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iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 18 No. 1 (2024) | OPEN ACCESS

https://doi.org/10.3991/ijim.v18i01.46309

PAPER

The Impact of Implementing a Moodle Plug-in as an AI-based Adaptive Learning Solution on Learning Effectiveness: Case of Morocco

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ABSTRACT

This article presents feedback on the implementation of an Artificial Intelligence-based adaptive learning Moodle plugin aimed at enhancing the engagement levels and academic performance of 102 Moroccan high school students. The primary objective of this study was to assess and compare the performance of students utilizing the adaptive learning system with those employing conventional learning methods. To guarantee the efficacy of this approach, a participant satisfaction survey and a comprehensive summative evaluation were conducted, revealing the positive impact of AI-based adaptive learning on the participants. The results of this study highlight the potential benefits of integrating AI-driven adaptive learning into high school computer science curricula, emphasizing how it may raise student engagement and academic performance. These results strengthen the determination to use this teaching methodology with students in future educational activities.

KEYWORDS

adaptive learning, artificial intelligence, education, Moodle, adaptive systems

1 INTRODUCTION

Due to the COVID-19 outbreak, remote learning and learning management systems (LMS) have become more important. This shift has prompted educators to encourage students' independent study, curiosity, and thirst for information.

However, despite the significant efforts made, it is still easy to see that learners are demotivated and disinterested in the learning process [1]. This inspired the authors to look into techniques for awakening students' interest and boosting their motivation with the ultimate goal of enhancing their performance. Among the strategies explored, AI-based adaptive learning stood out as a potential answer [2]–[4]. Each student's unique demands are satisfied by this approach, which uses technology and individualized learning paths to adapt the learning process to fit their needs

Ezzaim, A., Dahbi, A., Haidine, A., Aqqal, A . (2024). The Impact of Implementing a Moodle Plug-in as an AI-based Adaptive Learning Solution on Learning Effectiveness: Case of Morocco. *International Journal of Interactive Mobile Technologies (iJIM)*, 18(1), pp. 133–149. https://doi.org/10.3991/ijim.v18i01.46309

Article submitted 2023-09-28. Revision uploaded 2023-11-03. Final acceptance 2023-11-07.

and preferences [5]–[7]. The aim is to reignite students' excitement for studying and create an atmosphere where they may succeed academically. The term "adaptive learning" has been portrayed in a variety of literary works, sometimes as an educational approach and at other times as a system or technology. Yarandi & Jahankhani (2013) posit that adaptive learning is a subject of study centered around customizing the learning path depending on the knowledge, learning preferences, and habits of the learners. The main goal is to successfully address individual requirements by personalizing the educational experience [8]. Adaptive learning, according to Waters (2014), is an approach of education and remediation that makes use of data collection and algorithms to give individualized curriculum adaptations in response to each student's proven level of comprehension [9]. As per [10], adaptive learning is a type of educational technology that has the power to significantly improve students' learning experiences as well as the accessibility and standard of higher education. Contrary to what was said above, other researchers assert that adaptive learning is more than a simple technique or approach; it is a sophisticated system created to take into account a variety of personal traits, such as emotional, cognitive, and behavioral traits. Its main objective is to locate and offer the best adaptive learning environment adapted to the individual characteristics of each learner [11].

In order to engage actively in the learning process and retain persistence in their studies, learners need to be motivated, which is described as the commitment, engagement, and perseverance of the student in a task [12]. This parameter encourages students to take notes, participate in class discussions, and seek a deeper knowledge of the material. These actions improve learning effectiveness, which in turn affects students' general performance and results in improved academic performance. This leads us to highlight the benefits of using this learning approach or system, which aims to build students' confidence and motivation to succeed academically as well as achieve mastery in the subject matter. Supporting the contention of the authors of [13], AI-enabled Adaptive Learning Systems (ALS) are designed to tackle a range of challenges faced by students, encompassing learner disengagement, low motivation, and associated issues.

According to several studies, using an adaptive learning system has numerous benefits, the most notable of which is that it offers learning that is customized to the learner's unique preferences, traits, and learning styles in terms of difficulty, presentation and navigation. Additional benefits are cited, many of which derive from the use of such systems, including increasing learning speed, enhancing learning outcomes, and avoiding "cognitive overload" and "lost in hyperspace" [14]. A Systematic Literature Review published in 2020 shows that adaptive learning also allows for good management of the display level of alternative learning pages based on the individual's learning characteristics, as well as the classification of learners with similar characteristics to provide a collaborative learning environment [15]. Motivation and progress monitoring of learners, based on gamification theory and short quizzes are among the benefits of adaptive learning systems. These systems benefit not only the students but also the teachers. Adaptive learning systems enable instructors to use a variety of teaching methods (problem-based learning, case studies, etc.), diversify learning activities, easily identify the learners' learning styles, assess the material to prioritize its relevance and benefit to the students and finally identify which content the students are having difficulty with through analysis of their progress [16].

The Moroccan high school Computer Science curriculum serves as the study's specific context, which also serves as the source of inspiration for the research.

Traditional classroom instruction was the norm in Moroccan high schools prior to the COVID-19 epidemic. However, the epidemic forced a swift switch to online education, highlighting the necessity for practical approaches to maintain students' interest and motivation in their studies. This project began by examining how adaptive learning systems can be used to overcome these problems and reignite student interest.

This study is also complies with the broader educational reform initiatives in the nation, such as the Strategic Vision of the 2015–2030 Reform of the Moroccan Education System [17], [18], the 2022–2026 roadmap for education reform in Morocco [19], the National Charter for Education and Training (CNEF) [20], [21] and the framework law 17–51 [22, p. 19], [23]. These programs, which place a strong emphasis on modernization and innovation in education, are in line with the goal of investigating how adaptive learning systems might help achieve these objectives, particularly in the context of high school computer science instruction.

The purpose of this research is to study the impact of adaptive learning on learner motivation and performance as well as to address the challenges associated with the Moroccan education system, particularly the high school computer science curriculum. According to the hypothesis, tailored and engaging learning experiences provided by adaptive learning systems have the power to increase student engagement and, as a result, have a good effect on their academic achievement.

In this article, the authors firstly focus on the background of the study, which inspired them to investigate an AI-based adaptive learning solution.

2 CONTEXT OF THE STUDY

The study takes place in the 1st year of high school, in computer science; it was built on two hypotheses:

- Students exposed to an AI-based adaptive learning system will demonstrate significant improvement in academic performance compared to students who receive traditional non-adaptive instruction.
- Implementing an AI-powered adaptive learning solution in high school classrooms will lead to increased student engagement and motivation towards their studies, resulting in higher levels of independent learning and active participation.

To test the validity of these hypotheses, a representative sample of 102 students was carefully selected and categorized into two distinct groups:

- Experimental group (52 students): This group is the subject of the application of the AI-based adaptive learning system in your research.
- Control Group (50 students): This group serves as a baseline comparison and they will be taught using the traditional approach.

Throughout this endeavor, adherence to the guidelines and official instructions set forth by the Moroccan Ministry of National Education of the preschool and sports regarding the teaching of computer science within the common core was maintained. The pedagogical objective of this experience was to equip learners with the skills to proficiently use spreadsheet software, with a particular focus on MS Excel. The knowledge associated with this training encompassed the following key areas:

- Familiarity with the graphical environment of the software.
- Proficiency in using a spreadsheet effectively.
- Understanding the concept of cell addresses.
- Mastery of creating and utilizing formulas within the software.

To succeed in the experiment, the implementation of a complete learning environment was required, one that engages learners and enables adaptive learning through flexible features and intelligent capabilities. In this regard, the Moodle learning management system (LMS) was selected as the platform of choice. This platform gave us the tools to create a structured program that included a variety of components, including texts, videos, presentations and discussion forums, to successfully convey educational information tailored to each student's interests [24], [25].

To present the educational content in a way suitable for each learner, "Personalized Study Guide (PSG)" is utilized, which is a Moodle plug-in generating a personal learning path for students [26].

The objective behind implementing this plug-in is to harness its capabilities in identifying students' unique learning styles and tailoring personalized learning paths. The aim is to pique students' curiosity and motivate them to interact with the platform actively. The goal is to implement a learning environment that caters to each student's unique requirements and preferences by utilizing the adaptive and customized features of this solution. This will encourage a greater feeling of participation and motivation over the course of the student's academic career.

The Moodle plug-in used: The Personalized Study Guide (PSG) is a cutting-edge Moodle plug-in made to build personalized learning paths based on students' unique learning styles. The plug-in provides two unique methods for identifying these learning styles. In the first approach, a questionnaire created by Felder and Silverman, called the Inventory of Learning Styles (ILS), is used. As an alternative, to determine students' preferred methods of learning, the PSG might examine their prior Moodle activity patterns. The PSG can determine which resources are most compatible with students' learning styles by evaluating the learning-style weightings for each learning resource and activity in the course. Utilizing these determined weightings, the plug-in creates a customized suggestion for the best learning materials and activities, delivering a unique and interesting learning experience for each learner [26].

To make predictions, the PSG plug-in operates in conjunction with the Behavior Analytics plug-in (BA), which performs clustering analysis. In this procedure, BA treats all of the activities on a course page as nodes in a graph, and the connections between the nodes stand in for how students may access those activities. Subsequently, each student is assigned a centroid point based on their interactions with activities and the coordinates of the nodes. To achieve this, the plug-in utilizes the centroid subgraph algorithm, which aids in identifying the centroids of the learning paths. After teachers determine the desired number of student groups, the k-means algorithm is applied to cluster students accordingly. By integrating these algorithms, the PSG can effectively generate personalized learning paths that align with students' preferences and behaviors, ensuring a more tailored and effective educational experience [26]–[29].

Furthermore, the use of the k-means as a classification technique seems obvious, but what is meant by "k-means"? As an unsupervised learning technique, k-means clustering is regarded as an AI algorithm used for dividing data into k clusters based on similarity [30]. It has uses across many industries, and its effectiveness and simplicity make it a popular method in machine learning and data mining.

3 RELATED WORKS

Numerous case studies have been conducted on the application of AI-based adaptive learning systems. The basis of this research on the application of adaptive learning approach in terms of technologies, factors used, and results, specifically utilizing the Moodle learning management system, is laid out in this part, which is a thorough analysis of relevant works and current literature.

In this study [31], the "University CourseAssist" Moodle plugin, driven by machine learning, accurately identified English levels and learning styles in undergraduates. It improved English grammar proficiency through customized learning paths. Students reported increased motivation and satisfaction. Ongoing plugin development is essential to prevent obsolescence, highlighting the need for continuous learner input. Another study presents an automated method for identifying students' preferred learning style in order to provide customized Moodle courses. Data mining is used to make use of ILS replies from students and Moodle interaction data. Moodle's adaptive mechanism is put into practice and assessed. The findings are encouraging: while taking into account simpler patterns, this technique has a favorable effect on students' motivation and performance [32]. This study [33] presented a framework that follows Bloom's Taxonomy and provides students with tailored content based on their learning preferences and knowledge levels. The study showed a notable improvement in both student performance and engagement. The authors of this study [33] presented a framework that follows Bloom's Taxonomy and provides students with tailored content based on their learning preferences and knowledge levels. The study showed a notable improvement in both student performance and engagement. This study [34] combines educational data mining, adaptive learning, and gaming to improve student performance and engagement. The results show that adaptive gamification performs better than gamification alone, having a favorable effect on student engagement and academic achievement. Through this study [35], the authors propose a unique recommendation approach that focuses on adapting learning materials to learners' preferences. They introduce LearningPartnerBot, a chatbot that works with Moodle and is supported by natural language processing. Real-time responses and personalized suggestions provided by LearningPartnerBot lead to better learning outcomes. Within the Moodle architecture, this project developed an e-learning application to track student usage information. The Felder-Silverman Learning Style Model (FSLSM) learning categories are used to cluster learners using the Fuzzy C Means Algorithm. Based on each learner's FSLSM learning style, the site delivers adaptable customizable user interfaces. A statistical study supports the system's adaption and demonstrates how it improves student performance [36]. This study [37] examines the use of machine learning models to categorize students based on their levels of engagement and assess the risks of disengagement in terms of interactions and academic performance using Moodle Data. Analysis of these interactions revealed a significant link between them and student achievement.

In the majority of cases, these studies are conducted in higher education using various technologies and data analytics to improve student learning and engagement. This study aims to make a contribution by integrating a new AI-based Moodle plugin into the educational environment of a Moroccan high school, encouraging individualized learning and increasing student engagement and performance.

4 METHODOLOGY

To evaluate the impact of the AI-based adaptive learning approach on students' motivation and performance, a comparison research design was selected. By obtaining, evaluating, and contrasting pertinent data, this method is an invaluable tool for making wise judgments [38].

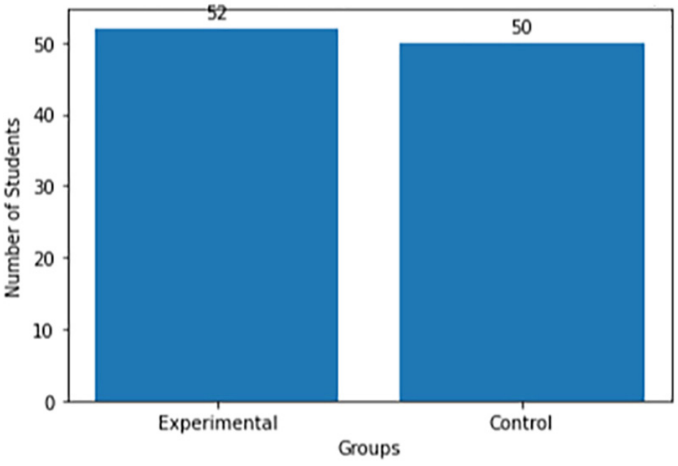

Fig. 1. Number of students in experimental and control groups

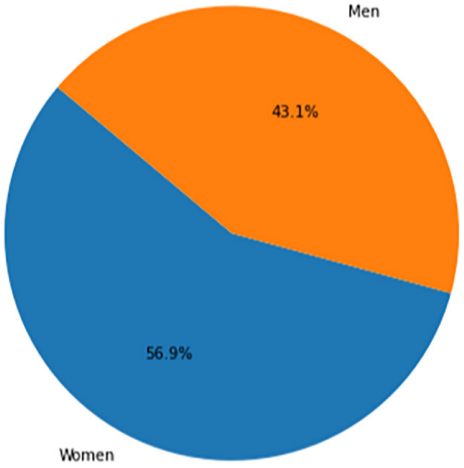

Fig. 2. Gender distribution among 102 students

Participants: The study included 102 students from Oulad Zerrad High School's first year, affiliated with the Moroccan Provincial Directorate of El Kelaa des Sraghna. Participants in this study were from both the literary and scientific fields, with 58 women (57%) and 44 men (43%) participating. A random selection process was used to allocate these participants to respective groups. A diversified representation was guaranteed and any possible biases in group composition were reduced by this random assignment (see Figure 2).

52 students comprised the initial group, sometimes referred to as the Experimental group. During the deployment and evaluation of the AI-based adaptive learning system on their learning experiences, this group served as the central focus of the study efforts. Through this application, the aim is to investigate how this novel strategy can potentially enhance students' motivation and consequently improve their academic performance.

The second group, referred to as the Control Group, was made up of 50 students. This group's function was to provide a crucial baseline for comparison. These students were taught using conventional techniques, which allowed us to evaluate and contrast results between the two groups. The research successfully gathered to evaluate the effectiveness of the adaptive learning system in comparison to traditional teaching methods thanks to this comparative approach, which provided important insights into the potential advantages of implementing adaptive learning systems in the context of high school computer science education in Morocco (see Figure 1).

The Approach Used: Through this comparative analysis, a contrast between two distinct learning methods will be achieved. The traditional approach involves a spreadsheet course delivered with standard didactic materials like a video projector, the teacher's computer, PowerPoint presentations, and student mobile devices (Smartphone, tablet and laptop) for practical work, and the AI-based adaptive learning approach. In the adaptive learning method, the same content will be presented in various forms (PDF, Assignments, Videos, PPts, Forum etc.), tailored to each learner's preferred style of learning, adhering to the Felder-Silverman Learning Style Model

(FSLSM) (see Table 1) [39]. This way, learners will engage with educational materials customized to their individual learning preferences.

Table 1. Formats for educational content according to FSLSM

Processing	Active	Videos, PPTs, Demo, Exercise, Assignments
	Reflective	PDFs, PPTs, Videos, Announcements, References
Perception	Sensing	Examples, PDFs, Videos, Practical Material
	Intuitive	PDFs, PPTs, Videos, Forum, Topic, List, References
Input	Visual	Images, Charts, Videos, References
	Verbal	PDFs, Videos, Email, Announcements
Understanding	Sequential	Exercise, References, Assignments, Sequential
	Global	Topic Lists, References, Exercise, Assignment

For this research, three assessment instruments have been selected:

- To conduct the comparative analysis, participation rates in both the Experimental group and Control group were observed and compared. The aim was to measure student involvement and engagement.
- Motivation assessment: In order to assess the level of student motivation towards the new pedagogical approach (AI-based adaptive learning), a satisfaction questionnaire comprising five questions was created. The questionnaire was administered in both French and Arabic languages. Here's a more detailed breakdown of the questionnaire:
  1. **Effectiveness of PSG Plug-in in Meeting Personal Interests (Yes/No):** This simple question was designed to determine how well the PSG plugin matched each learner's individual interests.
  2. **Participant Feedback on Comprehension and Retention (From Very Good to Bad):** In order to better understand how well students understood and remembered the course information, this question intended to elicit their subjective comments. The alternatives for the students' responses ranged from "very good" to "bad."
  3. **Motivation through AI-based Adaptive Learning Approach (From Very Motivating to Not Motivating):** This question measured how motivated students were when utilizing the AI-based adaptive learning method. Students might select from three options to express how motivational they found the method.
  4. **Recommendation of the Adaptive Learning Method to Colleagues (Yes/No):** The simple yes/no question asked students if they would suggest the adaptive learning approach to their peers.
  5. **Preference for Continuing Adaptive Learning in Future Courses (Yes/No):** With a yes/no response option, this inquiry sought to ascertain if students preferred to continue using adaptive learning in future classes.

  Participants were situated in a classroom environment while the questionnaire was given out in class. The online survey tool Google Forms was utilized for efficient reply collection. With the help of this technique, participant replies might be organized and recorded in an efficient manner.
- **Performance assessment:** To measure the learners' performance in each group, a comprehensive summative evaluation was conducted at the conclusion of the training, which includes a variety of evaluation techniques, such as short

answers, multiple-choice questions, and practical problem-solving exercises. Both groups underwent the same assessment under identical conditions, ensuring a fair and unbiased comparison of their achievements. This process allowed us to analyze the effectiveness of the AI-based adaptive learning approach compared to the traditional method in terms of student performance. The evaluation instrument was thoughtfully designed to gauge how well students were learning in a variety of dimensions, including understanding of the course material, problem-solving prowess, critical thinking, and overall mastery of the curriculum. The goal of this varied evaluation strategy was to provide a comprehensive picture of each student's academic progress. This evaluation methodology for both groups made it possible to compare the effectiveness of the AI-based adaptive learning strategy versus the conventional teaching strategy in terms of performance.

5 RESULTS

Participation rate: The participation rate was calculated by tracking the attendance of students over the course of three weeks (see Table 2 and Figure 3). According to official guidelines, the spreadsheet chapter required a total of 6 hours of instruction, while the common core level had a weekly session of 2 hours, allowing for a three-week training period as specified. Monitoring students' attendance during this timeframe determined their level of engagement and involvement in both learning methods. It is important to note that attendance was not mandatory to ensure accurate results. The study focused on the students' intrinsic-motivation and willingness to participate without any external pressure or requirements for attendance.

Table 2. Comparison of participation rates

Weeks	Participation Rate in Control Group (Classic Method)	Participation Rate in Experimental Group (Adaptive Learning Method)
Week 1	76%	86.54%
Week 2	58%	96.2%
Week 3	46%	98%

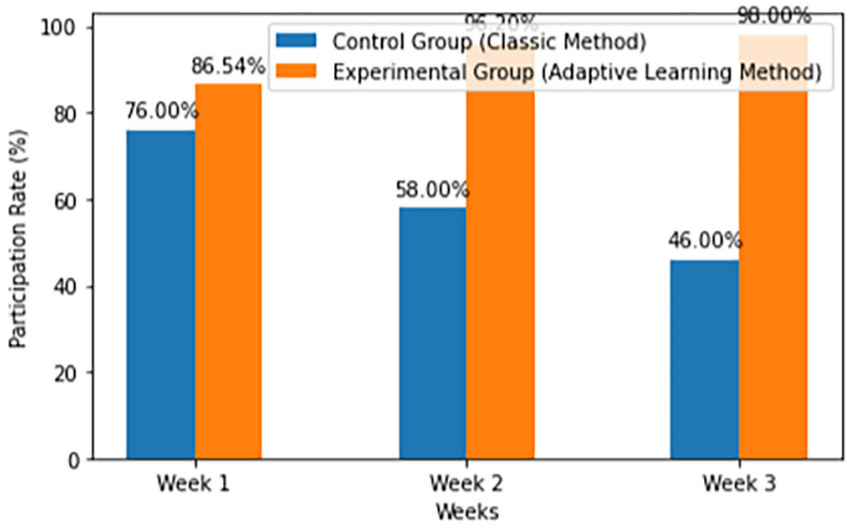

Fig. 3. Participation rate comparison between control and experimental groups

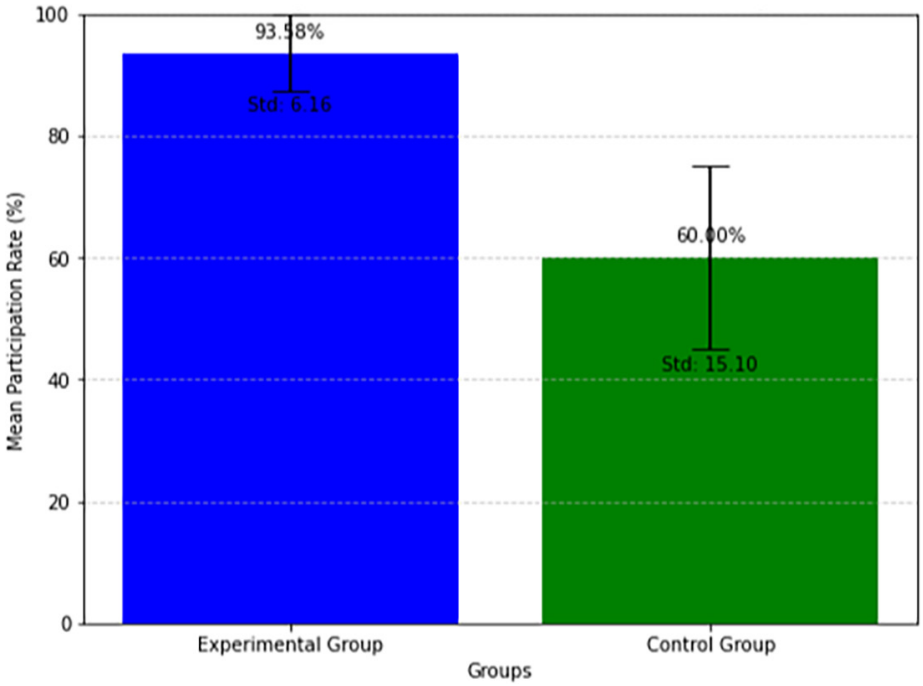

Fig. 4. Mean participation rate and standard deviation comparison

According to the results in Figure 4, the Experimental Group was more engaged overall than the Control Group, with a mean participation rate of 93.58% higher. The Experimental Group's lower standard deviation of 6.16 further indicated that its participants' involvement rates were more uniform. Comparatively, the Control Group had a lower mean participation rate of 60.00% and a larger standard deviation of 15.10, indicating a lower level of involvement overall and more variation in participation rates within the group. These findings could indicate that the experimental group's adoption of an AI-based adaptive learning strategy had a beneficial effect on student engagement and involvement.

Performance rate: The learner's performance rate indicates the grade achieved in the evaluation conducted at the conclusion of the training. The graph below displays the overall average of each of the two groups.

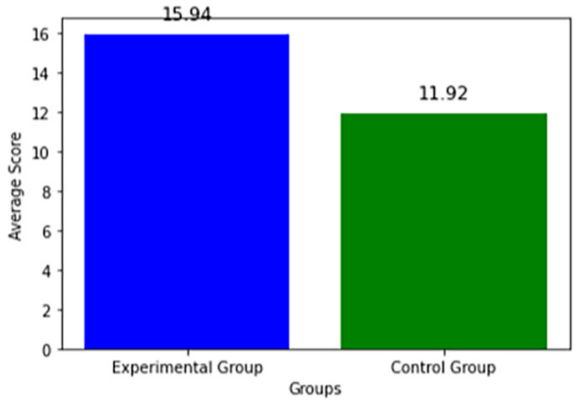

Fig. 5. Comparison of performance rates

In terms of their evaluation scores, which serve as a representation of performance rate, Figure 5 shows a considerable difference between the experimental

group and the control group. The experimental group achieved a much higher average of 15.94 than the control group, which had an average score of 11.92. This significant difference in means suggests that the experimental group's implementation of the AI-based adaptive learning solution has had a beneficial influence on their performance in comparison to the control group's traditional training.

Answers to the questionnaire: From the experimental group, 51 answers to the satisfaction survey were gathered. According to the results, 86.3% of students in the experiment group said that the course material actually matched their particular interests (Figure 6).

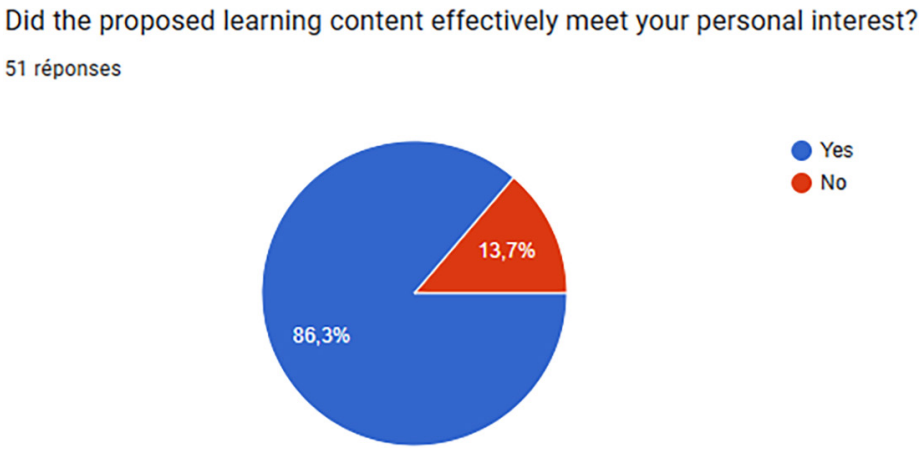

Fig. 6. Effectiveness of PSG plug-in: meeting personal interests

The evaluation of the AI-based adaptive learning approach using the PSG plug-in revealed its effectiveness as a highly successful learning method. Among the participants, a significant 60.8% reported that the approach enabled them to comprehensively understand and retain the course material. An additional 23.5% found it to be a good learning method, while 15.7% regarded it as moderately good (Figure 7).

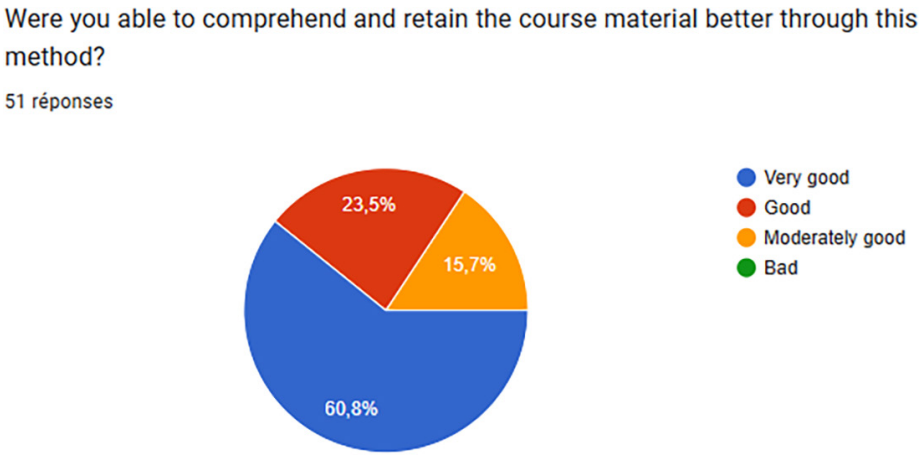

Fig. 7. Participant feedback on comprehension and retention

The AI-based adaptive learning approach has an effect on students' motivation, as shown by the fact that 60.8% of the sample felt motivated by this method, 27.5% were moderately motivated, and 11.8% were not at all motivated (Figure 8).

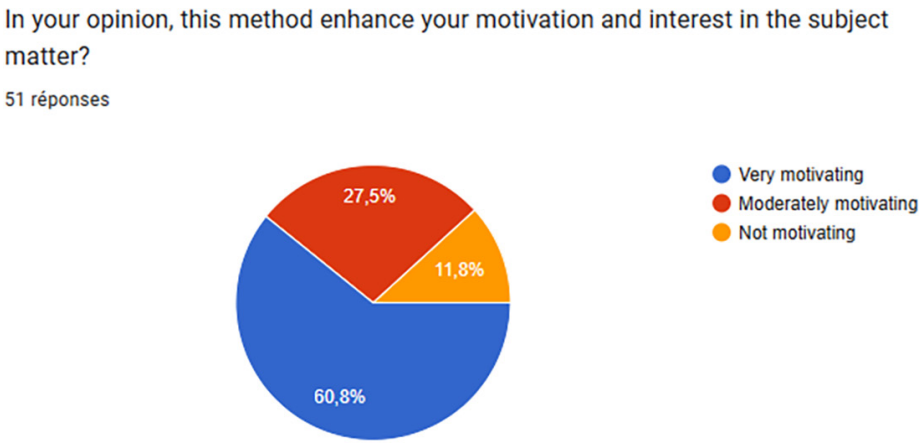

Fig. 8. Motivation through AI-based adaptive learning approach

As shown in Figure 9, 84.3% of the students endorse the AI-based adaptive learning plug-in "Personalized Study Guide", and they desire to repeat the experience of learning using this method in other disciplines (Figure 10).

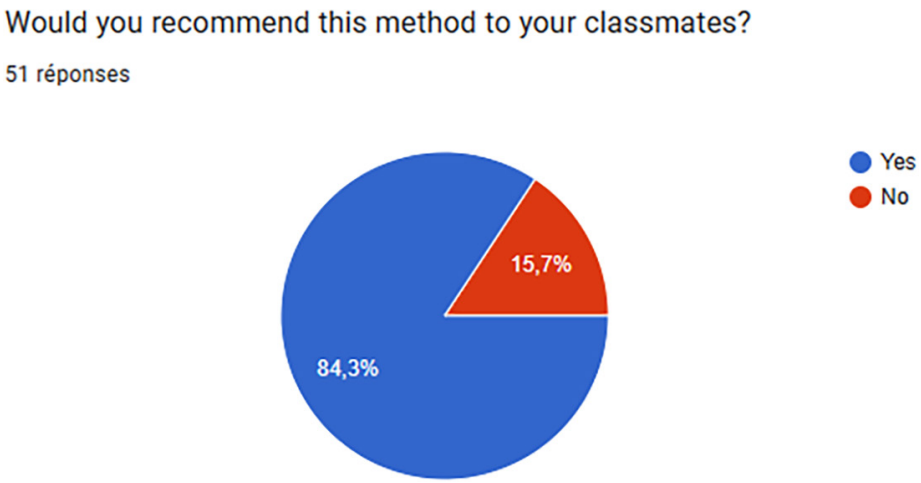

Fig. 9. Recommendation of the adaptive learning method adopted

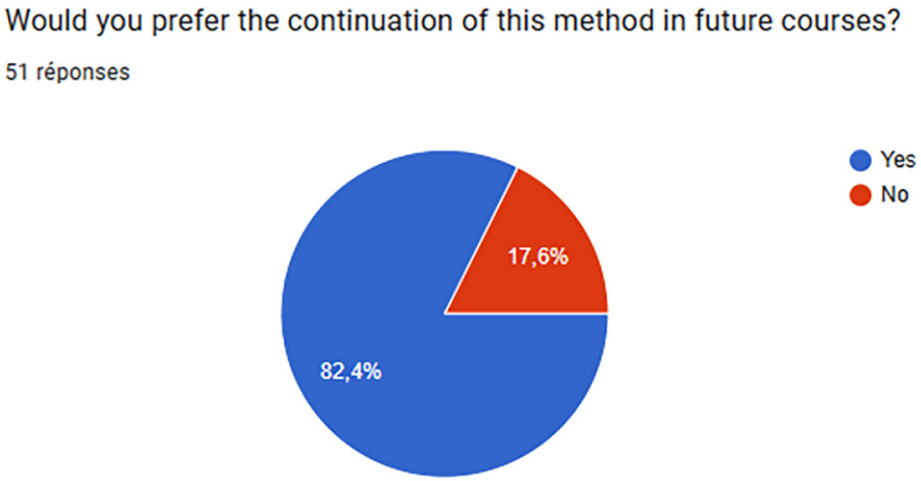

Fig. 10. Preference for continuing adaptive learning in future courses

6 DISCUSSION

In the framework of the "Moroccan secondary cycle," this research is a trailblazing innovation that tackles the basic problem of harnessing artificial intelligence, especially adaptive learning, to improve learner motivation, engagement, and academic success.

Due to the constant advancement of education and the sizable student population in each class, educators have encountered significant difficulties in meeting the demands of each individual student during the traditional teaching process. It proved to be a challenging task to modify the curriculum to accommodate different learning preferences and the students' strengths and shortcomings. As traditional one-size-fits-all strategy has grown less successful at addressing the various requirements of learners, the adaptive learning stands out in this situation as a potentially effective way to close this gap. Adaptive learning platforms may customize the learning experience to each student's preferences, learning pace, and aptitude by leveraging artificial intelligence and data-driven insights. However, this approach offers a framework to address students' motivation issues, particularly given that nearly all students are eager to try out this novel method.

Although it is the first time that the PSG plug-in is used for learning in the Moroccan context, there was a very high adaptation rate of educational content (86.3%) on Moodle LMS. This high satisfaction rate shows that, for the majority of learners, the tailor-made learning ways produced by the AI adaptive learning solution have made learning more interesting and inspiring. Nevertheless, the 13.7% of participants who responded negatively might be associated with the limited duration of the training period. The relatively short training duration might have resulted in insufficient data to allow the plugin to fully adapt and respond to the individual preferences of these learners.

Based on the key findings, the Experimental Group had a mean participation rate that was 93.58% greater than the Control Group's, which was 60.00%. Furthermore, although the Control Group had a higher standard deviation of 15.10, indicating greater fluctuation in participation rates, the Experimental Group had a lower standard deviation of 6.16, indicating more consistent engagement levels among its members. These findings clearly imply that implementing an adaptive learning technique based on AI has a favorable effect on student engagement and involvement.

The results of this study also demonstrate the extremely positive impact of the adaptive learning solution by showing that a large majority of students considerably benefit from the individualized and personalized learning ways provided by the system. Understanding the subject resulting from these personalized learning paths has had a considerable impact on the overall performance of students. The successful results highlight the way in which the adaptive learning strategy improves the understanding, commitment and academic success of students and this was supported by the fact that the Experimental Group (15.94) and Control Group (11.92) had significantly different mean assessment ratings. This shows that the Experimental Group's strategy was superior to the Control Group's conventional training strategy in terms of improving academic achievement and performance.

Using the PSG plug-in, this study also evaluated the performance of the AI-based adaptive learning technique. Notably, 60.8% of participants said that using this strategy helped them fully comprehend and remember the course information. Additionally, 15.7% thought it was a somewhat good learning approach, and 23.5% thought it was a good one. These results highlight how the AI-based adaptive learning approach improves students' comprehension and recall of course information.

In term of motivation, the AI-based adaptive learning approach also had a positive impact. By using this strategy, a considerable 60.8% of the sample claimed to be motivated, compared to only 11.8% who were completely unmotivated and 27.5% who were only moderately driven. According to these findings, the adaptive learning strategy helped students become more motivated. The fact that 84.3% of students supported the AI-based adaptive learning plug-in "Personalized Study Guide" and said they would like to replicate the experience in other disciplines was a promising finding (Figure 10). This shows that students were eager to continue utilizing the strategy in their education even when they were happy with it.

The findings of this study are consistent with other studies described in the related works section that have emphasized the advantages of AI-based adaptive learning systems in enhancing motivation, performance, and engagement. These results support the idea that individualized learning routes suited to each student's needs can improve educational performance. This work also makes a contribution by demonstrating that students are open to using similar methods in other fields, which is supported by their willingness to do so.

It is important to recognize the limitations of this study even if it offers insightful information about the effects of AI-based adaptive learning on student motivation and academic achievement in the setting of high school computer science education in Morocco. First off, because the study was done in a particular high school and subject area, it may be challenging to generalize the conclusions to broader educational settings. Furthermore, the majority of this evaluation was based on quantitative metrics, and a more thorough qualitative analysis may have provided a more in-depth understanding of the student experience.

To provide a more thorough grasp of the possibilities of adaptive learning, future research paths should take into account extending the study's scope to include other educational environments and topics. Studies that are ongoing might examine how long-term improvements in motivation and academic performance last. A more comprehensive understanding of the usefulness of adaptive learning systems in improving student outcomes may be obtained by investigating the viewpoints of educators and their involvement in putting them into practice.

In conclusion, this method fosters student engagement by instilling intrinsic motivation in them, encouraging active participation in lessons and the autonomous application of information to progress. What's more, the adopted platform encourages contact with peers via discussion forums and chats, generating a chance for group learning. By combining the benefits of e-learning, personalized learning paths generated by the PSG plugin, social interaction and other tools provided by the Moodle LMS, this approach offers a dynamic and supportive adaptive learning system, enabling students to flourish academically while nurturing their sense of autonomy and curiosity.

7 CONCRETE FINDINGS

In this section, the actual research results are presented, emphasizing concrete findings and novel insights. This research focuses on a number of areas, including motivation, performance, engagement, and the enthusiasm of students to continue using the system. These findings offer a thorough analysis of the effects of AI-driven adaptive learning on the educational process and show how they line up with other studies in the area.

Engagement & Involvement: Compared to the Control Group (60.00%), the Experimental Group (93.58%) had a much greater participation rate. Additionally, there were more consistent involvement levels in the Experimental Group.

Performance Rate: The Experimental Group outperformed the Control Group in terms of average evaluation score (15.94 vs. 11.92), demonstrating the beneficial effects of AI-based adaptive learning on academic performance.

AI-Based Adaptive Learning's Efficacy: 60.8% of participants said the AI-Based Adaptive Learning technique was extremely helpful in comprehending and remembering all of the course material.

Motivation: A sizable 60.8% of students said that the AI-based adaptive learning technique has inspired them.

Desire for Continued Use: 84.3% of students said they would like to continue using the AI-based adaptive learning system in additional subjects.

8 CONCLUSION

While immensely advantageous, adaptive learning systems do have some limits that should be recognized. The availability and caliber of data provide one of the main obstacles. To effectively tailor learning routes, these systems rely on data analysis, which calls for a considerable volume of data. Additionally, the effectiveness of adaptive learning is greatly influenced by the platform's capabilities and the underlying algorithms. Such platforms are more readily available to institutions or organizations with ample resources since they need expertise, time, and resources to develop and maintain.

The study and analysis of the experience of adaptive learning as a learning method are of significant importance. It highlights the value of the transition from traditional educational approaches to those that prioritize the interests of learners, promoting motivation and encourage independent learning. This change ultimately improves the overall quality of the learning process.

Despite the positive results of this study, a limitation that must be dealt with in the future research is the possibility of applying this approach to all subjects. Another drawback is the accent placed by the current solution on the personalization of content, which is mainly based on learning styles. This encourages us to reflect on the second perspective, in which an architecture for a learning system that takes into account many elements, including leisure, the degree of difficulty, the learning style, and more, will be presented. To further increase the learning process and to respond to a wide range of preferences and individual demands.

9 ACKNOWLEDGMENT

I would like to thank Dr. Aziz Dahbi, Dr. Abdelfatteh Haidine and Dr. Abdelhak Aqqal, for their patient instruction, passionate support, and constructive criticisms of this study effort.

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