




## PAPER

# Engagement Metrics and Online Course Completion: A Mobile-Centric Data-Driven Study

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## ABSTRACT

It has been witnessed that post-COVID there has been a rapid expansion of online education, that has heightened the need to understand learner engagement and its influence on course completion, especially in a mobile-first digital landscape. This is a data-driven study that explores key engagement metrics such as time spent on courses, number of videos watched, quizzes taken, and quiz scores to evaluate their impact on the completion rates of online courses. The dataset has been referred from health, arts, science, and programming for over 5,000 user records. This study investigates how behavioral patterns and device types, particularly mobile phone usage, affect learner success. The study employs descriptive and comparative analytics to measure the relationships between engagement indicators and completion outcomes. Variables like course category, time spent on course, and device type are analyzed alongside performance metrics such as completion rate and quiz scores. The findings show that higher engagement through interactive content, especially video consumption and quiz participation, is significantly associated with improved completion rates. Learners accessing courses via mobile devices exhibited distinct engagement behaviors that suggest the importance of mobile-optimized learning strategies. This study is applied in a global context, and we have applied publicly available anonymized data to analyze results and offer actionable insights for educational platforms, instructional designers, and policy-makers aiming to enhance learner retention and success in online learning environments.

## KEYWORDS

engagement metrics, online course, data driven, mobile phone usage

## 1 INTRODUCTION

This study investigates how learner engagement metrics influence course completion outcomes in online education, with particular attention to mobile device usage. We have used a large, anonymized dataset sourced from Kaggle for evaluating the behavioral data from thousands of online learners across various course categories. The research has identified engagement indicators such as time spent on

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course material, number of videos watched, quizzes taken, and quiz performance. Then the completion rates were analyzed and compared between learners who completed the course and those learners who did not complete it. Additionally, the study examined the kind of device used to learn, like mobile learning or the usage of other devices for learning, and how these devices have impacted the learner's engagement and course completion. The results have confirmed that higher engagement significantly correlates with successful course completion, and users who have used mobile devices as the medium of learning have better outcomes than non-mobile users. This study is based on data-driven approach, which provides valuable insights for improving online education platforms and learner success strategies.

The current study focuses on learner engagement, course completion, and device accessibility. Learner engagement refers to the extent to which students interact with the online learning content and activities, measured through variables such as time on task, content interaction (videos), and assessments (quizzes). Course completion is a binary outcome indicating the outcomes as completed or not completed. The study has applied the concept of learning analytics, which explains the use of data to evaluate and improve learning experiences [1]. These concepts are integrated in the current research to explore the behavioral patterns that can affect academic performance in digital education environments.

Mobile learning (Mlearning) refers to the use of mobile devices such as smartphones and tablets to access educational content anytime and anywhere [2]. In this study we have evaluated the mobile use by analyzing completion patterns among users who accessed courses via mobile devices [3]. The results showed that learners using mobile devices for course access have higher course completion rates; this provides evidence of benefits of flexibility, convenience, and real-time access to learning resources through mobile devices. Mlearning supports learners in many ways, from balancing study with personal and professional commitments to making learning easy valuable for learners who reside in the remote regions [4].

This study is about online course engagement and completion, particularly with respect to Mlearning which focuses on theories in educational psychology, instructional design, and technology acceptance. These theories are important because they can explain the behavioral patterns observed in the data and provide a conceptual foundation for understanding learner motivation and success in digital environments.

Self-Determination Theory (SDT) was given by Deci and Ryan in the year 1985, which has the foundation on motivation theory, explaining three basic psychological needs such as autonomy, competence, and relatedness [5]. With reference to the current study, autonomy can be achieved when learners can access and control their learning schedule (e.g., via mobile devices). Competence relates to learners feeling capable of mastering the course material (e.g., through quizzes and scores). Relatedness may apply in social or collaborative learning features, although this study focused more on individual behaviors. SDT helps explain why learners who are self-directed and feel empowered through accessible platforms like on Mlearning are more likely to complete their courses.

Another theory is a Cognitive Load Theory (CLT), which was given by Sweller in 1988. This theory has suggested that learning is most effective when cognitive effort and should not be overwhelmed by extraneous distractions. This theory supports the idea that well-structured online courses with manageable content, such as videos and quizzes, which can help learners to process and retain information. Here the engagement indicators are "Time Spent" and "Videos Watched," which are indirectly reflecting on how learners interact with instructional design elements that align with this theory [6].

Finally, the Engagement Theory which was given by Kearsley and Shneiderman in 1998, which has explained that the learning can best occur when learners are meaningfully engaged through interaction and involvement [7]. According to this theory, successful learning environments include challenge, active participation, and motivation elements such as participating in discussions, taking quizzes and completing online tasks before the deadlines. This theory intensifies the positive association between engagement indicators and completion outcomes [8].

The current study has applied the MLearning theory, which is built on the existing educational models but emphasizes the contextual, personalized, and flexible nature of MLearning. It has recognized the shift in learning patterns when learners have constant access to content via portable devices such as mobile phones. In the current research, the role of device type can reflect on how Mlearning is supporting the immediate and context-sensitive learning, which contributes to greater learner satisfaction and persistence.

Mobile technologies play an important role in making education accessible, flexible, and continuous because of the nature of portability, where learners can access the course anywhere and anytime [9]. These features make the digital learning experience rich and easy. Currently there is an increasing number of smartphones globally; therefore, Mlearning is no longer an alternative but a necessity in digital education. Most of the key functions of mobile technologies are app-based, for example, Moodle or Coursera. These functions include offline content caching, live chat and discussion forums, and gamified assessments and quizzes. Figure 1 shows the mobile learning architecture, which includes the client side (user’s mobile device), application layer (middle tier), server-side (backend services), and cloud and AI integration.

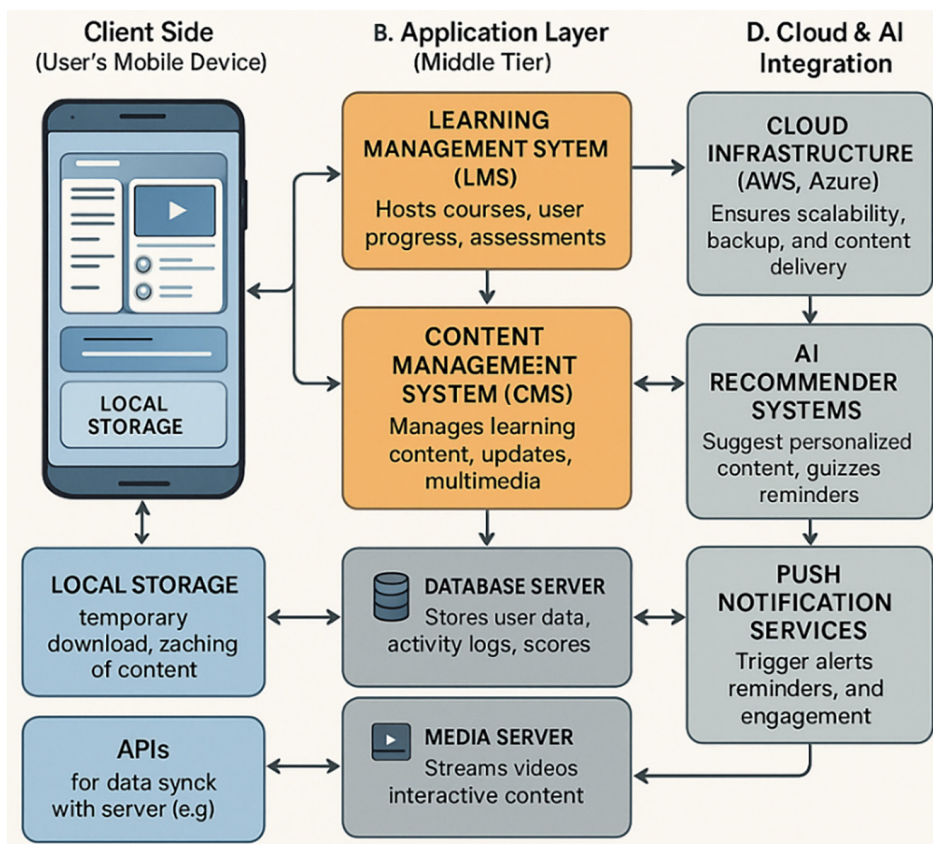


Fig. 1. Mobile learning architecture

The working process of mobile technologies start with the user logging into the mobile learning app via secure authentication. The next step is using the app to retrieve course data from the LMS through APIs. The content will be streamed or cached, depending on user settings, as a next step. Learners will be able to interact with videos, quizzes, and discussion forums after joining or accessing the app. As a next step, engagement data is sent back to the server, updating learner records in real time from the app. AI modules analyze patterns to personalize future learning paths or recommend additional materials, and in the final step the administrators and educators monitor learner progress using dashboards.

The current study has two research objectives (RQ). RQ1 examines how engagement metrics such as time spent, videos watched, quizzes taken, and quiz scores can influence course completion rates in online learning, and RQ2 assesses the impact of device type, such as mobile vs. non-mobile, on learner engagement and course completion outcomes. These objectives are measured by using the engagement indicators or metrics, which are quantitatively analyzed using descriptive and inferential statistical techniques in the current study.

The study has many benefits, like it will provide data-driven insights for educational improvement. The research provides clear evidence on how engagement indicators such as time spent, quizzes taken, and video consumption are directly responsible for the course completion, and therefore these insights help course and app developers, strategize their working model to achieve effective learning. This study also supports the optimum usage of Mlearning by showing that mobile users demonstrate slightly higher completion rates and validates the growing importance of mobile accessibility in online education. This can encourage institutions to prioritize mobile-first design, enhancing learning opportunities for diverse and remote populations.

Mlearning provides the scalability and applicability across platforms that can be used for large, diverse datasets from multiple course categories, which ensures that the findings are generalizable across various disciplines and platforms. Educational institutions and e-learning providers can apply these insights to design more effective digital learning experiences.

The study has faced a few challenges. The dataset does not include demographic variables such as age, gender, and education level and contextual factors such as motivation and prior experience, which limits the depth of behavioral interpretation and personalization potential. Secondly, the course completion is measured as a binary outcome only, such as completed vs. not completed, which does not explain the progress of learners. As an observational study based on secondary data, the research reveals associations but cannot establish causality. For example, while high engagement correlates with completion, it cannot definitively prove that engagement causes completion without experimental control. Last but not least, the device classification is also binary, where the comparison is between mobile vs. non-mobile. This study has a limitation on focusing on the relevance of hybrid learning environments where learners can use different devices or use web browsing for learning.

## 2 LITERATURE REVIEW

Over the past decade and especially during and post COVID-19 Pandemic, the integration of mobile technologies in education has dramatically transformed the landscape of digital learning. Studies have shown that Mlearning has enabled the learners to access educational content flexibly, conveniently, and in real-time. Study conducted in the year 2022 has emphasized that mobile technologies has

enhanced learner engagement by offering continuous learning opportunities, while another study has confirmed that mobile device adoption is significantly associated with the improved learning outcomes [10]. Also, mobile based learning has offered students a higher level of satisfaction for course access and creative learning experiences. Similarly, a study in 2025 has provided a systematic mapping of mobile technology use in education that has explained the benefits of interactive tools and personalization for online learning [11]. These past studies have clearly highlighted the positive role of mobile platforms in supporting accessible, learner-centered education in the digital era.

Several past studies have explored the relationship between engagement metrics and learning outcomes in mobile-based education, such as the study conducted in the year 2025 has investigated the role of big data analytics and mobile applications in higher education [11]. This study has revealed the relevance of combining behavioral data with mobile interfaces, which could give the outcome of more personalized and effective learning experiences. In 2025, a study has shown the reviews of the top 100 cited papers on mobile learning, identifying “engagement” as a recurring theme linked to learner success in completing the course or program [12]. A study conducted in 2025 has stressed the importance of mobile based strategies for the course design which has advocated the application of mobile-optimized content to support active and flexible learning [13]. These studies reinforce the importance of mobile engagement but often focus on theoretical or small-scale implementations rather than large-scale, data-driven evaluations.

The current study has shown advances in the field of online learning by conducting a large-scale, data-driven empirical analysis of over 5,000 learners across diverse course categories using anonymized data from Kaggle. Unlike prior research that typically relies on surveys or experimental setups, this study applies quantitative metrics such as time spent on course, videos watched, quizzes taken, and quiz scores to directly assess engagement and course completion. Moreover, the study provides a comparative analysis between mobile and non-mobile users, an approach not extensively addressed in earlier literature. The use of real-world engagement data enables more robust and generalizable insights into how mobile devices impact learning success across different disciplines.

Despite the existing literature, several gaps remain unaddressed, which this study begins to fill. First, many earlier studies do not quantify the effect of specific engagement metrics on course completion. Second, few studies examine mobile learning in a comparative context, assessing how different device types affect user behavior and outcomes. Third, past research often overlooks behavioral patterns derived from actual learner data, instead relying on perceptions or intentions. This paper addresses these gaps through a rigorous analysis of real engagement data.

### 3 RESEARCH METHODOLOGY

To measure the research objectives, we have applied a quantitative method where data-driven research methodology has measured the relationship between engagement metrics or indicators and online course completion, with an emphasis on mobile device usage. The analysis is based on a dataset sourced from Kaggle, which is publicly available. This dataset is an anonymized records of learner interactions for various online course categories such as health, arts, science, and programming. The key variables identified for the current study are time spent on the course, number of videos watched, number of quizzes taken, quiz scores, completion rate, and device type (mobile vs. non-mobile). We have used descriptive statistics to

understand the distribution and central tendencies of the indicators for analyzing the results. Additionally, comparative analysis is conducted to examine differences in engagement patterns between mobile and non-mobile users. This methodological approach enables a robust assessment of learner behavior and success factors within the online learning environment.

Independent variables (engagement metrics or Indicators)

- Time spent on course → Measures learner’s time commitment
- Number of videos watched → Indicates content engagement
- Number of quizzes taken → Reflects assessment participation
- Quiz scores → Reflects content understanding and performance
- Device type (Mobile vs. non-mobile) → Represents access mode

Mediating variable (behavioral engagement)

- Completion rate → Acts as a behavioral indicator reflecting ongoing engagement

Dependent variable

- Course completion (0 = Not Completed, 1 = Completed) → Final success outcome

Relationship flow shows the engagement metrics (inputs) which leads to increase in completion rate causing positively influences on course completion. Device type moderates the relationship between engagement and completion, showing whether mobile access supports or hinders engagement effectiveness. Figure 2 shows the relationship flow of engagement and device types for the current study.

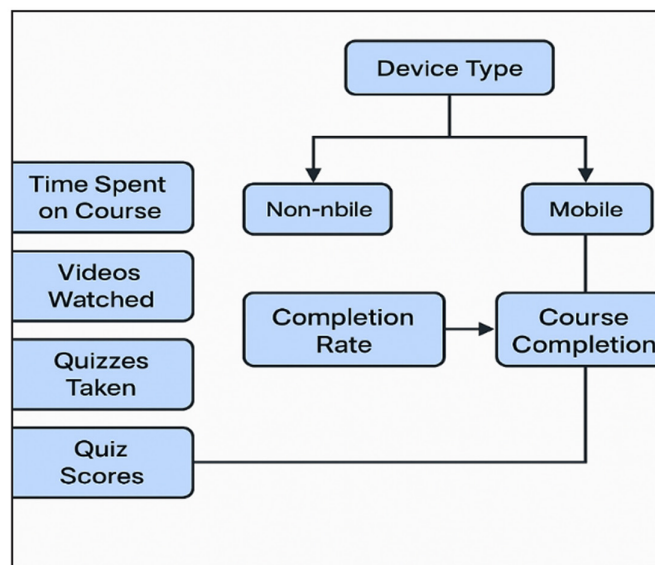


Fig. 2. Engagement flow and device type completion rate

## 4 RESULTS

During COVID-19 pandemics and later, world has witnessed the rapid expansion of online education. The digital learning has increased the need to understand learner

engagement and its influence on course completion with major focus on Mlearning as first digital landscape. Current study is a data-driven study which explores key engagement metrics or indicators such as time spent on courses, number of videos watched, quizzes taken, and quiz scores. These indicators are applied to evaluate their impact on the completion rates for online courses. Large online learning dataset is sourced by Kaggle which encompass the diverse course categories from various disciplines such as Health, Arts, Science, Programming, etc. The dataset has the records of over 5,000 users for online education. This study refers to the dataset and investigates how behavioral patterns and device types, particularly mobile usage, affect learner success. The study employs descriptive and inferential analytics to measure the relationships between engagement indicators and completion outcomes. Variables like course category, time spent on course, and device type are analyzed alongside performance metrics such as completion rate and quiz scores.

This study has primarily employed descriptive statistics and comparative (group-based) analysis to measure the relationship between engagement metrics and course completion, aligned with its quantitative methodology. The key statistical method used to analyze the results is mean comparison, where average values of engagement indicators were calculated and compared between two groups, learners who completed the course (Course Completion = 1) and those who did not (Course Completion = 0) as expressed in binary form. Descriptive statistics helped to summarize the central tendency and dispersion of key engagement variables. The mean and standard deviation are applied for the variables are Time Spent on Course, Number of Videos Watched, Number of Quizzes Taken, Quiz Scores, and Completion Rate.

These values provided a baseline for understanding typical learner behavior and variability across the dataset. Like comparative (group-based) analysis is used to evaluate the effect of engagement. Learners are divided into two groups based on the binary variable course completion. In the next stage the group means of each engagement metric were compared. This method revealed that the higher values of engagement metrics were consistently associated with higher course completion rates.

For device type analysis, a cross-tabulation (contingency table) is used to evaluate the relationship between device type (mobile vs. non-mobile) and course completion. This allowed the study to observe differences in completion behavior based on access mode. Mobile users slightly outperformed non-mobile users in completion rates, though the difference was modest.

To address the research objectives, multiple engagement indicators were quantitatively measured using descriptive and inferential statistical techniques. RQ 1 focuses on measuring engagement indicators and course completion. The key engagement metrics or indicators are used as time spent on course (measured in hours), number of videos watched, number of quizzes taken, quiz scores (percentage), and completion rate (percentage of course progress). To measure RQ1 we have applied the formula of the completion rate which is expressed as given below:

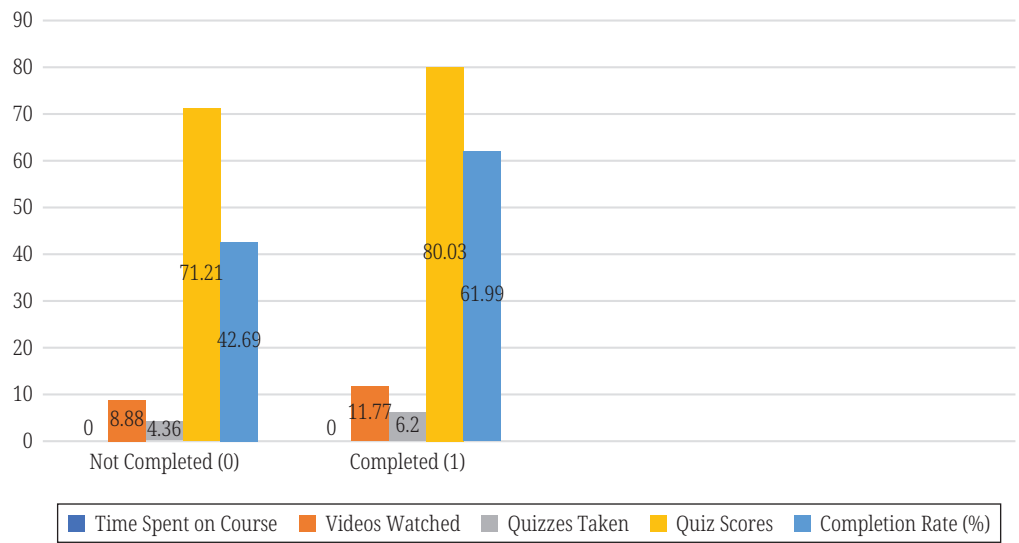
$$\text{Completion Rate} = \left( \frac{\text{Time Spent} + \text{Activities Completed}}{\text{Total Course Activities}} \right) \times 100$$

Here, the course completion is a binary outcome (0 = Not Completed, 1 = Completed). The results indicate that learners who completed the course scored significantly higher across all engagement indicators. Table 1 shows the data set from Kaggle for engagement metrics vs. course completion also see Figure 3 for the trends of engagement metrics for course completion.

**Table 1.** Engagement metrics vs. course completion

Course Completion	Time Spent on Course	Videos Watched	Quizzes Taken	Quiz Scores	Completion Rate (%)
Not Completed (0)	45.95 hours	8.88	4.36	71.21	42.69
Completed (1)	56.58 hours	11.77	6.20	80.03	61.99

The data is substituted in the formula for measuring the completion rate. The results show that online learners spent on average 56.6 hours, watched 11.8 videos, took 6.2 quizzes, and had an average quiz score of 80%, compared to non-completers who spent only 45.9 hours, watched 8.9 videos, took 4.4 quizzes, and scored 71.2%.



**Fig. 3.** Engagement metrics vs. course completion

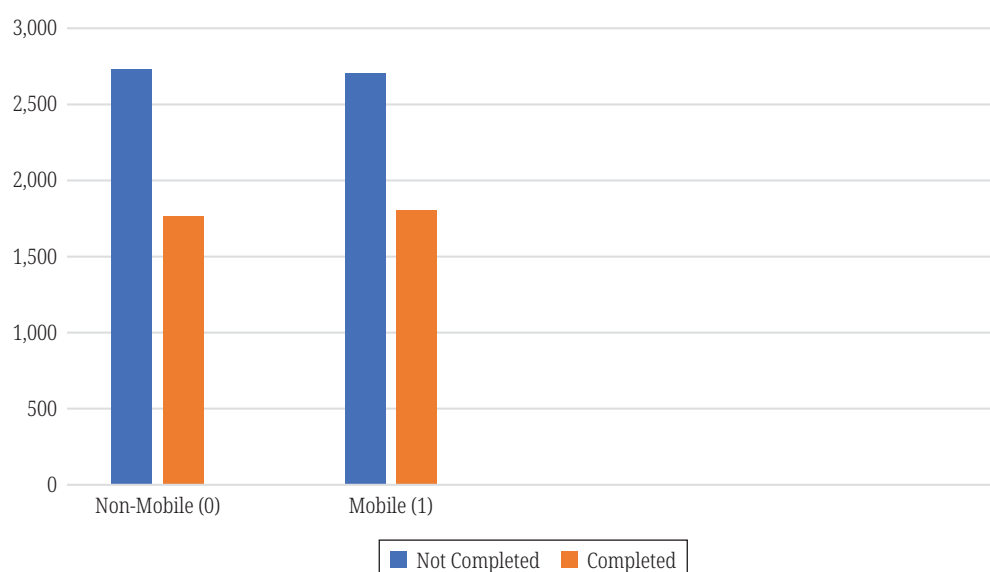
Findings show that the completion rate is higher among completers (62%) vs. non-completers (43%), showing strong evidence that increased interaction and online engagements with various tools enhance course success.

RQ 2 measures the impact of device type. Device usage is categorized under binary expression like 0 for non-mobile devices such as desktops and laptops and 1 for mobile devices such as smartphones, tablets. We examined the count of users who completed and did not complete courses across device types based on the data set sourced from Kaggle. Table 2 shows the data set for course completion for mobile users and for non-mobile users for the course completion and Figure 4 shows the graphical presentation for the impact of device type on course completion. Completion Rate by device is calculated as given below:

$$\text{Device wise Completion Rate} = \left( \frac{\text{Number of Completions}}{\text{Total users on Device}} \right) \times 100$$

**Table 2.** Device type vs. course completion

Device Type	Not Completed	Completed
Non-Mobile (0)	2,729	1,765
Mobile (1)	2,703	1,803



**Fig. 4.** Device type impact on course completion

Results from the data set show that there are 1,803 mobile users who have completed out of 4,506 users. We applied the device wise completion rate and 40% completion rate is calculated. Similarly, there are 1,765 non-mobile users out of 4,494 users and we calculated device wise completion rate, 39% completion rate is calculated.

Although the difference between both is very marginal but mobile learners have showed slightly higher completion. The findings suggest that mobile accessibility may support flexible learning for the user and also highlight the importance of mobile-optimized content for improving online education outcomes.

The findings illustrate that higher engagement is associated with better course completion, and mobile learners are nearly as likely or slightly more to complete courses compared to non-mobile learners.

The findings have revealed that the higher engagement through interactive content like videos and quiz participation is significantly related to impact the completion rate. Learners who access their courses through mobile devices show higher engagement behaviors which suggest the importance of mobile technologies in an online learning. The data set presents a global context therefore, it gives actionable insights for online course developers, professionals and designers for building online learning strategies.

In addition, the results of this study demonstrate a clear and measurable relationship between learner engagement indicators and online course completion. This explains that learners who have completed their courses were more engaged in online contents for the learning. This exhibits for the online course developers to plan more engaging learning contents for the users.

## 5 CONCLUSION

The study explains that learner engagement is a significant predictor of course completion in online education platforms. The analysis has confirmed that indicators such as time spent on course content, number of videos watched, quizzes taken, and quiz performance have a strong correlation with successful course completion.

Moreover, there is also an advantage found for mobile users in completion in comparison to non-mobile users as a platform for accessing and learning the courses. This explains the importance on developing the courses on Moodle or another online platform with mobile friendly interface. Findings also highlight the important of constant development of access platforms with latest tools and technologies because these platforms also play critical role for improving student outcomes in digital education settings.

For future work, the study suggests to apply predictive modeling techniques such as decision trees or machine learning for the identifying the classifiers which could enhance early identification of at-risk learners. Also, future research can incorporate demographic data also such as motivation levels, or learning styles because this can offer a deeper understanding of individual engagement behaviors. The currents study is mostly focusing on quantitative methods whereas in future, studies can apply mixed methods to measure the course completion rates incorporating motivational indicators.

## 6 ETHICAL STATEMENT

This study uses a publicly available dataset from Kaggle that contains fully anonymized and aggregated user data. No personally identifiable information (PII) is included, and there are no privacy concerns or risks of data misuse. The authors declare that there is no conflict of interest, and all ethical guidelines for secondary data use have been duly followed. The data set on Kaggle can be accessed through the given link: <https://www.kaggle.com/datasets/thedevastator/online-course-user-engagement-data>

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