Exploring Student Expectations and Preferences Regarding Online Adaptive Revision: Implications for the Successful Design of Personalized Learning Systems

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***Abstract*—To better understand students' needs regarding personalized revision, we explored their expectations of adaptive learning and evaluated their experiences with flipped learning throughout a semester. This study builds upon previous research that identified Moodle as the most effective online assessment platform, with the goal of developing an Personalized Exam Revision (PER) plug-in for Moodle. By integrating theoretical frameworks such as Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), DeLone and McLean, as well as the Kano model, we developed a unique conceptual model that guided the design of our questionnaire. We then analyzed survey data gathered from students at Chouaib Doukkali University. Adopting an original mixed-methods approach we integrated Principal Component Analysis (PCA), followed by the K-means clustering algorithm to optimise the separation of groups, as well as Natural Language Processing (NLP), to derive meaningful insights from the data. The findings provide valuable insights into students' requirements, preferences, and satisfaction levels, as well as the impact of Moodle on their learning process. Based on these results, we propose strategic recommendations for developing an adaptive revision module that aligns with students' actual needs, ensuring that our Moodle plug-in is developed in the right direction to effectively enhance the assessment process.**

***Keywords*—adaptative learning, Personalized Exam Revision (PER), online assessment, Unified Theory of Acceptance and Use of Technology (UTAUT), Kano's model, Natural Language Processing (NLP), K-means**

I. Introduction

As part of the implementation of the digital transformation set out in the ESRI 2023 PACT reform, the Digital Skills module is of capital importance insofar as its content and the didactic and pedagogical mechanisms it puts in place are fully in harmony with the objectives of modernising the ecosystem of Higher Education, Scientific Research and Innovation in Morocco [1]. This module aims to develop students' technical skills, enable them to use essential digital tools and to promote digital culture through an understanding of online security, data protection and digital ethics. The Ministry is adopting a hybrid approach to the teaching of this module, aimed at strengthening students' distance learning skills while encouraging the regular adoption of this teaching modality. Adopting a flipped classroom model for this course, face-to-face sessions are dedicated to practical work and interactive exercises with teachers. At the same time, course materials, videos and online quizzes are available on the Moodle platform, enabling students to work at their own pace from home, This implies that learners require more remote assistance and supervision in order to effectively support them in their independent learning process.Furthermore, our choice of this sample is justified by the fact that it represents a significant part, given that the module is taught in all Moroccan institutions, across all disciplines [2].

Continuing on from our initial comparative study, which revealed that Moodle is the most appropriate online assessment platform for implementing a Personalised Revision Exam (PER) plug-in, we then chose to reinforce our study with the support of a questionnaire centred on the student in order to better understand their expectations and measure their acceptance or resistance to this new assessment tool [3, 4]. Our aim in this paper is to uncover and predict students' preferences and acceptance of adaptive revision in Moodle, a topic not covered in existing work [5–7]. To deepen our understanding of students' needs, we designed a questionnaire to explore their expectations of adaptive revision and to assess their experience of learning in Moodle. Based on recognised theoretical models such as UTAUT, Technology Acceptance Model (TAM), and Kano, the authors developed a conceptual model adapted to our research context. This conceptual model made it possible to identify the key variables and the potential relationships between them. Based on this model, we devised a structured questionnaire designed to measure and validate the dimensions and hypotheses pre-defined in the model. In the analysis part of the questionnaire, we used techniques such as Principal Component Analysis (PCA), Natural Language Processing (NLP) and the K-means clustering algorithm to identify specific insights. These methods have enabled us to highlight the key factors influencing student satisfaction and learning effectiveness on Moodle.

Our results show that students particularly value intuitive features, content that is constantly updated and adapted to their progress, and continuous access with online support. By better understanding these expectations and needs, we will take them into account in improving the Moodle platform to offer a more engaging and effective exam preparation experience, thereby increasing student satisfaction and academic performance.

This paper is structured in several complementary sections following the IMRAD methodology. In the first part, a theoretical framework is proposed to contextualise and support the problem studied, followed by the design of the conceptual model, which will constitute the underlying architecture of our approach. This is followed by a presentation of the questionnaire, developed using the Kano approach. The third section's methodology describes how the

questionnaire was posted online and how the data was gathered. Analyzing and discussing the findings, with an emphasis on understanding the replies received, constitute the final phase.

II. Methodology

A. Theoretical Foundations and Proposed Conceptual Model

In the field of information and communication technologies, several theoretical models have been developed to understand and predict the acceptance and use of information systems [8]. Among these, the Technology Acceptance Model (TAM), developed by Davis in 1989, explains how users come to accept and use a technology, based on Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) [9]. This model has been extended by TAM2 and TAM3 to include social and cognitive variables and user expectations [10]. The UTAUT (Unified Theory of Acceptance and Use of Technology) model, proposed by Venkatesh *et al.* in 2003, unifies several theories of technological acceptance by identifying four main determinants: expected performance, expected effort, social influence and facilitating conditions [11]. UTAUT has also been adapted into UTAUT2, mUTAUT, and finally UTAUT-Education to study the adoption of e-learning technologies [12]. While UTAUT is capable of predicting the adoption of a technology, the Kano model, developed by Noriaki Kano in 1984, explores user satisfaction by categorizing the quality attributes of a product or service, distinguishing between basic, performance, attractive, neutral and reverse attributes [13, 14]. Finally, DeLone and McLean's model (1992, updated in 2003) measures the success of information systems along six dimensions: system quality, information quality, service quality, use, user satisfaction and net impact [15]. Natural Language Processing (NLP) is a branch of artificial intelligence that enables the analysis and understanding of textual data. In our study, NLP was used to extract key information from students' text responses, providing detailed insights into their preferences and expectations [16, 17]. In addition, the K-means clustering algorithm was employed to analyze and interpret the data, identifying significant groupings in the students' responses [18, 19].

The design of our conceptual model is based on an integrative approach combining TAM, UTAUT, DeLone & McLean and Kano's model in order to obtain a comprehensive view of student acceptance and satisfaction with an adaptive revision plug-in for Moodle [20]. This combination, far from being arbitrary, is based on existing work which has already explored the integration of these models, each adapting them according to its specific needs [21]. We used a composite method rather than a single theoretical model, choosing the most pertinent dimensions from a number of reference models, such as the DeLone & McLean model, TAM, and UTAUT.

In our approach, we have brought these models together within a unified framework, selecting the most relevant dimensions to simultaneously analyse the plug-in's adoption, satisfaction and pedagogical impact. As illustrated in the representation below (Fig. 1), this hybrid structure enables a more thorough analysis that is customized to the goals of our educational plugin.

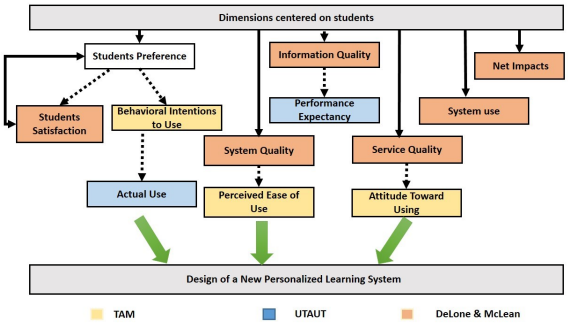


Fig. 1. Architecture of the conceptual model.

B. Elaboration and Administration of the Questionnaire

The conceptual model that results from this questionnaire is structured for analyzing the quality and impact of an online revision system such as Moodle during the 'Digital Skills' course. It makes it possible to collect accurate data on expectations, the student experience and user satisfaction levels, which are essential for improving and adapting the services offered by the platform.

Based on the quality dimensions of the DeLone and McLean model, its questions are formulated to measure student preferences, satisfaction, use of the system, and perceived net impacts which are presented in Table 1. The questions on students preferences examine expectations regarding the frequency and type of revision content. Questions on system and information quality use the Kano model to assess how different levels of performance and relevance affect satisfaction. Service quality is also examined using the Kano model, focusing on continuous access to the platform and online support. The questions on use of the system and satisfaction are inspired by a Likert scale, measuring the degree of satisfaction gradually. Finally, the 'Net Impacts' dimension assesses the effects of online assessments on autonomy, skills acquisition and the development of Information and Communication Technology (ICT) skills. The results are analysed using techniques beginning with Natural Language Processing (NLP), the Kano model, Principal Component Analysis (PCA) and the K-means method to strengthen the results by grouping the data.

For the Kano-type scale, the possible responses will be organised in five-level Likert scales, with options ranging efrom 'I would be very satisfied' to 'I would be very dissatisfied', passing through degrees of indifference or acceptability for the first four McLean & Delone dimensions [22]. For the last three dimensions, the choices vary from "Strongly disagree" to "Strongly agree" in Likert, allowing respondents to position themselves in a neutral situation.

- Posting the questionnaire online: Sampling and collecting responses:

After validation, the questionnaire link was administered to students at three institutions belonging to Chouaib Doukkali University (Faculty of Science, Faculty of Letters and Humanities, and Faculty of Legal, Economic and Social Sciences) during the second semester. The collection of responses lasted approximately one month.

Table 1. Questionnaire structure (DeLone and McLean quality dimensions)

Questionnaire Structure	Questioning Method	Survey Item	Analysis Method
User Preference / Intention to use		Approaching exams, would you be interested in a revision session on Moodle?	
		How often would you like the platform to offer revision sessions?	
		What type of revision content would you prefer to receive from the plug-in?	
		What revision resources do you consider essential to reinforce your preparation?	
		If you could add a revision method or feature, what would it be?	NLP
A /System quality	Kano	How would you react if an adaptive revision tool on Moodle was extremely easy to use and always worked reliably without errors?	Kano
		If the adaptive revision tool on Moodle was not easy to use and often encountered errors, how would this affect your satisfaction?	
B/Information Quality		How would you react if an e-learning tool offered you revision content that was not only relevant but also constantly updated and adapted to your progress?	
		If the e-learning tool didn't offer you revision content that was relevant, up-to-date or adapted to your progress, how would this affect your satisfaction?	
C/Service quality		How would you react if you had continuous access to Moodle for revision, with full online support available at every stage of your learning?	
		How satisfied would you be if you didn't have continuous access to Moodle for revision, nor online support available?	
System use		I use Moodle for assessing my online learning.	Principal Component Analysis & K-means
		I rely on Moodle's online assessment tools to gauge my learning progress.	
		I use online assessment tools (quizzes, assignments, etc.) on Moodle to progress and develop my skills.	
User satisfaction Inspired by Edward Diener's Life Satisfaction Scale		Generally, I am satisfied with how Moodle facilitates my learning.	
		The conditions for taking online assessments are excellent.	
		I am satisfied with the features and resources available on Moodle for my studies.	
		So far, I find that Moodle has played a positive role in my educational journey.	
		If I had other assessment options, I would still choose Moodle's assessment techniques.	
Net Impacts		This type of online assessment has allowed me to increase my autonomy and self-regulation.	
		This type of online assessment has improved my learning process.	
		During the online learning assessment, I was able to acquire the skills I targeted at the beginning of the course.	
		Online learning assessment has allowed me to develop my skills at my own pace	
		I had the opportunity to familiarize and develop my ICT knowledge.	

The majority of respondents are from the Faculty of Letters and Humanities, representing more than half of the participants in this survey (Table 2). This high level of participation can be explained by the fact that the survey was administered directly to our digital Skills students in this faculty, which probably encouraged their active and motivated participation.

Table 2. Distribution of students by faculty

Faculty	Frequencies	Percentage
Faculty of Sciences	16	7.5 %
Faculty of Arts and Humanities	112	52.6 %
Faculty of Law, Economics, and Social Sciences	85	39.9 %

- Evaluation of experiences and obstacles:

In terms of using Moodle for the "Digital Culture" course, the most frequently reported answers range from "Very often" (26.3%, or 56 students) to 'Always' (22%, or 48 students). The main obstacles faced when using Moodle are technical problems, such as slow loading and bugs, as well as interface and usability problems.

- Identification of preferences and expectations:

183 students, or 86.7% of the total, answered "Yes" to express their interest in revision sessions on Moodle, in particular "After each class session" or "Just before exams". The most popular types of revision content are videos and summarized texts. Revision resources deemed essential include adaptive practice tests and personalized content suggestions. Suggestions for improvement include ideas such as creating lesson summaries in the form of mind maps, demonstrating an interest in varied and interactive revision methods.

C. NLP Analysis of Learner Preferences for Revision Functionalities

The aim of this analysis is to identify students preferences for different revision features. The question: If you could add a revision method or feature, what would it be? was analysed using Natural Language Processing (NLP) extract what the students were able to express freely in this open question. After pre-processing the data (cleaning, removal of stopword lemmatisation),a lexical and thematic analysis was carried out to identify recurring keywords and the main subjects covered.To guarantee data consistency, replies were cleaned to exclude special characters and changed to lower case, as seen in Fig. 2. To eliminate redundant terms and concentrate the study on the most pertinent phrases, we employed stop word lists for Arabic, French, and English. The most common words in user responses were found using the "CountVectorizer" method. The responses were then divided into five primary categories: "Mental Map," "Summary," "Revision Feature," "SEO Optimization," and "Other" by means of the 'categorize_response' function. These results provide a better understanding of the trends and opinions expressed by the students.

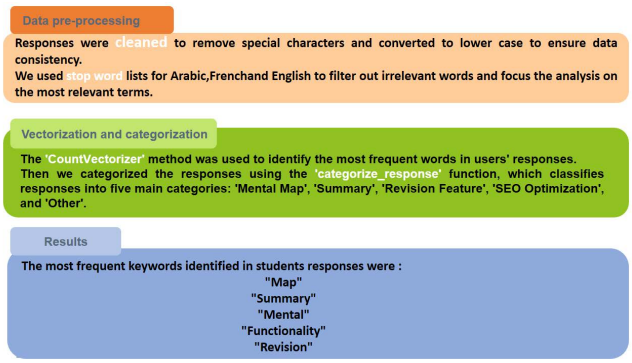


Fig. 2. Diagram illustrating the three main steps : (a) data preprocessing, (b) vectorization and categorization, and (c) frequent keyword identification.

The keywords as depicted in Fig. 3 demonstrate the most frequent terms after cleaning and removing stop words. The graph below in Fig. 4 illustrates the distribution of user responses across the different categories.

Fig. 3. Word cloud representing frequent keywords.

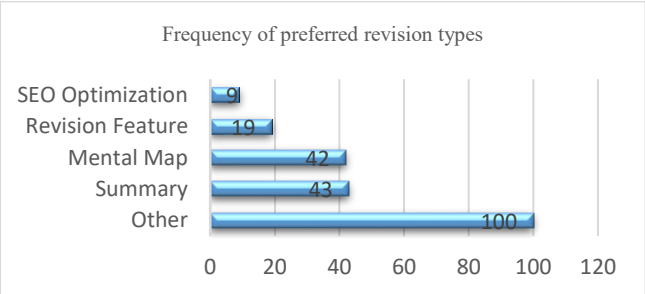


Fig. 4. Distribution of student responses by category.

Keyword analysis reveals that users show a marked interest in mind maps and summaries, perceived as effective methods for revision. Furthermore, category analysis shows that the "Other" category contains the highest number of responses, indicating a diversity of unique preferences and suggestions. The "Summary" and "Mental Map" categories are also popular, suggesting that many users value these features for their studies.

- **Questionnaire reliability**: In order to examine the internal consistency of the different groups of items and to guarantee the robustness of the results obtained, this section is devoted to assessing the reliability of the questionnaire [23]. Table 3 provides a summary table of Cronbach's alphas for the different questionnaire groups:

Table 3. Cronbach's alpha values for different groups

Group	Cronbach's α
Faculty of Arts and Humanities	0.871
Faculty of Sciences	0.873
Faculty of Law, Economics, and Social Sciences	0.828

Cronbach's alphas indicate good internal consistency. As the values obtained for the different groups are all above 0.8, they testify to good internal reliability [24], suggesting that the questionnaire questions are indeed measuring the same concept within each group.

III. Result and Discussion

After cross-tabulating the responses (positive and negative forms) for each item to place it on the KANO matrix. The Table 4 presents the link between the responses and the significance of the different combinations.

Table 4. Kano matrix for decoding question results

Functional	Dysfunctional				
	Like	Expect	Neutral	Accept	Dislike
Like	Q	A	A	A	O
Expect	R	I	I	I	M
Neutral	R	I	I	I	M
Accept	R	I	I	I	M
Dislike	R	R	R	R	Q

Note: **A**: "Attractive Quality", **M**: "Must-be Quality", **R**: "Reverse Quality", **O**: "Onedimensional Quality", **Q**: "Questionable or contradictory answer", **I**: "Indifferent Quality".

By categorising all the attributes with the aggregating frequencies, it appears that the indifferent category (I) dominates the majority of the frequencies among all the categories, with a marked presence in all the questions proposed. This observation can be justified by several factors :

1) Given that this was the first experiment in Morocco in hybrid teaching of digital Skills, after the COVID experiment, it is estimated that most of the students among the respondents, their attention seemed to be focused more on the running of the course and were not interested in revision [25].
2) In addition, this situation can also be explained by the fact that it was difficult for the students to be 'coherent' in responding to the functional and dysfunctional characteristics of the e-learning system at the same time, so the easiest thing for them to do was to be 'indifferent'.

To do this, we ignored the "indifferent" responses that are in the majority (these numbers are put in brackets) for all three items, and concentrated on the second and third most frequent responses as being rather indicative.

As presented in the Table 5 the responses reveal a dominance of the "One-dimensional" category for all three attributes (system quality, information quality and service quality). This underlines the fact that ease of use, reliability, content relevance and continuous access are perceived as performance factors. The more these aspects are improved, the more satisfaction increases; conversely, a drop in performance leads to overall dissatisfaction. In addition, the significant presence of the "A" category represents an opportunity to better surprise and satisfy another sample of students.

Table 5. Results of the kano survey

Dimensions	N° Item	A	M	O	R	Q	I	Total	Category	Satisfaction coefficient (S) = $\frac{A+O}{A+O+I+M}$	Dissatisfaction coefficient $(DS) = \frac{-(M+O)}{A+O+I+M}$	Overall Satisfaction Index (OS) = S+DS
Quality system	A	**32**	20	**52**	26	17	**(66)**	213	O	0.494	−0.42	0.071
Information Quality	B	**28**	31	**39**	25	15	**(75)**	213	O	0.387	−0.40	−0.017
Service quality	C	**30**	22	**58**	23	13	**(67)**	213	O	0.497	−0.45	0.045

The next step after the categorization of quality attributes is to assess the influence of quality attributes on students'

overall satisfaction with online revision.

A first satisfaction index (S), also called Best, evaluates satisfaction when the service meets the requirement. It is calculated by dividing the sum of people who rated the requirement as Attractive (A) and Onedimensional (O) by the total number of people who rated the requirement as Attractive (A), Onedimensional (O), Must-be (M) and Indifferent (I).

A second index, called Dissatisfaction (DS), also known as "worst case", indicates the extent to which customer satisfaction deteriorates when functionality is not guaranteed.

The overall satisfaction index is the sum of the satisfaction and dissatisfaction indices.

The satisfaction coefficient scale ranges from 0 to 1, the dissatisfaction coefficient from −1 to 0, and overall satisfaction from −1 to 1.

The satisfaction indices for the three dimensions as shown in the Fig. 5 provide an in-depth understanding of students' needs and expectations for an adaptive revision tool on Moodle. Service quality has the highest satisfaction index (0.497), indicating that continuous access to Moodle and comprehensive online support are highly valued, although their absence results in moderate dissatisfaction (−0.045). System quality follows with a satisfaction index of 0.494, showing that ease of use and reliability are also crucial, without causing great dissatisfaction in the event of a fault (−0.042), and with an overall satisfaction of 0.071. Information quality, while benefiting from a lower satisfaction index (0.387), remains important, as relevant and up-to-date content is appreciated, but its absence leads to only low dissatisfaction (−0.040), although some students may be dissatisfied, reflected in a slightly negative overall satisfaction (−0.017). To maximize overall student satisfaction, the development of the adaptive revision plug-in must therefore prioritize continuous access and online support, followed by the system's reliability and ease of use, as well as the quality and relevance of the content offered.

Fig. 5. The coefficients of Customer Satisfaction (CS) and Customer Dissatisfaction (CDS).

In summary, the Kano method emphasizes that it is essential to focus on these three essential aspects when developing our revision plug-in for Moodle so that it is well aligned with students' expectations and needs.

1) According to item A :(Quality System), **Ease of use and reliability** are primordial: Ensure that the plug-in is intuitive and works without error to maximize satisfaction.
2) According to item B: (Information Quality), **Relevant and personalized content** is also a priority: Offer revision content that is constantly updated and adapted to each student's progress.
3) From item C: (Service Quality) **Continuous access and online support** is crucial: Guarantee permanent access to Moodle and offer comprehensive online support to help students throughout their revision process.

Finally, the significant presence of category A students in our study highlights an opportunity to positively surprise another sample of students, by anticipating their expectations and proposing targeted improvements to the service. Thus, our results not only confirm the trends observed in the literature, but also offer a complementary perspective by emphasising the importance of a differentiated approach to optimising the student experience and encouraging their adoption of learning technologies.

A. Factor Analysis of Model Dimensions via PCA

Principal Component Analysis (PCA) is a technique for synthesizing information when there are **d** quantitative variables and **n** individuals [26]. It is very useful when there is a large amount of quantitative data to be processed and interpreted. The aim of this data analysis phase is to identify the interrelationships between the variables in the proposed model. At this stage, the focus is on reducing the data and identifying the relationships between the variables.

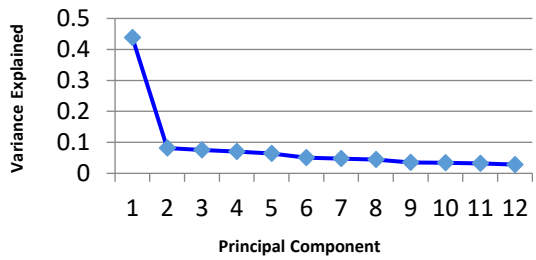


Fig. 6. Elbow diagram.

The elbow diagram as illustrated in the Fig. 6 shows the proportion of variance explained by each principal component and the "elbow" point justifies the choice of the most appropriate k. The first Principal Component (PC1) explains 43.78% of the total variance, followed by the second principal component (PC2), which explains 8.11% of the variance. The following components explain decreasing portions of variance.

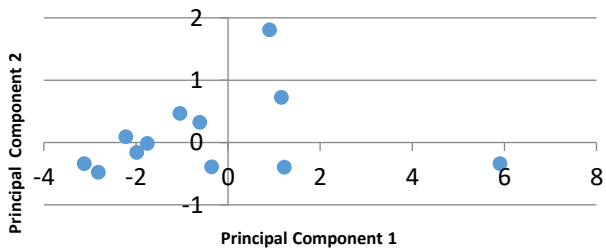


Fig. 7. PCA biplot.

The PCA biplot (Fig. 7) visualizes the projection of individuals onto the first two principal components (PC1 and PC2). The points represent student responses, and their relative positions indicate similar or different response patterns. The correlation matrix's eigen-decomposition provides the raw data, and the graphic helps in the interpretation of the variables' roles as well as the grouping of observations.

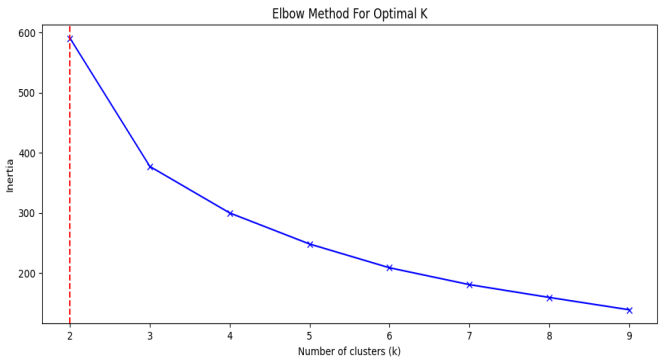
The first principal component (PC1 = 43.78%) can be interpreted as an overall measure of Moodle satisfaction and

effectiveness, reflecting students' perceptions of the ease of use of the platform, satisfaction with the features and resources offered, and the positive impact on their educational journey. In parallel, the second main component (PC2 = 8.11%) focuses on more specific aspects related to the impact of online assessments, capturing how these assessments contribute to students' autonomy. It is influenced by questions concerning learning enhancement and autonomous regulation. This component highlights the importance of online assessments in enabling students to progress at their own pace while developing ICT skills.

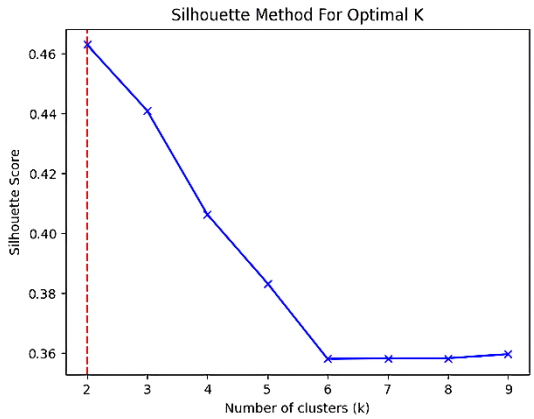
B. *Application of the K-means Algorithm*

The hybrid technique of using Principal Component Analysis (PCA) upstream of the K-means algorithm is an approach that has been largely validated in the literature, combining statistical rigour and interpretability. By reducing the dimensionality of the data while preserving its informative structure, it improves the quality of the clustering by optimising the separation of the groups and facilitating the interpretation of the results.

The aim of this approach is to apply K-means to data projected into the space of principal components (PC1 and PC2), thereby enabling more relevant and exploitable segmentation. The silhouette illustrates in Fig. 8 score assesses the quality of clusters regarding their cohesiveness and separation.



(a)



(b)

Fig. 8. (a) Silhouette method for optimal K, (b) elbow method.

The joint analysis of the validation methods, in particular Elbow and Silhouette (Fig. 8), indicates that the optimal number of clusters is $k = 2$ for Moodle users.

The K-Means graph in Fig. 9 shows the results of clustering on the first two principal components (PC1 and PC2). Two distinct clusters are visible, each one in the reduced PCA space is represented by a different color. Cluster centroids represented in red are well separated, indicating good cluster separation in this reduced space.

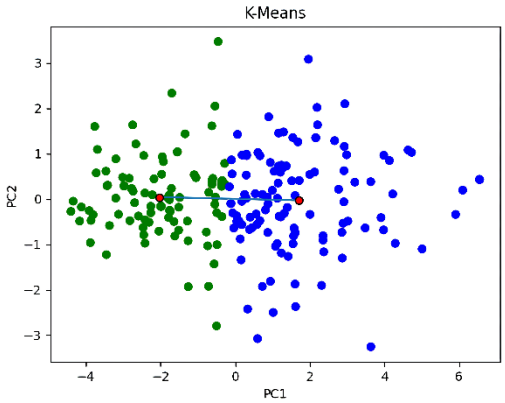


Fig. 9. K-means clustering.

- The green cluster (lower averages): The respondents in this cluster use Moodle less frequently for assessment their learning. They are generally less satisfied with the way Moodle facilitates their learning, and find that they acquire the targeted skills less often. In addition, they perceive fewer opportunities to develop their ICT skills. This situation may be attributed to a lack of familiarity or confidence with the platform, requiring efforts to improve engagement and regular use of Moodle.
- The blue cluster (Upper-middle averages): Respondents in this cluster are highly engaged and use Moodle for various evaluation and monitoring activities. They express a high level of satisfaction with the platform, stating that it facilitates their learning and helps them develop their skills at their own their own rhythms. They have also had more opportunities to develop their ICT skills. This group values Moodle's current features, and their feedback can guide future improvements to keep their satisfaction.

IV. Conclusion

Ensuring the acceptance of a technology among a target audience, particularly higher education students, is essential before undertaking any educational technology initiative. Furthermore, the revision period is an essential component of formative assessment and a critical step in an applicant's success. Students are frequently under a lot of stress and pressure during this era. They will therefore select easy-to-use, intuitive, and less stressful revision tools, which will promote more efficient and calm learning. This study has developed an exhaustive conceptual model, based on a panoply of leading theoretical models in the field of human-computer interaction and technology acceptance, such as DeLone and McLean's model. By capturing the expectations and satisfaction levels of users via a questionnaire. Exploiting the results, we are confident that we are on the right path in the development of an adaptive revision plugin. Based on these results, it is crucial to focus on three main aspects to meet the specific needs of students and improve their online learning experience. Firstly, the plugin should improve overall student satisfaction by making revision more interactive and adapted to their specific needs. Secondly, it

should help students to self-regulate their learning and develop their autonomy by offering personalised feedback and revision plans tailored to their progress and congnitif level. Finally, the plugin should incorporate tools and resources that help students to develop their ICT skills and improve their learning process on an ongoing basis. By focusing on these aspects, the adaptive revision plugin will make a significant contribution to optimizing student satisfaction and academic performance on the Moodle platform, thereby highlighting the positive impact of our research work.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

The contribution for each author in this research is as follows: Conceptualization, methodology, validation, formal analysis, analysis, investigation, data curation, writing-original draft preparation done by 1th author, supervision, writing-review & editing, have been done by 2nd and 3rd author. All authors had approved the final version.

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