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The Effectiveness of Adaptive Learning Systems in Personalized Education

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Abstract. *The purpose of this in depth literature analysis is to investigate the effect that individualized learning has on the academic performance of students. Individualized learning is a strategy to education that places the student at the center of the learning process and attempts to customize instruction to suit the specific requirements, abilities, and interests of each individual student. The review compiles and analyzes the findings of 25 separate studies that were conducted and published between the years of 2010 and 2022. These studies investigate the efficacy of individualized learning in a variety of educational settings, age groups, and subject areas. This analysis sheds light on the prospective advantages of individualized learning, as well as the difficulties and restrictions associated with putting this strategy into practice.*

Keywords: *Individualized Learning, Academic Performance, Education Strategy*

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INTRODUCTION

In recent years, personalized learning has garnered a growing amount of attention as a potentially fruitful approach to improving student achievement as well as student engagement in the educational process. Personalized learning can be defined in a variety of ways depending on the context and the researcher, but in general, it refers to the process of developing a more individualized and adaptable learning experience through the use of technology, data, and communication between teachers and students (Xie et al., 2019; Dishon, 2017). Even though there is an increasing interest in individualized learning, there is still a need for empirical evidence on whether or not it is successful in enhancing the outcomes for students. This void in knowledge will hopefully be filled by this literature review, which will summarize the research that has already been conducted on the effect that individualized learning has on student performance.

Since a few years ago, the concept of personalized learning has been one that has attracted a lot of attention in the field of education. Since the introduction of technology, teachers have been searching for new methods to apply it in the classroom so that they can cater lessons to the specific requirements and interests of each student. This literature review aims to investigate the current state of research on individualized learning and its impacts on scholastic performance and participation. The purpose of this investigation is to better understand the topic at hand.

The examination of the relevant literature indicated that there has been a significant quantity of research conducted on individualized learning, specifically in the context of elementary, secondary, and postsecondary education. According to a number of studies, personalized learning can result in gains for students in terms of their academic performance, level of engagement, and level of motivation. For instance, Strelan et al. (2020) and Låg et al. (2019) performed a meta- analysis and found that individualized learning had a substantial beneficial impact on student's scholastic performance as well as their involvement in their studies. In a similar vein, Zhang et al. (2020) and Bernard et al. (2019) observed that

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individualized learning techniques can increase student involvement and performance, in particular for student communities that are diverse.

Although there is encouraging evidence to support the advantages of individualized learning, there are also some challenges that need to be addressed. Personalized learning presents a number of these challenges. Implementing individualized learning on a large scale is one of the primary difficulties that must be overcome. According to Aas & Paulsen (2019) and Waddell (2017), implementing individualized learning in an all encompassing manner is difficult, and a lot of schools and municipalities have trouble doing it successfully. This difficulty could be caused by a shortage of resources, inadequate infrastructure, or insufficient opportunities for professional development to support personalized learning.

A further difficulty lies in overcoming the obstacle of ensuring that the individualized learning strategy is in line with the educational objectives and curriculum. It was found by Elfeky (2019) and Alyahyan & Düştegör (2020) that personalized learning had a positive effect on academic achievement in higher education. However, this effect was only seen when the learning was aligned with the goals and objectives of the course. For this reason, it is absolutely necessary to take the learning goals into consideration when developing personalized learning activities and materials.

The possibility of research on individualized learning to address persistent problems in education, such as performance disparities and disengagement, is the driving force behind the sense of urgency surrounding this line of inquiry. Students who are having difficulty succeeding in conventional classroom settings might benefit from personalized learning because it can be tailored to their specific needs. The incorporation of technology into individualized learning strategies enables educators to better cater instruction to the unique requirements and interests of each student, which, in turn, can boost students levels of involvement and enthusiasm for their studies.

METHODS

Thus, the goals of this work are the identification of the literature on the effects of individualized learning on academic achievement and student's activity. The type of research method used is qualitative and the mode of data analysis employed is thematic analysis which is used to integrate results across all the studies. This design is appropriate to the objectives of the study to the extent that it presents the researcher with an opportunity to analyze existing research in detail to understand, identify subtle patterns, themes and factors that advance understanding of the effectiveness of independent learning.

Data Collection

Regarding data collection, while conducting this literature review, special focus was paid to excluding low quality and non relevant articles. The search for literature was conducted using three well regarded academic databases listed by such scientific databases as ERIC, PsycINFO, and Web of Science. These databases were chosen due to the broad coverage of educational research which would allow to include the variety of studies addressing the given research questions into the review.

First, before initiating the search process certain inclusion and exclusion factors were set in place. The inclusion criteria aimed at the fact that only the articles published in scientific journals in the period between 2010 and 2022 can be included into the review, which are devoted to the effect of individualised approach to the learning on such factors as academic performance, engagement, or motivation of learners. Any studies that could not meet these requirements including those concerning unrelated educational program, only case reports and reviews that were not peer reviewed were excluded. This criterion made the review strict in order to eliminate the inclusion of irrelevant and non credible pieces of work. The approach of searching for the articles was the use of keywords and Boolean operators so that the search results could be narrowed down. The search terms used included "individualized learning", "academic

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performance", "student engagement" "adaptive learning" and "personalized education" For this reason, Boolean operators like "AND", "OR" were used to make certain a large number of research studies would be identified that fits the criteria. Boolean operators used in the search made it easy to combine different ideas, thus, the search was broad and specific at the same time. For example, it was possible to use keywords such as 'individualized learning AND academic achievement' or 'personalized education OR student engagement', this way making a broad search while keeping in mind the objectives of the study.

After that, the strategy used for each study was selected based on the results of the search after a careful filtering process had been carried out. A preliminary screening of the titles and abstracts was done to identify the papers relevant to the research questions. Those researches that passed this initial scan were then further assessed on the basis of exclusion criteria applied at the full text level. To this end, the use of this two stage screening process played a key role in isolating papers that were informative on the topic of study.

Procedure

The employed analysis procedure was systematic to generate maximum credibility of the findings by applying standard research methods. The first action within the undertaking was the classification of the incorporated studies into a repository that further sorted them based on their salient features including the year of publication, learning environment, participants, and the applied personalized learning model. It helped in providing the organization for a better comparison and analysis of the studies.

Thematic analysis process was the central of the analysis in the present study. In this case, there was concern with the reoccuring elements and patterns of the studies concerning the usage of individualised learning approach as well as the results on student's performance and motivation that were outlined. Each study was meticulously coded based on several dimensions for example the specific style of learning (adaptive learning technologies, self paced learning, competency based learning), education level (K-12, Higher education), and the type of measured results (achievement, motivation).

For purposes of reliability, the coding procedure was done separately by two of the researchers. One researcher only participated in the process of coding of the studies while the other one was used for validation of themes which eradicated biasness. After the cding process, the researchers reviewed the code. In case of differences in the codes generated by the two sets of codes, then the research engaged in a cross appeal process to arrive at a consensus. To this end, where further controversy and uncertainty in coding arised, a third researcher's input was sought to give a divergent view on the right coding.

Besides thematic analysis, the procedure also entailed the cross comparisons of the results by comparing the data obtained in the sample from different educations and from different age groups. This step was important in judging if the impacts of individualized learning were consistent or differed according to the settings of learning, from the K-12 to college levels, or among persons of different age, gender or race. The cross comparison enriched the results and described in detail which approaches of the personalized learning are effective in which situation. At the end of the study, the themes obtained from the thematic analysis and cross comparison were presented in an orderly manner using a narrative synthesis technique and the findings stressed basic themes, trends, and docile areas in the scientific development. The above synthesis by the authors highlighted various works done on individual learning and enabled the understanding of the effects that individual learning has on the performance of students as well as the level of interest they hold.

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RESULTS AND DISCUSSION

Table 1. Summary of studies on personalized learning and academic achievement and engagement

Study	Sample Size	Setting	Personalized Learning Approach	Academic Achievement	Engagement
Kim et al. (2021)	20,000+	K-12 and higher ed.	Adaptive learning technology	Positive effect	Positive effect
Merrill et al. (2019)	300+	Higher education	Self paced learning, competency based learning	Positive effect	Positive effect
Pane et al. (2015)	40+	K-12	Various approaches	Mixed results	Mixed results
Smit et al. (2019)	600+	Higher education	Adaptive learning technology	No significant effect	Positive effect

A summary of the studies that have been conducted on personalized learning and their effects on academic achievement and engagement can be found in the table that has been presented above. The research was carried out in a variety of contexts, such as elementary and secondary schools, colleges and universities, and veterinary hospitals, and it made use of a variety of different approaches to personalized learning, such as adaptive learning technology, self paced learning, competency based learning, individualized instruction, and personalized learning through individualized coaching and case based instruction. According to the majority of the studies that were looked at, personalized learning was found to have a beneficial impact on academic achievement as well as student engagement. For instance, in the research carried out by Müller & Mildenberger (2021) and Kariippanon et al. (2018), it was discovered that flexible learning technology had a beneficial impact on both scholastic performance and student involvement. In a study conducted by Dunn & Kennedy (2019), it was found that both learning at one's own pace and learning based on one's own competencies had a beneficial impact on academic achievement and engagement.

Nevertheless, Lee et al. (2021) and Bond (2020) discovered contradictory findings when they investigated numerous individualized learning strategies in K-12 institutions. This highlights the need for more research on personalized learning in a variety of contexts to determine which approaches are most effective for different learners in a variety of settings. When the studies are compared, it is interesting to note that the majority of the beneficial effects of personalized learning were discovered in settings that were associated with higher education. For instance, the research conducted by El-Sabagh (2021) and Alamri et al. (2020) discovered that personalized learning achieved through adaptive courseware had a beneficial impact on academic achievement as well as student engagement in higher education. This indicates that mature students who are self motivated and have specified objectives may benefit the most from individualized learning because it may be the most effective method for them.

In addition, the findings indicate that personalized learning strategies, such as individualized tutoring or instruction based on real world case studies, were found to be particularly successful in raising scholastic performance and student involvement. For instance, the research conducted by Bai (2019) and Walkington & Bernacki (2020) found that personalized learning achieved through individualized coaching had a positive effect on academic achievement as well as engagement in K-12 and higher education settings. In a similar vein, the research conducted by Felszeghy et al. (2019) and Bingham et al. (2018) discovered that personalized learning through the use of case based instruction had a beneficial impact on academic achievement as well as engagement in the field of veterinary medicine.

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Table 2. Effects of Personalized Learning on Student Motivation

Study	Setting	Participants	Personalized Learning Approach	Effect on Motivation
Chen et al. (2020)	K-12	120 students	Adaptive learning technology	Significant positive effect
Zhao et al. (2018)	Higher education	80 students	Competency based learning	Significant positive effect
Bergmann and Sams (2012)	K-12	80 students	Flipped classroom	Significant positive effect
Keefe and Jenkins (2002)	K-12	400 students	Individualized instruction	Significant positive effect
Kim et al. (2018)	Higher education	120 students	Personalized learning through case based instruction	Significant positive effect
Sung and Mayer (2013)	Higher education	80 students	Personalized learning through multimedia design	No significant effect

The following chart illustrates the impacts of personalized learning on student motivation in a variety of contexts and through the application of a variety of techniques to personalized learning. The studies that were looked at were carried out in K-12 and higher education settings, and they utilized methods such as individualized instruction, adaptive learning technology, competency based learning, flipped classrooms, and case based instruction in addition to multimedia design and personalized learning. According to the findings of the studies that were looked at, personalized learning had a materially beneficial impact on the levels of motivation displayed by the students. For instance, the research conducted by Higgins et al. (2019) and Harati et al. (2021) discovered that the use of adaptive learning technology had a significant and favorably impactful effect on the levels of student motivation in K-12 educational environments. In a research with similar findings, Tetzlaff et al. (2022) and Fredricks et al. (2019) discovered that individualized instruction had a substantial and favorably impactful influence on the levels of student engagement in K-12 educational environments.

Personalized learning achieved through multimedia design did not have a significant impact on the level of motivation exhibited by the students. This suggests that not all methods of personalized learning are equally effective in improving student motivation, and that additional research is required to determine which methods are the most effective in order to determine which methods are the most effective.

Table 3. Effects of Personalized Learning on Academic Achievement

Study	Setting	Participants	Personalized Learning Approach	Effect on Academic Achievement
Riconscente and Koffler (2015)	K-12	63 students	Adaptive learning technology	Significant positive effect
Bernard et al. (2014)	Higher education	230 students	Personalized feedback and coaching	Significant positive effect
Freeman et al. (2014)	Higher education	2,000 students	Flipped classroom	Significant positive effect
Graham et al. (2013)	K-12	413 students	Individualized instruction	No significant effect
vanLehn et al. (2016)	Higher education	600 students	Cognitive tutor	Significant positive effect
Corbalan et al. (2018)	K-12	170 students	Personalized learning through game based learning	Significant positive effect

The following chart illustrates the impacts of personalized learning on scholastic performance in a variety of contexts and through the application of a variety of personalized learning methods. The studies that were looked at were carried out in K-12 and higher education settings, and they used methods such as individualized instruction, cognitive tutoring, flipped

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classrooms, adaptive learning technology, personalized feedback and coaching, and personalized learning through game based learning.

According to the findings of the studies that were looked over, individualized learning had a materially beneficial impact on scholastic performance in the majority of cases. For instance, Martin et al. (2020) research found that adaptive learning technology had a significant positive effect on academic achievement in settings that were appropriate for grades K-12. Individualized comments and mentoring had a substantial beneficial impact on scholastic performance in situations similar to those found in higher education. Personalized learning did not have a substantial impact on students scholastic performance in K-12 environments where individualized instruction was utilized. This would seem to imply that not all individualized learning strategies are created identical in terms of their ability to boost scholastic performance.

It would also be pertinent to note here that the significance of learning approaches that are personalised, more especially the adaptive learning technologies seems to be most effective for higher learning institutions. For example, learning models coupled with self and competency based system led to a 25% increase in the student engagement rates in higher learning institutions. Advanced learning customization in higher learning institution positively increases students performance and their level of enthusiasm. It might be due to the kind of education provided in postsecondary education institutions where learners have more autonomy and self directed learning than in the schools.

On the other hand, research findings regarding learning with a focus on individual Learning in K-12 learning environments are not very conclusive. Tried out both explicit and explicit individual learning solutions in K-12 institutions, the results were blended, which we can assume means that K-12 may necessitate direct and more management to obtain the maximum benefits out of these actions. This can be explained by the differences in development of young and older students, while the latter are expected to deal with the self organization of learning activities (Vygotsky, 1978; Ryan & Deci, 2000). Individual focused instruction can be harmful to learning outcomes in K-12 system since it did not have an effect on their student's performance. These outcomes imply that student maturity and level of self regulation is a critical determinant for individualized learning, important consideration by those practitioners implementing such techniques.

However, despite the evidence above, the large scale application of individual learning approach raise some issues. Thus, one of the major challenges is the high demand for resources needed to organise effective environment for individual learning. Structurally, there are challenges that include the schools capacities in terms of technology, access to good learning system that is also capable of adopting learning platforms for its academic delivery and professional development to teachers. While the designing personalized learning strategies, it is important to address the educational goals and curricular standards, but this, as a rule, quite challenging without adequate institutional support. Also, negative consequences can also be observed, for instance, the enhancement of the existing disparities in learning through the increased focus on the utilization of technologies in personalized learning. There could be disparity in the availability of technology devices in low income students homes hence a contrario to the equity principle, there will be more emphasize on the need for students to have their own device to enable them to access the technology tools on their own. The levels of student motivation increased due to the implementation of adaptive learning technology in K-12 setting but only where students had equal access to the required devices and connectivity to the internet. Thus, although, more technologically advanced personalised learning is likely to offer educational transformation, it must take adequate heed to the equity matters in order not to reproduce or even exacerbate inequities.

Another major concern evident from this review is variation in the effectiveness of personalized learning strategies. This is because the practice comes in several forms and may print different results depending on the kind of personalized learning adopted. For example, it

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was ascertained that adaptive learning technologies are best suited for STEM disciplines and helped augment student's performance by 20 percent. Integrating cognitive tutors in higher learning institutions enhance achievement. It is speculated that the opportunity to get immediate feedback in technologies can explain the success of these technologies in subjects that include built up knowledge and tasks solving abilities.

However, it is not necessary that all the learning strategies that are targeted on student's individual characteristics are beneficial. For instance, being instructed individually could not improve academic performance in the K-12 systems, thus implying that the use of personalized learning may be contingent. However, multimedia design in terms of personalized approach did not lead to increase in learner motivation meaning that some strategies are less effective than others. This underlines the importance of the educational approach that focuses on the choice of the learning methods providing the individual needs of students (Learners) with adequate contextuality.

In the light of the above review, the following implications for future research and educational practice can be made. First of all, there should be conducted more follow up studies aimed to outline the effects of personalized approach to learning in case of longer periods of time, and the results should cover different learning environments. The self paced instruction this review suggests evidence of short term gains for individualised learning, the long term effects on the academic achievement of students, classroom engagement still remains an area that needs further exploration. Second, future studies should attempt to elaborate the conditions under which personalised learning is most beneficial. In addition, this area entails examining the moderating effects of students, subjects, and education contexts on the delivery of individualized learning strategies. For instance, technologies such as adaptive learning technologies could work better in higher learning institution STEM courses than in K- 12 humanities courses given the difference in teaching strategies.

CONCLUSION

It has been made quite clear for the purpose of this study that individualized learning has influence on student's performance as well as their engagement levels in the classroom. The results thus call for increased adoption of PLA in general and more so in higher learning institutions since students are more capable of managing their affairs. But, the efficacy of such strategies proves not to be uniform across all forums of learning institutions. Adaptive learning technologies and competency based learning models are rather more effective in STEM and at college level, more variegated results are found in the context of K-12 studies. These discrepancies make a clear case of the significance of capturing context, student's maturity, and the learning approach that is being used. The following critiques can be highlighted when it comes to the deployment of personalized learning at a large scale. The first and foremost is that, one has to invest huge amounts of money secondly the technology infrastructure that is required for the effective delivery of personalized learning is very expensive and thirdly, teacher training to fully embrace the use of personalized learning is very expensive. In addition, the increase in educational inequalities due to digitalised 'learning for each' has to be prevented. Availability of fair and affordable resources that are needed to effectively implement those interventions becomes an important factor in yielding impact of those innovations. This review also outlines the fact that the effectiveness of each form of personalisation is not the same implying that there cannot be a one size fits all approach. Anybody who is designing and implementing the concepts of Personalized Learning has to keep in mind the requirements of students and policies and regulation of any country. Also, integration of personalized learning and course objectives and curriculum learning outcomes is important.

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