

The use of M-learning to foster the development of self-regulated learning in university students: A systematic review⁶

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ABSTRACT

The rapid development of mobile technologies and their price decrease have enabled mobile devices to become ubiquitous. Both lecturers and students are integrating mobile technologies into teaching and learning. The continuous global innovation in emerging mobile technologies and their ever-increasing overlap with the lives of students and lecturers in Higher Education Institutions (HEIs) have thrust M-learning and self-regulated learning into prominence. Accordingly, this review analyses conference proceedings and national and international journals on the potential of M-learning for fostering self-regulated learning. To select relevant sources, a systematic literature review approach was employed. This study fills gaps in existing literature and investigates how mobile devices might enhance self-regulated learning among university students. It also signals future research directions and offers implications for researchers and practitioners in HEIs.

Keywords: self-regulated learning (SRL), mobile learning, higher education institutions, mobile devices

INTRODUCTION

Self-regulated learning is undoubtedly essential at the university level. This is not only because students are expected to manage and control their own learning (Lee, Watson & Watson, 2019), but also as they must develop these skills to gain knowledge in their specific field of study (Waluyo, 2018). Research indicates that one major cause of high dropout and failure rates among university students is their lack of self-regulated control over the learning process (Jansen et al., 2020; Sletten, 2017; Van der Veen & Peetsma, 2009). The value of aiding students in enhancing their self-regulated learning (SRL) abilities cannot be understated. The concept of SRL emerged as a research focal point in the educational psychology field during the 1980s. The growing interest in this area was due to its implications for student engagement and efficacy in learning tasks (Zimmerman & Schunk, 2011). Since then, the importance of SRL has further been validated through continuous research emphasis. Investigative forays into this subject resulted in exploring the influence of various social elements on students' self-regulated learning capabilities, offering a comprehensive understanding of the complex dynamics at play (Hadwin et al., 2011; Zimmerman, 2002)

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Self-Regulated Learning (SRL) is defined by Zimmerman (1986) as the degree to which learners generate ideas, feelings, and behaviours to achieve their learning objectives. This involves engaging intellectually, motivationally, and behaviorally in their learning processes. Following on from this, Zimmerman (2002) suggested that SRL processes incorporate self-directed activities and beliefs in self, thus enabling learners to transform their mental abilities into academic competencies. Usher and Pajares (2008) further expound the definition of SRL, seeing it as a metacognitive process that empowers students to expand their thinking. This happens when they critically analyze and evaluate the consequences of their choices, hence finding alternate pathways to academic success. From these definitions, it suggests a clear link between SRL and the development of learning processes that produce thoughts and behaviors, thereby shaping how individuals approach tasks to reach their objectives. Various studies suggest that university students can acquire SRL skills with appropriate support mechanisms such as direct instruction, modelling, practice (both guided and autonomous), reflection, self-observation, and social backup (Anand, 2015; Palalas & Wark, 2020; Van Nguyen et al., 2020; Yot-Domínguez & Marcelo, 2017).

Strategies are often suggested to help university students manage their learning (SRL). However, Anand (2015) pointed out a main issue with most of these approaches is that they are not easy to fit into a student's busy schedule. This shows the need for SRL methods that students can easily implement. Anand (2015) recommends using mobile devices to support SRL. This suggestion could fit well with students' busy lives and offer a practical solution. The literature indicates that mobile devices have the potential to serve as learning tools, as suggested by Anand (2015) and corroborated by Anshari et al. (2017), Ariel & Elishar-Malka (2019), Dalvi-Esfahani (2020), and Van Nguyen et al. (2015). Hartley et al. (2020) also associated the use of mobile devices, exemplified through multitasking during study, with improved resource management, an important competence in a learning environment. This underscores the potential for interventions that guide students towards more effective study strategies, leading to better academic outcomes, as proposed by Hartley et al. (2020). Importantly, a link has been established between mobile learning (M-Learning) and self-regulated learning (SRL) by preceding research such as that by Van Nguyen et al. (2015) and Yot-Domínguez, Marcelo (2017). M-Learning is defined by Pinkwart et al. (2003: 385) as a 'a type of learning that uses mobile devices to support learning'. This covers a range of devices including, but not limited to, Smartphones, Laptops, Tablets, Smartwatches, Hotspots, and even Mobile gaming consoles and many more (Busse et al., 2019). In an era where mobile technology is rapidly advancing, this paper aims to offer an in-depth systematic review of prior research, thereby enhancing understanding of how mobile learning (M-learning) can enable the promotion of self-regulated learning amongst higher education (HE) students. Understanding this is crucial as self-regulation in learning is a key skill for success in, HE and beyond. This paper presents the guiding methodological framework in place, followed by a delineation of the search parameters, study selection, and inclusion criteria. The paper ultimately culminates with the findings from the examined literature, with subsequent recommendations and a conclusion.

This paper aims to provide a comprehensive systematic review of previous research in order to deepen the understanding of the ways in which mobile learning (M-learning) can facilitate the development of self-regulated learning among students in higher education (HE).

RESEARCH QUESTION

What are the educational discipline areas, levels, and contexts in which M-learning is used to foster the development of self-regulated learning in university students?

METHODOLOGICAL FRAMEWORK

The objective of this study is to conduct a comprehensive systematic literature review on the use of M-Learning in promoting Self-Regulated Learning (SRL) in university students. The research question was systematically addressed through a meticulous review of relevant past studies. This approach involved the careful selection, identification, and synthesis of primary research papers. The authors employed a

systematic, clear, and reproducible technique in this study that serves two main purposes: (1) to identify and select pertinent past research; and (2) to analyze and synthesize the obtained data from the selected papers. This strategy rendered a credible representation of reviewed journal articles because of the rigorous method and unbiased synthesis of the literature employed (Gopalakrishnan & Ganeshkumar, 2013; Onwuegbuzie & Frels, 2016). Hence, the goal is not only to showcase the application of M-learning in fostering SRL but also to contribute to the accumulation of credible, unbiased academic resources on the subject.

Search criteria

Search criteria were defined by three subtopic areas: search strategy, study selection and inclusion criterion, and analysis framework.

Search strategy

A systematic search for relevant studies was done utilising reputable electronic databases, including Springer, Taylor and Francis Online, Google Scholar, Science Direct, and Web of Science Core Collection, and Scopus in order to find the research that met the selection criteria. The following search terms were used: the use of M-learning by a university student and SRL among university students. In addition, phrases including combinations of one M-learning and self-regulated learning keyword (e.g., 'mobile' AND 'self-regulated*') were employed to find relevant primary studies using electronic databases.

Study selection and inclusion criteria

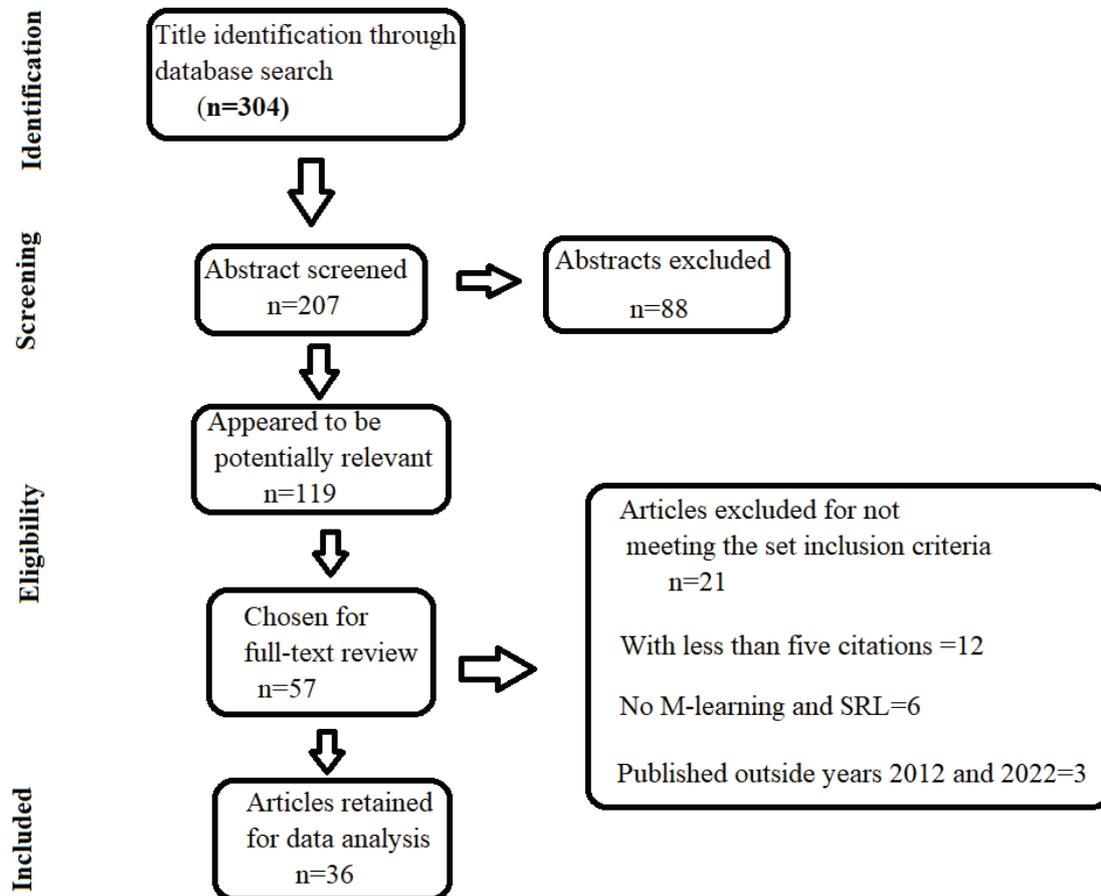
The papers had to meet the following selection criteria that were developed for the literature review in order to be included in the current study:

- a) Journals and peer-reviewed publications are required to focus on M-learning and SRL
- b) The article was published in a peer-reviewed English-language journal
- c) The paper must be published between the years 2012 and 2022 in indexed, peer-reviewed, national, and international journals
- d) The research was conducted within formal education settings
- e) The article should have a minimum of five citations.

To identify search strategies and inclusion criteria, the authors in this paper individually examined two of the four data sets. Following the first sorting of the titles returned by the keyword search, a subset of the abstracts was selected for further evaluation. The remaining abstracts of publications were then divided into three categories: (1) keep for a comprehensive examination, (2) reject outright, or (3) pend rejection for reconsideration. The authors classified the findings based on abstract analyses and determined to which category each article belonged.

Through a keyword search, 304 journal articles were found. Of these, 119 seemed potentially fitting for the study. The first author subdivided these 119 articles into two categories: 81 were named 'Selected for Further Review', and 38 were 'Possible Rejects that Require Reconsideration'. During the first phase, 13 articles from the 'Possible Rejects' category were preserved for full-text review. Also, 57 articles were chosen from both categories for an extensive text review. The main features: inclusion criteria, and methodological soundness like article cohesion between the research question, methods, tools, and findings, were used to assess a subset of these papers. The second author reviewed the findings in each article. After careful evaluation, 36 articles were set aside for data analysis, marked with an asterisk in the reference section. Figure 1 summarizes the selection process of the 36 articles involved in the data analysis.

Figure 1:
Selection of relevant peer reviewed journal articles



Results of the reviewed literature

The review of the previous research yielded some key elements in the study of SRL and Mobile Learning. These include students' perceptions of using M-learning to foster self-regulated learning; discipline areas, level of study and educational contexts in which M-learning is used to promote self-regulated learning; types of mobile devices used to promote the development of SRL in university students and different ways on how M-learning is used to foster self-regulated learning among university students. Table 1 present the countries where these studies were conducted.

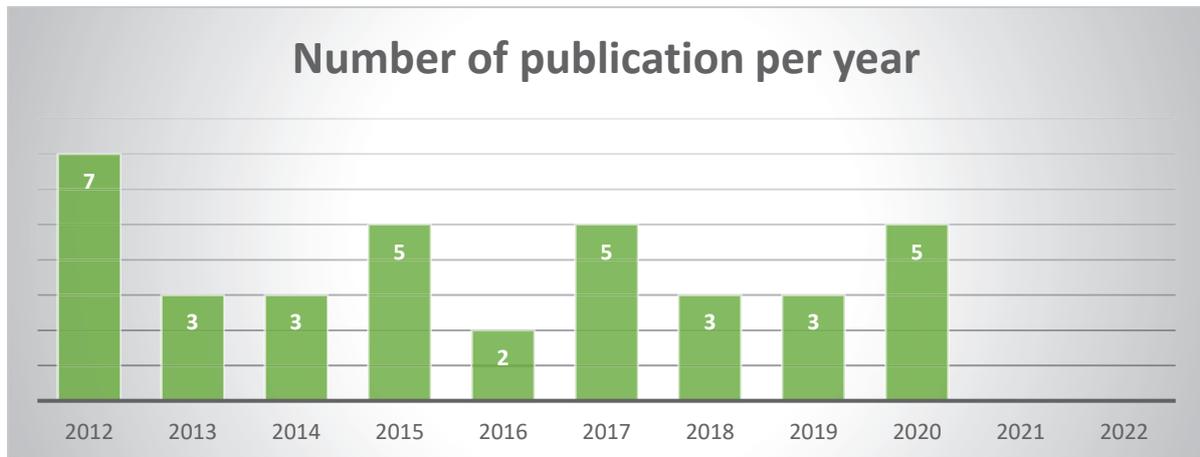
The review of previous research on Self-Regulated Learning (SRL) and Mobile Learning (M-learning) revealed several key elements. These elements included students' perceptions on using M-learning to foster SRL; the various academic fields, study levels, and educational contexts where M-learning is used; the specific mobile devices employed to enhance SRL among university students; and the diverse methods of utilizing M-learning to foster SRL among university students. Table 1 presents the countries where these studies were conducted.

Table 1:
Research Sites of the Studies (N = 36)

Country	N	Studies	Number of citations
United States	7	Dabbagh & Kitsantas, 2012; Gikas, & Grant, 2013, Wei et al 2012; Elhai, et al, 2018, Ames, 2013; Archbold Huffty Alegría et al 2014; Azevedo et al 2019,	2462, 2179, 246, 197,131, 59,33
Australia	2	Lee, 2013; Falloon, 2017	183,59
Singapore	1	Sha et al 2012,	19
Japan	1	Kondo et al 2012	177
New Zealand	1	Goh et al 2012,	110
Iran	2	Taleb, 2015; Pourrazavi, 2014	53, 101
Canada	3	Zare Bidaki et al, Ko, 2015, 2013; Boruff, & Storie, 2014,	34, 127,364
Netherlands	3	Jansen et al 2020, Tabuenca, et al 2015; Van Deursen et al, 2015	151, 244, 1090
South Korea	1	Cho, & Heron, 2015	302
Oman and United Arab Emirates	1	Al-Emran et al 2016	673
Turkey	1	Gökçearsan et al 2016	380
Germany	1	Yun et al, 2017	16
Spain	2	Alonso-Mencía et al, 2020, Yot-Domínguez, & Marcelo, 2017	51,153
Norway	1	Jeno, 2017	138
Brazil	1	Felisoni, & Godoi, 2018	209
Thailand	1	Waluyo, 2018	5
Taiwan	1	Chien, 2019	1
Malaysia	1	Albelbisi, 2019	30
Israel	1	Ariel, & Elishar-Malka, 2019	28
Indonesia,	1	Hanif, 2020	6
Brunei	1	Anshari el tal, 2017	443
China	1	Xiangming & Song, 2018	68
Sweden	1	Viberg et al. 2020	5

Figure 2 shows the number of publications in each year between 2012 and 2020. These are the articles that have been reviewed in this paper. Most papers are from 2012.

Figure 2:
Number of publications per year



Students' perception of using M-learning to foster self-regulated learning.

As one of the recent technologies in the education sector, M-learning has provided numerous exciting possibilities in the educational sector. It has made learning available regardless of location or time zones in higher education (Al-Emran & Shaalan, 2015). Studies show beneficial outcomes resulting from the use of mobile devices to enhance the educational process (Cavus et al., 2020; Patil et al., 2016; Taleb et al., 2015). For instance, Patil et al. (2016) carried out a study examining the attitudes and perceptions of medical undergraduates towards m-learning. They surveyed 90 third-year medical students from a tertiary healthcare facility, Nashik University, Department of Community Medicine. Utilizing a pre-approved questionnaire, the study explored students' learning methods to ascertain whether their learning approach was deep or superficial. Results indicated that students generally had a positive demeanor towards m-learning, deeming it an important learning tool. Despite this positivity, these medical students failed to fully utilize m-learning when given the chance.

Similarly, Hanif (2020) explored university students' SRL levels and their impact on m-learning adoption attitudes specifically for English learning. His study revealed that the majority of students considered m-learning as a valuable tool for education, as evident from their self-regulated m-learning usage. Further elaborating on the benefits of m-learning, a study conducted by Al-Emran et al. (2016) suggested m-learning as a practical method for university students to independently manage their learning process.

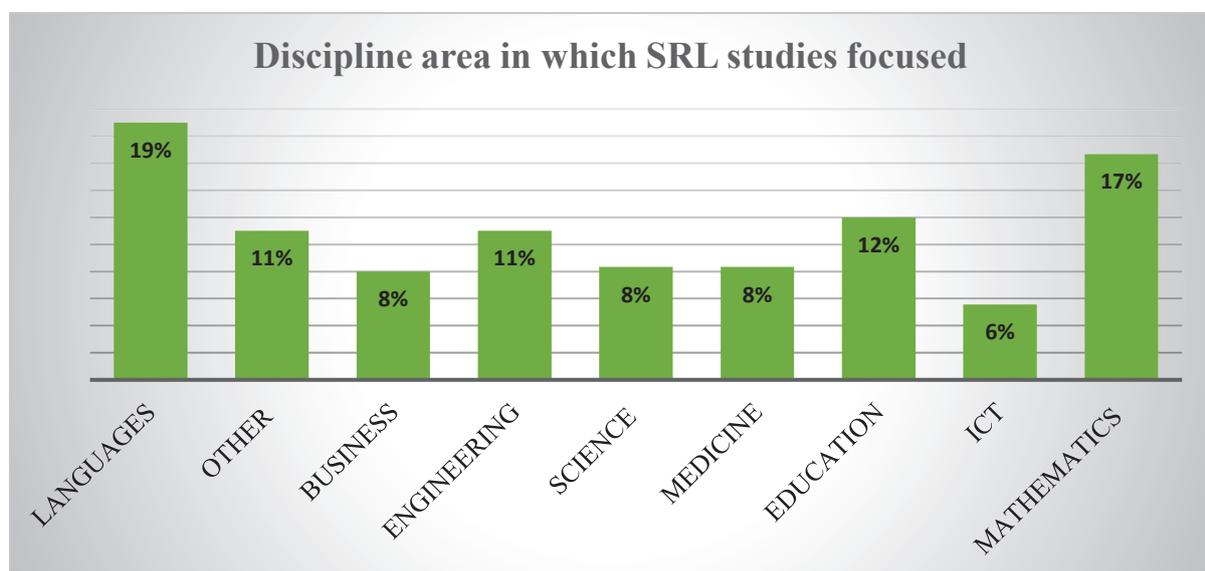
Furthermore, Yot-Domnguez and Marcelo (2017) conducted a study on how university students use digital technologies for SRL. Despite the frequent utilisation of digital technology by students, the study reveals that it is not often directed towards self-regulation of their learning. A significant proportion of students have not been trained or properly engaged in applying mobile technologies in their academic process. Consequently, they sporadically employ it to enhance their SRL skills. Thus, the study suggests the importance of informing students about the value of technologies often used in mobile learning and promoting their integration into the learning process. This will result in the effective self-regulation of students' learning (Domnguez, & Marcelo, 2017). Therefore, it is necessary to develop deliberate strategies that enable students to utilize mobile technology to promote their self-regulated learning.

Discipline areas of study

The data in Figure 3 demonstrate that among the reviewed papers in this study, seven focused on language studies, accounting for 19.2 %, followed by mathematics (n=6; 16.7%). Information Communication Technology (ICT) recorded the least focus with only two papers (5.6%). Both theoretically and experimentally, these papers demonstrate how SRL theories and methods could assist in

understanding M-learning processes. They indicate that student motivation majorly determines their engagement level in M-learning activities, encompassing variables like metacognition, motivation, and behaviour. In addition, the studies in Medicine, Mathematics, Engineering, and Science discuss how M-learning influence students' motivation, cooperation, and perspectives on information-seeking and sharing. The idea that M-learning can help students boost their skills in specific areas while promoting SRL is assessed. Furthermore, the language studies utilized various tools to support independent learning by students. They revealed that leveraging these technological tools inspired students to learn independently, visible in factors like time spent on learning activities, the satisfaction gained from the activities, and self-assessed achievement. SRL was evident in aspects of goal specificity and personalized learning task development.

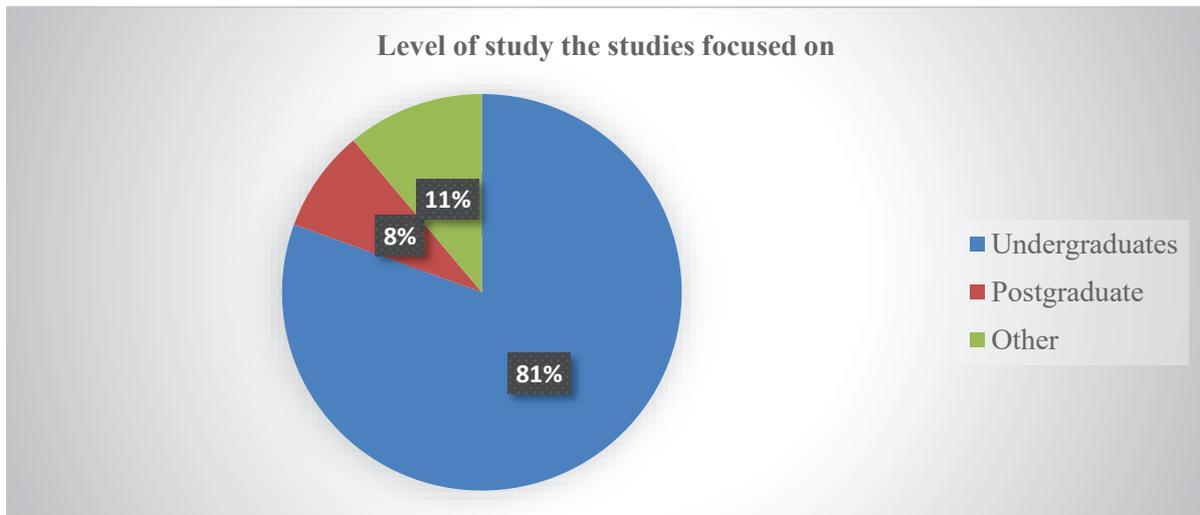
Figure 3:
Discipline area which SRL studies focused on



Level of study on which the study focused

In Figure 4, a significant majority of the studies, 81% (n=29), involved undergraduate students. This was followed by an unspecified group of students representing 11% (n=4), and postgraduate students at 8% (n=3). Whilst the utilization of mobile technologies is commonplace amongst these students, these tools are not typically applied in managing their own learning processes. Frequently employed technologies within universities, as identified by the studies, encompass instant messaging, mobile applications, and internet research. Notably, the most commonly used self-regulation learning techniques are associated with social support. However, the extent and frequency of using these techniques are subject to variation among students. More specifically, postgraduate students tend to deploy them more regularly compared to their undergraduate counterparts.

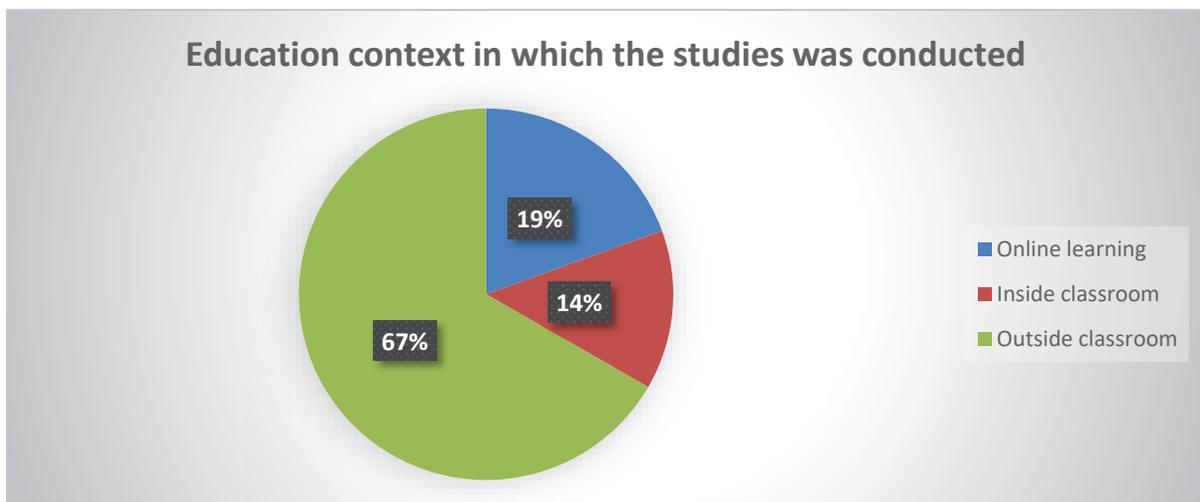
Figure 4:
Level of Study the studies focused on



Education context in which the studies were conducted

The studies in the reviewed literature involved students in three educational contexts: inside the classroom, outside the classroom, and online learning, as shown in Figure 5.

Figure 5:
Discipline area in which studies focused on

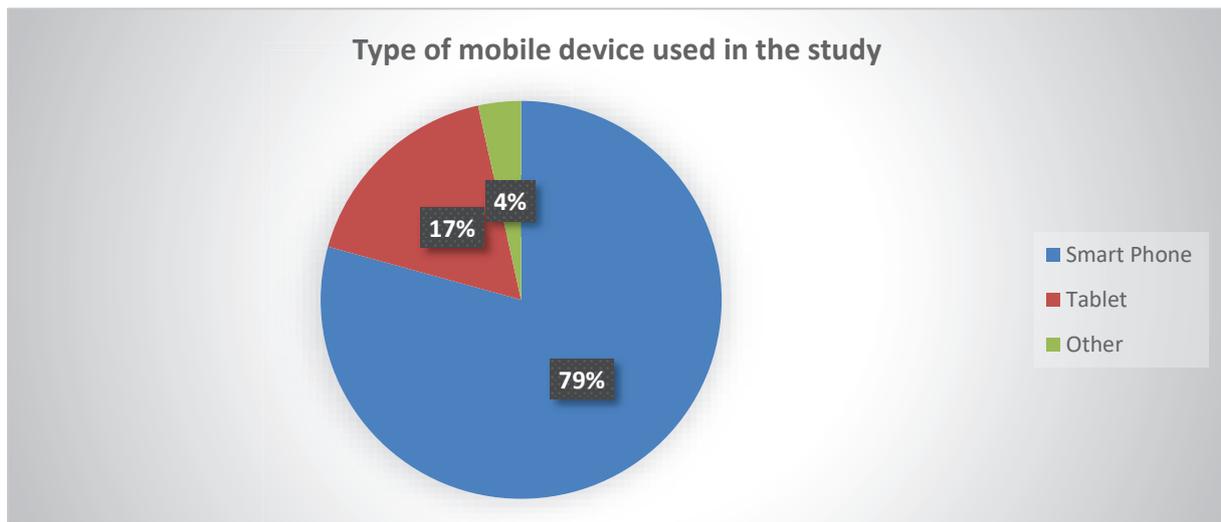


Most of the studies ($n=24$; 67%) focused on using mobile learning outside of the classroom context, followed by a smaller portion ($n=7$, 19%) focused on online learning contexts. A mere five studies (14%) focused on inside a classroom setting. The studies on online learning homed in on behaviours that promote SRL in a mobile learning environment. The results indicated that the use of social media and mobile devices facilitated opportunities for interaction and collaboration. Moreover, these tools allowed students to actively participate in content creation and communication. Mobile devices were used extensively in all aforementioned disciplines (Figure 3), both inside and outside the classroom, to enable students to manage and control their learning effectively. Furthermore, it was found that these devices also supported students in regulating their own learning processes (Yot-Domnguez & Marcelo 2017).

Types of mobile devices university students use to promote the development of SRL.

The reviewed studies show that the commonly used mobile device used in the studies to promote SRL is a smartphone (n=23, 79%), followed by a tablet (n=5, 17%). A smartphone is a widely used and extensively researched gadget in all the fields shown in Figure 6. Most studies focus on how students use smartphones to manage and control their learning.

Figure 6:
Type of mobile devices used in the study



The use of M-learning to foster self-regulated learning among university students

A systematic review of prior studies has divulged various methods through which M-learning can be utilized to enhance SRL. Among these, Yun et al. (2017) explored the enhancement of M-learning tools specifically designed for SRL, through the use of sensors. Their findings suggest that while training students in SRL is feasible, its real-world applicability and consistent enforcement across different contexts remain uncertain. Hence, they introduced the concept of sensor technology in SRL, proposing its integration into the design of learning companions. Concepts such as environmental learning cues, behavioural patterns, cognition signals, and motivational factors were suggested as critical sensor-recognition criteria. The aim of their proposition was to enable mobile devices to discern vital learning data, aiding students in realizing their individual potential and achieving superior learning experience.

In addition, Chin-Wen (2019) and Ren'ee et al. (2020) utilized pre-recorded short videos, including self-regulated learning (SRL) instruction and study suggestions, in their studies to augment students' SRL. They encouraged students to play these videos on their mobile devices, leveraging them as guides for the suggested study techniques. The findings from these studies illustrated that this intervention approach had a positive impact on the students' ability to complete their studies. Consequently, based on these results, it seems reasonable to suggest that aligning expectations between students and teachers regarding appropriate mobile device usage could improve the learning environment. This alignment also has the potential to facilitate learners' use of mobile devices as educational or learning tools.

Tabuenca et al. (2015) looked at graduate students taking three different online courses in their longitudinal study. Over four months, the students used their mobile devices to track their study time. The study showed concrete demonstration that recording study time benefited the learners. Moreover, the research provided valuable information about how to design mobile alerts. As suggested by the results, these alerts have the potential to motivate online students to manage their own learning more effectively.

Furthermore, various mobile applications have been utilized to promote SRL amongst a growing number of university students. For instance, Xiangming and Song (2018) used the Rain Classroom, a mobile application dedicated to English language acquisition, in their study exploring the intersection of mobile technology affordance and social consequences. The Rain Classroom comprehensively optimizes the pedagogical process. This involves distributing courseware before classes via text and voice on PowerPoint presentations, enabling real-time participant feedback during class, and facilitating interactive multi-screen interaction between students and lecture presentations. One unique feature of the Rain Classroom which further supported students in steering their learning was the automatic creation and storage of comprehensive learning data on student's mobile devices. Similar,

Kondo et al. (2012) utilized a tool called Mobile-Assisted Language Learning (MALL) in their research. MALL is technology used to support students in bettering their listening and reading scores on the Test of English for International Communication (TOEIC). The outcomes of their research showed that the MALL module boosted self-study in terms of time spent on learning, satisfaction from tasks, and self-measured accomplishment. In a related study conducted by Jenó (2017), it was found that mobile applications could help biology students learn to identify biological species faster. The study showed that using a mobile application helped students better understand the significant learning value of 'sedge identification.

Most of the research reviewed primarily in this paper focuses on utilizing Mobile Learning as a tool to enhance SRL. Other studies have delved into the role of mobile device usage, investigating how M-learning influences SRL. Moreover, certain research papers have explored the intricate relationship between M-learning, SRL, and additional variables that contribute to the growth of SRL. The outcomes of these studies are largely optimistic. Many of them indicate that M-learning significantly improves SRL and impacts other facets of learning. In summary, extensive research has investigated the link between M-learning and SRL, giving a promising outlook towards the potential of M-learning as a fundamental tool for bolstering SRL skills.

RECOMMENDATION AND CONCLUSION

The findings from the 36 studies systematically reviewed in this paper indicate that mobile learning offers significant benefits in promoting SRL. Moreover, the literature selected presents a combined view of the various factors involved in the study of M-learning and SRL. These results reveal that a noteworthy proportion of students in higher education have a positive response towards using M-learning to manage their learning strategies more effectively.

Acquiring SRL skills has the potential to aid students in higher education to surmount the multitude of challenges that arise throughout the learning process. Nevertheless, it is crucial to provide some level of instruction and training to facilitate a smooth adoption of M-learning to encourage SRL. Although providing training for self-regulated learning techniques is feasible, the clarity of their efficacy in various contexts is obscured, with minimal encouragement given. Moreover, it is essential to implement mobile technology that can bolster students' learning experience, aiding them in becoming more competent individuals with enriched learning experiences.

Nevertheless, it is important to note that students should be encouraged to learn in an environment free of pressure, viewing it as a pathway towards personal development. This involves creating environments that are free from fear and technological intimidation, particularly when designing interventions to support students in utilizing mobile devices for SRL. Implementing this involves making suitable mobile technology accessible to students. Moreover, the proposed use of mobile technology should not disrupt their learning process. Additionally, providing students with access to information that enhances their emotional and cognitive stability is crucial. Crucially, support in selecting effective learning techniques can empower students to successfully manage and regulate their learning.

This paper posits that smartphones, frequently used mobile devices, are important for promoting SRL in university students. The evidence from the reviewed literature suggests that various mobile learning strategies, such as mobile applications and pre-recorded videos, provide an effective support for SRL. Based on the findings, mobile learning could be instrumental in fostering SRL development among university students. However, it is important to note that students need suitable guidance to optimally use mobile learning for their SRL. Hence, we recommend that higher education intuitions deliberately incorporate both SRL and mobile learning into their standard curriculum. It is crucial that well-informed and tech-savvy lecturers leverage mobile learning tools to aid students in their journey towards becoming self-regulated learners.

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