



Relationship between Digital Learning Engagement, Peer-Study Practices, and Academic Performance among MBBS Students: A Cross-Sectional Study

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ABSTRACT

Medical education in Pakistan is gradually adjusting to changes in how students' gain access to and process and apply knowledge. While the MBBS curriculum continues to rely heavily on face-to-face teaching, the learning environment surrounding students has expanded beyond the classroom. Universities and affiliated teaching hospitals now operate within a setting where digital platforms, recorded lectures, online academic content, and informal peer networks play a visible role in everyday learning practices. These developments have prompted educators to reconsider how learning actually occurs outside scheduled teaching hours. Current medical students' study with and rely on resources provided and available digitally, accessing them to supplement traditional instruction in classroom teaching. This may include online lecture recordings, other educational videos, and mobile applications, which have become increasingly commonly to revise or study complex topics or explain concepts introduced during lectures. In addition to provided platforms such as through the LMS, students frequently also use publicly available information, in the form of digital content, that is in particular, digitally available educational material shared through video-based or social media platforms. The study finds that students' peer-study practices have also changed over time and with more and more students relying on messaging application to clear concepts and create online discussions, the traditional peer study library groups have evolved not only distance but also with the help of online and digital forums that encourage digital peer study engagement, rather than one on one in person interactions. Such evaluations may be conducted later to correlate knowledge with student passing/failing, or their performance, to deem them ready for clinical applied medical training; however, digital learning engagement and peer study may still informally persist and continue unassessed, as part of continuing medical education practices, as required by the accreditation council guidelines for adult education.



Background of the Problem

Since medical education is undergoing a transformation post Covid-19, where students are versatile and flexible enough to adopt out of the box learning strategies, there is a transformation from reliance on traditional classroom materials and teaching to adopting digitally available and peer-based learning strategies. This includes the use of Youtube dedicated channels, e-learning platforms and modules and social medial referenced study groups, which has ultimately shaped the informal curriculum. According to Johnson et. all (2022), this also effects how medical school students' access and process information connected to the formal curriculum. There are a lot of International and national studies which predict a decline in physical lecture attendance, even when attendance is strongly encouraged by accreditation council guidelines and enforced by the college (Burgess & Ramsey, 2020). According to Rajab et. All (2022), however, students remain flexible and the sizeable shift toward flexible, self-paced learning involving digital strategies, is more popular and may be linked to the students' desire for less vague or detailed explanations, visual aids, and saving on time efficiency (Rajab et al., 2020).

In South Asia, including Pakistan, these trends are more pronounced. Medical colleges often record large official enrollments (e.g., 300–350 students per MBBS batch), but only 80–120 students attend face-to-face lectures regularly (Ahmed et al., 2023). Students increasingly depend on YouTube channels such as Armando Hasudungan, Anatomy Zone, and Dr. Najeeb Lectures, often supplemented by WhatsApp academic groups where peers share summaries, notes, and exam- focused materials. Research shows that digital learning improves conceptual understanding and exam preparedness when used effectively (O'Doherty et al., 2021), yet other studies caution that unsupervised online learning may expose students to inconsistent or inaccurate content (Naseer et al., 2022). Despite widespread use, the academic consequences of digital and peer- learning strategies remain unclear in Pakistan. Most available studies focus on student satisfaction or perceived usefulness rather than actual exam scores or performance indicators (Ahmed et al., 2023; Johnson et al., 2022). Furthermore, little is known about how learning behaviors differ among students in the foundational years (1st–3rd year MBBS), who rely heavily on basic sciences and conceptual coursework. This evidence is essential for medical colleges facing declining lecture attendance, shifting learning behaviors, and the need to develop blended- learning policies aligned with student needs.

Statement of the Problem

Students are increasingly adopting digital and peer-based learning instead of attending classroom lectures, yet the influence of this shift on academic performance remains poorly understood by curriculum planners. Although studies show declining lecture attendance globally (Burgess & Ramsey, 2020), and increasing reliance on online videos and mobile learning apps (Rajab et al., 2020), there is limited research evidence evaluating whether these digital learning methods or digital engagement overall improves or hinders performance outcomes of students.

Research Question

The research questions are based on the above proposed conceptual framework:

Research Q1: What is the relationship between digital learning engagement and academic outcomes among MBBS students in Years 1–3?

Research Q2: What is the relationship between peer-study practices and academic outcomes among MBBS students in Years 1-3?

Research Q3: To what extent do Year 1, Year 2, and Year 3 students participate in digital learning and peer-study practices?

Justification of the Study

There is a growth in online educational materials that are including full lectures, short video lectures, recorded lectures, video recorded tutorials, live tutorials and even social media driven materials that are the new norm of learning from traditional classroom based in person learning to self-directed and peer group study learning. This research study wants to determine the extent which MBBS students in particular years 1-3 are engaged in self-directed or digital learning, and then determine whether this can be used to formally integrate such digital and peer learning practices into the curriculum design. Comparing the 1-3 years of medical school students will show case the trend of reliance from 1st to 3rd year on digital media and peer study practices as student progress and the clinically related or clinical medical science curriculum context increases. This would then focus student support services that adequately support students on high quality materials with faculty engagement, instead of the variety of varied materials available on line, which may be out of the curriculum and context. This may include faculty approved short lectures on topics, playlists/podcasts and even relevant faculty approved YouTube or other digital medial channels. Therefore, this study is going to aid in the faculty and administration of the college/university in determining the extent and findings to plan for further blended learning approaches through the formal curriculum.

Scope of the Study

The scope of the study is focused on measuring the extent of digital learning engagement, peer study practices and academic performance among undergraduate MBBS students enrolled at public sector medical colleges in Karachi Pakistan. The study is focused on the pre-clinical or early clinical years as these stages of academia usually relate to teaching foundational medical concepts and focus on theoretical learning, where study strategy such as digital learning and peer study may play a heavier role in the success of the student in their undergraduate program of study. The justification of this is that early year's undergraduate students may rely on digital learning as an engaging tool over traditional learning methods in order to explain complex concepts and to further build their understanding of conceptual framework of the curriculum. The study is investigating two independent variables as per the conceptual framework formed, which is digital learning engagement and peer study practices, and their association with the dependent variable, which is perceived academic performance. Digital learning engagement includes the use of digital learning platforms such as YouTube, recorded lectures, learning applications and peer study may include group study/ group discussion and participation in peer learning activities to enhance understanding of complex medical topics, along with motivation to study with classmates and sharing materials with peers frequently. The scope does not include postgraduate students, trainees or those students from any other program, nor does the study account for factors that may be socio-economic, personality traits or quality of teaching offered at the institution. The parameters of the target population must be met regardless of the learning environment offered.

Significance of the Study

This study is important because medical education is rapidly shifting from traditional Lecture-based teaching to more flexible, technology-driven learning approaches. Many MBBS students now rely on digital resources such as YouTube, online lectures, social media study groups, and peer teaching to prepare for their exams. However, there is limited local evidence showing how much students actually use these methods and whether these methods are linked to better or worse academic outcomes. Implications for Medical Educators, curriculum planner and students, along with institutional leadership, who guide policies related to digital learning and academic support services, along with future researchers, which is seen in literature review, there is limited research on digital learning and

peer study practices among medical undergraduate students in Pakistan. Overall, significant because it can guide improvement in lesson design, blended learning and teaching resources.

Study Limitations

Since it is designed as a cross-Sectional Design, although quantitative in nature, can be a limitation as it can identify and explore relationships but at one point in time. The study is also limited to one institution so the study focuses on a single public sector medical college, which may limit the generalizability of the findings to other institutions or provinces. Variation in academic Outcome Measures: Self-reported versus actual, which are measured using students' exam scores or percentages, and may vary across modules taught, departments and even assessment types, such as theory, viva and OSPE/OSCE. There is also inconsistent digital access where some students may have internet access or device limitations, which could affect their digital learning engagement.

Literature Review

Digital learning and engagement are practices and methods of learning adopted by many students in opposition to the conservative and traditional style of learning that is face to face or synchronous, and it gained traction after Covid-19's period of isolation where blended or synonymous modes of learning were preferred and adopted with the increase in learning management systems available for use by the students to access curricular content, along with recorded lectures and various online academic textbook and reference resources that increased students' digital learning footprint. With relation to medical education all over the world, it is generally acceptable that the conservative pedagogies of medicine are face to face learning in order to acceptably be qualified with the competencies and skills a healthcare professional dealing with patient care usually employs. Digital learning platforms may vary and such platforms may also include video and mobile based applications, and tools that support self-paced learning, which is particularly helpful in tackling complex topics and analyzing concepts that are theoretically difficult to understand for individuals.

There is a variety of literature examining digital learning engagement with peer study practices, but very limited research emerging from literature review from the Pakistani context. The subsequent review of literature shows a gap in the correlation of this to academic performance and also informs the need to conduct research in this area in order to influence educational policy and planning. In a study in 2023, Adhikari et al found that students who engaged with digital learning resources having better academic performance outcomes among medical students in a post-pandemic world, where the study also emphasized enhanced understanding of complex concepts as students were able to access the digital learning tools repeatedly, leading to a greater understanding and allowing revision. Furthermore, Alrayyes and Alzahrani in 2023 also reported in their study that academic outcomes were significantly predicted by digital learning engagement, especially when integrated into a structured learning environment.

On the same track, Al-Fadli in 2024 also researched the effectiveness of online learning in the higher educational health sciences sector and found that students who engaged with digital content actively, rather than passively, had better academic outcomes achieved. This meant that quality and in-depth active engagement with the digital learning tools is key to influencing learning outcomes and effectiveness. Furthermore, Goh and Sanders' (2022) research study also further highlighted some key predictors of digital learning effectiveness in MBBS students, referring to motivation, perception of usefulness of digital resources and self-regulated study, finding that successful outcomes are dependent on students engaging with available resources and digital learning may not be effective if the other identified main factors such as motivation is also not activated.

YouTube and Other Digital Learning Platforms

Another learning platform that has gained popularity is YouTube, and it is one of the most utilized tools for use by medical professionals, especially those at the undergraduate stage, as it provides both audio and visual mediums. A study conducted by Aboshady (2022) indicated that YouTube is an additional learning resource used by students enrolled in the MBBS program, where it found that complex foundation topics taught in subjects such as anatomy and physiology were engaged for further visual and conceptual understanding. Another study by Ahmed et al in 2022 examined the same type of social media platforms, such as YouTube and found that social media videos are a supplementary resource for young medical students to use in order to review and prepare for examinations. They particularly like to use it for breakdown and understanding of complex topics, with a particular concern regarding orientation of curriculum with the content and quality of videos found online, suggesting they were not in alignment. Other studies, similarly conducted by Tasnim and Karim in 2023 found that a blended or hybrid learning environment with incorporation of digital learning tools as a digital or online resource supported or reinforced classroom learning but didn't necessarily act as replacements for traditional teaching. This is an important finding as most undergraduate students may substitute online content found through complimentary resources for curriculum guided instruction delivered through traditional teaching methods, such as in the classroom or lab practice. Despite the concerns of quality of content available on line and even the reliability of the content delivered online, there is consistent use of digital learning resources found in research studies, but studies suggest that the concerns do exist and the use of digital learning resources in medical education should be complimentary if recommended or verified, as inaccurate or incomplete information may affect academic outcomes and performance in exams. However, according to Cook et al aligning the conservative curricular models of teaching medicine to healthcare professionals with digital learning tools resulting in digital engagement can be shown to increase the understanding of complex medical concepts, as aligned with objectives defined in the curriculum (Cook et al., 2010).

Social Media Based Student Learning Engagement

Social media platforms have a particular popularity in posting channels that host content creators to create videos that are either educational, entertainment purposes, or both. The platforms such as WhatsApp, Facebook and Instagram have been popular among this current generation of students, who are technologically savvy and also facilitative learners, to be more engaged on social media to share and discuss information, pass on academic content recommendations and even collaborate on joint projects or assignments. A study by Iqbal and Iqbal (2023) on academic outcome resulting from impact of social media-based learning concluded that social media platforms do enhance student engagement through self-directed learning and further facilitate review cycles or support increased peer interaction that can be done beyond the lecture halls and traditional teaching spaces.

Hussain et al in 2023 specifically explore the use of What's app for peer teaching and found that its engagement increases sharing of knowledge and also improves communication of undergraduate medical students, leading to better student performance. They found it helps to not only enhance concepts but also reinforced learning through review of concepts with peers, as what's app is primarily a communication tool. Therefore, the above-mentioned articles enhance and align with broader literature from research suggesting that social media in particular also serves as a complimentary and supplementary learning environment, with tools that enhance academic outcomes and tools that reinforce the quality of interactions with either other peers or content.

Peer Study Practices

There is an established norm that students that learn together also work together to help achieve better academic outcomes, and in medical education, this is particularly true in problem solving that takes place collaboratively, and group discussions that incorporate peer to peer interactions and peer teaching of concepts within or outside of a group. A systematic review conducted by Foster and Snaith in 2024 found that peer led learning led to positive associations with academic outcomes in health professions education groups, where it was found that medical education actually promotes active peer engagement in order to resolve difficult concepts. This reinforced not only improved critical thinking skills, but also retained knowledge among peers participating in peer study practices. Furthermore, Bawa in 2022 highlighted the role of peer-to-peer interactions and collaborations through digital learning environments, such as LMS or others, where a student led community was formed within academia that created enhanced student engagement and lead to sustained motivation for students. This also ultimately led to improved performance and sustainable learning outcomes for the students that participated in the peer led academic community.

Additionally, peer study is not a new concept in education as students from across various disciplines and in particular medical education often use peer study or group study to ensure understanding and retention of complex foundational or advanced level concepts. Group discussion on topics that are beyond one peer's understanding may lead to explanation of concepts, leading to clearer understanding for all while also reinforcing and identifying a knowledge gap for one peer to another.

Academic Performance and Digital Learning

Literature review of digital learning engagement with the dependent variable of academic performance of undergraduate students is varied, but not all studies conclude with a positive outcome or significant correlation, as there are some aspects of research that suggest that reliability on digital learning platforms without curriculum guided or instructor led guidance may lead to just superficial learning, not exploring in depth the complexity of the concepts, and this may lead to retention issues, affecting academic outcomes. The use of digital learning platforms and social media platforms should ideally be integrated into the formal education system and the learning process should be acknowledged with legitimate tools validated for this purpose and provided by the educational institutions. Adhikari et al in 2023 found a positive relationship between digital learning practice and academic outcomes, but the study again reinforced that learning efficiency is only enhanced by provision of access of validated digital tools in blended learning environments and flexible access to materials. Similarly, in Dhar et al. all, a research study conducted in 2022, there was a significant association found among medical undergraduate students and their online learning behavior with examination performance. Those who utilized and engaged in digital resource had better academic performance overall.

Peer Study and Academic Performance

Peer study practices have also shown consistent improved academic performance, but it was found that those students tended to perform even better in formal examination systems, whose participation in peer led learning group activity was greater than those who had studied individually or didn't participate in any peer study group at all. Furthermore, Foster and Snaith (2024) and Hussain et al (2023) also demonstrated that WhatsApp messaging peer learning discussion groups tended to have an overall higher performance outcome rate as these environments were known to facilitate the sharing of knowing and collaborative problem solving at the same time. Therefore, most of the literature on this says that even though social media-based peer interactions enhance students' study habits and academic outcomes, the peer learning aspect is also a big predictor of academic success, particularly in

a learning environment where students are faced with complex formal curricula, such as with medical education's modular curriculum.

Integrative Digital Learning and Peer Interaction

It can be found in recent literature searches of article of both digital learning and peer interaction that the inter-connectedness of both of these factors, dimensionally, support each other. Digital learning and peer interaction facilitate each other, allowing undergraduates to share in an environment that is both collaborative, and supportive of shared knowledge virtually. Research conducted on this in 2025 by Rosaline et. Al found that students engaged with digital platforms were further influenced by their usefulness and content quality, and they would be more likely to engage digital learning tools if they found them to be related to the benefit of their academic outcomes and overall performance. This usually extended to peer collaborations through online learning platforms too. Bawa in 2022 also found that digital learning environments provided greater opportunities for students to exchange knowledge and interact with each other, so in all, the research concludes that peer learning and interaction with digital learning practices should be seen in the same inter-related context, and perhaps even complimentary, rather than separate constructs in the learning process of a student. While researching literature review on the constructs defined above, it was found that digital learning engagement and peer study had several gaps, such as these studies were not conducted within Pakistani context, as most of the studies were developed for first world countries, with a limited number conducted in the South East Asian countries, particularly in Pakistan. There is also very little literature in the combined effect of digital learning engagement and peer study on academic performance. Furthermore, it can be seen that there is little evidence of how learning behaviors are different from academic years, and particularly within the medical education curriculum, which is a complex curriculum defined with a modular design and focuses on different learning strategies to understand the depth of the curriculum. The present study being conducted looks at both the relationships between digital learning and peer study practices, and examines academic performance among medical students of the Pakistan context.

Given the limited research found in the current local context, it was evident that literature review would not be limited to the undergraduate medical students only, and may explore the behaviors of other professionals that may use digital learning tools to seek a deeper understanding of complex concepts, and how self-regulated their online learning behavior actually is. Furthermore, blended learning opportunities, in opposition to just traditional face to face instructional strategies have gained considerable traction in medical education and students have benefitted from structured teaching and from flexible online learning environments. In this context Lu and Wu in 2019 did a meta-analysis on comparing both online and offline learning behavior in medical undergraduates, and found that online learning or digital learning behavior was equally effective or better than traditional off line learning in improving performance outcomes. The study also found that digital learning platforms have allowed repeated exposure of contents, which is great in tackling complex concepts of medical education.

George et all in 2014 also determined that online learning or e-learning environments actually helped improve knowledge acquisition within healthcare students and in particular, they found it effective for preparing through interactive quizzes, discussion forums and even multi-media content usually not found in offline learning environments. The other aspect is that digital learning engagement was found to be effective and significant when it is structured as opposed to passive learning that doesn't engage through interactive content. Overall, most of these studies actually concluded that digital learning engagement as a factor was most effective when structured, regardless of other supportive variables. Similarly, Lie et all in 2013 analyzed the responses of medical students to a structured session on social media professionalism and found that students' awareness these matters was increased with targeted awareness, along with self-regulation of online behavior. However, academic performance was not

measured, but the study does highlight the importance of how digital engagement can have an influence on students' interaction patterns, either directly or indirectly affecting peer engagement and learning. Furthermore, Ashraf et al in 2024 researched this topic in the Pakistani context and found that blended learning or even self-regulated learning practices were predicted significantly by technological competence of medical students, also predicting their academic performance and enhancing collaborative learning practices (Ashraf et. All 2024).

In order to study literature regarding the online learning factors affecting digital engagement, Shabbir et al in 2025 also looked at and analyzed technological access, peer interaction and instructor's presence with regards to success in online environments. This study was useful in examining the link between digital engagement and peer interaction to performance of students academically (Shabbir, Laiba & Ishtiaq 2025). An article regarding online readiness for MBBS students in Pakistan from Yaseen et al (2025), where there was a relationship noted among motivation, learner control, as attributes for self-directed learning, influencing academic outcomes. This article was found to support the idea that learner engagement and its motivating factors do in fact influence performance, along with digital readiness.

In an article on Malaysian MBBS students from a study by Jalal et al in 2023, it was reported that awareness and willingness to engagement in peer learning practice was found to be indicative of academic outcomes and improved performance. However, in 2022, Mahmoud and Husein conducted a research study whose findings indicated that digital peer engagement can enhance communication, without the benefit of performance outcomes being significantly linked to digital learning engagement (Mahmoud and Husein 2022). Banna et al. in 2015 also explored online student engagement and found that interactive digital features particularly enhance the learning experiences and active digital engagement and collaboration are going to be dominant in addressing meaning learning experiences, especially with instructor and peer interactions. Another research study by Chonkar et al in 2019 also was reported to have found that there was a positive association with perceived learning outcomes and student engagement in online course; supposing that this led to the conclusion that learning approaches are in fact linked to academic success through outcomes achievement. Lefebvre et al. (2016) studied residents' understanding of social media professionalism and reported better digital decision-making among those with prior instruction. While focused on postgraduate learners, the findings emphasize that structured digital guidance shapes responsible engagement, which is relevant to understanding digital learning behaviors in undergraduate medical students.

Student Engagement with Self-Directed Learning

Goh and Sanders in 2022 also looked at a factor such as self-directed learning, and its influence on digital learning, and in particular in medical education where students of higher education had higher levels of motivation to self-regulate and those same students had greater engagement with digital resources, leading to an improved academic performance outcome, as students began to take ownership of the learning process through self-directed strategies. Although students in hybrid learning environments who were also interested in engaging with online resources had higher levels of satisfaction and better perceived academic performance, the study highlighted that self-directed learning allows students to tailor their individual learning needs through study strategies. These findings are important to look at in particular relevance to the present study being conducted among medical students whose informal curricular expectation is to adopt their learning strategies through self-directed learned skills early in their educational career, in the pursuit of better educational performance outcomes. Finally, it is important to mention that collaborative learning environments are also reviewed in literature in the context of academic achievement, and it is an effective learning

strategy that involves students or peers working together to achieve shared learned outcomes, ideally through group discussions, problems solving and knowledge shared.

Valdez et. Al in 2020 also looked at what improves academic achievement in health professions education and it found that those students who participated in group learning activities also retained their shared knowledge better, and Schmidt et al in 2011 highlighted that the effectiveness of such methods as PBL, common in medical education, enhanced critical thinking while allowing students to explore complex and in-depth problems by encouraging students to engage with their content.

In conclusion, the reviewed literature found that digital learning engagement and peer study practices may be considered as factors that influence academic performance of individuals in medical education program, where digital learning provides the flexibility and accessibility for self-directed learning. Peer study practices may promote more collaborative learning, where in medical education critical thinking is important to master as a core competency.

Research Methodology

The study is a cross-sectional Quantitative research study, meaning data will be collected at one point in time and consisting of students from pre-clinical years. Since the purpose is to measure how much / to which proportion students use digital learning and how much they are engagement per week, we will utilize a survey/ questionnaire to measure the two variables and the independent variable, which is academic outcomes. These are self-reported academic outcomes measured in perceptions, and the population of the study is all medical students in years 1-3 and this makes a population around 1050 students. Students will be sampled through Stratified Random Sampling technique, and a sample of 320–350 students overall will be selected to ensure good accuracy and allow comparison across the three years. This research study is a cross-sectional quantitative to examine the relationship between Digital Learning Engagement (H1), Peer-Study Practices (H2), and Academic Outcomes among MBBS students enrolled in pre-clinical years at a public sector medical college. A survey-based procedure/research design is selected because it allows efficient measurement of student learning behaviors and academic performance indicators at a single point in time, which is appropriate for comparing patterns across three academic years.

Target Population

The target population included undergraduate students that are enrolled in the MBBS program, or medical students enrolled at selected public sector medical college in Pakistan, which is a population of 450 students' total. This population represents the pre-clinical of a students' education, where the concepts are mostly foundational and reliant on conceptual understanding leading to complex problem solving. This group is targeted because ultimately the students in these groups are likely to engage in self-directed learning, using digital learning apps or other programs/platforms, while they are also engaged in peer study, either in groups or through other means in order to adapt to the academic rigor of the program. Therefore, by including enrolled students in three academic years, not considering their actual lecture attendance, the research study can gain a comprehensive representation of the different kinds of learning and studying behaviors that students engage in various academic years. The accessible Population is also the focus, so all enrolled students-regardless of lecture attendance—will be included in the sample, provided they are registered as full-time undergraduate MBBS students in pre-clinical years.

Sampling Technique and Sample size

The employed sampling technique will be stratified sample technique, probability sampling technique, where the sample size is determined by equal year-wise representation, and this will allow year wise

exploration of data in line with the study's objectives. Population and sampling are determined as follows where the total population is approximately a total student population of 450 students. Applying the Cochran's formula, which is commonly used for calculating sample sizes in survey-based research, and for at the 95% Confidence level and a 5% Margin of error, and the assumed response distribution is 50%. So, using the standard sample size formula with finite population correction, the minimum required sample size for a finite population of 450 students is approximately 207 students. To account for non-response or incompletely filled questionnaire/survey instruments, the 10% additional responses will be required, resulting in a target sample size of approximately 228 students, an additional 21 responses.

Research Hypothesis:

H01: There is no significant relationship between digital learning engagement and academic outcomes among MBBS students.

H02: There is no significant relationship between peer-study practices and academic outcomes among MBBS students.

H03: There are no significant year-wise differences in participation in digital learning or peer-study practices.

Research Instruments

A Structured, self-administered questionnaire will be used to capture the behavioral learning strategies through a reliable measure, and aligned with the variables introduced in the conceptual framework. The variables introduced in the conceptual framework include the following:

1. Digital Learning Engagement Scale which is the exploration the extent of use, frequency of use of certain modes of digital engagement, such as YouTube, accessing recorded online lectures, medical apps, other AI tools
2. Peer-Study Practices, which may include group study, peer teaching, WhatsApp group study, collaborative studying at the library.
3. Academic Outcomes, which are self-reported module scores, CGPA, or self- perceived performance of the student overall.

Data will be collected through a structured and self-administered questionnaire which is designed to assess digital learning engagement, peer study practices, and perceived academic performance within the sample size of the target population. The questionnaire is to be administered through google forms, and this allows for efficient and accessible data collection from participants that are in the sample size, automatically recording their responses. The first section of the questionnaire, section A, was to record the demographic information of the participants including age group, year of study, and device availability, along with reliability of the internet in a Likert scale format. This allows for detailed descriptive analysis and comparisons. Section B of the instrument focused on digital learning engagement, designed to measure the frequency and extend of which students may engage in or use learning resources, such as YouTube, recorded lectures, other educational applications available digitally and even other digital learning platforms for learning purposes. Section C measured the peer study practices, focusing on extent and this includes peer study group, peer teaching, collaborative learning, and engagement in apps for the purpose of academic discussion and learning with other peers. The Section D of the research instrument measures the perception of the participants regarding their academic performance, either above or below average overall and in consideration with their peers. This is the measurement of the dependent variable in the study and it is self-reported in terms of academic performance in the year and in written and practical/clinical assessments, measured in a

Likert scale ranging from “Strongly Disagree” to “Strongly Agree”. All question items in sections B, C and D have a response scale that is a 5 point Likert scale, ranging from 1 to 5, allowing for quantitative analysis of the varying learning behaviors and outcomes.

Pilot Study

A pilot testing study was conducted after the questionnaire is finalized and distributed to 25 students within the identified target population, which was then used to determine the relevance and validity of items. This ultimately led to either refining the factors selections, questions asked or the response scale. Then reliability was assessed using Cronbach’s alpha with a greater than 0.7 to be considered as acceptable for internal consistency. The results of the pilot determined that the instrument was found to be internally reliable with a Cronbach’s alpha of 0.881, and this helped to reduce the ambiguities in the survey questionnaire.

Validity of Instrument

The instrument is considered to be valid in terms of the validity of the instrument being what it is intending to measure. In this research study, both content and face validity were established. The content validity was ensured by developing the questionnaire based on established literature on digital engagement, peer study practices and academic performance as variables. Then, the instrument was reviewed and piloted, as the subject reviewer in education and medicine was able to look at the relevance of the items and overall comprehensiveness of the items. They also determined that the items were provided with clarity. The pilot study conducted also established face validity and it was found that the participants of the pilot study only suggested adding a minor element, such as inclusion of 1-5th years of medicine to improve feedback on the constructs being measured. They suggested that adding 4th and 5th year students provided for a more valid instrument as first year students are not necessarily well-versed in study techniques, whereas, 4th and 5th year students are able to engage with digital tools as well as have sustainable learning patterns, including those with peers and groups as well as have faced examinations that lead to determine if those study techniques would be effective or not. Therefore, it became important to include the 4th and 5th year students in this study.

Reliability of Instruments

The reliability of the questionnaire survey was assessed to measure the internal consistency of the Likert scale like items, where the number of items analyzed were 18, and the Cronbach’s alpha value was evaluated, which yielded good internal consistency. According to the standard criteria values of Cronbach’s alpha values above 0.70 are good internal consistency, and this survey yielded consistency of .881, which indicates good strong reliability.

Further analysis also revealed that questions 10-15 regarding digital learning engagement resulted in good reliability of 0.738 Cronbach’s alpha, whereas peer study practices factor questions from 18-23 had a Cronbach’s alpha of 0.895, which is excellent reliability, while academic performance (Qs 24-31) showed acceptable reliability at 0.70. These indicate that the questionnaire items are able to measure their respective constructs and that the survey instrument is reliable for use in statistical analysis.

Method of Data Collection

The methods of data collection include development and pilot testing of the instrument, questionnaire/survey developed with the research objectives in mind. This would be preceded by ethical approval of the board responsible for this purpose. The data for this study would be then collected using a structured online questionnaire developed through google forms. They are able to

visibly link the research questions with the variables it is intending to measure. The topic was framed and the scope of study was identified initially, followed by identification of the population and sample size, and the sampling technique was determined. The questionnaire was designed based on available literature review and the conceptual framework of the study, which focused on digital learning engagement as an independent variable, peer study practices as an independent variable determining the effect on academic outcomes (self-reported), as a dependent variable. The questionnaire was then reviewed for validity and pilot study was done to determine if the variables identified are reliably measured by the instrument. A pilot study was conducted in a small fraction of the MBBS students, and this would be followed by any modifications in the instrument based on feedback received. The finalized questionnaire would be then be converted to an online link to ensure easy access for response collection, followed by data cleaning and data transfer to SPSS.

The participants would be informed about the voluntary participation and ensure to provide informed consent before participation in the study. The method of distribution may include official channels such as email and What's app as through the class CRs, and students would be given approximately 2 weeks to respond to the survey. The data would be interpreted for testing the hypothesis of the study by transfer into SPSS software and the latest version would then assist in statistical analysis.

Data Analysis

Qualitative and Quantitative: Demographics

Current Year of Study

The first demographic question asked about the respondents and their current year of study. The distribution of responses by current year of study (n=349), found that first year students accounted for 68.5% of the sample size, while 2nd year students represented 10.6% of the total respondents, and 3rd year students comprised of 10% of the sample size.

Age Group

The age group distribution of respondents at n=349 found that the 18-20 age group category comprised of 77.1% of the total sample, indicating that the majority of the respondents were in the early stage of their undergraduate medical career, followed by the 21.-23 years age group at 20.6% and 23% of responses from the 24.26 years category, there were no respondents in the 27 years or above category. The data distribution suggests that the sample reflects the perspective of the early year medical students in their undergraduate program of choice, MBBS and with limited input from older or more advanced cohorts.

Gender

The gender distribution of the participants (n=350), indicates that there are 69.4% female total respondents and there are 30.6% male participants in the survey.

Primary Device Used for Studying

The distribution of devices used for studying by the sample size indicates that laptops are the most common devices used by the respondents, with 40.35, which smartphones at 33.7% is the next common device, which reflects a reliance on mobile based learning from those devices. Then tablet, which constitute 24% of usage, followed by the desktops and other devices, which are collectively less than 2%, indicating a very small dependence on fixed or alternative technologies. Therefore, the findings indicate that there is a clear preference for mobile digital devices, particularly laptops and smartphones, as the primary tool for academic learning engagement.

Device Availability

Based on the previous question, device availability (n=350) indicates that the participants have access to both smartphones and a laptop (77.1%), and this reflects a higher level of digital resource availability, with only a small percentage (18.9%), which rely on smartphones only, suggesting limitations on larger more expensive technology. In contrast, there is a negligible percentage of laptop only users, and the combinations of each are minimal, as per the responses indicated.

How Would you Rate your Internet reliability?

The internet reliability rating from 1=very poor to 5=very good indicates a moderate to positive perception among the undergraduate student respondents. The largest percentage of students rated their internet reliability as a 3 (31.1%), and 4 (31.1%), suggesting that their experience average to good connectivity regarding the internet. Additionally, approximately 18.3% rated their internet reliability as a 5, which is very good, indicated highly reliable internet access, while a smaller proportion (10.6%) also rated their reliability as a 2, and 8.9% as very poor. Overall, approximately 80/5% of respondents rated their internet reliability between average and very good and this demonstrates that most undergraduate students have an adequate to strong internet access though a smaller population still faces connectivity issues that may impact digital learning engagement.

Average Lecture Attendance Frequency

The frequency distribution of lecture attendance of the sample size indicates that majority of the students have a high level of attendance in lectures, meaning in class participation. 54% of the respondents reported excellent attendance (>85%), and an additional 35.7% indicated good attendance within the range of 71-85%, whereas there was minimal proportion of undergraduate students who reported 51-70% lecture attendance and even more minimal reported that they attend less than 20% in the less than 20% category.

Which digital learning resources do you use or access frequently?

The frequency distribution of digital learning resource usage that 311 respondents (88.9%) utilize YouTube Educational videos as the most frequently used resource, followed by medical learning applications (25.7%) and online lecture recordings accessed at 22.3% or 78 respondents.

How many hours per week do you spend on digital learning activities?

In terms of digital learning hours per week, the largest percentage (24%) report spending between 11-15 hours per week, followed by 6-10 hours (22.9%), and 0-5 hours (22.3%), while 16.6% spent 16-20 hours in digital learning per week, followed by minimal percentage of 14.3% at 21+ hours.

How many hours per week do you spend studying with peers?

Peer study time is indicated at 0-5 hours per week by the majority of the respondents at 63.1%, followed by 20.3% at 6-10 hours and minimally at 21+ hours, while 8.9% of respondents engage with peers for 11-15 hours we week.

Which types of peer study interactions do you participate in? (Select all that apply)

The distribution of peer study interactions by the respondents indicated that the most common form of interaction is sharing academic notes with peers at 52.3% (183 respondents), and this indicates that resources being exchanged is highly sought after. This is followed by group study sessions at 44.9% and participation in what's app study groups at 39.7%, where this shows a greater role of informal and digital collaborations. Furthermore, peer teaching is a type of peer study interaction at 33.4% which

indicates a more active or moderate instructional engagement or collaboration among peers. While 14% of overall respondents also chose to reply to one or more of the listed options, suggesting combined or varied peer study interactions.

How would you describe your overall academic performance in the previous module/semester?

The distribution of overall academic performance in the previous module or semester indicates that most students perceived their performance from “average” (45.7%) to “above average” (33.7%), followed by 11.7% rating it as “outstanding/extraordinary”. A smaller proportion of these respondents rated below average performance (approximately 8%), while only a minute percentage (< 2%) rated their performance as “poor”.

Compared with my classmates, my academic performance is:

The description of self-comparison of academic performance from peers at n=350, indicated that majority of the students perceive their performance as “above the class average”. The largest percentage at 47.1% reported their academic performance at about average, and 33.4% considered themselves above average. A smaller proportion of the sample size also rated their performance “much higher” than their peers at around 4-5%. Overall, generally 80% of the respondents rated themselves as average or above, suggestive of a general positive self-perception of academic standing relative to peers.

Based on my most recent exam results, my performance level is:

The frequency distribution of exam-based performance results, also self-reported at n=350 indicated that students perceive their performance average to above average, with the largest percentage reported “average performance” at 43.4%, and 37.4% who rated themselves “above average”, while an additional 9.1% rated their performance as “exceptional”. Only 2-3% rated “poor” performance, while 7-8% rated below average performance, with overall over 90% of students’ self-reported performance falling within the range of ‘average’ to “exceptional” categories respectively.

What was your approximate GPA in your most recent examinations?

The majority of students at 55.4% reported their GPA in the most recent examination in the range of 3.6-4, followed by 26.9% within the 3.1-3.5 range with overall high academic achievement. A smaller percentage at 14% falls within 3.6 to 3.0 range, while few students also reported GPA below 2.5. The data was self-reported and categories were defined in terms of grading systems in the current context

Data Analysis: Inferential Findings (Hypothesis Testing)

H01: There is no significant relationship between digital learning engagement and academic outcomes among MBBS students.

Pearson Correlation			
DIGITAL LEARNING ENGAGEMENT * ACADEMIC PERFORMANCE			
		Digital Learning Engagement	Academic Performance
Digital Learning Engagement	Pearson Correlation	1	.305**
	Sig. (2-tailed)		.000
	N	352	352
Academic Performance	Pearson Correlation	.305**	1

	Sig. (2-tailed)	.000	
	N	352	352

** . Correlation is significant at the 0.01 level (2-tailed).

Within statistical software, Pearson correlation was conducted to examine the relationship between digital learning engagement and academic performance. The results indicated a positive and statistically significant correlation between the two variables, with $r=0.305$, $p=0.001$ (2 tailed), and $N=352$. This means that the higher levels of digital learning engagement are associated with between academic performance and the strength of the correlation ($r=.305$) can be interpreted as moderate relationship.

H_01 stated that there is no significant relationship between digital learning engagement and academic outcomes among MBBS students. It can be found that from the correlation results, $r =0.305$ and $p=0.000$ (<0.05), since the p value is less than 0.05, the relationship is statistically significant; therefore, the null hypothesis (H_0) is rejected.

H02: There is no significant relationship between peer-study practices and academic outcomes among MBBS students.

Correlation			
PEER STUDY PRACTICES * ACADEMIC PERFORMANCE			
		Peer Study Practice	Academic Performance
Peer Study Practice	Pearson Correlation	1	.445**
	Sig. (2-tailed)		.000
	N	352	352
Academic Performance	Pearson Correlation	.445**	1
	Sig. (2-tailed)	.000	
	N	352	352

** . Correlation is significant at the 0.01 level (2-tailed).

Correlation			
DIGITAL LEARNING ENGAGEMENT * PEER STUDY PRACTICE			
		Digital Learning Engagement	Peer Study Practice
Digital Learning Engagement	Pearson Correlation	1	.338**
	Sig. (2-tailed)		.000
	N	352	352
Peer Study Practice	Pearson Correlation	.338**	1
	Sig. (2-tailed)	.000	
	N	352	352

** . Correlation is significant at the 0.01 level (2-tailed).

Pierson correlation testing was performed on the variables peer study practices and academic performance, and $r=0.445$, $p<0.001$ (2 tailed), $N=352$, where the relationship was found to be positive and moderate, and statistically significant. Null hypothesis # 2, is rejected, as $p =0.000$ (<0.05), $r =0.445$, and since the p -value is less than 0.05, the relationship is found to be statistically significant. This indicates that peer interactions play a role in academic performance and outcomes and digital learning engagement and peer study practices are both inter-related, where students may combine both learning approaches; however, the strength of the relationship of peer study practices with academic

performance ($r=0.445$) is comparatively stronger than digital learning engagement to academic performance ($r=0.305$).

Digital Learning Engagement (Year Wise ANOVA).

H03: There are no significant year-wise differences in participation in digital learning or peer-study practices.

ANOVA					
Digital Learning Engagement					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.570	4	.142	.298	.879
Within Groups	165.623	347	.477		
Total	166.192	351			

ANOVA: ($p = .879 > .05$), not significant

One way ANOVA was conducted to examine the differences year wise in digital learning engagement and the results indicated that there was no statistically significant difference.

$P = .879 / p > 0.05$ suggests that the variation across academic years is negligible and not statistically meaningful. The low f value also confirms minimal differences across groups relative to within group variability. Therefore, the null hypothesis is not rejected for digital learning engagement, indicating that students across various academic years demonstrated similar digital engagement levels.

ANOVA					
Peer Study Practices					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.749	4	.937	1.161	.328
Within Groups	280.070	347	.807		
Total	283.819	351			

With regards to Year Wise ANOVA results for Peer Study Practices, it was also found to show no statistically significant difference with a p value of 0.328 (>0.05). The F (4, 347). In the Post Hoc LSD results. All pairwise comparisons show that $p > 0.05$, indicating no statistical difference observed between any specific year groups, with the closest comparison of 2nd year to 4th years ($p = 0.0520$ does not meet statistically significant, as per Post Hoc LSD results. Across both dependent variables, digital Learning Engagement was found to be not significant ($p = .879$) and Peer-Study Practices was found to be not significant ($p = .328$).

In conclusion, one way ANOVA was done to examine if there existed any year wise differences, between study years of MBBS professional I, II, or III, in terms of digital learning engagement and it was found that there were no statistically significant difference across years of study in both variables, digital learning engagement nor peer study practices. Post Hoc comparisons using LSD further confirmed that pairwise differences did not exist between the group years selected ($p > 0.05$). Therefore, the null hypothesis is not rejected that means that participation in digital learning engagement and peer study practices is consistent across years of study. It can be further interpreted that academic progression across professional years of study does not statistically influence students'

engagement in digital learning and peer study behaviors, meaning there is a uniformity of learning strategies adopted by undergraduate students in years 1-3.

Discussion

Summary of the Study

The study's research objectives were to determine the extent of digital learning engagement and peer study practices on academic outcomes or performance among professional year medical students with the specific objective to determine the extent of these relationships as written below:

Since the study conducted a quantitative research investigation on the patterns of digital learning engagement and peer study practices among undergraduate medical students, the cross-sectional nature of the survey allowed a one-time insight into several years of study to note engagement patterns with a focus on their digital devices, their access to the world wide web to access digital resources, internet reliability, study behavior and academic self-performance.

Furthermore, the study also investigated if the year of study does in fact statistically influence participating in digital learning engagement behaviors and peer study practices, using one way ANOVA, whereas regression analysis and correlation was also used in the research investigation to explore the predictive role of peer study practices and academic performance on digital learning engagement.

Findings of the Research

The key findings of the research included demographic data that informed that the first year (68.5%) students and female (69.4) participants were the majority of the respondents, whereas most of the respondents were aged 18-20 years of age (77.1%), where we can predict these to be early stage undergraduate learners. In terms of digital access infrastructure, 77.1% of the respondents had both smartphones and laptops, where it was also found that internet reliability was found to be generally rated as "moderate" to "good", and with 80% or above rating their internet reliability as, "between average and very good". The learning preferences of the participants indicted that majority of the students had laptops (40.3%) and smartphones at 33.7%, which were their primary study devices and furthermore, YouTube educational videos were the most frequent ways of accessing digital learning resources at 88.9%. additionally, most of the undergraduate students worked on digital learning engagement activities at least 6-15 hours per week. In terms of peer study practices, it was found that peer study practices (PCP) were limited in terms of hours spent weekly, no more than 0.5 hours weekly according to the majority (61.3%) and most common types of peer interactions were found to be "sharing academic notes" at 52.3% and this was followed by group study interactions at 44.9%. in terms of reported academic performance, most students rated their academic performance to be among average (45.7%) or above average at 33.7%; whereas, lecture attendance was found to be particularly high, with as much as 90% of respondents selecting "good to excellent attendance". In terms of the inferential findings, it can be summarized that no significant year wise differences were found among digital learning engagement year wise using ANOVA, similarly with peer study practices, which did not allow us to reject Ho3; whereas, peer study practices and digital learning engagement were both significantly associated with academic performance.

Conclusion

The research study findings concluded that statistically significant and meaning ful relationship do exist among the key variables, leading to a clear acceptance or rejection of the hypothesis proposed. Students were strongly inclined towards technologically engaging individual learning environments,

where they were particularly in favor of video-based pedagogies, such as YouTube videos. In conclusion there are statistically significant and educationally meaningful relationships demonstrated among the variables introduced, with a positive and statistically significant correlation between digital learning engagement and academic performance ($r = 0.305$, $p < 0.001$), and this is a moderate association according to the r figure; which lead to the first null hypothesis being rejected, confirming a relationship between increased digital learning linked to academic outcomes. Secondly, the peer study practices of undergraduate medical students were found to have far stronger correlational relationship with academic performance with $r = 0.445$, $p < 0.001$, suggestive of a moderately strong relationship existing between the two variables; this lead to the null hypothesis (H_{02}) being rejected, in essence leading to the conclusion that the collaborative learning environment that may exist through peer study practices is a more influential predictor of enhancing academic performance and outcomes of undergraduate medical students, than compared to digital learning engagement alone. Furthermore, a significant relationship that is also positive exists between digital learning engagement and peer study practices ($r = 0.338$, $p < 0.001$) as these learning strategies are considered either complimentary or corresponding to each other, rather than being alone or mutually exclusive of each other.

In contrast to this, the relationship significance of either variable with academic years of the student population was found to have no statistical significance, either in digital learning environment ($p = 0.879$) or peer study practices ($p = 0.328$); therefore, null hypothesis (H_{03}) was accepted, with the implication that undergraduate students of MBBS across years have demonstrated consistently behaviors with regards to their digital learning engagement and peer study practices. Therefore, this leads to the conclusion that while both digital learning engagement and peer assisted learning practices are both learning strategies that significantly contribute to academic performance of an undergraduate medical student, such patterns of engagement remain stable and consistent across each stage or career progression of undergraduate medical education.

Recommendations

Based on the conclusion and findings, there are some recommendations that may be considered by curriculum designers and reviewers, with respect to integrating digital learning resources of content that is engaging within the curriculum, where the faculty and students have both access to digital learning platforms as part of the official curriculum. These platforms may include video-based learning and medical apps. These digital learning strategies should also be aligned into teaching pedagogies and then aligned according to the preferences of the students, with regards to learning engagement. Furthermore, it is also a recommendation to enhance and promote group or peer structured learning activities, where formal peer teaching programs or mentorship programs from year to year would lead to the formation of collaborative learning groups, in order to enhance the levels of peer engagement among learners of the same and different types of learners, across class years. Additionally, it is a strong recommendation to enhance digital infrastructure and access with targeted support for those that have limited connectives or device access, as this would encourage digital learning in rural areas as well as urban areas, where further research can also be conducted to see what type of balances approaches to learning lead to more successful academic outcomes. Furthermore, additional research may be conducted on gender based or performance-based differences among learners based on these two variables. The findings and conclusion contribute to the modern learning behaviors of students in undergraduate medical programs, and this also emphasizes the growth of engagement with digital devices along with traditional classroom teaching methodologies to contribute to excellence in academics.

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