

Exploring Factors Influencing Students' Attitudes and Engagement in Duolingo-Based Mobile-Assisted Language Learning Using Decision Tree Analysis

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Abstract

This study investigates the factors influencing students' attitudes toward and engagement with using Duolingo as a Mobile-Assisted Language Learning (MALL) platform. While previous research has primarily applied linear models such as the Technology Acceptance Model (TAM), limited studies have explored non-linear relationships among learner perception variables using rule-based analytical approaches. To address this gap, this study employs Decision Tree analysis to examine how perceived usefulness, perceived ease of use, and learning motivation influence students' attitudes toward using Duolingo. Data were collected in 2024 from 102 undergraduate Business Administration students through an online Likert-scale questionnaire. The J48 decision tree algorithm was applied to identify hierarchical decision rules and key predictor combinations explaining students' attitudes toward application use. The results indicate that perceived usefulness is the most influential factor affecting learner attitudes, followed by ease of use and learning motivation. The model achieved an overall classification accuracy of 80.2%, with a Kappa coefficient of 0.6485, indicating substantial agreement. The findings provide insights for educators and application developers in designing more effective mobile language-learning environments that enhance student engagement and motivation.

Keywords: Decision Tree, Mobile-Assisted Language Learning (MALL), Duolingo, Perceived Usefulness, Learning Motivation

Introduction

Recently, mobile applications have played a significant role in helping people learn new skills and knowledge. Language-learning apps have become very popular because they are easy to use, interactive, and fun. In mobile-assisted language learning, learners can study anytime and anywhere by using smartphones or tablets. Duolingo is an example of this kind of learning tool. Studying a second language is very important in today's world of globalization and international communication. For university students, studying a new language through mobile applications can help them improve

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their studies and prepare for future careers. However, the most important success factors of these apps depend on students' attitudes, motivation, and how often they use these apps. Therefore, it is important for teachers and app developers to understand what psychological and technological factors affect students' use of such applications. (Nushi & Egbali, 2017) Studying a language remains a crucial component of education, especially within the context of globalization and the growing need for effective international communication. For university students, mobile applications give the opportunity to acquire a new language through digital tools to enhance academic potential and contribute to future career advancement. However, learners' attitudes, levels of motivation, and perceptions of usefulness are the key factors for successful learning. Therefore, understanding the psychological and technological factors influencing students' acceptance and sustained use of such applications has become an important issue for both educators and application developers. Many scholars applied the Technology Acceptance Model (TAM) to examine users' acceptance of technology in previous research. (Fan, 2023) According to TAM the two motivational determinants (namely, perceived usefulness (PU) and perceived ease of use (EOU)) determine users' attitudes towards technology that subsequently impact their behavioral intention and actual usage. In terms of language learning apps, some recent works have extended the TAM model for analyzing learners' involvement with Mobile-Assisted Language Learning (MALL) tools.

For instance, studies adopting Technology acceptance model (TAM) have found that perceived ease of use, perceived usefulness and motivation are the major predictors of behavioral intention and technology adoption in e-learning context Likewise, findings from research on Duolingo have evidenced learners' vocabulary improvements along with enhanced motivation and self-regulation in mobile-assisted language learning. (Loewen et al., 2019) In light of these results, the present study seeks to examine how these major predictors are interrelated and as such related to learner attitudes towards Duolingo. The underlying technique for the analyses performed in this study is Decision Tree analysis, which allows identification of key factors and their hierarchical relationships in influencing learner attitudes as well as involvement. Compared to regular regression or SEM methods, Decision Tree algorithms have the ability to detect non-linear relationships and meanwhile generate explanatory rule-like structures that enhance our understanding of learner behavior in sophisticated learning environments (Wang, 2021; Song & Wang, 2025). This strategy has been successfully implemented in MALL studies to forecast learner performance, engagement and target word difficulty - while maintaining interpretability of the predictions from a pedagogical point of view- (Matzavela et al., 2021). In particular, the effect of Perceived Ease of Use (EOU), Perceived Usefulness (PU), and Learning Motivation (MOT) on students' attitude toward using Duolingo is investigated in this research. By uncovering the critical action rules of

learner engagement, this study offers empirical evidence in favor of Duolingo regarding its motivational design as a digital language learning platform. It is anticipated that the findings of this study will inform MALL research, educators and developers in the design of more effective user experience (UX) for adaptive data-driven learning systems.

Objective

1. To explore the factors influencing students' attitudes and engagement toward using Duolingo as a Mobile-Assisted Language Learning application.
2. To examine how perceived usefulness, perceived ease of use, and learning motivation influence students' attitudes toward using the application.
3. To identify hierarchical decision rules and key predictor combinations that explain students' Attitude Toward Use (ATT) toward Duolingo using a decision-tree model.
4. To apply Decision Tree analysis to identify hierarchical decision rules and key predictor combinations that explain students' attitudes toward Duolingo-based language learning.

Literature review

The researcher has conducted an extensive study, reviewing textbooks and relevant documents covering the following topics:

2.1 Mobile-Assisted Language Learning (MALL) and Duolingo Mobile-Assisted Language Learning (MALL) has become an important approach to second language learning, using mobile devices like smart phones and PDAs for flexible and self-paced learning. Of MALL tools, Duolingo is one of the most popular applications which offer gamified practices, immediate feedback and adaptive learning paths to enhance vocabulary learning and learner engagement (Nushi & Eqbali, 2017; Ajisoko, 2020). Studies have indicated that incorporating interactivity to support independent learning is helpful for enhancing motivation, satisfaction, and effectiveness of the learners using mobile applications. (Shortt et al., 2021).

2.2 Technology Acceptance Model (TAM) Technology Acceptance Model (TAM) has been commonly used to investigate user acceptance of information technology applications, in terms of educational software. TAM suggests that Perceived Usefulness (PU) and Perceived Ease of Use (EOU) play a critical role in forming individuals' attitudes toward technology, thereby affecting their behavioral intention and subsequent usage behavior. (Granić & Marangunić, 2019) Many educational studies have adopted the TAM to evaluate learners' acceptance of m-learning applications, and have confirmed that higher PU and EOU make users form more positive attitudes and generate further intention to use the application proliferously. (Ibrahim et al., 2018; Ajisoko, 2020; Abuhassna et al., 2023)

2.3 Perceived Usefulness (PU) Perceived Usefulness describes the extent to which a user feels that using a kind of technology improves their performance. As for language learning, PU represents learners' belief in how Duolingo enhances the linguistic ability and vocabulary acquisition, and how it facilitates the learning efficiency. Research indicates that increased perceptions of PU correlates positively with positive AT toward and use of educational technologies, such as MALL tools. (Tahar et al., 2020).

2.4 Ease of Use (EOU) Ease of Use is a measure of how easy it is believed to be to use a technology. In TAM, EOU not only lead to affect users' attitudes directly but also indirectly serve as a determinant of their behavioral intention via PU (Davis, 1989). Intuitive interface design, ease of use and accessibility for features in language learning applications can promote greater EOU in mobile device interfaces, which enhances learners' involvement and hampers their impediments to learn. (Natasia et al., 2022)

2.5 Learning Motivation (MOT) As a vital element for the success of language learning, the importance of MOT is widely acknowledged. Motivation is a *sin qua non* of learners' persistence, activeness and orientation in learning. Within the framework of Mobile-Assisted Language Learning (MALL), apps, such as Duolingo, have made use of the concepts underlining gamification points and streaks with virtual rewards aimed at increase intrinsic and extrinsic motivation among learners (Nushi & Eqbali, 2017). These characteristics motivate and support sustained engagement and practice, turning monotonous language exercises into enjoyable gaming experiences. The impact of motivation on learners' attitudes, satisfaction and general learning outcome in digital learning environments has been established by earlier studies (Loewen et al., 2019). Based on these findings, the present research highlights that motivation is a crucial predictor of students' engagement and attitudes toward Duolingo. By the use of Decision Tree analysis, the investigation aims to find the manner in which different level of learning motivation combine with perceived usefulness and ease of use in order to predict learner overall engagement patterns. It is thus important to have a basic understanding of the hierarchical nature of motivational influences so that developers and teachers may derive practical implications for enhancing the design of gamified learning activities to sustain mobile language learners' interest.

2.6 Attitude Toward Use (ATT) Use Attitude is associated with the general attitude, in a positive or negative sense, that learners have toward using a technology. Attitude functions as intermediary from behavioral intention or use behavior in TAM and its derived studies. For those who are learning with Duolingo, attitude might be three components: perceived enjoyment, perceived usefulness, and intention to recommend this app to friends in the future for ongoing use and learning. (Mailizar et al., 2022)

3. Previous Research

Many studies have explored learners' perceptions of mobile-assisted language learning (MALL) applications and their adoption drivers. These studies also yield valuable empirical evidence that can be used to gain insights into the constructs of our study such as Perceived Usefulness (PU), Ease of Use (EOU), Learning Motivation (MOT) and Attitude Toward Use (ATT).

3.1 Duolingo and Language Learning Nushi and Egbali (2017) examined Duolingo as a second language learning mobile app. Their research indicated that the gamified design, immediate feedback, and user-friendly environment of Duolingo highly motivate users to learn. In the same way, Shortt et al (2021) investigated students' attitudes towards Duolingo for learning English vocabulary, noting that the app increased motivation, interest in learning and independent practice. These studies highlight that educational apps can offer a fruitful learning experience if they include interactive and adaptive features.

3.2 Technology Acceptance and TAM in Education The technology acceptance model (TAM) has been extensively used to account for learners' acceptance of educational technologies. TAM was first developed by Davis (1989) and suggests that Perceived Usefulness (PU), and Perceived Ease of Use (EOU) have an effect on users' attitudes which affect their behavioral intention. Mailizar et al., (2021) expanded TAM, and empirically validated these relationships in different contexts through longitudinal studies. In a similar vein, Tahar et al., (2020) in recent study employed TAM to mobile learning and concluded that perceived usefulness (PU) and EOU significantly influence students' attitudes toward continued use in the higher educational environment.

3.3 Learning Motivation and Attitude Success in language learning is to a great extent dependent upon motivation. Wisnuwardhani (2022) claimed that intrinsic motivation, integrative motivation and learner's interest could affect the learning. For mobile-assisted language learning, gamification elements (e.g., points and streaks) in applications can raise learner motivation and influence attitudes toward the application. (Nushi & Egbali, 2017) Ajisoko (2020) also pointed out that cultural differences, as well as personal differences, can shape attitudes in respect of MALL tools however the role of motivation seems to be significant for adoption and sustained use.

3.4 Empirical Studies Using Decision Tree Applications in Mobile-Assisted Language Learning (MALL)

Recent studies in Mobile-Assisted Language Learning (MALL) have utilized more and more data-driven approaches to personalize learning and enhance learner achievement likelihood. The most popular of these are the decision-tree algorithms, which are attractive for their interpretability as well as due to the performance on complex learner data. Wang (2021) applied a decision-tree model to evaluate the

complexity of English words in an aided learning system, according to which teachers can automatically tailor educational materials based on learner's behaviour. This provided an illustration that decision-tree rules could be used to predict vocabulary difficulty levels in an accurate manner but also provide transparency of information for teachers. A follow-up deployment was described in a journal publication in *Wireless Communications and Mobile Computing* (2021) to additionally validate the algorithm's support for adaptive and explainable learning interventions. Song and Wang (2025) further advanced this method by constructing an improved decision-tree model for predicting the difficulty of vocabulary learning and automatically provide tutoring in accordance with that. They found that learning outcomes were significantly better when adaptive instruction used model-based predictions.

Apart from the previous examples, other research has used decision trees in more general MALL situations. For example, the Conference Proceedings of Science and Information (SAI) (2024) compared various machine learning classifier on predicting learner performance in mobile reading tasks, and found that simple decision tree model achieves better accuracy with more interpretable results when compared with complex ensemble models. Likewise, work in affective learning has also used decision tree models to recognize learners emotions and engagement states for delivering motivational feedback on the go. (Matzavela et al., 2021; Pearlin & Gnana, 2024) Throughout the empirical work described here, decision-tree algorithms are repeatedly found useful for trading off accuracy against pedagogical transparency—a crucial factor in educational technology. As a result, the incorporation of decision-tree models into MALL environments may increase personalization, while also offering educators actionable and interpretable feedback to support evidence-informed teaching.

A Summary of Previous Research on Mobile-Assisted Language Learning and TAM, along with a table presenting the key information is as following;

Table 1 Summary of Previous Research on Mobile-Assisted Language Learning (MALL) and the Technology Acceptance Model (TAM)

Author(s) & Year	Purpose / Focus of Study	Method / Model Used	Key Findings / Contributions
Abuhassna et al. (2023)	To analyze trends in applying the Technology Acceptance Model (TAM) for online learning.	Bibliometric and content analysis.	Found that TAM remains the most influential framework for studying user acceptance in online and mobile learning; highlighted growing research interest in integrating psychological and technological variables.

Author(s) & Year	Purpose / Focus of Study	Method / Model Used	Key Findings / Contributions
Ajisoko (2020)	To investigate the use of Duolingo to improve English vocabulary learning.	Experimental design using Duolingo app.	Results showed significant improvement in students' English vocabulary; Duolingo was effective in promoting motivation and self-learning.
Fan (2023)	To explore English learning motivation and behavioral intention to use Chinese social media for English learning using TAM.	TAM integrated with motivation constructs.	Perceived usefulness, ease of use, and motivation significantly influenced behavioral intention toward language-learning platforms.
Granić & Marangunić (2019)	To review how TAM has been used in educational contexts.	Systematic literature review.	Confirmed TAM's robustness across educational technologies and suggested extensions including social and contextual factors.
Ibrahim et al. (2018)	To evaluate acceptance of e-learning among university students.	TAM framework applied via survey.	Both perceived usefulness and ease of use were significant predictors of e-learning acceptance.
Mailizar et al. (2021)	To analyze teachers' behavioral intention to use e-learning in mathematics education.	Extended TAM model (with attitude and facilitating conditions).	Found strong support for TAM constructs; motivation and external support also influenced adoption.
Natasia et al. (2022)	To study user acceptance of the NUADU e-learning platform.	TAM-based quantitative analysis.	Demonstrated that perceived usefulness and ease of use influenced intention to use; suggested system improvements.
Nushi & Eqbali (2017)	To review Duolingo as a mobile application for second-language learning.	Qualitative app review.	Concluded that Duolingo supports self-paced learning, vocabulary retention, and learner engagement.
Shortt et al. (2021)	To review literature on Duolingo and gamified MALL from 2012–2020.	Systematic review of published studies.	Found that Duolingo's gamification enhances motivation, engagement, and autonomous learning but may lack deep grammar instruction.
Tahar et al. (2020)	To test TAM constructs and technology readiness in e-filing adoption.	Extended TAM with security and readiness factors.	Perceived usefulness, ease of use, and security positively influenced intention to use digital systems.

Author(s) & Year	Purpose / Focus of Study	Method / Model Used	Key Findings / Contributions
Wisnuwardhani (2022)	To examine instrumental and integrative motivation in English learning outcomes.	Quantitative correlational study.	Both motivation types significantly affected English learning outcomes, highlighting the importance of motivation in language learning.

Despite the growing body of research on Mobile-Assisted Language Learning (MALL), most existing studies rely primarily on linear statistical models such as regression analysis or Structural Equation Modeling (SEM). While these approaches are useful for examining direct relationships among variables, they may not fully capture the complex and non-linear interactions that influence students' attitudes toward mobile learning applications. Limited research has applied rule-based machine learning approaches, such as Decision Tree analysis, to explore hierarchical relationships among learner perception variables in MALL environments. Therefore, this study applies a Decision Tree model to identify key predictor combinations that explain students' attitudes toward using Duolingo. Furthermore, Business Administration students were selected as the target population because language proficiency is increasingly important in global business communication, international collaboration, and digital commerce. Understanding how these students perceive and engage with mobile language-learning tools can provide valuable insights for integrating such technologies into higher education learning environments.

Unlike traditional statistical methods that assume linear relationships between variables, Decision Tree analysis is capable of identifying complex hierarchical patterns and interactions among predictors. This approach provides interpretable classification rules that can reveal how combinations of factors influence learner attitudes and engagement. Despite these advantages, the use of decision tree methods in MALL research remains limited. Therefore, applying Decision Tree analysis in this study offers an alternative analytical perspective for understanding students' behavioral responses to mobile language-learning applications.

Methodology

The present research is intended to investigate the factors influencing students' attitudes toward language learning in Duolingo. It is accordingly particular to the predictors that influence learners' attitudes and engagement by focusing on PU, EOU, and MOT. This paper uses a Decision Tree data mining approach to discover hierarchical structures and predictive relationships among these variables. Its view allows

for a clearer interpretation of the effects of individual factors as well as their combinations with students' ATT to use Duolingo in addition to being data-driven.

Scope of Research

1.1 Focus of Research This article aims to identify what and how factors lean towards students' attitudes in using Duolingo for language learning. Taking data mining technique as an analysis tool, we develop DTM model that is capable of finding and ranking best predictors contributing to students' learning attitudes. This analytical method is motivated using decision trees to educational data, where relationships between knowledge and perception data are exploited to uncover hidden learning patterns or information (Song & Wang, 2025; Wang, 2021). The dataset used in this study consists of responses from 102 undergraduate students. The dataset includes demographic variables and perception-based constructs measured using Likert-scale items. The input features for the Decision Tree model include perceived usefulness, perceived ease of use, learning motivation, and several supporting perception indicators. The target variable is Attitude Toward Use (ATT), which is classified into three categories: positive attitude, neutral attitude, and negative attitude.

1.2 Population and Data Collection The focus group was comprised of 102 third- and fourth-year undergraduate Business students. Census sampling procedures were adopted to secure full coverage of data from all students within the target population. Information was gathered in 2024 using a structured online questionnaire formatted on Google Forms. A four-variable scale was developed using a five-point Likert scale including Perceived Usefulness (PU), Ease of Use (EOU), Learning Motivation (MOT) and Attitude Toward Use (ATT).

1.3 Analytical Methods, Methodologies and Tools Quantitative methods Several more quantitative techniques were utilized for the analysis. Bivariate analyses summarized demographic characteristics and described the response profile in mean, standard deviation, or proportion. Cronbach's alpha was used to evaluate the internal consistency reliability in each of the constructs. Predictive relationships between the variables were investigated through a Decision Tree analysis using Classification and J48 algorithm in WEKA.

1.4 Research Framework This study is theoretically based on the Technology Acceptance Model (TAM) with an addition of Decision tree analysis in Mobile-Assisted Language Learning (MALL). The model assumes three exogenous variables (EOU, PU and MOT) affect the dependent variable ATT toward using Duolingo.

- **Ease of Use:** The extent to which students believe that Duolingo is easy to use and does not require much effort, thus affecting their intention to use the app.
- **Perceived Usefulness (PU):** The degree to which users believe that using Duolingo improves the effectiveness, and results of their language learning.

- Motivation to Learn Learning: It is both intrinsic and extrinsic reasons that make students engage with the application and then continue working on their learning.

1.5 Cross-validation: To ensure the reliability of the classification model, 10-fold cross-validation was applied during the training and testing process. This method divides the dataset into ten subsets and iteratively uses nine subsets for training and one subset for testing, thereby reducing the risk of overfitting and improving model generalizability.

Through the Decision Tree analysis, these relationships will be statistically examined to determine which variables (and which combinations of these measures) have the greatest impact on positive user attitudes. The model is anticipated to uncover hierarchical decision rules that illustrate how individual learner characteristics and perceptions jointly influence their use of Duolingo.

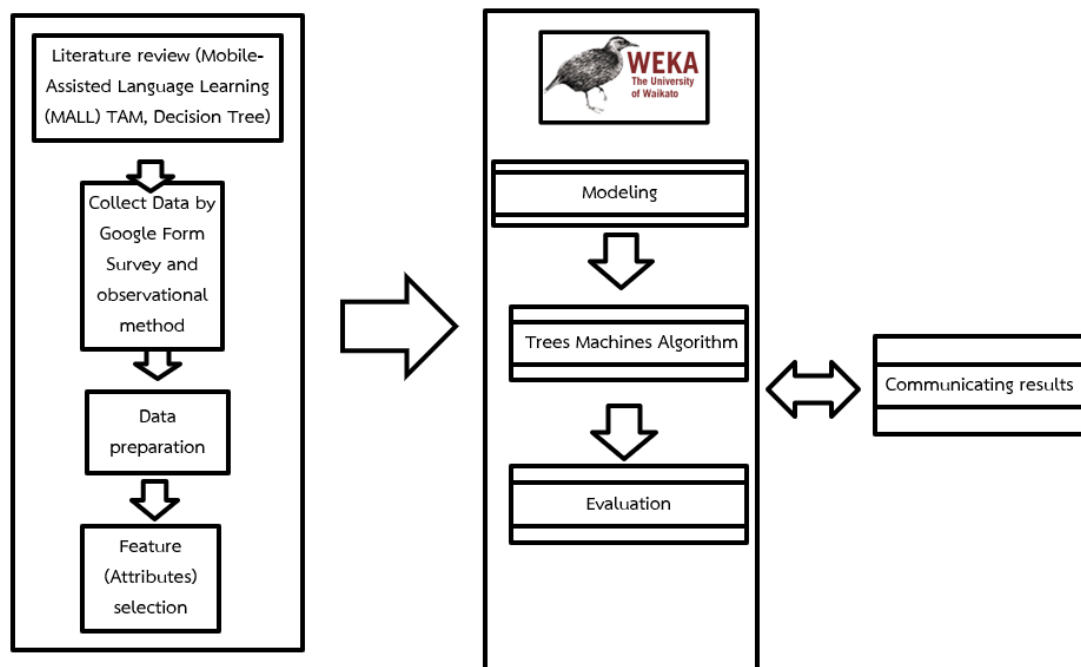


Figure 1 A visual schematic of the research model depicting hypothesized paths from EOU, PU and MOT to ATT.

Results

Descriptive Analytics

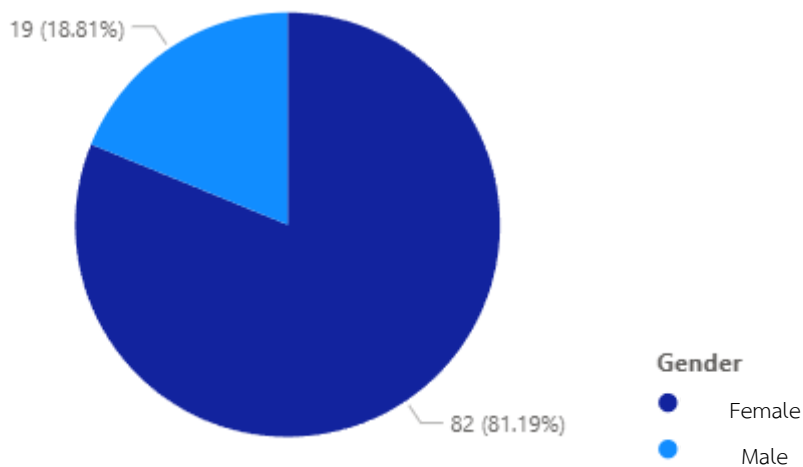


Figure 2 Gender Distribution of Respondents

The majority of respondents in the study were female (81%), while men contributed with 19%. The respondents' average GPA was 2.67, which implies a moderate level of academic achievement. The standard deviation of 0.41 shows relatively small variation in academic performance, meaning most students have similar GPA levels. This consistency supports the reliability of the group's feedback, as there are no extreme performance outliers

Table 2 Most Preferred Functions (FT)

Function	Mean
Learning Modules – Daily-life Language	4.44
Learning Modules – Vocabulary	4.35
Rewards (Gems/Coins after lessons)	4.35
Survey (Learning Purpose Identification)	4.32
Pretest (Language Level Check)	4.31
Daily Challenge	4.30
Streak Feature	4.30

Analysis of 'liked' functions in Duolingo shows that the highest-rated function, Learning Modules – Daily-life Language ($M = 4.44$), highlights the importance of real-world communication contexts. The value of authentic communication situations. Vocabulary practice and Rewards ($M = 4.35$ each) motivated by showing concrete progress as well as for maintaining motivation. Survey, Pretest, Daily Challenge as well as Streaks were also rated very high overall ($M \approx 4.3$), proving that setting clear targets

and keeping track of individual progress, along with motivational components who spur learners to daily learning played a significant getting to know dynamics role. In general, these insights suggest that users like functions which include ‘real-life utility, game-like rewards and personalized progression.

Decision Tree Analysis and Interpretation

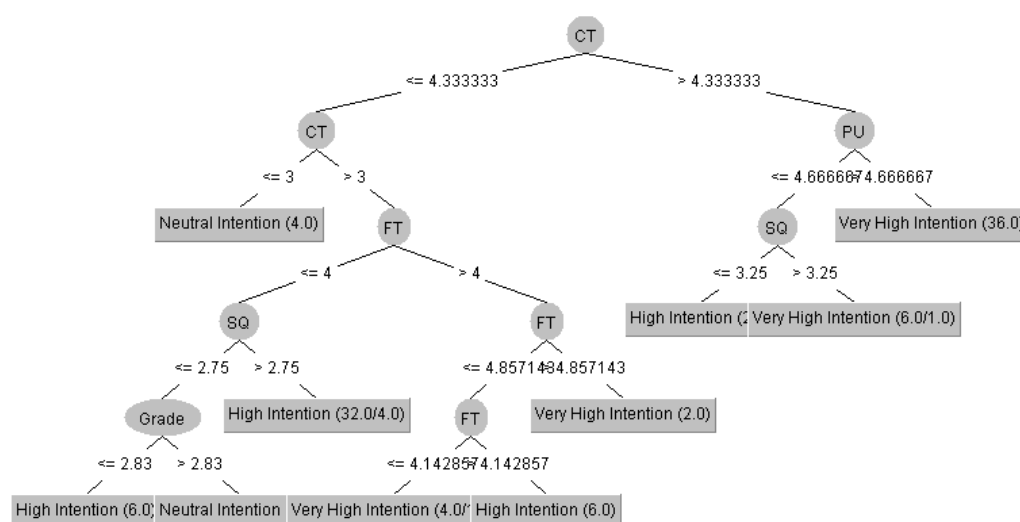


Figure 3 Decision Tree by Tree.J48

=== Summary ===

Correctly Classified Instances	81	80.198 %
Incorrectly Classified Instances	20	19.802 %
Kappa statistic	0.6485	
Mean absolute error	0.1619	
Root mean squared error	0.3355	
Relative absolute error	41.3792 %	
Root relative squared error	75.9809 %	
Total Number of Instances	101	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.894	0.130	0.857	0.894	0.875	0.762	0.920	0.886	Very High Intention
	0.818	0.211	0.750	0.818	0.783	0.603	0.841	0.756	High Intention
	0.300	0.011	0.750	0.300	0.429	0.443	0.809	0.395	Neutral Intention
Weighted Avg.	0.802	0.153	0.800	0.802	0.791	0.661	0.874	0.781	

From figure 3 this research used decision tree analysis to explore the factors determining students’ behavioral intentions and attitudes towards using Duolingo as a mobile-assisted language learning (MALL) platform. The predictive model considered

Functionality (FT), Content Quality (CT), Service Quality (SQ), Learning Motivation (MOT) and Attitude Toward Use to explain vehicle technology acceptance. In terms of concept, Functionality (FT) correlates with Perceived Usefulness (PU), indicating the extent to which students believe that Duolingo features are useful for learning. Content Quality (CT) and Service Quality (SQ) are dimensions of Ease of Use (EOU), which refer to how well the app's instructional content and technical resource can simplify the learning process and make it superior for enjoyable use.

The decision tree classifier correctly classified the 101 cases including 81 (80.2%) overall accuracy and with a Kappa statistic of 0.6485, which indicates substantial agreement beyond chance. This indicates that the decision tree reasonably encapsulates the logical formation of relations among learners' perceptions (FT, CT, SQ), motivation (MOT) and attitude (ATT). In addition, the Mean Absolute Error (0.1619) and Root Mean Squared Error (0.3355) are low as well which indicates that the dispersion of predictions is moderate, validating the model's effectiveness. In the class-level prediction, which is based on classes, the model showed the best result in predicting Very High Intention learners with true positive rate of 0.894, precision of 0.857 and F-measure of 0.875. The ROC area (average 0.920) also shows that the tree discriminates well between engaged and not-so-engaged learners. Not so in the case of High Intention class, which presented a good TP rate (0.818) and F-measure (0.783), proving that our decision tree managed to notice 23 into moderate motivated behaviors or people. Contrastingly, within the Neutral Intention group accuracy was significantly reduced (TP = 0.300), suggesting that the transfer from moderate and high engagement levels is not always sharp in real learning environment situations. The relationship is evident in the confusion matrix: among those predicted as Very High Intention, 42 were correct predictions; however, 5 of them are underpredicted by getting classified into High intention (which shows a small overlap between high engaged ones). For the High Intention, 36 were classified correctly and seven were overpredicted as Very High Intention and one into Neutral Intention. 3 Neutral learners were accurately classified while most others leaned up into higher-intention categories. This finding indicates that many respondents hold a positive sentiment towards the use of Duolingo for language learning.

Discussion

Explaining the predictors, Functionality (FT), which is conceptually identical to Perceived Usefulness (PU) was established as a dominant split node of the model. Learners who find Duolingo's functionalities to be instrumental and useful are more likely to possess high motivation and strong behavioral intention to continue using the platform. This focus on pragmatic, actionable features is consistent with previous work in MALL and educational decision trees that emphasizes practical, interpretable rules for instructional design. For instance, decision tree research studies that focused on adaptive

content selection or personalization point out that trees can give readable rules (in terms of if-then splits) and so educators or developers will be able to easily use them in sequencing the content or interventions. (Wang, 2021)

At the same time Content Quality (CT) and Service Quality (SQ), conceptually associated with Ease of Use, influence how comfortable students in terms of contents, they understand what is happening on this app and how satisfied are students using that system. Well-designed lessons and user-friendly interfaces with timely feedback, coupled with its ease of use and effectiveness in Duolingo, enhance learning persistence. Motivation (MOT) is another factor that occupies a central place in the hierarchical structure of the decision tree. There is a positive relationship between students' intrinsic and extrinsic motivation (pertaining to Duolingo's reward system) and their pro-learning attitudes as well as learning behavior. This enhancement is transferred to perceived usefulness and ease of use, which in turn enhances continued usage by users. In summary, the decision tree reveals a symbiosis among Functionality (PU), CT and SQ components of Ease of Use (EOU), and MOT in inferring learner intention. The results are that gamified features, ease of use and service quality of Duolingo increase learners' attitudes and behavioral intentions positively. The implications of the study are MALL designers should not only pay attention to technical functionality, but they also need to guarantee pedagogical content quality and system support where users can experience good results in engagement and learning satisfaction. (Abu-Dalbouh, 2021)

One notable limitation of the model is its relatively low predictive performance for the "Neutral Intention" category. This may be attributed to the ambiguous nature of neutral responses, where students neither strongly accept nor reject the application. External factors such as classroom environment, personal learning preferences, or inconsistent usage patterns may also influence neutral attitudes. Future research could address this limitation by incorporating additional behavioral variables or expanding the dataset to capture more diverse learner characteristics.

Suggestion

Enhance Functional Effectiveness (Perceived Usefulness)

1. The study also found that Functionality (FT) a concept that is theoretically congruent to Perceived Usefulness (PU), has the strongest effect on predicting intention to use Duolingo among students. If anything, developers should focus on the betterment of such features that help facilitate and enhance the learning process like real-world conversation exercises, progress report and adaptive feedback system. Strengthening such functors leads to an increased confidence of the learners in the fact that they are supported in their language proficiency and learning objective by this very application.

2. Improve Ease of Use through Quality Design

CT and SQ were equally important elements, evidencing the weight of EOU in user experience. Well-planned, robust content paired with seamless app navigation and stable system performance can help minimize user's frustration and increase satisfaction. Making sure that content is authentic and technical support staff are supportive will also enhance the perceived ease of continued use.

3. Strengthen Learning Motivation through Gamification

Motivation to Learn (MOT) is involved in maintaining the users' participation. The platform should continue to develop its gamified learning elements, i.e., daily challenges, streak rewards and customized goals, in order to sustain the motivation of learners. Incorporating new motivation techniques as cooperative assignments, progress targets and accomplishment rewards might be able to enhance sustained interest in learning and long-term retention. (Kessler et al., 2023)

Recommendations for future research or further research

It is recommended that further studies extend the present decision tree model by incorporating a bigger and broader sample to make research findings more generalizable across various learning situations and proficiency levels. More psychological or behavioral factors (e.g., learner autonomy, self-efficacy and social participation) could be added into other studies to depict a more complete landscape of language learning in the mobile-assisted context. It might also provide more insights to compare with other data mining methods, such as random forest or neural networks to address the complex relationships among predictors. Additionally, longitudinal analyses would enable investigation of changes in users' perceptions of overall functionality, content quality and motivation as they accumulate time using Duolingo. Last but not least, due to the qualitative nature of interviews or focus groups are suggested to supplement the quantitative data and explore in depth learners' experiences that help to design more personalized and pedagogically effective mobile learning.

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