Benefits and Challenges of Mobile-Learning Brought to Student Learning Outcomes in Higher Education: A Systematic Review from 2014-2023

Jingdan Kang
The National University of Malaysia

Abstract
The development of technology has brought new development opportunities to education, in other words, mobile and remote learning have become an indispensable part of various schools. In addition, the impact of mobile and remote learning on students has attracted attention from all sectors of society. Mobile learning has been utilized in the process of teaching and learning in higher education, leading to various impacts on student learning outcomes. Many researchers have conducted empirical studies to explore how mobile learning impact student outcome in higher education institutions. To facilitate the use and design of mobile learning and improve teaching and learning in the digital age, there is a urgent need to review existing literature and identify benefits and challenges that ML lead to student learning outcomes. This study uses systematic literature review (SLR) to analyse 355 articles from Scopus and wos. Mobile learning bring benefit as follows: Providing Flexibility and Accessibility; Improving learning effectiveness;Developing internal motivation and positive attitude; Enhancing student engagement. On the other hand, mobile learning cause several challenges: current functions failed to complete leaning and teaching outcomes; Distracting user from knowledge learning; leading to vision impairment. I suggest further researcher to identify how ML influence teachers and teaching process.
Keywords: Mobile Learning, Higher Education, Learning Outcomes, Systematic Literature Review, Influence

Introduction
Background
Advanced digital communication technology and mobile devices have imposed remarkable changes in teaching and learning (García-Martínez et al., 2019). Mobile and distance learning has been widely adopted as a teaching aid at various levels of education practice, playing an increasingly important role in the process of teaching and learning and in the education system. Traxler (2013) indicates that mobile devices act as unparalleled access to communication and information in teaching and learning. Under these circumstances, mobile learning has increasing various influences on student learning, which draws great attention from educators and academic researchers. Currently, there are a large number of existing studies exploring how mobile learning affects student learning from different facets and

perspectives, including student learning motivation, learning process, and cognitive development (Jia et al., 2022).

The rapid development of digital communication technology makes mobile learning more convenient and accessible for teachers and learners, promoting the application of mobile and distance learning in education field. Particularly, during the age of pandemic area and post-pandemic area, mobile learning is used a tool and a strategy to address the crisis of teaching and learning difficulties during the pandemic lockdown (Kärchner et al., 2022). Existing research demonstrates that learning methods via internet benefit student in several way, such as promoting the equity in education since it allows students to get access of learning resources despite of geographical location (Boyinbode et al., 2012). Besides, technology-assisted learning considerably enhances learning performance and encourages learning motivation (Kärchner et al., 2022).

Definition of Mobile Learning
As mobile learning is a relatively new concept, there is no consensus on the definition. Fischer (2011) defined mobile learning as the process of generating new knowledge through interaction between humans and interactive technologies when using mobile devices. Keegan (2005) defined mobile education as the process of educating or training through small electronic devices such as PDAs, handheld computers, handheld computers, mobile phones, or networks.

Significance of the Research
With the development of smartphone and mobile devices, mobile learning has been one of the dominant and prevalent learning methods among e-learning (Wilkinson & Barter, 2016). Mobile learning has been utilized in all stages of education, including pre-school level, school level, higher education, professional education and lifelong education. A large number of previous studies has explore how ML influence student learning in different educational stages and various disciplines. John and Yunus (2021) indicate that of social media has been integrated in teaching speaking skills. Lai and Hwang(2015) point out that teaching strategies with mobile technologies allow teaching shift from traditional teacher-centered teaching into innovative learning practices and student-centered learning. Eger (2018) indicates that teachers using mobile learning spend more time observing students' learning process. Ifeanyi and Chukwuere (2018) found out that mobile learning efficiently promotes student engagement. Despite benefits, existing studies also indicate that ML also imposes challenges and negative influences on student learning (Jia et al., 2022). In order to optimize ML and improve student learning, it is necessary to review the benefits.

Trends in Mobile Learning
ML has been used in different stages of education and in different groups of students. Consequently, researchers have paid great attention to student-related issues in mobile learning. A large number of previous research has explored the effect of ML on student learning, including learning process, student engagement, student performance, learning motivation and learning outcomes. For instance, Yu (2019) focus on how mobile learning affect English vocabulary learning at a Chinese high school students. Lim et al (2019) explore how to develop a productive mobile learning approach by review top-cited ML-related studies that involving various ML learning methods and analyzing student behaviors, thinking

patterns, and cognitive processes. In terms of research area, many research focus on language learning, STEM, sport, medicine, and nursing. Many research also reviews research and trends in studies related to mobile learning.

Mobile Learning in Higher Education
A lot of the m-learning-related researches has been conducted in school-aged learners. However, research in the context of higher education is relevant and inconsistent (Nguyen et al., 2015). In the current context of higher education, the emergence of mobile learning is a relatively new phenomenon that has developed in the past decade (García-Martínez, 2019). Teaching and learning have been changed and shaped by digital communication education in recent decades. ML changed higher education in many facets, including the teaching process (curriculum, pedagogy, teaching methods) and learning process (Concannon, et al., 2005). Higher education has benefited from advanced technology and mobile learning. However, ML also imposes challenges and drawbacks to higher education. In regards to research focus, many researchers have paid attention to the influence and the use of ML in the context of higher education, including teaching-related issues, student learning-related issues, the use of mobile devices, and the design of mobile learning apps.

Zhang (2019) reviews how mobile learning influence English language learning outcomes in school-level Chinese students. Publications cited suggest that although mobile learning considerably promote learning outcomes, it have significant disadvantages that researchers and educators should not neglect. García-Martínez et al (2019) review research conducted in a university context to explore influential factors that positively encourage students to use mobile learning, the type of application that is frequently used, and the role teachers play in mobile learning. The results reveal that teachers' technological and pedagogical sorts of knowledge and teaching methods of mobile applications, the ease of use of mobile devices, and university infrastructure are key factors that promote the success of ML. In the learning process, teachers play a predominant role, acting as a guide and a supervisor. Sormunen et al (2022) examine the effects of the use of digital technologies on learning outcomes in the higher education context. The findings argue that digital technologies utilized in higher education have a considerable positive effect on student learning outcomes, including building academic knowledge, collaborative skills, and learning capacity and contributing to general competence development. However, this study point out further research is expected to exam whether digital technologies have negative effects on and bring challenges to students learning. NiKou (2018) shed light to the the effect of mobile-based assessment and the results reveal that most literature report a positive impact on student learning. It also identify a research gap, more studies are needed to exam negative impacts of mobile assessment. The target research group is elementary students in STEAM subjects. Bazhenova & Shuzhebayeva (2022) adopt a meta-analysis to review the mobile learning's effect on student cognitive learning outcomes. Some people believe that mobile learning is more conducive to developing students' learning outcomes in terms of both flexibility and accessibility in the learning process. Mobile learning uses handheld devices as a medium, combining diverse high-quality content, effective feedback, and good visualization to create more convenient and favorable mobile learning conditions. However, this review only include a small number of studies undermining the generalization of outlined findings. Wilson et al (2020) review digital technologies (mobile learning) impact undergraduate nursing student and presents that digital technology creates challenges and benefits to student learning in

delivering patient care. Mobile learning in clinical settings create benefit by increasing students confidence and sense of belonging, while it the lack of access of devices impede student ability.

Previous review focus on a specific research filed, such as Zhang (2019) focus on english vocabulary learning and Wilson et al (2020) focus on nursing education. Rajendran and Yunus (2021) investigate how mobile learning is adopted to enhance speaking skills among ESL and EFL learners. Some are outdated and do not involve articles published after 2019. some reviews discuss benefits while neglect challenges and disadvantage. Several review articles are limited in researches conducted before 2020.

A large number of mobile learning devices and teaching method to replace face-to-face teaching developed rapidly during the Covid-10 pandemic. In this regard, it is necessary to involve articles in the pandemic and post-pandemic age. Since 2020, technology based learning has played an important role in the teaching of epidemic crisis response. The COVID-19 pandemic has further force educators to build online teaching and blended teaching via digital learning technologies. identifying and Reviewing articles published after the pandemic would contribute to further research and provide advice to educators.

According to the mentioned research gap, this research proposes research questions as follows:
Q1: What are the benefits that mobile or distance learning brings to student learning outcomes in higher education?
Q2: What challenges does mobile learning bring to student learning outcomes in higher education?

Method
This research adopt systematic literature review to explore the research questions. SLR is a research method that gathers secondary data from existing academic literature to explore specific research questions in a certain academic domain. It has been confirmed to act as an effective research method to fulfill research gaps and answer research questions. Kitchenham (2004, p2) states that systematic review is able to produce new insight into research questions and generate integrated results by combining data from a number of relevant researches and bringing pieces of evidence together. In the review process, SLR brings evidence in different types of research together and then analyses data in a systematic and scientific way.

The procedure follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, which could be recorded as PRISMA, guidelines to search for literature, select desired literature, and analyze data. Compared with convenience literature review, PRISMA can minimize biases in selecting literature and therefore have higher degrees of reliability and validity (Moher et al., 2020).

The flow diagram illustrates the selection process.
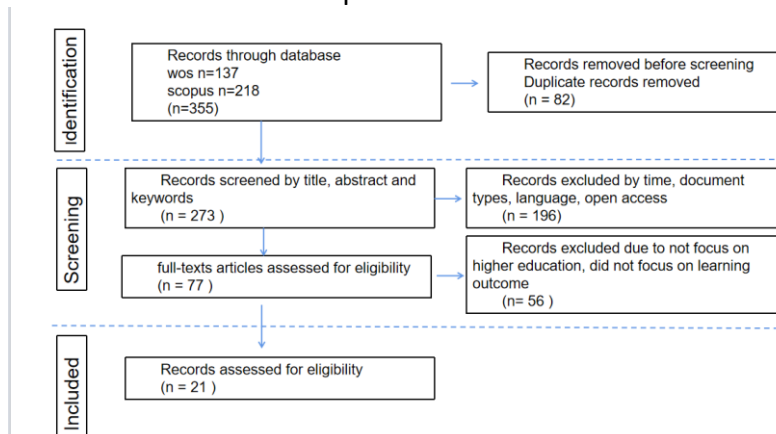
Identification

Firstly, the author chose wos and Scopus as databases of searching literature since they are considered the commonly cited and reliable databases for scholars in social science research. Then, I develop three constructs according to the research questions, namely 'mobile learning', 'learning outcome', and 'higher education'. next, i identify research strings as shown in table 1.

Table 1

Database	Search String
Web of Science (WoS)	TS=(("higher education" OR " tertiary education") AND ("mobile learning*" OR "mobile app*" OR "m-learning" OR "mobile devices*") AND ("learning outcome*" OR "student learning*"))
Scopus	TITLE-ABS-KEY (("higher education*" OR "tertiary education") AND ("mobile learning*" OR "mobile apps*" OR "m-learning" OR "mobile devices") AND ("learning outcome*" OR "student learning*"))

Screening

After the identification, I screen the duplicate of the two databases. 82 duplicate articles were removed, resulting in 273 articles for further screening. The next stage is to screen literature by title, abstract, and keywords, according to publication date, type of publication, language, and accessibility. Table 2 shows the inclusion criteria and exclusion criteria. 77 articles remain after the screening procedure. Then, the remaining full-text articles are assessed and 56 articles are excluded articles as they do not meet the following eligibility criteria: articles are conducted in the context of higher education, research question focuses on student learning outcomes. Finally, 22 articles are included for data analysis.

Inclusion Criteria	Exclusion Criteria
Studies conducted between 2014 and 2023	Studies conducted before 2014
Articles from journals	Conference proceedings, review articles, book chapters, reports
Articles are written in English	Articles are not written in English
Open access	Not open access

Included

The studies included are displayed in Table 3.

Study	Database	Aim	Samples	Findings
Kärchner et al. (2022)	WoS and Scopus	This analysis not only explains the direct impact of mobile device usage on academic performance, but also discusses how to successfully use these small tools in classroom environments, as well as how the use of handheld devices in actual educational environments is related to a wide range of motivation and other learning related factors.	The article included 59 samples (N = 4259) from 58 studies published between 1998 and 2021.	Students who use handheld devices for learning in the classroom have higher self-efficacy and learning motivation, as well as greater autonomy and self-determination. A more positive attitude towards learning and higher satisfaction with the learning itself. Using a handheld gadget also appears to assist in minimizing cognitive burden.
Glackin,Rodenhiser and Herzog(2014)	WoS and Scopus	Will the use of mobile devices affect students' normal access to library resources, especially online electronic resources? What are the advantages and	There are 22,000 students at the University of Boise State.	Having or utilizing more mobile devices boosted the frequency with which respondents accessed e-books significantly. Students viewed convenience and cost savings as the most significant

		disadvantages of using these mobile devices? Do these mobile devices influence students' learning?		benefits of utilizing mobile devices, whereas defects in functioning and pedagogy were drawbacks. Using e-books and mobile devices in the classroom has a major impact on students' educational experiences.
Chen(2022)	WoS	This article investigates the learning consequences of English learners who use mobile devices throughout their studies.	This study examined and discussed about 29 experiments, including real and quasi-experiments	According to the findings of this study, mobile learning has a significant favorable impact on English learning results. Mobile learning is changing English learning, but it will not replace the current English teaching approach.
Wang et al.(2022)	WoS	This study looks at how students used mobile learning during COVID-19. Besides, this study also investigating the impact of this scenario on the learning behavior and performance of high school students in the higher education environment.	Questionnaires were collected from 396 students in higher education institutions	The ability to study with anybody, at any time, and from any location enables students to raise their learning behavior by encouraging their development as autonomous learners and thinkers.

Romero-Rodríguez. *et al.* *(2020)*	WoS	This article examines mobile learning techniques used by university teachers and to aggregate experiences with building appropriate m-learning practices in the classroom.	An analysis was conducted on the responses of 1125 professors from 59 different universities in Spain.	Satisfactory results have been achieved in student learning. It is possible to apply these lessons to other scenarios.
Choo, Devakaran, Chew, and Zhang(2019)	WoS	The purpose of this study is to better understand trainee views of mobile learning by investigating the usage of mobile learning in clinical psychology training utilizing a novel smartphone application.	Selected eight clinical psychology trainees who were enrolled in relevant course subjects.	The convenience of the use of technological platforms and engaging learning methods assist in the development of confidence and the acquisition of practical skills. However, the quantitative findings were insignificant.
Ibragimov et al.(2023)	WoS	Educators are researching the usefulness of students using mobile phones in the classroom and attempting to incorporate insights from prior studies into their research.	1184 publications were obtained in the Scopus database for obtaining meta-analysis.	Mobile learning improves academic achievement, while social media, films, games, and other activities have a negative impact. There is a low correlation between these devices' use and learning outcomes.

Truong(2014)	WoS	Investigate the use of mobile applications in higher education and create an app to assist college students in better understanding class material and improving learning outcomes.	Led by the UNC President, the UNC Tomorrow team all of the campuses within the UNC System, including Carolina.	This pro as non- full-tim wherev they ca
Mortazavi et al.(2021)	Scopus	The study looked into the various elements that influence mobile-assisted language learning (MALL) in increasing language acquisition skills that are productive and receptive.	Choose the top 100 papers and documentary recordings from 2012 to 2020 to conduct a reliable comparison analysis of many essential characteristics.	Incorpo vocabul in stud technol of these
Alowayr and Al-Azawei(2021)	Scopus	The purpose of this article is to explore the level of acceptance among students towards mobile learning in higher education.	300 students from a public school in the Kingdom of Saudi Arabia. (The first semester of the 2019-2022 academic year)	Mobile learning to prov improve

El-Sofany and El-Haggar(2020)	Scopus	This article discusses how the use of mobile learning technology in higher education can improve the effectiveness of student learning outcomes.	Students from the second and third grades of the Computer Science Department. (200 people), and students from community colleges and liberal arts colleges.	Integrat can b increase access student
Bazhenova et al.(2022)	Scopus	Determining the overall effectiveness of mobile interventions on student academic performance in higher education. The study sought to discover common factors that favor academic accomplishment among eligible studies.	The total sample size of 12 papers was 1176, with publication dates from 2015 to 2021, meeting the inclusion criteria.	The re learning environ their ac
Mohammad,Fuad and Hourani(2016)	Scopus	The paper encourages the use of mobile technology to improve students' academic engagement with their university and assist them in comprehending their present academic status.	Jordanian University students who downloaded mobile learning apps during their first academic year in 2014-2015.	UniApp with th academ necessit secure
Elkhateeb,Shehab and El-Bakry(2019)	Scopus	Presented the "Easy-Edu" mobile learning system, this system not only makes learning easier, but also pays attention to the needs of students, make communication and collaboration between students and teachers more convenient.	An experiment was conducted on 100 students taking a programming course at the Information Technology Institute of Mansoura University.	It is qu mobile be adde
Anuyahong and Pucharoen(2023)	Scopus	The purpose of this study is to investigate the impact of using mobile learning technology in higher education on student engagement and learning outcomes.	A regular undergraduate student from a large public university in the United States.	Mobile student learning sustaina learning studied
Ahmadi et al.(2023)	Scopus	Create and assess the usefulness of online learning resources on basic pedagogy in	The second-semester students of the	The ave using

		increasing students' teaching performance.	University of Semarang in Indonesia in 2020/2021.	learning the de significa outcom
Khan, Abdou, Kettunen and Gregory(2019)	Scopus	The purpose of this article is to investigate the many ways in which students use mobile devices in higher education study.	Sixteen students from four universities in Bangladesh participated in semi-structured interviews	College qualitat researc compre educati
Seta,Afrizal,Hidaya nto and Theresiawati(2022)	Scopus	The elements impacting mobile learning applications were determined based on students' opinions of factors affecting mobile learning in order to improve the student learning process in Indonesian universities.	The questionnaire collected data from 264 e-learning users.	Based variable interact perceive
Huda et al.(2018)	WoS	Investigate the novel design of MLE utilizing big data methodologies, and then implement the model in big data-based learning environments to boost online learning in higher education.	A review of peer-reviewed journals, books, and conference papers was conducted.	A mode outcom rich tea MLE perform
Wang et al.(2023)	Scopus	This study examines the issues of independent English vocabulary learning in universities using a 5G network and offers a reform of the independent English vocabulary teaching environment using 5G and cloud computing.	Choose five separate colleges at random to survey college students.	The use study c also h indepen
Bikanga Ada, Stansfield and Baxter(2017)	Scopus	This study investigates teachers' and students' experiences and attitudes toward social media applications as a means of improving feedback availability in a mobile learning scenario.	British university educators (n = 70) and students (n = 540).	The fin are ent social m

Data Analysis Procedure
This research adopts analysis to answer research questions. As collected data qualitative, I developed themes from the data.

Results
By developing a theme from the secondary data of the remaining literature, the result response to the research questions as follows

Q1:What are the benefits that mobile learning brings to student learning outcomes in higher education?

Benefits	Study
Providing Flexibility and Accessibility	[1][2][6][2][4][8][9][11][10][15]
Improving learning effectiveness	[1][4][3][18][11][20][5][[15][17][19]
Developing motivation and positive attitudes	[1][3][4][5][6][8] [11] [20] [21]
Enhancing engagement	[11][13][15][18]

1. Providing Flexibility and Accessibility
According to [1][2][6][2][4][8][9][11][10][15], one of the prominent advantages of mobile learning is making learning more flexible and accessible. The most frequently noted features are portability and convenience. [1][4][11] state that mobile learning makes learning is a convenient way to access learning materials. From [8, 9,15], students suggest that they can choose when and where to study with mobile devices. According to the results of [6], the majority of students believe that mobile learning devices are very adaptable. This will improve the learning process as these small tools can provide better learning services for students and teachers, not limited by time and location. In addition, [2] stated that students utilizing electronic devices could download free e-books, which could save money and time. [10] reveals that mobile learning provides more opportunities for students. All of this research shows that flexibility and accessibility is the primary elements driving the popularity of mobile learning.

2. Improving learning effectiveness
Another benefit is improvement in learning effectiveness. According to [18][11][20][5][16][[15][19], mobile learning significantly enhances student learning effectiveness by improving performance, acquiring more knowledge and learning skills and providing personalized learning.[1][4][3] review much research discovered that students use mobile devices for learning for a variety of reasons and that this new method of learning has been proven to boost student performance and academic achievement. Besides, [19][12][10][8] mobile learning offers more personalized content, such as personalized learning spaces, schedules, and projects.

[19,12] do a meta-analysis of existing studies and find that mobile learning improves learning outcomes. [10] discovered that mobile electronic devices may customize personalized information for students based on their varied needs, providing users with an excellent learning experience. From instructional materials to scheduling, mobile learning can provide diverse options to adapt to various scenarios.

The authors of [4] investigated the function of mobile learning in improving student outcomes in the context of the COVID-19 scenario. Moreover, as learning intermediaries, mobile applications can still give academic support to people throughout the lockdown period, ensuring that they can get access to learning resources during than pandemic. [5,11] also claimed that group talks with other students helped participants develop their collaboration. [18] investigates the effectiveness of mobile learning environments. Outside of the classroom, students can gather more targeted and multimedia learning tools to reinforce the principles provided in class. Students said that this is useful and that these application models could elicit effective communication among classmates or professors, provide informal and formal learning opportunities, and maintain communication with others.

3. Developing internal motivation and a positive attitude

As reported by [1][2][3][4][5][6][8] [11] [20] [21], mobile learning has been proven to create internal motivation and positive attitude of studying. Participants in [1,4] feel more autonomous and self-determined. [6] reveal that instructors and students are enthusiastic about using mobile devices and social media apps for teaching and learning. In [5], mobile learning increases students' autonomy and learning habits, as well as their confidence, because they have gained practical skills. As demonstrated in [3, 20], when students learn English via 5G networks and mobile devices, their vocabulary and overall performance improve because e-learning is more practical than traditional techniques. These studies show the effectiveness of mobile learning in improving capacities and learning outcomes. One of the findings of [2] shows that mobile learning assists in minimizing cognitive burden. [8,11,21] demonstrate that mobile learning boosts students' positive perspectives on academic learning.

4. Enhancing student engagement

[13] [15] point out that the mobile app assists students in engaging with their university The findings from [11][18] show that using mobile technology in the classroom improves attentiveness and focus by providing vibrant and fascinating video displays and images.

Q2: What challenges does mobile learning bring to student learning outcomes in higher education?

We summarized several of the most apparent challenges of mobile learning in the second study question. These issues may contribute to lower student satisfaction and acceptance, as well as negatively impact academic progress. The most commonly noted were the lack of a comprehensive learning system, a lack of interaction, and excessive entertainment features on mobile devices. At the same time, some students claimed that using electronic gadgets frequently produces eye fatigue and dizziness, resulting in poor learning efficiency.

Challenges	Study
Failure in completing learning and teaching objectives	[13][14][9]
Distracting user from knowledge learning	[7]
Vision impairment	[2]

1. Current functions fail to complete expected learning and teaching objectives

Study [13] shows evaluate a new mobile learning app, indicating the satisfactory performances and drawbacks. The positioning and service systems lack updates and maintenance, negatively impact the users' satisfaction and reduce the system's popularity. Other shortage is the the lack of face-to-face communication. [14] presented the "Easy-Edu" mobile learning system failed to implement the multiple learning objective with current modules. [9] find out that functional concerns continue to be a barrier in the learning process, preventing it from completely replacing traditional teaching paradigms.

2. The the lack of focus on knowledge learning

In [7] reveal that the use of social media, playing mobile games, and reading entertainment literature distract student from knowledge learning. This entertainment-oriented system may have a negative impact on academic attainment. According to surveys, many students become addicted to this entertaining content rather than using mobile devices to study. Self-discipline is especially crucial when mobile devices allow adequate freedom. Students with

poor self-control are frequently more vulnerable to the negative consequences of mobile learning.

3.Vision impairment
[2] emphasized the physical features and difficulties that mobile devices bring. More than 70 college students were interviewed for this study, and the interviewees stated that utilizing electronic devices for an extended period of time can cause eye fatigue and a lack of concentration. Second, some users may find e-books "difficult to read" and have symptoms such as dizziness. These issues make it difficult for mobile learning systems to be tailored to all demographics.

Discussion
Findings highlight the benefits that mobile and distance learning brings to student learning outcomes in the field of higher education. Overall, the four most prominent benefits of mobile learning are 1.Increasing flexibility 2. Improving learning effectiveness 3.Developing internal motivation and positive attitude; 4.Enhancing student engagement. On the other hand, mobile learning cause several challenges: current functions failed to complete leaning and teaching outcomes; Distracting user from knowledge learning; leading to vision impairment. The findings indicate that while M-Learning have limitations, it impose significant positive impacts on student learning outcomes in the context of higher education. Further research need to explore M-learning in higher education from various facets and have a deep understanding of how ML impact student learning process and outcomes.In addition , I suggest further researcher to identify how ML influence teachers and teaching process.

Reference
Ahmadi, F., Syahputra, H., Hardyanto, W., Kristanto, A., Pramono, S. E., Parinsi, M. T., ... & Sugihartono, I. (2023). Developing Mobile Learning Application Containing Basic Pedagogy Material as the Supplement in Improving College Students' Learning Outcome in Teacher Training Institutes of Indonesia. *European Journal of Educational Research*, *12*(1).

Alowayr, A., & Al-Azawei, A. (2021). Predicting mobile learning acceptance: An integrated model and empirical study based on higher education students' perceptions. *Australasian Journal of Educational Technology*, *37*(3), 38–55. https://doi.org/10.14742/ajet.6154

Anuyahong, B., & Pucharoen, N. (2023). Exploring the Effectiveness of Mobile Learning Technologies in Enhancing Student Engagement and Learning Outcomes. *International Journal of Emerging Technologies in Learning (iJET)*, *18*(18), pp. 50–63. https://doi.org/10.3991/ijet.v18i18.40445

Bazhenova, E. D., & Shuzhebayeva, A. I. (2022). The Impact of Mobile Learning on Undergraduate Students' Cognitive Learning Outcomes: A Meta-Analytic Review. *International Journal of Engineering Pedagogy*, *12*(5).

Bazhenova, E., Shuzhebayeva, A., Kuntuganova, S., Bazhenova, M., & Murygina, S. (2022). The Impact of Mobile Learning on Undergraduate Students' Cognitive Learning Outcomes: A Meta-Analytic Review. *International Journal of Engineering Pedagogy (iJEP)*, *12*(5), pp. 42–53. https://doi.org/10.3991/ijep.v12i5.32821

Bikanga Ada, M., Stansfield, M., & Baxter, G. (2017). Using mobile learning and social media to enhance learner feedback: Some empirical evidence. *Journal of Applied Research in Higher Education*, *9*(1), 70-90.

Boyinbode, O., Bagula, A., & Ng'ambi, D. (2012, June). A mobile learning application for delivering educational resources to mobile devices. In *International conference on Information Society (I-society 2012)* (pp. 120-125). IEEE.

Choo, C. C., Devakaran, B., Chew, P. K. H., & Zhang, M. W. B. (2019). Smartphone Application in Postgraduate Clinical Psychology Training: Trainees' Perspectives. *International journal of environmental research and public health*, *16*(21), 4206. https://doi.org/10.3390/ijerph16214206

Concannon, F., Flynn, A., & Campbell, M. (2005). What campus-based students think about the quality and benefits of e-learning. *British journal of educational technology*, *36*(3), 501-512.

Elkhateeb, M., Shehab, A., & El-Bakry, H.M. (2019). Mobile Learning System for Egyptian Higher Education Using Agile-Based Approach. *Education Research International*.

El-Sofany, H. F., & El-Haggar, N. (2020). The Effectiveness of Using Mobile Learning Techniques to Improve Learning Outcomes in Higher Education. *International Journal of Interactive Mobile Technologies (iJIM)*, *14*(08), pp. 4–18. https://doi.org/10.3991/ijim.v14i08.13125

Glackin, B. C., Rodenhiser, R. W., & Herzog, B. (2014). A library and the disciplines: A collaborative project assessing the impact of eBooks and mobile devices on student learning. *The Journal of Academic Librarianship*, *40*(3-4), 299-306.

Mohammad, H., Fuad, A., & Hourani, M. A. (2016). Using Mobile Technologies for Enhancing Student Academic Experience: University of Jordan Case Study. *International Journal of Interactive Mobile Technologies*, *10*(1).

Huda, M., Maseleno, A., Mat Teh, K. S., Don, A. G., Basiron, B., Jasmi, K. A., … Ahmad, R. (2018). Understanding Modern Learning Environment (MLE) in Big Data Era. *International Journal of Emerging Technologies in Learning (iJET)*, *13*(05), pp. 71–85. https://doi.org/10.3991/ijet.v13i05.8042

Ibragimov, A. G., Gimaliev, V. G., Khrisanova, E. G., Aleksandrova, N. S., Omarova, L. B., & Bakiev, A. G. (2023). Assessing the effectiveness of smartphones in education: A Meta-analysis of recent studies. *Online Journal of Communication and Media Technologies*, *13*(2), e202310.

Ifeanyi, I. P., & Chukwuere, J. E. (2018). The impact of using smartphones on the academic performance of undergraduate students. *Knowledge Management & E-Learning*, *10*(3), 290-308.

Jia, S., & Harji, M. B. (2022). Systematic Review of Mobile-Assisted Task-Based Learning Based on WoS (2013-2022). *Journal of Information Technology Education: Research*, *21*, 571-595.

Kärchner, H., Trautner, M., Willeke, S., & Schwinger, M. (2022). How Handheld Use is Connected to Learning-Related Factors and Academic Achievement: Meta-Analysis and Research Synthesis. *Computers and Education Open*, 100116.

Keegan, D. (2005, October). The incorporation of mobile learning into mainstream education and training. In *World Conference on Mobile Learning, Cape Town* (Vol. 11, pp. 1-17).

Khan, M. S. H., Abdou, B. O., Kettunen, J., & Gregory, S. (2019). A phenomenographic research study of students' conceptions of mobile learning: An example from higher education. *Sage Open*, *9*(3), 2158244019861457.

Kitchenham, B. (2004). Procedures for performing systematic reviews. *Keele, UK, Keele University*, *33*(2004), 1-26.

Lai, C. L., & Hwang, G. J. (2015). An interactive peer-assessment criteria development approach to improving students' art design performance using handheld devices. *Computers & Education*, *85*, 149-159.

Chen, M. L. (2022). The Impact of Mobile Learning on the Effectiveness of English Teaching and Learning—A Meta-Analysis. *IEEE Access*, *10*, 38324-38334.

Mortazavi, M., Nasution, M. K., Abdolahzadeh, F., Behroozi, M., & Davarpanah, A. (2021). Sustainable learning environment by mobile-assisted language learning methods on the improvement of productive and receptive foreign language skills: A comparative study for Asian universities. *Sustainability*, *13*(11), 6328.

Nguyen, L., Barton, S. M., & Nguyen, L. T. (2015). Ipads in higher education—Hype and hope. *British Journal of Educational Technology*, *46*(1), 190–203.

Nikou, S. A., & Economides, A. A. (2018). Mobile-based assessment: A literature review of publications in major referred journals from 2009 to 2018. Computers & Education*, 125, 101-119.*

Romero-Rodríguez, J. M., Aznar-Díaz, I., Hinojo-Lucena, F. J., & Cáceres-Reche, M. P. (2020). Models of good teaching practices for mobile learning in higher education. *Palgrave Communications*, *6*(1), 1-7.

Kärchner, H., Trautner, M., Willeke, S., & Schwinger, M. (2022). How Handheld Use is Connected to Learning-Related Factors and Academic Achievement: Meta-Analysis and Research Synthesis. *Computers and Education Open*, 100116.

Romero-Rodríguez, J. M., Aznar-Díaz, I., Hinojo-Lucena, F. J., & Cáceres-Reche, M. P. (2020). Models of good teaching practices for mobile learning in higher education. *Palgrave Communications*, *6*(1), 1-7.

Seta, H. B., Afrizal, S., & Hidayanto, A. N. (2022). Analysis of a Mobile Learning Adoption Model for Learning Improvement Based on Students' Perception. *Journal of Information Technology Education: Research*, *21*, 169-196.

Snilstveit B, Oliver S, Vojtkova M. Narrative approaches to systematic review and synthesis of evidence for international development policy and practice. *J Dev Effect* 2012; 4: 409–429.

Sormunen, M., Heikkilä, A., Salminen, L., Vauhkonen, A., & Saaranen, T. (2022). Learning outcomes of digital learning interventions in higher education: A scoping review. *CIN: Computers, Informatics, Nursing*, *40*(3), 154-164.

Truong, D. (2014). How to design a mobile application to enhance teaching and learning?. *International Journal of Emerging Technologies in Learning*, *9*(3).

Wang, T. (2023). Effect of using 5G and cloud computing environment for independent college english vocabulary learning. *J Cloud Comp* 12, 70. https://doi.org/10.1186/s13677-023-00447-1

Wang, Z., Qadir, A., Asmat, A., Aslam Mian, M. S., & Luo, X. (2022). The advent of Coronavirus disease 2019 and the impact of mobile learning on student learning performance: The mediating role of student learning behavior. *Frontiers in psychology*, *12*, 796298.

Wilkinson, K., & Barter, P. (2016). Do mobile learning devices enhance learning in higher education anatomy classrooms?. *Journal of pedagogic development*, *6*(1), 14-23.

Wilkinson, K., Dafoulas, G., Garelick, H., & Huyck, C. (2020). Are quiz-games an effective revision tool in Anatomical Sciences for Higher Education and what do students think of them?. *British Journal of Educational Technology*, *51*(3), 761-777.

Wilson, C. B., Slade, C., Wong, W. Y. A., & Peacock, A. (2020). Health care students experience of using digital technology in patient care: a scoping review of the literature. *Nurse Education Today*, *95*, 104580.

Yu, Z. (2019). A systematic review on mobile technology-assisted English learning. *International Journal of e-Collaboration (IJeC)*, *15*(4), 71-88.

Lim, G., Shelley, A., & Heo, D. (2019). The Regulation of Learning and Co-Creation of New Knowledge in Mobile Learning. *Knowledge Management & E-Learning*, *11*(4), 449-484.

Bazhenova, E. D., & Shuzhebayeva, A. I. (2022). The Impact of Mobile Learning on Undergraduate Students' Cognitive Learning Outcomes: A Meta-Analytic Review. *International Journal of Engineering Pedagogy*, *12*(5).

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Prisma Group. (2010). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *International journal of surgery*, *8*(5), 336-341.