a digital learning environment for it to be classified as adaptive to individual knowledge, experience, and interests and for it to be effective and efficient in supporting and promoting desired learning outcomes. [122] define personalised learning as a systematic learning approach that focuses on tailoring instruction to individual student strengths. It refers to the various educational methods and academic support strategies that address the distinct learning needs of each student. According to [123] the definitions of personalised learning vary according to the framework of the author, however common themes that describe personalised learning which are student-centered, flexible learning, and mastery of competencies are always outstanding within such varied definitions [124] and propose that personalised learning should be viewed on a continuum rather than stating a single definition. It should be tailored to and continuously modify individual learners' preferences, interests, and aspirations. Personalised adaptive learning has been touted as the most promising emerging tool for increasing student learning and success [125]. Personalised learning materials are customized to individuals' needs. [126]

noted that personalised learning is about what you do, not how you do it. While it is possible personalise learning in a classroom, it is quite a daunting task to personalise instruction when there are more than a few students in a classroom. Adaptive technology allows each student to progress at their own pace through course work, and those who perform highly than others have the chance to demonstrate their mastery of more fundamental concepts and can be allowed to move quickly to dedicate their time to more lofty areas. Moreover, those students requiring more practice and remediation can go through lessons as many times as possible. Personalised instruction allows the instructors to devote time to each student than teaching the entire class at the same time.

Focus on practice and remediation

A key feature of an adaptive learning platform is the ability to provide real-time feedback. While traditional education often relies on delayed feedback such as graded assignments and examinations which may not provide timely insights into students' progress or areas where they need improvement [127], conversely adaptive learning platforms offer real-time feedback on assignments and practice exercises allowing students to identify gaps in their understanding of concepts [128]. When a struggling student makes a mistake, the system can provide explanations and educational practice opportunities for the specific concepts the student finds challenging. Adaptive learning focuses on how students practice and this deliberate focus on practice allows for skills transference [129]. Adaptive learning focuses on student creativity, by allowing students to learn by doing as opposed to learning from instruction. This helps in providing answers to problems, and situations by availing scenarios for decision-making. During the process of practice, students are allowed to work at their own pace without having a fixed amount of time to complete an exercise [130]. According to [131], having a fixed

amount of time for an exercise before moving on has a detrimental effect on students learning. In the implementation of adaptive learning focusing on practice, students use technology to improve learning not just scaling up of content [132]. With the application of adaptive learning technology students interact with a variety of instructional content, activities, and assessments, to give them a deeper understanding of a concept rather than have them memorize specific concepts. The adaptive learning approach therefore assists learners in focusing on areas they haven't yet mastered through remediation, providing real-time monitoring feedback on their progress [133]. Adaptive remediation offers a tailored instructional method, adjusting support to each learner's requirements. By their very nature remedial programs are targeted towards raising a student's basic skills and abilities to the level that is expected of their age [134]. Remedial instruction therefore focuses on helping students to meet the standards by offering instruction that is calibrated to their current abilities and knowledge. It allows for a more nuanced and personalised teaching strategy. [135], lauds the provision of remediation as an important component of adaptive learning. Remediation is an excellent way to improve the academic readiness of students. It contributes to students gaining mastery over the areas that they struggle with. Remediation empowers students to improve their learning outcomes drastically. The design of a remediation program is primarily targeted at reducing the student's cognitive gap. It therefore necessitates for the student data to be used for creating an impact on their learning journey rather than just for evaluation and feedback. According to [136], remediation and intervention have a significant impact on the academic performance of learners. However [137], cautions that schools must be wary of over-remediation and should strive to offer accelerated learning opportunities to all students. Overuse of academic remediation may bring about temporary gains but could impede long-term progress and ultimately stifle student progress. Targeted remedial interventions can be helpful, but it

is important to recognize when these interventions start to take over classrooms and schools [138]. Researchers such as [139], suggest that schools should focus on learning acceleration instead of remediation because remediation often resorts to reteaching prior knowledge before moving on to the level content.

Visualised learning process

Visual learning is an educational approach that incorporates graphic aids to convey information thus leveraging individuals' innate ability to process visual data faster and more effectively than text data. Using an interface, the adaptive platform helps to simplify the gauging of the learning process for both the instructor and the student [140]. Students can visually determine their achievements through a learning map color-coded display. Visual learners can learn through images, graphs, charts, diagrams, and other visual aids. They can easily recall information by visualizing it in their minds and tend to have a strong spatial awareness and a keen eye for detail [141] The method taps into a cognitive process where learners gain knowledge through visual means, making it a crucial strategy for teachers to enhance understanding and retention of information. [142] define visual learning as the assimilation of information from visual formats. It is based on the notion that learners' learners understand information better when they see it. It is an effective way to engage learners in the learning process and to help them understand concepts quickly. The use of visuals has become the captivating stars that illuminate the path to knowledge. According to [143], visual learners excel at remembering pictures, images, and demonstrations. As the saying goes a "picture speaks a thousand words". This underscores the fact that visuals play a crucial role in the learning process by leveraging engagement, improving comprehension, facilitating memory retention, and promoting critical thinking. The application of visuals in learning captures the student's attention, making the learning

experience more enjoyable. Visual aids such as videos, images, and infographics attract and maintain learners' interest leading to increased engagement and their motivation to learn. Visual aids simplify information and make it more accessible. when learners analyze and interpret visual stimuli, they develop high-order thinking skills. While visual learning instruction typically involves visualizations, students usually explain in words [144]. Effective use of visual aids substitutes monotonous learning environments and increases personal understanding of the areas of learning when they experience successful and pleasant learning in learning [145]. For a visual learner an adaptive learning platform uses visual aids to explain concepts by offering simulations or interactive activities, (

Incorporation of Open Educational Resources (OERs)

According to [146], at the first UNESCO World Congress on Open Educational Resources in 2012 the "Paris Declaration" on OER adopted the conceptualization of OER as "teaching, learning, and research materials in any medium -digital or otherwise that reside in the public domain or have been released under a common license that permits no-cost access, use adaption, and redistribution by others with no or limited restrictions". AI tools can be used to develop new OERs using natural language processing and machine learning capabilities. According to [147], generative AI can produce educational content across various domains. For instance, AI could be used to generate textbooks, worksheets, or lessons based on the curriculum guidelines or learning objectives, thereby expanding the availability of OERs. Generative AI can also assist in curating and recommending OER based on learners' individual needs. Ai can also be employed to keep OER materials up to date by generating new content based on recent developments or research [148]. This can help educators create interactive learning materials, and simulations, expanding a range

of available OERs and enabling novel teaching practices. One such popular platform that demonstrates such capabilities is ChatGPT. Some AIs can develop tailored recommendations for OERs based on learners' performance, learning preferences, and development areas. The use of OER has changed the way education is accessed and delivered [149]. According to [150] the use of OER has bridged the gap in access to learning materials to a wider community. This has contributed to a substantial decrease in the lack of access to learning materials while also improving the quality of education. With its power to democratize learning OER has emerged as a game changer in empowering learners across the globe. OER allows educators to customize and adapt learning materials to suit their specific teaching styles and student needs. Unlike proprietary resources that often come with restrictions on modification, OER provides the flexibility to tailor content according to individual requirements [151]. OER plays a significant role in the technology-driven education landscape by providing flexible, and often free resources that educators and learners can use to enhance the teaching and learning experience. The advantage of OER is that they are cost-free, and the content can be adapted and modified freely, especially when targeting specific populations such as those with disabilities or special [152].

This implies that learners can use OER that meets their requirements, making the learning pathway more engaging and effective. OER therefore offers exciting opportunities to augment the production, dissemination, and access to quality educational resources.

The use of OERs provides students with free access to a variety of high-quality instructional resources. According to [153]. a combination of OERs and adaptive systems makes it possible to adapt a variety, of course, materials to fit within specific online programmes and differentiate individual learning pathways to meet the needs of specific individual learners. Regardless of

one's outlook on the impact of AI in society, its integration into spheres of our lives is progressing fast. Concerning OERs, AI offers opportunities to augment the production, dissemination, and access to quality educational resources.

Challenges for Quality Assurance of Adaptive Learning Strategies

Despite the benefits brought about by adaptive learning platforms, like various technologies they bring with them their own set of challenges like having to convince teachers and instructors of their efficiency, finding resources and solutions, and data analysis. One of the main reasons that educational systems do not offer personalisation options has to do with a variety of challenging issues ranging from interoperability, usage across a variety of devices, and open corpus knowledge, to the design of meta-adaptive systems.

Convincing teachers and instructors

Change can be difficult, and many educators may be resistant to embracing new teaching methods and approaches. Still, adaptive learning technologies face resistance from teachers, educators, and instructors who are expected to adopt the technology in their classrooms. Teachers' attitudes and beliefs are crucial factors in determining the role and effectiveness of technology in the classroom. Attitudes and beliefs about technology and pedagogy in general influence how teachers implement technology in the classroom **[154]**.

In adaptive learning approaches technology puts the learner at the system's center, but like any other vocation, education faces resistance from teachers' educators, and parents who are hesitant to embrace new technologies and approaches. Teachers and instructors tend to have a strong opinion that computers

and digital technology leave students at the mercy of algorithms. A common barrier for teachers adopting the use of adaptive learning technologies is understanding how their role might change [155]. It is the adjustment in guiding students in their work using the software that instills a sense of fear in a lot of teachers and instructors They believe technology has a limited scope of personalisation and thus if students are unable to master a topic, they might get demotivated quite easily. Teachers and instructors therefore need to understand that adaptive learning requires them to change their roles to information managers [156]. They should work with adaptive learning systems to reap the benefits of education software and applications. To overcome the challenge of not embracing adaptive learning technologies it is important to provide professional development opportunities and providing support and resources can help educators see the value of implementing these technologies [157].

Interoperability

The concept of interoperability can be circumscribed as a condition that exists between information systems and is not a barrier to accomplishing a task that spans multiple systems. According to [158], it refers to the ability of different systems and software applications to communicate, share data, and use shared information. It means that learners can access and complete courses from different sources and devices and their progress can be recorded and reported across different management systems. Interoperability enables business processes to flow from one application to another, thus demonstrating that systems can work with each other in a near real-time fashion to share critical business information [159]. Several challenges need to be addressed before an organisation can achieve true interoperability. In most cases, budgetary restrictions pose a serious barrier to achieving seamless information flow [160]. The usability of individual systems and the

lack of training for these systems are major hurdles to seamless information exchange [161]. One of the most significant challenges faced by institutions in implementing adaptive systems is achieving seamless content interoperability, enabling content to be shared and reused across various systems and organizations. Their interoperability is still low. Their learner models are developed starting from different standardization and are not reusable to a certain extent. Personalised adaptive learning systems require semantic-based and context-aware systems to achieve semantic interoperability between heterogeneous information resources and services [162]. In terms of managing adaptive learning systems, semantic heterogeneity exists due to the distributed nature of learning services from different providers who may apply different formatting for service presentation and description. Users may find difficulty in discovering and sharing with other services. [163] identified information overload as a barrier to achieving interoperability. To reduce the overload of retrieved resources and provide individualised educational experiences personalisation of learning materials must be considered. Interoperability reduces or eliminates the problem of islands of automation. From a general point of view, an information provider seeks to make content available to the widest audience at the lowest cost possible. Although interoperability is part of the university's strategic direction, it is often impeded by costs. One major barrier to interoperability is a lack of coordination among departments. the problem of coordination stems from technical or practical challenges. For example, inconsistencies around the implementation of standards may result in information systems not integrating information between systems or even not integrating third-party information.

Technical challenges

The current landscape of educational technology is marked by the integration of hardware and software tools and the

development of adaptive learning systems. These advancements continue to shape education by making it more accessible, engaging, and personalized for all learners of all ages and backgrounds [164]. This has the potential to revolutionize the way we approach teaching and learning. However, implementing adaptive learning systems requires robust technological infrastructure including the internet, sufficient computing resources, and adequate data storage capacity. According to [165] implementing adaptive learning requires significant investments in technological infrastructure. Instructional designers also must ensure that all learning materials are compatible with different devices and platforms used by students in their process of learning. This is not only logistically challenging but also expensive for institutions with limited resources and those that are in areas with low technological adoption rates. Adaptive learning comes with technical challenges. These systems rely on complex algorithms to adapt learning material and these algorithms need to be carefully designed and tested to ensure they are working properly and correctly [166]. Additionally, these systems need to be able to handle large data sets thus requiring significant computational resources. Furthermore, because adaptive learning systems are delivered online, they require reliable internet connectivity. This can be a challenge in areas with limited internet access as such it can become a barrier to learners who do not have access to a computer or other devices.

Resources

Improving the quality of education is essential for ensuring that all students have access to high-quality education and that they are equipped with the knowledge and skills necessary to survive and succeed in the world. The provision of high-quality education requires promoting innovation and integration of technology in the learning environment [167]. Imparting education through

adaptive learning is expensive. Developing an adaptive learning solution is not a matter of cost but takes a lot of skill to come up with such a system [168]. Institutions need to come up with the right team of developers who can handle such projects deftly. Institutions must conduct thorough research on the mobile applications development market to ensure that the company they are outsourcing the product from has the needed experience and capability to handle such products. A lot of universities are partnering with high-tech companies in the creation of adaptive learning programs that use algorithms to tailor virtual-based instruction to adapt to the specific needs of learners [169]. Some institutions take the risk of using adaptive learning systems which are cheap, with no proven efficiency with the hope that they will be effective in the long run. Overall, this is a high-stakes endeavor to research and pour resources into developing adaptive learning programs. Although adaptive learning systems are cost-effective in the long run, they usually require high upfront investment to implement, and that usually takes up a huge budget. This makes university management assess whether allocating available resources toward developing and implementing adaptive learning systems is worth it.

ACKNOWLEDGMENTS

This Book Chapter would not have been possible without the contributions of several people. I thank my friend Dr Joseph Evans Agolla who introduced me to the book chapter writing space. I would like to take notice of the encouragement from my daughter Maatla Shaleen Sebopelo who constantly reminded me of the deadline for completion of the chapter.

Finally, I thank my wife Phodiso Khane Sebopelo for her patience and tolerance, especially when I disappeared to my study table every evening.

CONFLICT OF INTEREST

"The author declares no conflict of interest."

CONCLUSION(S)

Education has never been about being better than others, but about making meaningful contributions to society and the world at large. Before the advent of adaptive learning technologies, education was about what instructors planned for the students but the arrival of adaptive learning with its emphasis on personalised learning has enabled learners to facilitate learning based on their individual needs and to also learn at their paces based on their capabilities. Adaptive learning has brought about a series of benefits for teachers, instructors, institutions, and most importantly students. With adaptive learning systems teachers can now use data to help students learn better, and where possible create new learning programs. Since adaptive learning is technology-based it is affected by challenges that are common to technological systems and applications found in most technology-based systems. Despite these challenges, the future of adaptive learning tools looks promising. With advances in technology and more research on the effectiveness of adaptive learning its widespread use is rightfully expected. This will certainly lead to more personalized, effective, and accessible learning experiences for all learners.

REFERENCES

[1]. Moreno-Guerrero, Antonio-José, Jesús López-Belmonte, José-Antonio Marín-Marín, and Rebeca Soler-Costa. "Scientific development of educational artificial intelligence in Web of Science." Future Internet 12, no. 8 (2020): 124.

[2]. Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. Computers and Education: Artificial Intelligence, 1, 100001.

[3]. Al-Tameemi, G., & Xue, J. (2019). Towards an intelligent system to improve student engagement and retention. *Procedia Computer Science, 151,* 1120-1127.

[4]. Oguzo, N., & Akpelu, F. E. (2022). ADAPTIC LEARNING AND LEARNING ANALYSIS. BW Academic Journal, 9-9.

[5]. Christodoulou, A., & Angeli, C. (2022, June). Adaptive Learning Techniques for Personalized Educational Software in Developing Teachers' Technological Pedagogical Content Knowledge. In Frontiers in Education (Vol. 7, p. 789397). Frontiers.

[6]. Komatsu, H., Rappleye, J., & Silova, I. (2021). Student-centered learning and sustainability: Solution or problem?. Comparative Education Review, 65(1), 000-000.

[7]. Smyrnova-Trybulska, E., Morze, N., & Varchenko-Trotsenko, L. (2022). Adaptive learning in university students' opinions: Cross-border research. *Education and information technologies, 27*(5), 6787-6818.

[8]. Daugherty, K., Morse, R., Schmauder, A. R., Hoshaw, J., & Taylor, J. (2022). Adjusting the Future of Adaptive Learning Technologies via a SWOT Analysis. Intersection: A Journal at the Intersection of Assessment and Learning, 3(2), n2.

[9]. Kubat, U. (2018). Identifying the Individual Differences Among Students During Learning and Teaching Process by Science Teachers. International Journal of Research in Educational and Science, (IJRES), 4(1), 30-38. DOI:10.21890/ijres.369746

[10]. Zhai, X. (2023). ChatGPT and Ai: The game changer for education. Available at SSRN.

[11]. Doroudi, S. (2022). The intertwined histories of artificial intelligence and education. International Journal of Artificial Intelligence in Education, 1-44.

[12]. Teasley, B. (2015) Adaptive Learning: Definition, History & Methodology. Retrieved from:https://study.com/academy/lesson/adaptive-learning-definition-history-methodology.html.

[13]. Capuano, N., & Caballé, S. (2020). Adaptive learning technologies. Ai Magazine, 41(2), 96-98.

[14]. Oguzo, N., & Akpelu, F. E. (2022). ADAPTIC LEARNING AND LEARNING ANALYSIS. *BW Academic Journal*, 9-9.

[15]. Shet, J. P. (2020). Adaptive and Blended Learning _ the Panacea for the Challenges of E-Learning.

[16]. Zhou, X., Smith, C. J. M., & Al-Samarraie, H. (2023). Digital technology adaptation and initiatives: a systematic review of teaching and learning during COVID-19. Journal of Computing in Higher Education, 1-22.

[17]. Rof, A., Bikfalvi, A., & Marques, P. (2022). Pandemic-accelerated digital transformation of a born-digital higher education institution. Educational Technology & Society, 25(1), 124-141.

[18]. Patil, D., & Naqvi, W. M. (2020). COVID-19 and education system: Impact of current pandemic on adaptive learning strategies in medical education system. *International Journal of Research in Pharmaceutical Sciences*, 403-406.

[19]. Ulanday, M. L., Centeno, Z. J., Bayla, M. C., & Callanta, J. (2021). Flexible learning adaptabilities in the new normal: E-learning resources, digital meeting platforms, online learning systems and learning engagement. Asian Journal of Distance Education, 16(2).

[20]. Divanji, R. A., Bindman, S., Tung, A., Chen, K., Castaneda, L., & Scanlon, M. (2023). A one stop shop? Perspectives on the value of adaptive learning technologies in K-12 education. Computers and Education Open, 5, 100157.

[21]. Pena-Levano, L. M., & Melo, G. (2022). Adaptation of Teaching Strategies During the COVID-19 Pandemic. Applied Economics Teaching Resources (AETR), 4(1), 12-33.

[22]. Kabudi, T., Pappas, I., & Olsen, D. H. (2021). AI-enabled adaptive learning systems: A systematic mapping of the literature. Computers and Education: Artificial Intelligence, 2, 100017.

[23]. Minn, S. (2022). AI-assisted knowledge assessment techniques for adaptive learning environments. Computers and Education: Artificial Intelligence, 3, 100050.

[24]. Gligorea, I.; Cioca, M.; Oancea, R.; Gorski, A.-T.; Gorski, H.; Tudorache, P. Adaptive Learning Using Artificial Intelligence in e-Learning: A Literature Review. Educ. Sci. 2023, 13, 1216. https:// doi.org/10.3390/educsci13121216

[25]. Joshi, M. (2023). Adaptive Learning through Artificial Intelligence. Available at SSRN 4514887.

[26]. Al Ka'bi, A. (2023). Proposed artificial intelligence algorithm and deep learning techniques for development of higher education. International Journal of Intelligent Networks, 4, 68-73.

[27]. Joshi, M. (2023). Adaptive Learning through Artificial Intelligence. Available at SSRN 4514887.

[28]. Zhai, X., & Wiebe, E. (2023). Technology-based innovative assessment. *Classroom-based STEM assessment*, 99-125.

[29]. UNESCO. (2023). Global Education Monitoring Report 2023: Technology in Education—A Tool on Whose Terms?.32. Mirata, V., Hirt, F., Bergamin, P., & van der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: findings from a Delphi study. International Journal of Educational Technology in Higher Education, 17, 1-25.

[30]. Marshall, S., & Sankey, M. D. (2023). The Future of the Learning Management System in the Virtual University. In Technology-Enhanced Learning and the Virtual University (pp. 283-304). Singapore: Springer Nature Singapore.

[31]. Moshtari, M., & Safarpour, A. (2023). Challenges and strategies for the internationalization of higher education in low-income East African countries. Higher Education, 1-21.

[32]. Mirata, V., Hirt, F., Bergamin, P., & van der Westhuizen, C. (2020). Challenges and contexts in establishing adaptive learning in higher education: findings from a Delphi study. *International Journal of Educational Technology in Higher Education, 17*, 1-25.

[33]. Pugliese, L. (2016). Adaptive learning systems: Surviving the storm. Educause Review, 10(7).

[34]. Costa, R. S., Tan, Q., Pivot, F., Zhang, X., & Wang, H. (2022). Personalized and adaptive learning: educational practice and technological impact. Texto Livre, 14.

[35]. Preston, Jane P., Sean Wiebe, Martha Gabriel, Alexander McAuley, Barbara Campbell, and Ron MacDonald. "Benefits and challenges of technology in high schools: A voice from educational leaders with a Freire echo." Interchange 46 (2015): 169-185.

[36]. Israel, S.E., Block, C.C., Bauserman, K.L. and Kinnucan-Welsch, K. eds., 2006. Metacognition in literacy learning: Theory, assessment, instruction, and professional development. Routledge.

[37]. Khatoon, M. (2023). Development of Metamemory and the Role of Working Memory among Indian Adolescents.

[38]. Jia, X., Li, W., & Cao, L. (2019). The role of metacognitive components in creative thinking. Frontiers in Psychology, 10, 2404.

[39]. Padmanabha, C. H. (2020). Metacognition: conceptual framework. Journal on Educational Psychology, 14(1), 1-11.

[40]. Basu, S., & Dixit, S. (2022). Role of metacognition in explaining decision-making styles: A study of knowledge about cognition and regulation of cognition. Personality and Individual Differences, 185, 111318.

[41]. Schraw, G. and Moshman, D., 1995. Metacognitive theories. Educational psychology review, 7, pp.351-371.

[42]. Razak, N. A., Pangil, F., Zin, M. L. M., Yunus, N. A. M., & Asnawi, N. H. (2016). Theories of knowledge sharing behavior in business strategy. Procedia Economics and Finance, 37, 545-553.

[43]. Özçakmak, H., Köroglu, M., Korkmaz, C., & Bolat, Y. (2021). The Effect of Metacognitive Awareness on Academic Success. African Educational Research Journal, 9(2), 434-448.

[44]. Stanton, J. D., Sebesta, A. J., & Dunlosky, J. (2021). Fostering metacognition to support student learning and performance. CBE—Life Sciences Education, 20(2), fe3.

[45]. Voorhees, D. H., LeMay, L. E., Nagy, E. A., & Perez, A. E. (2022). Successes with metacognition: Empowering faculty and transforming student learning. New Directions for Community Colleges, 2022(199), 17-33.

[46]. Carlon, M. K. J., & Cross, J. S. (2022). Knowledge tracing for adaptive learning in a metacognitive tutor. Open Education Studies, 4(1), 206-224.

[47]. Kautzmann, T. R., & Jaques, P. A. (2019). Effects of adaptive training on metacognitive knowledge monitoring ability in computer-based learning. Computers & Education, 129, 92-105.

[48]. Ingkavara, T., Panjaburee, P., Srisawasdi, N., & Sajjapanroj, S. (2022). The use of a personalized learning approach to implementing self-regulated online learning. Computers and Education: Artificial Intelligence, 3, 100086.

[49]. Ericsson, K. A., & Harwell, K. W. (2019). Deliberate practice and proposed limits on the effects of practice on the acquisition

of expert performance: Why the original definition matters and recommendations for future research. Frontiers in psychology, 10, 2396.

[50]. Gladwell, M. (2002). The talent myth. The New Yorker, 22(2002), 28-33.

[51]. Ericsson, K. A., & Lehmann, A. C. (1996). Expert and exceptional performance: Evidence of maximal adaptation to task constraints. Annual Review of Psychology, 47, 273–305. https://doi.org/10.1146/annurev.psych.47.1.273.

[52]. Goodyear, R. K., & Rousmaniere, T. (2019). Introduction: Computer and internet-based technologies for psychotherapy, supervision, and supervision-of-supervision. Journal of Clinical Psychology.

[53]. Memmert, D. (2017). Coaching tactical creativity in team sports. In *Perspectives on athlete-centred coaching* (pp. 36-46). Routledge.

[54]. Mahalingam, M., & Fasella, E. (2017). Effective use of technology for asynchronous learning to elevate students' knowledge and problem-solving ability. In Unplugging the Classroom (pp. 149-158). Chandos Publishing.

[55]. Grant, D. G. (2022). Becoming an Expert on Purpose: How Deliberate Practice Informs Teacher Effectiveness. In Pedagogy-Challenges, Recent Advances, New Perspectives, and Applications. IntechOpen.

[56]. Van Gelderen M. Using a comfort zone model and daily life situations to develop entrepreneurial competencies and an entrepreneurial mindset. Front Psychol. 2023 May 15;14:1136707. doi: 10.3389/fpsyg.2023.1136707. PMID: 37255520; PMCID: PMC10225726.

[57]. Balan, A., & Sjöwall, D. (2023). Evaluation of a deliberate practice and growth mindset intervention on mathematics in 7th-grade students. Scandinavian Journal of Educational Research, 67(4), 549-558.

[58]. Ellison, D. W., & Woods, A. M. (2016). Deliberate practice as a tool for effective teaching in physical education. Journal of Physical Education, Recreation & Dance, 87(2), 15-19.

[59]. Güllich, A., Faß, L., Gies, C., & Wald, V. (2020). On the empirical substantiation of the definition of "Deliberate Practice"(Ericsson et al., 1993) and "Deliberate Play"(Côté et al., 2007) in youth athletes. Journal of Expertise, 3(1), 1-19.

[60]. Bilalić, M., Đokić, R., Koso-Drljević, M., Đapo, N., & Pollet, T. (2023). When (deliberate) practice is not enough–the role of intelligence, practice, and knowledge in academic performance. Current psychology, 42(27), 23147-23165.

[61]. Tisza, G., & Markopoulos, P. (2023). FunQ: Measuring the fun experience of a learning activity with adolescents. Current Psychology, 42(3), 1936-1956.

[62]. Hefkaluk, N., Linehan, C., & Trace, A. (2024). Fail, fail again, fail better: How players who enjoy challenging games persist after failure in "Celeste". International Journal of Human-Computer Studies, 183, 103199.

[63]. Frommel, J., Klarkowski, M., Mandryk, R.L., 2021. The struggle is Spiel: on failure and success in games. In: Proceedings of the 16th International Conference on the Foundations of Digital Games, pp. 1–12. https://doi.org/10.1145/.

[64]. Annetta, L.A., Murray, M.R., Laird, S.G., Bohr, S.C. and Park, J.C., 2006. Serious games: Incorporating video games in the classroom. Educause quarterly, 29(3), p.16

[65]. Darwesh, A. M. (2016). Serious Games in Adaptive Learning. Journal of University of Human Development, 2(4), 418-423.

[66]. Shaheen, A., Ali, S., & Fotaris, P. (2023). Assessing the Efficacy of Reflective Game Design: A Design-Based Study in Digital Game-Based Learning. Education Sciences, 13(12), 1204.

[67]. Ahmad, M. (2019). Categorizing Game Design Elements into Educational Game Design Fundamentals. Game Design and Intelligent Interaction, 1-17.

[68]. Perrotta, C., Featherstone, G., Aston, H., & Houghton, E. (2013). Game-based learning: Latest evidence and future directions. Slough: nfer, 1-49.

[69]. Babacan Çörekci, T. (2023). Game-Based Learning in Interior Architecture Education. Design and Technology Education, 28(1), 55-78.

[70]. Zourmpakis, A. I., Kalogiannakis, M., & Papadakis, S. (2023). Adaptive gamification in science education: An analysis of the impact of implementation and adapted game elements on students' motivation. Computers, 12(7), 143.

[71]. Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. Educational psychologist, 50(4), 258-283.

[72]. Kallevig, K. A. (2015). Perceptions of failure in education: Changing the fear of failure through gamification.

[73]. Adipat, S., Laksana, K., Busayanon, K., Asawasowan, A., & Adipat, B. (2021). Engaging Students in the Learning Process with Game-Based Learning: The Fundamental Concepts. International Journal of Technology in Education, 4(3), 542-552.

[74]. Krouska, A., Troussas, C., & Sgouropoulou, C. (2022). Mobile game-based learning as a solution in COVID-19 era: Modeling the pedagogical affordance and student interactions. Education and information technologies, 1-13.

[75]. Murre, J. M., & Dros, J. (2015). Replication and analysis of Ebbinghaus' forgetting curve. PloS one, 10(7), e0120644.

[76]. Craig, P., & De Búrca, G. (2020). EU Law: Text, Cases, and Materials UK Version. Oxford University Press, USA.

[77]. Zaidi, A., Caines, A., Moore, R., Buttery, P., & Rice, A. (2020). Adaptive forgetting curves for spaced repetition language learning. In *Artificial Intelligence in Education: 21st International*

Conference, AIED 2020, Ifrane, Morocco, July 6–10, 2020, Proceedings, Part II 21 (pp. 358-363). Springer International Publishing.

[78]. Plaskura, P. (2019). Modelling of forgetting curves in educational e-environment. Information Technologies and Learning Tools, 71(3), 1-11.

[79]. Mohamad, S. N. M., Salleh, M. A. M., Hakim, M., Hamid, A., Sui, L. K. M., & Mohd, C. K. N. C. K. (2019). Adaptive learning strategies with gamification to enhance learning engagement. Indian Journal of Science and Technology, 12(31), 1-8.

[80]. Bae, C. L., Therriault, D. J., & Redifer, J. L. (2019). Investigating the testing effect: Retrieval as a characteristic of effective study strategies. Learning and Instruction, 60, 206-214.

[81]. Alam, M. S. (2020). Dr. Md. Shabbir Alam, Dr. Jyoti Agarwal. (2020). Adopting a Blended Learning Model in Education: Opportunities and Challenges. International Journal of Early Childhood Special Education. International Journal of Early Childhood, 12(2), 01-07.

[82]. Karpicke, J. D., & Blunt, J. R. (2011). Retrieval practice produces more learning than elaborative studying with concept mapping. Science, 331(6018), 772-775.

[83]. Brame, C. J., & Biel, R. (2015). Test-enhanced learning: Using retrieval practice to help students learn. *Retrieved October*, *15*, 2020.

[84]. Ye, Z., Shi, L., Li, A., Chen, C., & Xue, G. (2020). Retrieval practice facilitates memory updating by enhancing and differentiating medial prefrontal cortex representations. *Elife*, *9*, e57023.

[85]. Gonzalez, L., & Kardong-Edgren, S. (2017). Deliberate practice for mastery learning in nursing. *Clinical Simulation in Nursing*, *13*(1), 10-14.

[86]. Firth, J., Torous, J., Nicholas, J., Carney, R., Pratap, A., Rosenbaum, S., & Sarris, J. (2017). The efficacy of smartphone-based mental

health interventions for depressive symptoms: a meta-analysis of randomized controlled trials. *World Psychiatry*, *16*(3), 287-298.

[87]. Ortega-Tudela, J. M., Lechuga, M. T., Bermúdez-Sierra, M., & Gómez-Ariza, C. J. (2021). Testing the effectiveness of retrieval-based learning in naturalistic school settings. SAGE Open, 11(4), 21582440211061569.

[88]. Rangel, F., Celli, F., Rosso, P., Potthast, M., Stein, B., & Daelemans, W. (2015). Overview of the 3rd Author Profiling Task at PAN 2015. In CLEF2015 Working Notes. Working Notes of CLEF 2015-Conference and Labs of the Evaluation forum.. Notebook Papers.

[89]. Rohrer, D., Dedrick, R. F., & Stershic, S. (2015). Interleaved practice improves mathematics learning. Journal of Educational Psychology, 107(3), 900.

[90]. Samani, J., & Pan, S. C. (2021). Interleaved practice enhances memory and problem-solving ability in undergraduate physics. npj Science of Learning, 6(1), 32.

[91]. Hultberg, P., Calonge, D. S., & Lee, A. E. S. (2018). Promoting long-lasting learning through instructional design. *Journal of the Scholarship of Teaching and Learning*, *18*(3).

[92]. Nemeth, L., Werker, K., Arend, J., & Lipowsky, F. (2021). Fostering the acquisition of subtraction strategies with interleaved practice: An intervention study with German third graders. *Learning and Instruction*, *71*, 101354.

[93]. Schorn, J. M., & Knowlton, B. J. (2021). Interleaved practice benefits implicit sequence learning and transfer. Memory & cognition, 1-17.

[94]. Mielicki, M. K., & Wiley, J. (2022). Exploring the necessary conditions for observing interleaved practice benefits in math learning. Learning and Instruction, 80, 101583.

[95]. Onan, E., Wiradhany, W., Biwer, F., Janssen, E. M., & de Bruin, A. B. (2022). Growing out of the experience: How subjective

experiences of effort and learning influence the use of interleaved practice. Educational Psychology Review, 34(4), 2451-2484.

[96]. Amiri, M., & Farzanehfard, H. (2018). An interleaved nonisolated ZVS ultrahigh step-down DC–DC converter with low voltage stress. IEEE Transactions on Industrial Electronics, 66(10), 7663-7671.

[97]. Qadir, J., & Al-Fuqaha, A. (2020). A Student Primer on How to Thrive in Engineering Education during and beyond COVID-19. Education Sciences, 10(9), 236.

[98]. Tabibian, B., Upadhyay, U., De, A., Zarezade, A., Schölkopf, B., & Gomez-Rodriguez, M. (2019). Enhancing human learning via spaced repetition optimization. Proceedings of the National Academy of Sciences, 116(10), 3988-3993.

[99]. McKeachie, W., & Svinicki, M. (2013). McKeachie's teaching tips. Cengage Learning.

[100]. Kampen, M. (2019). How mastery learning helps every student succeed. Prodigy Education. https://www.prodigygame.com/main-en/blog/mastery-learning/

[101]. Guinness, K., Detrich, R., Keyworth, R. & States, J. (2021). Overview of Mastery Learning. Oakland, CA: The Wing Institute. https://www.winginstitute.org/instructional-delivery-learning

[102]. Pashler, H., Bain, P. M., Bottge, B. A., Graesser, A., Koedinger, K., McDaniel, M., & Metcalfe, J. (2007). Organizing Instruction and Study to Improve Student Learning. IES Practice Guide. NCER 2007-2004. National Center for Education Research

[103]. Asarta, C. J., & Schmidt, J. R. (2017). Comparing student performance in blended and traditional courses: Does prior academic achievement matter?. The Internet and Higher Education, 32, 29-38.

[104]. Shelle, G., Earnesty, D., Pilkenton, A., & Powell, E. (2018). Adaptive learning: An innovative method for online teaching and learning. The Journal of Extension, 56(5), 17.

[105]. Naibaho, L. (2019). TEACHERS'ROLES ON ENGLISH LANGUAGE TEACHING: A STUDENTS CENTERED LEARNING APPROACH. International Journal of Research-Granthaalayah, 7(4), 206-212.

[106]. Gallenstein, N. L. (2005). Engaging young children in science and mathematics. Journal of Elementary Science Education, 17(2), 27-41.

[107]. Gonulal, T., & Loewen, S. (2018). Scaffolding technique. The TESOL encyclopedia of English language teaching, 1-5.

[108]. Van de Pol, J., Volman, M., Oort, F., & Beishuizen, J. (2015). The effects of scaffolding in the classroom: support contingency and student independent working time in relation to student achievement, task effort and appreciation of support. Instructional Science, 43, 615-641.

[109]. Jumaat, N. F., & Tasir, Z. (2014, April). Instructional scaffolding in online learning environment: A meta-analysis. In 2014 international conference on teaching and learning in computing and engineering (pp. 74-77). IEEE.

[110]. Sarkany, D., & Deitte, L. (2017). Providing feedback: practical skills and strategies. Academic Radiology, 24(6), 740-746.

[111]. Narciss, S. (2012). Feedback Strategies. In: Seel, N.M. (eds) Encyclopedia of the Sciences of Learning. Springer, Boston, MA. https://doi.org/10.1007/978-1-4419-1428-6_283

[112]. William, D., & Leahy, S. (2015). Embedding formative assessment: Practical

[113]. Molin, F., Haelermans, C., Cabus, S., & Groot, W. (2021). Do feedback strategies improve students' learning gain?-Results of a randomized experiment using polling technology in physics classrooms. Computers & Education, 175, 104339.

[114]. Wisniewski, B., Zierer, K., & Hattie, J. (2020). The power of feedback revisited: A meta-analysis of educational feedback research. Frontiers in psychology, 10, 3087.

[115]. Mandernach, J., & Garrett, J. (2014). Effective feedback strategies for the online classroom. White Paper.

[116]. Markovic, I. (2023). Why Giving Instant Feedback Is Important for Effective Learning. Edu Me.

[117]. Peng, H., Ma, S., & Spector, J. M. (2019). Personalized adaptive learning: an emerging pedagogical approach enabled by a smart learning environment. Smart Learning Environments, 6(1), 1-14.

[118]. Zhu, D.M. Shen, New paradigm of educational technology research based on Big Data. E-Educ. Res. (10), 5–13 (2013)

[119]. Wan, D. Wang, Investigation on adaptive learning mechanism of big data based on Knewton platform. Mod. Educ. Technol. 26(5), 5–11 (2016)

[120]. Raj, N. S., & Renumol, V. G. (2022). An improved adaptive learning path recommendation model driven by real-time learning analytics. Journal of Computers in Education, 1-28.

[121]. Shemshack, A., & Spector, J. M. (2020). A systematic literature review of personalized learning terms. Smart Learning Environments, 7(1), 1-20.

[122]. Walkington, C., & Bernacki, M. L. (2020). Appraising research on personalized learning: Definitions, theoretical alignment, advancements, and future directions. Journal of research on technology in education, 52(3), 235-252.

[123]. Hughey, Judy (2020) "Individual Personalized Learning," Educational Considerations: Vol. 46: No. 2. https://doi.org/10.4148/0146-9282.2237

[124]. DeMonte, J. (2018). Micro-credentials for teachers: What three early adopter states have learned so far. Washington, DC: American Institute for Research. Retrieved from https://www.

air.org/sites/default/files/downloads/report/Micro-Creditials-forTeachers- September-2017.pdf.

[125]. Taylor, D. L., Yeung, M., & Bashet, A. Z. (2021). Personalized and adaptive learning. Innovative Learning Environments in STEM Higher Education: Opportunities, Challenges, and Looking Forward, 17-34.

[126]. Feldstein, M., & Hill, P. (2016). Personalized learning: What it really is and why it really matters. Educause review, 51(2), 25-35.

[127]. Lubis, F. (2019). Education in the disruption era. Britain International of Linguistics Arts and Education (BIoLAE) Journal, 1(2), 183-188.

[128]. Cavalcanti, A. P., Barbosa, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Mello, R. F. (2021). Automatic feedback in online learning environments: A systematic literature review. Computers and Education: Artificial Intelligence, 2, 100027.

[129]. Alrashedi, N. (2020). Adaptive learning to enhance students understanding in learning technology experience. Technium Soc. Sci. J., 9, 32.

[130]. Tong, D. H., Uyen, B. P., & Ngan, L. K. (2022). The effectiveness of blended learning on students' academic achievement, self-study skills and learning attitudes: A quasi-experiment study in teaching the conventions for coordinates in the plane. Heliyon, 8(12).

[131]. Luo, B., & Wang, M. (2023). Effects of start times on academic performance: Will metacognitive learning strategy or flipped classroom approaches help sleepy young university students?. The International Journal of Management Education, 21(2), 100806.

[132]. Niederhauser, D. S., Howard, S. K., Voogt, J., Agyei, D. D., Laferriere, T., Tondeur, J., & Cox, M. J. (2018). Sustainability and scalability in educational technology initiatives: Research-

informed practice. Technology, Knowledge and Learning, 23, 507-523.

[133]. Lipnevich, A. A., & Smith, J. K. (2022). Student–feedback interaction model: revised. Studies in Educational Evaluation, 75, 101208.

[134]. Brown, L. E., Kim, H. Y., Tubbs Dolan, C., Brown, A., Sklar, J., & Aber, J. L. (2023). Remedial programming and skill-targeted SEL in Low-Income and crisis-affected contexts: Experimental evidence From Niger. Journal of Research on Educational Effectiveness, 1-32.

[135]. Taylor, S., Ryan, M., & Elphinstone, L. (2021). Generating genuine inclusion in higher education utilising an original, transferable, and customisable model for teaching and assessing reflective learning. *Reflective Practice, 22*(4), 531-549.

[136]. Asio, J. M. R., & Jimenez, E. (2020). Effect of remediation activities on grade 5 pupils' academic performance in technology and livelihood education (TLE). Asio, JMR, & Jimenez, EC (2020). Effect of Remediation Activities on Grade, 5.

[137]. Finnan, C. (2018). Accelerating the learning of all students: Cultivating culture change in schools, classrooms and individuals. Routledge.

[138]. Kaffenberger, M. (2021). Modelling the long-run learning impact of the Covid-19 learning shock: Actions to (more than) mitigate loss. International Journal of Educational Development, 81, 102326.

[139]. Miles, K. H., Rosenberg, D., & Green, G. Q. (2017). Igniting the Learning Engine: How School Systems Accelerate Teacher Effectiveness and Student Growth through Connected Professional Learning. Education Resource Strategies.

[140]. Kasinathan, A. Mustapha and I. Medi, "Adaptive learning system for higher learning," 2017 8th International Conference on Information Technology (ICIT), Amman, Jordan, 2017, pp. 960-970, doi: 10.1109/ICITECH.2017.8079975.

[141]. Dewar, G. (2018). Spatial intelligence: What is it, and how can we enhance it. Parenting Science. www. parentingscience. com/ spatialintelligence. html.

[142]. Jamal, M. A., Brown, M., Yang, M. H., Wang, L., & Gong, B. (2020). Rethinking class-balanced methods for long-tailed visual recognition from a domain adaptation perspective. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 7610-7619).

[143]. Kay, R., Goulding, H., & Li, J. (2018). Assessing the impact of a virtual lab in an allied health program. Journal of Allied Health, 47(1), 45-50.

[144]. Bobek, E., & Tversky, B. (2016). Creating visual explanations improves learning. Cognitive research: principles and implications, 1, 1-14.

[145]. Shabiralyani, G., Hasan, K. S., Hamad, N., & Iqbal, N. (2015). Impact of visual aids in enhancing the learning process case research: District Dera Ghazi Khan. Journal of education and practice, 6(19), 226-233.

[146]. Pawlowski, J. M., & Hoel, T. (2012). Towards a global policy for open educational resources: The Paris OER declaration and its Implications. White Paper, Version 0.2, Jyväskylä, Finland.

[147]. Bozkurt, A. (2023). Generative artificial intelligence (AI) powered conversational educational agents: The inevitable paradigm shift. Asian Journal of Distance Education, 18(1), 198–204. DOI: https://doi.org/10.5281/zenodo.7716416 .

[148]. Méndez, E., & Sánchez-Núñez, P. (2023). Navigating the Future and Overcoming Challenges to Unlock Open Science. In: González-Esteban, E., Feenstra, R. A., Camarinha-Matos, L. M. (eds), Ethics and Responsible Research and Innovation in Practice. Lecture Notes in Computer Science, vol 13875. Cham: Springer. DOI: https://doi.org/10.1007/978-3-031-33177-0_13 .

[149]. Mtebe, J. S., & Raisamo, R. (2014). Investigating perceived barriers to the use of open educational resources in higher

education in Tanzania. International Review of Research in Open and Distributed Learning, 15(2), 43-66.

[150]. D'Souza, F. (2021). Awareness and use of open educational resources: a study. Library Philosophy and Practice (e-journal).6570. https://digitalcommons.unl.edu/libphilprac/6570

[151]. Wiley, D., Bliss, T. J., & McEwen, M. (2014). Open educational resources: A review of the literature. Handbook of research on educational communications and technology, 781-789.

[152]. Moon, J., & Park, Y. (2021). A scoping review on open educational resources to support interactions of learners with disabilities. *International Review of Research in Open and Distributed Learning*, *22*(2), 314-341.

[153]. Mićunović, M., Rako, S., & Feldvari, K. (2023). Open Educational Resources (OERs) at European Higher Education Institutions in the Field of Library and Information Science during COVID-19 Pandemic. Publications, 11(3), 38.

[154]. Levin, T., & Wadmany, R. (2006). Listening to students' voices on learning with information technologies in a rich technology-based classroom. Journal of Educational Computing Research, 34(3), 281-317.

[155]. Nordlöf, C., Norström, P., Höst, G., & Hallström, J. (2022). Towards a three-part heuristic framework for technology education. International journal of technology and design education, 32(3), 1583-1604.

[156]. Amro, F., & Borup, J. (2019). Exploring blended teacher roles and obstacles to success when using personalized learning software. *Journal of Online Learning Research*, *5*(3), 229-250.

[157]. Davidovitch, N., & Yavich, R. (2023). Study Group Size, Motivation and Engagement in the Digital Era. Problems of Education in the 21st Century, 81(3), 361-373.

[158]. Sandy, H. M., & Freeland, C. (2016). The importance of interoperability: Lessons from the Digital Public Library of

America. International Information & Library Review, 48(1), 45-50.

[159]. Bates, D. W., & Samal, L. (2018). Interoperability: what is it, how can we make it work for clinicians, and how should we measure it in the future?. Health services research, 53(5), 3270.

[160]. Shrank, W. H., DeParle, N. A., Gottlieb, S., Jain, S. H., Orszag, P., Powers, B. W., &

[161]. Ndlovu, K., Scott, R. E., & Mars, M. (2021). Interoperability opportunities and challenges in linking mhealth applications and eRecord systems: Botswana as an exemplar. BMC medical informatics and decision making, 21(1), 1-12.

[162]. Aroyo, L. M., Dolog, P., Houben, G. J. P. M., Kravcik, M., Naeve, A., Nilsson, M., & Wild, F. (2006). Interoperability in personalized adaptive learning. Journal of Educational Technology & Society, 9(2), 4-18.

[163]. Ndlovu, K., Mars, M., & Scott, R. E. (2023). Validation of an Interoperability Framework for Linking mHealth Apps to Electronic Record Systems in Botswana: Expert Survey Study. JMIR Formative Research, 7, e41225.

[164]. Tekesbaeva, N., Kultan, Y., Ongarbayeva, A., Ibraev, A., & Yerimbetova, Z. (2023). Digital technologies as an adaptive learning tool in higher education. In E3S Web of Conferences (Vol. 403, p. 08023). EDP Sciences.

[165]. Mahesa, D. (2023). ADAPTIVE LEARNING: THE KEY TO UNLOCKING STUDENT POTENTIAL AND IMPROVING ACADEMIC RESULTS. STIPAS TAHASAK DANUM PAMBELUM KEUSKUPAN PALANGKARAYA, 1(3), 96-107.

[166]. Gavrilović, N., Arsić, A., Domazet, D., & Mishra, A. (2018). Algorithm for adaptive learning process and improving learners' skills in Java programming language. Computer Applications in Engineering Education, 26(5), 1362-1382.

[167]. Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. International journal of research in education and science, 1(2), 175-191.

[168]. Anindyaputri, N. A., Yuana, R. A., & Hatta, P. (2020). Enhancing students' ability in learning process of programming language using adaptive learning systems: a literature review. Open Engineering, 10(1), 820-829.

[169]. Kruger, D. (2020). Adaptive learning technology to enhance self-directed learning. Self-directed multi-modal learning in higher education (NWU self-directed learning series), 5, 93-116.

HOW TO CITE:

ABNT

SEBOPELO, Phineas. **Adaptive Learning Strategies in Open and Distance Learning: Opportunities and Challenges for Quality Assurance**. (AI in Education: Innovations, Challenges, and Practices). Phineas Sebopelo, 2025. DOI: https://doi.org/10.37497/alumni.inbooks.3 Disponível em: ebooksalumni.org/index.php/omp/catalog/book/3 . Acesso em 27 outubro. 2025.

APA

Sebopelo, Phineas. (2025). **Adaptive Learning Strategies in Open and Distance Learning: Opportunities and Challenges for Quality Assurance**. Phineas Sebopelo. DOI: https://doi.org/10.37497/alumni.inbooks.3 Disponível em: ebooksalumni.org/index.php/omp/catalog/book/3 . Acesso em 27 out.. 2025.

ISO

SEBOPELO, P. **Adaptive Learning Strategies in Open and Distance Learning: Opportunities and Challenges for Quality Assurance** (AI in Education: Innovations, Challenges, and Practices). Phineas Sebopelo, 2025. DOI: https://doi.org/10.37497/alumni.inbooks.3 [Acesso em 27 outubro. 2025.] Disponível em: ebooksalumni.org/index.php/omp/catalog/book/3

Vancouver
Sebopelo, P. **Adaptive Learning Strategies in Open and Distance Learning: Opportunities and Challenges for Quality Assurance.** Phineas Sebopelo, c2025. [citado 27 de outubro 2025]. DOI: https://doi.org/10.37497/alumni.inbooks.3 Disponível em: ebooksalumni.org/index.php/omp/catalog/book/3

Alumni.in

EDITORA ALUMNI.IN
CNPJ: 42.065.021/0001-35
São Paulo, Brasil
Alumni.In Books e-ISSN: 3085-8569