




# Mobile learning: research context, methodologies and future works towards middle-aged adults – a systematic literature review

Syahida Mohtar<sup>1</sup>  · Nazean Jomhari<sup>1</sup> · Mumtaz Begum Mustafa<sup>1</sup> · Zulkifli Mohd Yusoff<sup>2</sup>

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## Abstract

Over the past several years, mobile learning concepts have changed the way people perceived on mobile devices and technology in the learning environment. In earlier days, mobile devices were used mainly for communication purposes. Later, with many new advanced features of mobile devices, they have opened the opportunity for individuals to use them as mediated technology in learning. The traditional way of teaching and learning has shifted into a new learning dimension, where an individual can execute learning and teaching everywhere and anytime. Mobile learning has encouraged lifelong learning, in which everyone can have the opportunity to use mobile learning applications to gain knowledge. However, many of the previous studies on mobile learning have focused on the young and older adults, and less intention on middle-aged adults. In this research, it is targeted for the middle-aged adults which are described as those who are between the ages of 40 to 60. Middle-aged adults typically lead very active lives while at the same time are also very engaged in self-development programs aimed at enhancing their spiritual, emotional, and physical well-being. In this paper, we investigate the methodology used by researchers based on the research context namely, acceptance, adoption, effectiveness, impact, intention of use, readiness, and usability of mobile learning. The research context was coded to the identified methodologies found in the literature. This will help one to understand how mobile learning can be effectively implemented for middle-aged adults in future work. A systematic review was performed using EBSCO Discovery Service, Science Direct, Google Scholar, Scopus, IEEE and ACM databases to identify articles related to mobile learning adoption. A total of 65 journal articles were selected from the years 2016 to 2021 based on Kitchenham systematic review

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✉ Syahida Mohtar  
msyahida@utem.edu.my

<sup>1</sup> Department of Software Engineering, Faculty of Computer Science and Information Technology, Universiti Malaya, 50603 Kuala Lumpur, Malaysia

<sup>2</sup> Department of Al-Quran and Al-Hadith, Academy of Islamic Studies, Universiti Malaya, 50603 Kuala Lumpur, Malaysia

methodology. The result shows there is a need to strengthen research in the field of mobile learning with middle-aged adults.

**Keywords** Mobile application · Self-directed learning · Middle-aged adults · Methodology

## 1 Introduction

Adulthood can be categorized into early, middle and late adulthood. Middle-aged adults come between the ages of 40 to 60, in other words is when one is in between the younger and older generations [42, 62]. This stage of age, notably is the age period that Hall [31] referred to as aging, where the signs of cognitive and physical ageing start to be noticeable, from the age of 40 and rapidly increase after the age of 65 [6, 54]. According to Yaffe and Stewart [94], a large part of adult life is made up of the mid-life period. This has been associated with many descriptive terms: mid-life syndrome, mid-life crisis, middlescence, empty nest syndrome, second adolescence, second honeymoon, age of fulfillment, and menopause. Aging population contributes to healthcare issues, not only amongst the older adults but towards middle-aged adults too. As mentioned earlier, the healthcare issues amongst the middle-aged adults are related to the decline in physical abilities, relational, and psychological capacities. For example, women in their middle age experience menopause and perceived personality change, which lead to severe depression, physical, and emotional problems [80]. According to Yaffe and Stewart [94], the most frequently identified events or concerns among middle-aged adults were: increased personal concern for health, death of a friend or relative, change in wage/salary, and concern for change in physical appearance.

When middle-aged adults enter their 60s, their reaction time starts to slow down further, and they experience a significant declination in their performance. The brain may also no longer function at its optimal level, leading to problems like memory loss, dementia, and may have issues with other cognitive functions such as language, attention, and visuospatial abilities [35, 61]. It has been widely assumed that the midlife period is a critical period, thinking about death and mortality, as well as experiencing decline in physical abilities, relational, and psychological capacities [80]. Therefore, early prevention should therefore be looked upon at the middle age stage to help with memory impairment, as well as emotional control.

Middle-aged adults typically lead very active lives while also engaging in self-development programs aimed at enhancing their spiritual, emotional, and physical well-being. Muslim adult, for instance, will prefer to go to the mosque, surau, or Islamic center to seek for Islamic education [42] to enrich their knowledge and gain serenity through the command of Islam. This indicates that an individual in the middle-aged is inclined to reflect and improve the quality of one's daily practice. Unfortunately, during the Covid-19 pandemic outbreak, many lectures at the mosques and other institutions could not be held, resulting in many people having to work from the home. As a result, many have taken the initiative to hold religious lectures online through video conferences such as via Zoom, WebEx, Jitsi Meet, Google Meet applications, and many more [1]. There are also those who watch religious lectures that have been prerecorded on certain channels, such as YouTube or podcasts. However, the enthusiasm and motivation for online and prerecorded learning is not the same and less encouraging as compared to face-to-face lectures.

Health management apps have shown to be useful for treating a variety of illnesses such as chronic illnesses caused by obesity, high blood pressure, diabetes, and so on [32]. As middle-

aged adults are smartphone and tablet active users, they can use these portable devices to track their healthy lifestyle habits, maintain social communication, prevent accidents, and seek information [91]. In addition to chronic illness management using mobile applications, there is also a concern on how middle-aged adults can utilize mobile technology in fulfilling their spiritual journey towards a quality lifestyle. For example, they can learn how to acquire a literal understanding of the Quran through a spiritual mobile application. This will help a Muslim to elevate their understanding, motivation, and devotion towards Islam, which eventually leads them to become a better person emotionally and psychologically. All of these exhibit many important experiences associated with middle-age adults, most involving work and family, and self-development [53].

Mobile devices such as smartphones have gained popularity because they allow people to stay in touch and provide easy access to information anywhere and anytime [89]. Therefore, investigating the acceptance and adoption of mobile learning by the middle-aged adults through a systematic literature is important in highlighting the gap for any future work.

This review paper presents the fundamentals of mobile learning and the utilization of mobile technology in the learning environments. Mobile learning theories are also highlighted to show the significance of mobile learning towards middle-aged adults. Based on the research context found in the selected literature, the researchers here provide a systematic mapping of the employed methodologies in the area of mobile learning research. The purpose of the systematic mapping is to determine the most appropriate methodology for future research on middle-aged adults in areas of mobile learning.

## 2 Mobile learning

M-learning is a subset of ‘e-learning’ while ‘e-learning’ is the subset of distance learning that focuses on learning across context and learning with mobile devices, which can take place anytime, anywhere [43, 62]. For example, learning may happen at the workplace, at home, and at places of leisure. The learning may be related to work demands, self-improvement, or leisure; and it is mobile with respect to time where it happens at different times during the day, on working days, or on weekends [68].

According to Ozdamli and Cavus [70], learners, teacher, environment, content, and assessment are the basic elements of mobile learning. The core characteristics of mobile learning are ubiquitous, portable size of mobile tools, blended, private, interactive, collaborative, and instant information. They enable learners to be in the right place at the right time, that is, to be where they can experience the authentic joy of learning.

Since learning can be performed anywhere and anytime using electronic devices, Traxler [85] defines that mobile learning is a learning process that is delivered through the support of mobile devices such as personal digital assistants, smartphones, wireless laptops, and tablets. This understanding is supported by Keegan [45] who suggested that m-learning should be restricted to learning on small and portable devices as mobile devices that could be carried everywhere.

According to Nordin, et al. [69], the requirements for mobile learning environment include technology, that is, (1) highly portable (to support learning whenever and wherever), (2) individual(the design should be able to support individual learning, cater for individual learning styles and be adaptable to learners’ abilities), (3) unobtrusive(where learners should be able to retrieve knowledge without the technology becoming a deterrent), (4)

available(enabling communication with friends, experts and/or teachers), (5) adaptable(the context of learning should be adaptable to situations and the individual's skills and knowledge development), (6) persistent( able to manage the learner's learning despite the changes in the technology itself), (7) useful(useful to learners for everyday chores), and (8) user-friendly(easy for people to use and must not create technophobia among new users).

### 3 Mobile technology

Today, it is fortunate that mobile technology's on-demand capability puts learning back into the learner's hands by allowing users to take the initiative in diagnosing their learning needs, formulating learning goals, identifying human, and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating those learning outcomes [50].

Mobile technology covers a wide range of mobile devices such as portable electronic devices used to perform a wide variety of communication, business, productivity, and lifestyle tasks such as parenting [26, 66]. It is also connected through a cellular communication network or a wireless connection. The common mobile technologies that allow these tasks are cellular phones, PDAs, handheld computers, tablets, laptops, and wearable devices. A standard mobile technology device, such as a cellular phone, may have one or more features such as a GPS, a web browser, an instant messenger system, an audio recorder, an audio player, a video recorder, and gaming systems [4].

In the area of healthcare, numerous studies have been conducted on the use of mobile devices with wearable devices [21, 39, 87] to monitor the health of the elderly and individuals with disabilities. By using mobile apps, the health of the elderly and young adults can also be tracked [12, 20, 40] and diagnosed using mobile game-based screening tools [34], especially when facing challenges and stressful time during the Covid-19 pandemic [79], or during post-college life transition [27]. Not all older people are proficient in using mobile devices. Therefore, there are researchers who make studies related to how older and young adults (university students) manages their mobile device security and privacy settings of their mobile devices in the context of social interaction and motivation [64, 67, 90].

Besides the usage of mobile devices in the healthcare area, the growth of mobile devices is significant and impactful in the education area such as in teaching history using 3D [57] and safety education [13], personal learning and workplace learning [29]. The use of mobile devices such as smartphones and tablets has become truly ubiquitous and has a potential for improving student learning, which can happen in collaborative, authentic settings, i.e., real life contexts and use active learning approaches [18]. As smartphones have become popular devices among youth nowadays [36, 65], these devices can be utilized and embraced in the classroom teaching environment. By having a smartphone with wi-fi connectivity, Bluetooth, camera, color display, audio/video recording capability, it is already suitable for a person to adopt m-learning [36]. Majority of students spend most of their time (6 to 24 hours) on the Internet using their smartphones [8].

Smartphones also have become essential communication tools for older adults to stay connected with their family and peers [93]. Compared with younger adults, older adults tend to be more likely to use mobile phones for their original design purpose—that is, making calls for instrumental reasons such as arranging plans and other instrumental activities rather than playing games, surfing the internet, or using auxiliary applications [91]. The intervention of

mobile technology in older adults' lifestyles can improve their well-being and keep their mind and body active as well as prevent or slow down cognitive decline. For instance, mobile games can be used to capture cognitive learning outcomes and the process of knowledge acquisition [92]. Through activities such as interacting with easy games [71], taking and managing photographs, sending messages via SMS, video or audio calls, and reading newspapers via webpages may help cognitive and noncognitive stimulation of older adults.

Mobile computing devices become more situated, personal, collaborative, and lifelong and these innovations will become embedded, ubiquitous, and equipped with enhanced features for rich social interaction, contextual awareness, and access to the Internet. Hence, extending learning outside the classroom and into the learner's environment, mobile learning can have a significant impact on middle-aged adults. However, based on the research context in the areas of mobile learning, existing studies have concentrated exclusively on aspects of the mobile device use, such as accessibility, usability, and adoption, among young and older adults, while middle-aged adults have received less attention. Thus, the use of mobile devices among middle-aged adults should be further investigated to determine how mobile devices can assist them in acquiring knowledge and developing themselves while leading hectic lifestyles and having to deal with the Covid-19 pandemic, towards their long-life wellbeing.

#### **4 Multimedia in Mobile learning application**

Using mobile device as a learning tool is a new way for learners to learn as they like, anywhere and anytime. Moreover, an application that contains multimedia elements such as text, animation, graphic and video will engage and attract the attention of the student. Mobile learning application used in mobile learning environments varies, such as Learning Management System (LMS), Short Messaging services (SMS), Podcasting, Social Networking, Instant Messaging, Blogging, Facebook, Microblogging, Wiki, QR, 3D and Augmented Reality [81].

SMS and videos have long been used as language learning tool through the use of mobile phones and personal digital assistants (PDAs) [68], and today, many have benefits from using WhatsApp, flashcards and mind maps, on-line videos, and social networks in learning. Recently, Duolingo is said to be a popular application for new language learning where learners can interact with intelligent chatbots that give corrective feedback and awards at the same time [49].

In the fast-aging population countries like China, senior users have become a significant new growth point that cannot be ignored in social network sites to keep continuous competitiveness. In China, WeChat is the most popular social software for senior citizens. This is due to the good user experience and operability, where some senior users manage to operate the application although they have no computer skills or they know little about the network [11].

On the other hand, instant messaging apps such as WhatsApp and Line have become a popular mobile app amongst students. In a classroom environment, the student may use these apps to interact with teachers outside the class and using smartphones to manage their group assignments. The use of instant messaging applications promotes collaborative learning [7] and flexible learning, improves student participation, increase communication and interaction between lecturers and students, as well as improve the performance of teaching and learning [10].

Text editors such as the Mobile MS office, content management systems such as Learning Management Systems (LMSs), and audio-video recording of lectures did not get much attention by the students in terms of its usage via the smartphone. The reason for the low usage of these

functions and features could be due to the limited screens space, which makes it difficult to read large documents, and the small sized keypad makes data entry cumbersome [36]. To make mobile learning more interesting, game-based elements have been used to improve the students' engagement and enjoyment in learning. For instance, Kahoot is a game-based technological platform that can be accessed from, for instance, smart devices or a laptop. The game-based learning application (app) can benefit working adults who are adult learners with diverse learning abilities. Chunking method was used to break down complex concepts into smaller parts in the form of multiple-choice questions. The students' learning process is tested and corrected, in real time, through the statistics which are generated from this chunking process. Kahoot creates a safe environment for students to make mistakes through multiple choice questions, and yet relearn it without being judged by their peers. However, the drawback of Kahoot is, it does not adequately support the learning experience of adult learners [74].

To achieve a successful ageing life, positive spirituality indeed has a close relationship with physical and mental abilities. There have been studies that develop an Empathic-Virtual Coach (VC) to involve senior users in enjoying a healthy lifestyle with respect to diet, physical activity, and social interactions, while in turn supporting their carers [41]. Furthermore, in addition to physical support, adults also require emotional and spiritual help for a balanced lifestyle. For example, Sevkli, et al. [75] in their study had designed and developed mobile Hadith Learning Systems (HLS) that were able to encourage and promote hadith learning for young and middle-aged Muslims. Hence, mobile apps appear to be one of the tools that can be used to promote a balanced well-being lifestyle for the older people such as their social status, independence in their everyday activities, health status, standard of living, or leisure activities of the aging population.

## 5 Mobile learning theory

According to Lee, et al. [56], there is an increasing number of adult learners entering or returning to university. Despite the growing number of nontraditional adult students in online higher education, little is known about the dynamic processes of adult distance learning, through which adult students struggle to develop their learning ability to balance their life and study, and to become self-regulated learners, and ultimately as competent selves and lifelong learners. The implementations of mobile learning are supported and guided by theories such as Behaviorism, Cognitivism, Constructivism, Situated Learning, Problem-Based Learning, Context Awareness Learning, Socio-Cultural Theory, Collaborative Learning, Conversational Learning, Lifelong Learning, Informal Learning as well as Activity Theory, Connectivism, Navigationism, Location-based learning [46, 68]. The classification of activities around the main theories and areas of learning relevant to learning with mobile technologies are shown in Table 1.

Lifelong learning happens not only in learning institutions such as community colleges or higher learning institutions, but can also happen anytime and anywhere according to the needs of the individual [69]. Informal and lifelong learning are often referred to adult education or continuing education, which means a learning process that occurs as blended learning with everyday life unobtrusively and seamlessly [73]. The unique characteristic of lifelong learning is the fact that it is centered on the learner. Because of that, the use of technology in offering a flexible learning framework is often favored by adult learners [69]. In addition, when compared to conventional methods such as textbooks, mobile learning tools, especially

**Table 1** Mobile Learning Theories Naismith et al. (2004)

Theory	Description
Behaviorist	Activities that promote learning as a change in observable actions.
Constructivist	Activities in which learners actively construct new ideas or concepts based on both their previous and current knowledge.
Situated	Activities that promote learning within an authentic context and culture.
Collaborative	Activities that promote learning through social interaction.
Informal and lifelong	Activities that support learning outside a dedicated learning environment and formal curriculum.
Learning and teaching support	Activities that assist in the coordination of learners and resources for learning activities.

learning through mobile apps, are intrinsically inspiring, provide greater satisfaction, increase student well-being, and have positive implications for long-term student persistence [78].

Lifelong adult learners are different from young learners (school or university students) who may devote significant amounts of time to study each day, as their learning time is scattered due to family responsibilities, work obligations, and other social obligations [44]. However, the keys to unlocking the secrets to successful adult learning online are embedded in the basic principles that guide adult learners. The subsequent six principles upon which Knowles [51] constructed his formal and andragogical concept are shown in Table 2.

## 6 Methodology

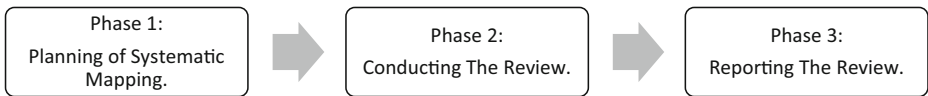
This study carried out an extensive literature review to identify the research gap, focusing on the related literature published within the period of 2016 to 2021. The aim of this systematic review is to investigate the trend of previous research on the acceptance and adoption of mobile learning by middle-aged adults. In order to justify the research gap based on the previous studies, this article will also provide views on the existing mobile learning usage targeted at solving user's adoption of mobile learning towards young and older adults.

To conduct the systematic review, the researchers followed the procedure defined by Kitchenham [48], which is one of the most complete and suitable methods for reviewing studies in computer science. We carried out this review in three main phases: 1) planning of systematic mapping; 2) conducting the review; and 3) reporting the review. The phases of this systematic review and the related activities are shown in Fig. 1.

**Table 2** The 6 principles of Adult Learning

Principles	Description
The learner's need to know	Adults need to know why they need to learn something.
Self-directedness	Adults need to self-direct and take responsibility for their learning.
The role of experience	Adult learners have a wide variety of experiences and backgrounds.
Intrinsic motivation	Adults are inspired to learn when what they learn can help them deal better with real-life circumstances.
Orientation to learning.	Adults are task-oriented and learn things best in the context of using them.
Readiness to learn.	Adults become ready to learn things they need to know and do in order to cope effectively with real-life situations.





**Fig. 1** Phases of conducting this systematic review

### Phase 1: **Planning of the Systematic Mapping**

Activities involved in this stage were aimed to identify the objectives of the review. These activities are as follows:

#### a) **Discovering the gap of the existing systematic reviews**

In this step, a comprehensive search was performed in the cyberspace to locate the related review studies in mobile learning. Some of the bibliographic databases accessed included EBSCO Discovery Service, Science Direct, Google Scholar, Scopus, and IEEE.

#### b) **Specifying the research questions**

The research questions we have formulated for this review attempt to acquire the understanding and to determine the research gap on mobile learning usage in assisting lifelong learning in the context of spiritual among middle-aged adults. These questions are related to the acceptance and adoption of mobile learning towards middle-aged adults. The research questions are:

1. What are the fundamentals and background of mobile learning in the learning environment, including its adoption, acceptance, and available applications?
2. What are the research methodologies employed in the current studies carried out in mobile learning field?
3. What are the core research gaps should be further investigated by researchers in mobile learning towards middle-aged adults?

#### c) **Identifying the relevant bibliographic databases**

To answer the research questions and find relevant studies, bibliographic databases that cover majority of journals and conference papers associated with the field of human-computer interaction and mobile learning were selected. Related literatures published within the period of 2016 to 2021 were chosen in this research and the relevant bibliographic databases are **ACM** (<https://www.acm.org/>), **Emerald** (<https://www.emerald.com/insight/>), **EBSCO** Discovery Service (<http://search.ebscohost.com>), **Science Direct** (<http://sciencedirect.com>), **Google Scholar** (<http://scholar.google.com>), **Scopus** (<http://scopus.com>), and **IEEE** (<http://ieee.com>).

### Phase 2: **Conducting the Review**

Activities involved in this stage were aimed to selecting related studies. These activities are as follows:

#### a) **Identifying the Relevant Studies**

In identifying the relevant studies, a search using key words such as “human-computer interaction”, “mobile learning”, “middle-aged adults”, “us- ability” was conducted. Accordingly, Boolean OR was used for alternative spellings, synonyms, or alternative terms, and Boolean AND was applied to connect the main terms. The complete list of search keywords of the review is provided in Table 3.



**Table 3** Keywords used in the article search

Term 1	AND	Term 2	AND	Term 3	AND	Term 4
Human-computer interaction OR HCI		Mobile learning OR M-learning OR Mlearning OR Applications OR Mobile devices OR Mobile Apps		Middle-aged OR Middle age OR Mid life OR Long-life Adults OR Older adults OR Adult		Adoption OR Acceptance OR Usability OR Use

Two additional search strategies were applied to retrieve the maximum number of relevant papers. The first strategy was reviewing the reference list of selected papers to find more related papers. The second strategy was googling the authors of selected studies to find potential related research.

b) **Defining Selection Criteria**

For selecting the primary papers, the following criteria based on the purpose of this study are defined.

**Inclusion Criteria:**

1. Studies containing mobile learning, acceptance, and adoption among mobile devices users.
2. Studies dealing with factors that contribute to the adoption and acceptance of mobile learning in the educational environments or working environments.
3. Studies utilizing mobile learning applications related to education, health care, data collection, and engineering that motivate users to use mobile learning.
4. Studied involving mobile learning users in category young adults, middle-aged adults, and older adults.

**Exclusion Criteria:**

1. Studies in learning environments that do not relate to the mobile learning context.
  2. Studies of mobile learning that involve children such as kindergarten students or users with special needs.
  3. Studies that are reluctant to serious mobile learning.
  4. Papers that are only available in the form of abstracts or PowerPoint presentations.
  5. Papers that are not written in English.
- c) **Selecting Primary Studies**

The titles and abstracts of searched papers were reviewed based on the inclusion and exclusion criteria. Every paper that met at least one of the criteria and without any of the exclusion criteria was included in the review. For papers that could not be excluded based on reading of the titles and abstracts, the full texts of the papers were reviewed. Through this process, 65 articles were selected from the 531 papers initially found. 292 papers were excluded only by reading the topics, 105 papers by reading the abstracts, and 65 papers by reading the full text.

d) **Validation control of the Primary Studies**

In order to maintain the quality of the selected studies, the primary studies chosen

by the first reviewer were double-checked by a second author. The evaluation of the selected paper was based on the evaluation questions as follows:

1. Whether a proposed mobile learning solution is implemented in the research context?
2. Whether the methodology of mobile learning solution is suitable for middle-aged adult?
3. To what extent the proposed solution effects the middle-aged adult in mobile learning?

The procedure of selecting the primary papers is illustrated in Fig. 2.

#### e) **Data Extraction and Synthesis**

In order to extract and synthesize the data to answer the research questions, the selected studies are classified into five categories as follows:

1. **Mobile learning and their research context:** This categorization answer the first research question and helps to find the fundamentals and background in mobile research based on research context such as acceptance, adoption, effectiveness, impact, intention of use, usability, and readiness.
2. **Methodology in the mobile learning research area:** In order to answer the second research question and find the methodologies employed in the related context, the research context with the methods employed by the researchers was mapped as shown in Table 7. Based on this mapping, the instruments that have been used in mobile learning research involving middle-aged adults can be identified.
3. **Instruments used in Mobile learning research context:** This category answers the second research question. From the systematic mapping done, it was found that the common research instruments used were Questionnaire, Interview, Experiments and Task Analysis. Here, the most preferable instruments used in mobile learning research were highlighted.
4. **Mobile learning solutions in general:** This category answers the third research question in order to find the gap in mobile learning research. Articles found in this study include mobile learning articles for young and older adults to show the trend of research towards adulthood. Since the focus of this systematic mapping is on identifying mobile learning technology applied to the middle-aged adults, thus those works focusing on the application of mobile learning not on adult learners or studies on users with special needs were excluded.
5. **Solution for middle-aged adult in mobile learning:** This category also answers the third research question in presenting the future works related to mobile learning involving middle-aged adults. This article begins by explaining the use of mobile technology in a learning environment, and the mobile learning theories that form the basis for the comparison of the existing mobile learning solutions for middle-aged adults.
6. **Effects of mobile learning on middle-aged adult:** This category answer the importance of the mobile learning towards middle-aged adults for a healthy well-being by assessing the number of studies related to middle-aged adults.

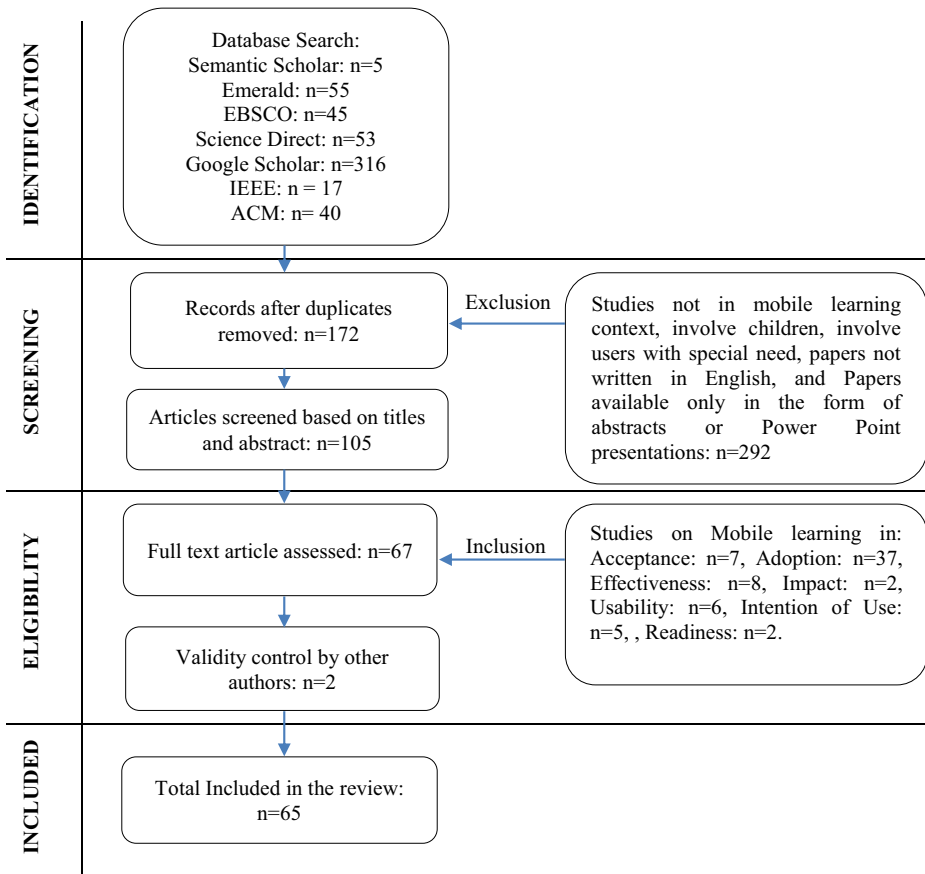


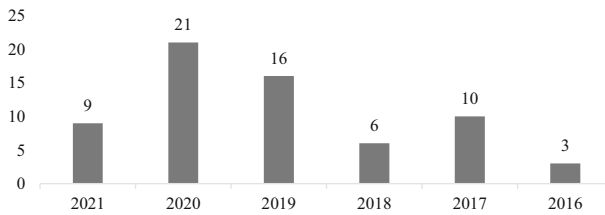
Fig. 2 Selecting the primary papers

Phase 3: **Reporting the Review**

In the following section, the outcomes of reviewing the selected studies were reported and the results were discussed in detail, to respond to the defined research questions.

**7 Results of the systematic mapping**

From the search procedure and criteria, a total number of 65 articles are extracted. The distribution of the primary studies according to the publishing year is shown in Table 4 and Fig. 3. The articles searched for this systematic review study are from 2016 to 2021. The reason is that this study aims to identify the latest research trends in the field of mobile learning with middle-aged adults. Finding shows that there are several studies from 2016 to 2018 that focus on this topic. The number of articles on mobile learning increased significantly from 2019 to 2020, which may be due to the outbreak of the Covid 19 pandemic. In education, for example, many institutions and organizations have drastically shifted from the traditional



**Fig. 3** Distribution of reviewed studies by year

teaching and learning approach to online platforms. As a result, there is a considerable amount of research on mobile learning focusing on students in schools, universities, and academic staff. Meanwhile, a lot of study has been done in the field of healthcare with the elderly and middle-aged individuals, because their health begins to decline at this age.

It would also be interesting to find out the distribution of studies by countries, as shown in Table 5. This shows that China had contributed the most research articles in this area of mobile learning. In article [13, 21, 72, 77, 81, 88], the country where the study was conducted was not specified.

## 8 Participants

The categories of participants in the selected studies consist of young adults, middle-aged adults, and older adults. The number of studies based on age category is illustrated in Table 6 and Fig. 4. It is found that the number of studies involving young adults is higher compared to studies involving older adults and middle-aged adults. This is due to the fact that young adults are frequent users of smartphones and are more adept at using mobile apps. Furthermore, since they are unable to attend college or universities due to the Covid-19 outbreak, many students are required to study online from home using mobile devices.

**Table 4** Summarization of selected studies from the year 2016 to 2021

Year	Studies
2016	de Lara, et al. [17], Tan and Law [83], Chittaro [13]
2017	Christensen and Knezek [14], Iqbal [36], Anshari, et al. [8], Mather, et al. [63], Wardaszko and Podgórski [92], Sevкли, et al. [75], Sundgren [81], Palacio, et al. [71], Sharma, et al. [76], Kuciapski [52]
2018	Gan and Balakrishnan [24], Al-Adwan, et al. [3], Thongsri, et al. [84], Bensalem [9], Venkataraman and Ramasamy [88], Cheng, et al. [12]
2019	Bere and Rambe [10], García Botero, et al. [25], Huang, et al. [32], Al-Sabbagh, et al. [5], MICAN [65], Dhanapal, et al. [19], Shuib, et al. [77], Yang and Lin [95], Daungcharone, et al. [16], Huizenga, et al. [33], Al Masarweh [2], Ejaz, et al. [21], Wan, et al. [90], Vacher, et al. [87], Mendel and Toch [64], Moore and DeBruhl [67],
2020	Li and Luximon [58], Farivar, et al. [22], Cid, et al. [15], Lin and Su [60], Klimova [49], Lin and Ho [59], Seah [74], Tu, et al. [86], Ansari and Khan [7], Cao, et al. [11], Justo, et al. [41], Lazar, et al. [55], Palalas and Wark [72], Guinibert [30], Jenó, et al. [38], Swanson [82], Galić, et al. [23], Zhang and Zou [97], Kiconco, et al. [47], Islam, et al. [37], Intarasirisawat, et al. [34]
2021	Shukla [78], Manca, et al. [61], Di Martino, et al. [20], Sin, et al. [79], Lewis and Taylor-Poleskey [57], Jones, et al. [39], Gong, et al. [27], Garg [26], Michelson, et al. [66], Jones, et al. [40]

**Table 5** Locations of the studies reviewed

Country	Num. of Articles	Reference	Country	Num. of Articles	Reference
Australia	1	[63]	Norway	1	[38]
Bangladesh	1	[37]	Oman	1	[76]
Belgium	1	[25]	Pakistan	1	[36]
Brazil	1	[17]	Poland	2	[52, 92]
Brunei	1	[8]	Romania	2	[55, 65]
China	11	[11, 12, 32, 58–60, 82, 83, 86, 95, 97]	Saudi Arabia	2	[2, 9]
Croatia	1	[23]	Singapore	2	[74, 90]
Czech Republic	1	[49]	South Africa	1	[10]
Germany	1	[5]	Spain	1	[41]
Greece	1	[82]	Thailand	2	[16, 84]
India	2	[7, 78]	Turkey	1	[75]
Italy	2	[20, 61]	Uganda	1	[47]
Jordan	1	[3]	United States	9	[14, 22, 26, 27, 40, 64, 66, 67, 79]
Malaysia	2	[19, 24]	Uruguay	1	[15]
Mexico	1	[71]	United Kingdom	2	[34, 39]
Netherlands	1	[33]	Europe	1	[87]

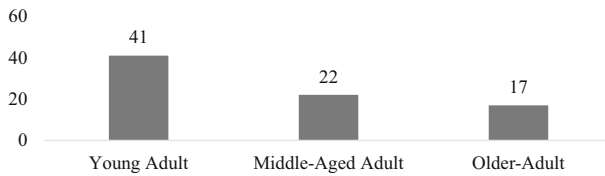
The details of the reference pertaining to the articles based on participants' categories (older adults (OA), middle-aged adults (MA), and young adults (YA)) are listed in Table 8.

## 9 Research context in Mobile learning

The articles obtained for this study were categorized by research area, as shown in Table 7. Based on the results, mobile learning was studied in the following areas: Education, Healthcare, Usability, Transactional Services, and Social and Communication. Figure 5 illustrates the number of articles published on each research topic. The finding shows that many researchers prefer to conduct research in the field of education. This is because computers and mobile devices are widely used in educational institutions among young adults. On the other hand, studies that focus on middle-aged and older adults are usually concerned with language or vocabulary learning. The healthcare field is also receiving a lot of attention from researchers, and studies on mobile learning in this field are usually related to elderly and middle-aged people because older people and middle-aged people tend to be more vulnerable to health problems. The number of articles from other fields is low because studies on middle-aged adults and mobile learning did not match the scope and range of years defined for this study.

**Table 6** Articles based on Participant's Category

Participant's Category	References
Older Adult	[11, 12, 15, 17, 20, 22, 32, 39, 41, 49, 58, 59, 61, 71, 79, 87, 95]
Middle-Aged Adult	[5, 11–14, 17, 21, 26, 32, 34, 37, 39, 40, 49, 52, 59, 63, 64, 66, 74, 75, 90]
Young Adult	[2, 3, 5, 7–10, 13, 16, 17, 19, 24–27, 30, 33, 34, 36–40, 47, 52, 55, 60, 64, 65, 67, 75, 76, 78, 81, 82, 84, 86, 87, 90, 92, 97]



**Fig. 4** Number of studies based on participants' age category

Because the study related to mobile learning is very broad, therefore the article obtained has been classified into research context. Research context was determined based on the previous and current research in the field of mobile learning. It was found that many researchers in the field of mobile learning have studied the acceptance, adoption, effectiveness, impact, intention of use, readiness, and usability of mobile learning. The categorized articles are listed in Table 9 in section 11, with additional information on the methodology used in each study. Figure 6 shows the number of articles obtained by research context.

## 10 Mobile learning towards the middle-aged adults

From these articles, not many researchers have examined the adoption of mobile learning by middle-aged adults. As mentioned earlier, a person in his or her forties is already inclined to focus on and enhance the standard of daily practice while also finding serenity. At this stage, many people have developed an inclination and willingness to gain more religious knowledge. Adult Muslims who work during the day, would rather choose to visit a mosque or *surau* to learn about Islam through religious lectures in the evening or at night. During the Covid-19 pandemic outbreak, many people were forced to work from home, and many lectures at the mosque were cancelled. As a result, many have taken the initiative to hold religious lectures via video conferences over the internet (e.g.: Zoom, WebEx). Others tend to watch religious lectures that have been posted on YouTube or other related platforms. However, as opposed to face-to-face seminars, the excitement and encouragement to attend online and prerecorded learning is lacking. Midlife brings with it a multitude of significant life experiences, the majority of which revolve around work, family, especially parenting, and self-development. Tablets are being used more commonly by middle-aged adults to monitor healthy lifestyle behaviors, maintain social contact, avoid injuries, and search information.

Many middle-aged and older adults are using the Internet to obtain information about health conditions and treatments, to get social support and advice from others with similar health-related experiences, and to access apps to help them manage their health [28]. For instance, Huang, et al. [32], studied on the attitude of middle-aged adults towards health app usage.

**Table 7** Articles based on research area

Area	References
Education	[2, 3, 5, 7–10, 13, 14, 16, 19, 23–25, 30, 33, 36, 38, 49, 52, 55, 60, 65, 72, 74–78, 81–84, 86, 88, 92, 97]
Healthcare	[11, 12, 15, 20–22, 32, 34, 39–41, 61, 63, 71, 87]
Social & Communication	[26, 27, 58, 66, 79, 95]
Design and Development (usability)	[37, 59, 64, 67, 90]
Transaction Service	[17, 47]

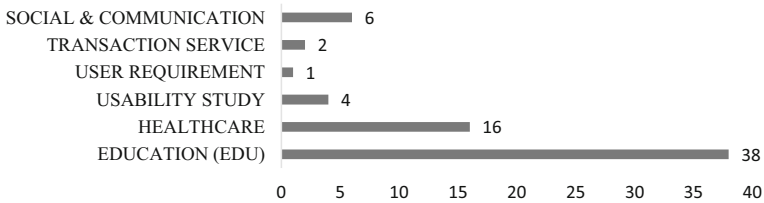


Fig. 5 Number of articles in the research domain

From the study, they discovered that middle-aged adults who have no habits in health management tend to consider health applications as valuable tools and have a positive impact on them, while those who already have the habit, do not tend to consider health applications as valuable tool to be used in their daily routines. There are also some middle-aged adults who decide not to use health apps due to some sentimental reasons and the confidence of middle-aged adults in using a smartphone influences their cognitive assessment of health apps.

Table 8 shows the list of studies that are related to middle-aged adults. The age range of the middle-aged adults by each researcher varies. In this study, the age range of the adult is between 40 to 60 years old, which means the selected articles involve participants in this age range. A total of 22 articles were selected that involved middle-aged adults. In the field of language learning, two papers were identified. From these articles, it is found that the study of mobile learning with middle-aged adults is widely conducted in education area. The use of mobile apps in healthcare is also considered important, as this area is also the focus of researchers. The remaining articles are related to the study of user requirements, usability, and the design and development of mobile apps for middle-aged adults.

## 11 Research methodology

Research methodology is the main key to perform academic research and the strength of a research. The research methodology found used in the selected articles are Questionnaire, Interview, Systematic Literature Review, Literature Review, Reporting, Task Analysis and Experiment. Figure 7 shows the most popular research method used by a researcher in the field of mobile learning is questionnaire (n=24). This methodology has been used in studies that require a large amount of data from many respondents. The second most popular research method used in mobile learning research area is the Interview (n=9). There are also studies that require the use of multiple research methods to answer research questions.

Table 9 shows the methodologies employed in the selected articles. However, articles [23, 49, 63, 72, 81, 83, 88], and [77] are not included because these articles are review articles.

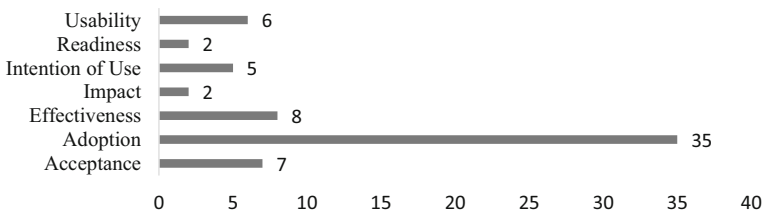


Fig. 6 Number of papers by research context



**Table 8** Research involving middle-aged adults

Reference	Year	Research Title	Middle-age range	Research Area
[49]	2020	Benefits of the Use of Mobile Applications for Learning a Foreign Language by Elderly Population.	50–85 years old.	Education-Language Learning
[5]	2019	Mobile language learning applications for Arabic speaking migrants—a usability perspective.	5–50 years old.	Education-Language Learning
[75]	2017	The design and implementation of a context-aware mobile Hadith learning system.	19–49 years old.	Education-Spiritual
[32]	2019	Middle-aged adults' attitudes toward health app usage: a comparison with the cognitive-affective-conative model.	45–65 years old.	Healthcare-Well Being
[11]	2020	Exploring seniors' continuance intention to use mobile social network sites in China: a cognitive-affective-conative model.	50–70 years old.	Healthcare-Well Being
[59]	2020	The development of a mobile user interface ability evaluation system for the elderly.	50–59, 60–69, 70–79 and >80 years old.	Usability
[37]	2020	Chakuri-Bazaar: A Mobile Application for Illiterate and Semi-Literate People for Searching Employment.	18–55 years old.	User-Requirement
[17]	2016	A study on the acceptance of website interaction aids by older adults.	>39, 40<59, and >60 years old.	Transaction Service
[52]	2017	A model of mobile technologies acceptance for knowledge transfer by employees.	<20, 21–30, 31–40, 41–50, and >50 years old.	Education-Knowledge Transfer
[74]	2020	Using Kahoot in law school: Differentiated instruction for working adults with diverse learning abilities.	Did not provide age range	Education - Law
[14]	2017	Readiness for integrating mobile learning in the classroom: Challenges, preferences, and possibilities.	Did not provide age range	Education
[13]	2016	Designing Serious Games for Safety Education: “Learn to Brace” versus Traditional Pictorials for Aircraft Passengers.	19–55 years old	Education
[21]	2019	The Effect of Cognitive Load on Gesture Acceptability of Older Adults in Mobile Application	55 years old and above	Healthcare-Well Being
[90]	2019	AppMoD: Helping Older Adults Manage Mobile Security with Online Social Help.	18–40, 50+ years old	Design and Development
[12]	2018	Evidence-based personal applications of medical computing models in risk factors of cardiovascular disease for the middle-aged and elderly.	40–100 years old	Healthcare-Well Being
[64]	2019	My Mom was Getting this Popup: Understanding Motivations and Processes in Helping Older Relatives with Mobile Security and Privacy.	<35, 35–54, >54 years old	Design and Development
[34]	2020	An Automated Mobile Game-based Screening Tool for Patients with Alcohol Dependence.	24–65 years old	Healthcare-Well Being
[39]	2021	Determinants of Longitudinal Adherence in Smartphone-Based Self-Tracking for	22–85 years old	Healthcare-Well Being

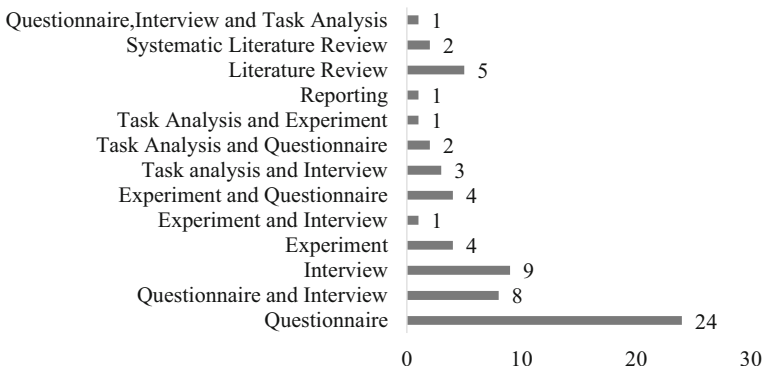
**Table 8** (continued)

Reference	Year	Research Title	Middle-age range	Research Area
[26]	2021	Chronic Health Conditions: Evidence from Axial. Its Changes so Often: Parental Non-/Use of Mobile Devices While Caring for Infants and Toddlers at Home.	25–45 years old	Social & Communication
[66]	2021	Parenting in a Pandemic: Juggling Multiple Roles and Managing Technology Use in Family Life During COVID-19 in the United States.	Did not provide age range	Social & Communication
[40]	2021	Be Consistent, Work the Program, Be Present Every Day Exploring Technologies for Self-Tracking in Early Recovery	21–60 years old	Healthcare-Well Being

In the literature, the questionnaire was found to be the most common method used by researchers for data collection involving many participants among young adults and middle-aged adults. On the other hand, the interview method only involved small groups of participants and was carried out in a short time period. Task analysis with interview method was used in three research studies to evaluate the usability, acceptance, and adoption. The studies were done towards young adults and older adults.

In the quantitative research method, the questionnaire instrument was used by the researchers to understand users' motivation to use e-learning as a medium of learning [60]; the use of mobile technology and means of internet access [24]; awareness in using mobile devices towards mobile learning [14]; investigate the perception of students related to educational use of mobile phones [36, 55, 76]; investigate students' behavioral intentions [3] and knowledge transfer among adult workers [52]; identify factors that affect the intention to use m-learning by learning the experience of the m-learning system by the participants [84], measure usability [19, 75]; use and engagement with m-learning [2]; collaborative learning experience in social media environment [7], students' immersion in the game and their perceived learning outcomes [33], and the use of mobile application [11, 65].

Almost all researchers have formally collected demographic data such as gender, age, degree program, year of study, and race of the participants. There is only one study that

**Fig. 7** Number of articles by research methodology

**Table 9** Research context and methodology

Research Context	Questionnaire (Q)	Interview (I)	Experiment (E)	Task Analysis (T)	Number of participants (n)				Duration in Week	ADULT GROUP Young (YA), Middle-Aged (MA), Older (OA)	Author
					Q	I	E	T			
Acceptance (n=6)	✓				328				n/a	YA	[24]
	✓				228				n/a	YA	[3]
	✓				313				n/a	YA, MA, OA	[17]
	✓				806			24	8	YA	[76]
Adoption (n=29)	✓	✓		✓	371	24			n/a	YA, MA	[97]
	✓				220				20	YA	[52]
	✓	✓			280	44			1	YA	[78]
	✓				337				1	OA	[22]
	✓	✓				74			n/a	YA	[60]
	✓				320				28	YA	[10]
	✓	✓			355	42			n/a	YA	[36]
	✓	✓			422	14			8	YA	[8]
	✓	✓				23			n/a	YA	[25]
	✓	✓				60			13	MA	[74]
	✓			✓					60	YA	[86]
		✓				238				n/a	YA
✓					360				n/a	YA	[7]
✓					111				n/a	YA	[65]
✓		✓				5			n/a	YA	[30]
✓		✓			263	30			1	YA	[19]
✓		✓			526	208			n/a	YA	[47]
✓		✓		✓	40	40		40	n/a	YA, MA	[37]
✓		✓			226	10			2	OA	[95]
✓					50				n/a	YA	[16]
✓			✓		78			50	n/a	OA	[41]
✓					84				n/a	MA, OA	[32]
✓					60				n/a	OA	[20]
✓		✓				24			n/a	OA	[79]
✓				✓					n/a	OA, YA	[87]
✓				198			17	n/a	YA, MA	[64]	

Table 9 (continued)

Research Context	Questionnaire (Q)	Interview (I)	Experiment (E)	Task Analysis (T)	Number of participants (n)			Duration in Week	ADULT GROUP Young (YA), Middle-Aged (MA), Older (OA)	Author
					Q	I	E T			
Effectiveness (n=8)	✓	✓			138		n/a	YA	[67]	
	✓				184		n/a	YA, MA, OA	[39]	
	✓	✓			-	30	n/a	YA	[27]	
			✓			160	3	MA	[66]	
		✓	✓			93	36	YA	[92]	
		✓			181		n/a	OA	[15]	
	✓	✓				16	1	YA	[33]	
	✓	✓	✓		58	58	n/a	YA	[82]	
	✓				48		n/a	YA, MA	[38]	
		✓	✓			10	10	YA, MA	[13]	
Impact (n=2)	✓	✓			40		n/a	MA	[21]	
	✓		✓		14	40	n/a	MA, OA	[12]	
Intention of Use (n=5)	✓				359		n/a	YA	[9]	
	✓				374		4	OA	[61]	
	✓				1208		n/a	YA	[84]	
	✓						n/a	MA, OA	[11]	
	✓						n/a	YA	[55]	
Usability (n=6)	✓	✓				17	n/a	YA, MA	[26]	
	✓	✓				17	n/a	YA, MA	[40]	
	✓	✓	✓			22	n/a	OA	[58]	
	✓	✓				135	n/a	MA, OA	[59]	
	✓	✓			33	33	n/a	YA, MA	[5]	
	✓	✓			20	32	n/a	YA, MA	[75]	
Readiness (n=1)	✓		✓			50	n/a	OA	[71]	
	✓				1430		n/a	OA	[90]	
								MA	[14]	

collects data on working background because the participants in the study involved working adults. Amongst the selected articles, Al-Adwan, et al. [3] and Lazar, et al. [55], validated the content of the survey using experts before the questionnaire was distributed to participants. Dhanapal, et al. [19] and Huizenga, et al. [33] carried out a pilot test to identify the flaws and improves the questionnaire. All but one of the researchers used Point Likert scale, while MICAN [65] uses short answer questions, multiple choices with 1 or n answers, single or two-dimensional questions. The duration of data collection was less than 40 weeks depending on the targeted number of participants.

For the qualitative research method, data was collected via task analysis and interviews. Data were captured through multiple channels including video data analysis and interview content analysis. From the selected articles, it is found that task analysis and interview method were employed in the mobile learning domain to understand participants' actions, performance, and usability towards mobile apps. The task activities that have been examined by researchers are navigation tasks (with task activity duration of 1.5 hours for older adults to complete searching and navigating using several mobile applications) [58], quiz activities using Kahoot application (held within 13 weeks for working adult and the task activities were perform in a classroom environment) [74], mobile devices usage training ( duration of 9 months of training intervention involving older people), and the task activities (e.g.: sending messages, video and audio calls ) was performed in a hospital [15]; Vocabulary learning [86, 97]; games application with task duration of 5 to 20 minutes [71]; and usability testing [30]. Open-ended questions were used in the interview sessions [71] and all the audio recordings of the interviews were transcribed verbatim for analysis purposes [58].

In the experimental research design, two groups were created with specific condition applied. The treatment group and the control group involved in the experiment and questionnaire research approach can be seen in articles [9, 16, 38, 92] as listed in Table 9. For instance, in Bensalem [9], aims at investigating students' perceptions about the use of WhatsApp in learning vocabulary and in the study, twenty-one participants were randomly assigned to the experimental group. Participants from the experimental group are required to complete and submit their vocabulary assignments via WhatsApp. In the assignment, students are required to search the meaning of new words in a dictionary and build sentences using each word. On the other hand, participants from a control group need to submit the same homework assignment using the traditional paper and pencil method. Later, a questionnaire was distributed to the participants and the collected data was used to measure the participants' perception of the use of WhatsApp in vocabulary learning.

## 12 Discussion

In this article, a systematic review was conducted to provide a thorough analysis on the methodologies adopted by researchers in mobile learning. The number of research papers in the year 2020 exceeds the number of research papers in the previous year. This could be due to the outbreak of the Covid-19 pandemic that triggered higher number of papers. During the pandemic, everyone had to work from home, and many organizations, including public and private higher learning institutions, were unable to carry out traditional teaching and learning activities. As a result, many studies or meetings were required to be conducted online.

The country with the highest number of research papers in the field of mobile learning is China with 11 articles. There is a lack of study in mobile learning that focuses on middle-aged

adults. Out of 65 research papers, a total of 22 research papers are related to middle-aged adults whereby the distribution of research can be seen in countries such as in Czech Republic (n=1), United States (n=5), China (n=3), Germany (n=1), Singapore (n=2), Turkey (n=1), Brazil (n=1), Poland (n=1), Bangladesh (n=1), United Kingdom (n=2) and 2 articles did not mention the country in which the research was carried out. Studies related to middle-aged adults in Malaysia are not very encouraging, therefore the study of middle-aged adults in the field of mobile learning needs to be given more attention.

The articles selected in this systematic review were classified by research context to identify the focus of previous researchers on the use of mobile learning by middle-aged individuals. Overall, it was found that studies related to the adoption of mobile learning, mobile applications and mobile devices have gained significant attention among researchers, followed by studies related to the acceptance and mobile learning usage. However, studies on examining the adoption and effectiveness of mobile learning usage towards middle-aged adults are still lacking. Examining the effectiveness of mobile learning usage is crucial to provide guidance towards decision making and development work in the future.

The field of education is a popular field for researchers as it involves teachers and young adults who are mainly engaged in the learning environments. Research on middle-aged adults in the educational field is found in seven articles, where two of the articles focused on vocabulary learning. One study on Hadith learning for middle-aged adults, which has been classified as a study on spiritual learning under the educational research domain was also identified. The remaining four articles are respectively related to the use of game applications in teaching adults, the use of mobile devices in sharing information among adult workers, and the readiness of the teachers in adopting mobile learning in a classroom. Besides that, there is also a lack of research towards middle-aged adults in the area of mobile usability and user requirements. Research in the healthcare domain mostly involves older adults where most researchers extensively investigate the use of mobile devices and mobile applications towards healthy ageing and wellbeing.

The coding of the research methods was based on the methods reported by the researchers in their methodology section. Questionnaire is a popular instrument used across quantitative and mixed research approaches for data collection. The questionnaire developed by the researcher will be validated by the experts and tested before it was distributed accordingly to the targeted participants. Task analysis and interview approach can be used to observe the behavior of the users and to evaluate users' feedback in the learning environment. Even though the method was not extensively used by the researchers from the selected literature focusing on middle-aged adults, this method to be employed in the mobile learning research to gain more insight on the effectiveness of mobile technologies in the learning environment of middle-aged adults was suggested.

Nowadays, almost everyone owns a smartphone, as smartphone prices have dropped significantly, making them affordable for more users. All smartphone users are capable to use most of the basic features of the mobile device, such as downloading applications from the Apple Store or Google Play. Given that middle-aged individuals are heavy smartphone users, it is critical to understand how users utilize mobile technology such as smartphones not just for work, leisure, and entertainment, but also for knowledge acquisition.

Middle-aged adults are self-directed, able to take responsibility for their learning, have a variety of experiences and backgrounds, and are motivated and willing to learn while effectively managing real-world situations. Hence, middle-aged adults can benefit from webinars and short courses delivered online. Therefore, more research should be conducted on mobile learning for middle-aged adults.

## 13 Conclusion and future work

The novelty of this study is that it contributes to the understanding of the research trends based on research context and methods used in research related to middle-aged adults in mobile learning. It is noted that there are still few studies that address the adoption and effectiveness of mobile apps in the area of religious orientation, especially among middle-aged adults. For instance, before the Covid-19 outbreak, middle-aged Muslims in Malaysia preferred to attend religious courses and trainings to improve their spiritual and religious orientation [96] based on face-to-face with teachers in a classroom. Therefore, it is critical to determine whether middle-aged adults intend and consent to religious and spiritual learning, such as learning the Quran to be conducted via mobile devices. It is hoped that the use of mobile learning will enable adults' lifelong learning to be improved and done continuously under any situation in the future. This study suggests further studies on middle-aged in the field of mobile learning as follows:

### Theme 1: **Skills and Knowledge Development**

The use of mobile learning among middle-aged adults begins with an awareness and intention to use mobile devices. Generally, middle-aged adults who own smartphones, they already have skills to download apps from the Google Store or App Store and set security preferences. Hence, they must intend to use mobile learning to develop their skills and knowledge. This is because between the ages of 40 and 60, they are usually busy with their work while facing problems such as increasing concerns about health, death of a friend or relative, changes in wages/salaries, and concerns about changes in physical appearance. Therefore, middle-aged adults need to seek knowledge that will make them be satisfied and enable them to lead a better and healthier lifestyle. For example, middle-aged Muslims can learn to understand the Quran through mobile learning to achieve a better quality of life because the Quran is the final revelation and book from Allah s.w.t to humankind as guidance and direction to the right path.

### Theme 2: **Mobile Learning Application with Multimedia**

Mobile learning Application with multimedia plays a great role in motivating learners in learning via digital devices such as smartphones. It is crucial to design and develop mobile learning apps with appropriate multimedia elements such as texts, images, icons, and animations that meet the needs of middle-aged adult learners. In addition, middle-aged adults need to be helped to increase their motivation to learn and improve their memory performance in vocabulary memorization. Therefore, for future work, mobile app development needs to be carefully developed based on user needs especially for the multimedia elements such as the text, graphic, video and animation.

### Theme 3: **Mobile Learning Application and Quick Assessment**

Assessment is a critical component of learning since it demonstrates progress. Because most of the learning occurs online and involves many students, a teacher develops easy assessment tools and procedures that enable them to rapidly assess their students' learning progress. Numerous game-based apps have aided in the facilitation of teaching and may be used to measure a student learning progress. Additionally, to make mobile learning more interesting, game-based elements have been used to improve the students' engagement and enjoyment in learning. For instance, Kahoot is a game-based technological platform that can be accessed



using, for instance, a smart device or a laptop. The game-based learning application (app) can benefit working adults who are adult learners with diverse learning abilities. Chunking method was used to break down complex concepts into smaller parts in the form of multiple-choice questions. The students' learning process is tested and corrected, in real time, through the statistics which are generated from this chunking process. Kahoot creates a safe environment for students to make mistakes through multiple choice questions, and yet relearn it without being judged by their peers. However, the drawback of Kahoot is, it does not adequately support the learning experience of adult learners Seah [74]. Therefore, in the future, the development of mobile learning apps for middle-aged adults might include a gamification aspect that allows easy assessment for self-monitoring of learning progress.

#### Theme 4: **Research Methodology**

The finding of this study shows that questionnaire is a popular instrument used across quantitative and mixed research approaches for data collection. The questionnaire developed by the researcher will be validated by the experts and tested before it was distributed accordingly to the targeted participants. However, based on the research context and methodologies found in the literature, the study on middle-aged adults was not getting the enough intention among researchers. Furthermore, as Covid-19 pandemic has impacted people's life, many are reluctant to participate in answering questionnaires as they may be unmotivated due to job loss, adaptation to new norms or due to the death of their family members. Therefore, in the future, it is hereby recommended that a contribution back to society such as given some tokens to the participants [66, 90] can be practiced in the research methodology. Besides that, a researcher also can conduct a free intensive course of related field to a group of respondents to upgrade the lifestyle and well-being among respondents. Hence, this can increase public participation in research, especially when involving busy and elderly respondents and at the same time the respondents can learn new knowledge while also contributing to the research study.

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