

Implementation of Mobile Seamless Learning Strategy in Primary and Secondary School: A Systematic Literature Review

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ABSTRACT

The expanding utilization of educational technologies, the introduction of digital classroom concepts, and the interest in teaching innovations have resulted in an increased recognition of the possible deployment of mobile seamless learning strategies to facilitate learning growth in educational institutions. Nevertheless, the majority of research has mostly concentrated on the application of mobile seamless learning strategies within the context of higher education. Consequently, there remains a dearth of research evidence and studies pertaining to the practical application and continuous execution of educational initiatives in pre-higher education. Hence, it is imperative to have a deeper comprehension of the execution of mobile seamless learning strategies in elementary and secondary education, based on existing literature on mobile seamless learning strategies. This systematic literature review (SLR) intended to uncover mobile seamless learning strategy research that focuses on adopting mobile seamless learning strategy at pre-higher education levels, including in pre-school, primary, or secondary school. This SLR was carried out based on the SALSA framework to determine the protocol, search, appraisal, synthesis, analysis, and reporting approaches. The data corroborate the claims that the application of mobile seamless learning method in school is still inadequate, while the deployment has been observed largely in developed countries. The implementation is focusing on the educational and learning context, research areas and research focus, data collection techniques, and mobile technology used. The literature review has demonstrated a dearth of research on the implementation of mobile seamless learning strategy at the primary and secondary education levels.

Keywords: systematic literature review, mobile seamless learning strategies, pre-higher education, primary school, secondary school, teaching and learning

INTRODUCTION

The integration of mobile seamless learning in primary schools has gained significant attention in recent years, as mobile devices become increasingly ubiquitous in society. Mobile seamless learning, which combines mobile technology with pedagogical approaches, can provide primary school students with access to educational resources and learning experiences that are not typically available within traditional classroom settings.

According to [2], mobile seamless learning can facilitate active learning, personalized learning, and collaborative learning among primary school students. By leveraging mobile devices, students can engage in interactive and engaging activities that promote critical thinking and problem-solving skills. Furthermore, mobile seamless learning can provide opportunities for primary school students to learn in authentic, real-world contexts, helping them to better understand the relevance and applicability of their learning.

Despite the potential benefits of mobile seamless learning, its implementation in primary schools poses several challenges, including concerns over safety and security, device management, and equity of access. Therefore, careful planning and consideration are required to ensure the successful implementation of mobile seamless learning in primary schools.

This academic article aims to explore the implementation of mobile seamless learning in primary schools, drawing on best practices and case studies from around the world to provide insights into successful imple-

mentation strategies. This article will also examine the challenges and opportunities associated with mobile seamless learning in primary schools, and offer practical recommendations for educators seeking to adopt this approach. The major objective of this paper is to provide a scholarly contribution to the expanding field of research on mobile seamless learning in primary schools. Additionally, it seeks to offer valuable information to educators who are interested in improving the quality and efficacy of their instructional practices.

Implementation of Mobile Seamless Learning Strategy

Mobile Seamless Learning refers to a form of flexible education that occurs in a continuous manner, extending beyond the confines of traditional classroom settings. It encompasses learning experiences that take place not just within educational institutions, but also within families and communities. [22],[26],[38]. Whereas, [40] state that in the seamless learning, the learning occurs because of both individual and collective efforts and across all different contexts. A research on seamless learning was done by [30] contain inquiry learning used to study the theories and discussion methods. The implementation of seamless learning through the utilization of mobile devices aligns with contemporary advancements in education.

[6] used seamless learning and utilizes mobile in the language learning. The physical and temporal constraints of the classroom environment impose limitations on students' learning experiences. However, the development of character necessitates ongoing learning and support, extending beyond the confines of educational institutions to encompass the broader spheres of family and community. [11], [23].

There are ten dimensions of Mobile Seamless Learning (MSL), namely: (1) includes both informal and formal teaching; (2) social and individual teaching; (3) across place/locations, (4) across time; (5) access knowledge/resources everywhere; (6) covers both digital and physical world; (7) combined use of several types of devices; (8) switch between several tasks; (9) knowledge synthesis; (10) includes several models of pedagogical activities [38].

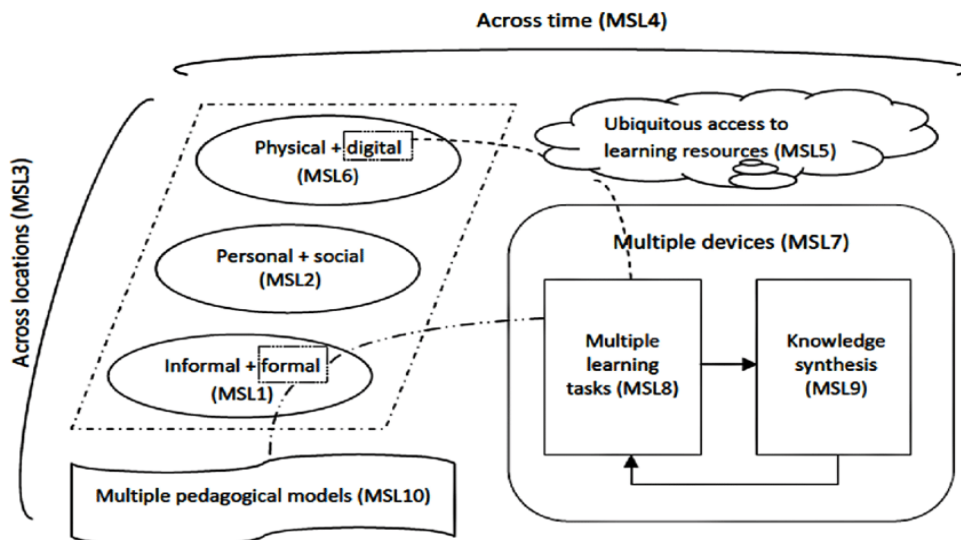


Fig. 1. Visualization of the 10D-MSL dimensions ([36], p. E20)

Previous Systematic Literature Review Studies

Mobile seamless learning has gained increasing attention in the field of education due to the ubiquitous presence of mobile devices and the potential for anytime and anywhere learning. Numerous prior SLR have investigated the efficacy of mobile seamless learning within educational settings.

One such study by [19] analyzed 39 studies published between 2007 and 2016 and found that mobile seamless learning can positively impact student learning outcomes such as knowledge acquisition, critical thinking, and problem-solving skills. Similarly, [4] reviewed 19 studies that obtained by an electronic search conducted on various educational databases, including ERIC, EBSCOHOST, ProQuest, Wiley International Science, Elsevier Direct, JSTOR, and Sage Journal Online. Published between 2007 and 2017 and identified benefits of

mobile seamless learning such as enhancing student engagement, motivation, and learning outcomes. However, the study also highlighted challenges related to device management, equity of access, and teacher training.

[35] conducted comprehensive SLR, encompassing a total of 48 articles published between the timeframe of 2010 to 2019. The findings of this research revealed that... mobile seamless learning can improve student engagement, motivation, and learning outcomes. The study also identified challenges such as technical support, device management, and the need for appropriate teacher training. Another study by [28] analyzed 25 studies published between 2008 and 2018 and found that mobile seamless learning can enhance student engagement, collaboration, and learning outcomes. The study also emphasized the importance of appropriate teacher training and support for the successful implementation of mobile seamless learning.

[7] conducted a meta-analysis of 51 studies published between 2005 and 2012 that explored the use of mobile devices for learning in K-12 education. The studies were analyzed to identify the benefits, challenges, and best practices of mobile seamless learning. The study found that mobile seamless learning has several benefits, including increased student engagement and motivation, improved collaboration and communication, and enhanced access to educational resources. The authors also identified several challenges, including issues related to device management, technical support, and equity of access. The study further identified best practices for implementing mobile seamless learning, including the importance of aligning mobile learning activities with curriculum goals and instructional strategies, providing training and support for teachers and students, and developing appropriate assessment methods.

In aggregate, the aforementioned research indicate that the implementation of mobile seamless learning holds promises for augmenting student learning results and fostering increased engagement within educational settings. However, careful consideration of technical and pedagogical factors and appropriate teacher training and support are critical for successful implementation.

To answer the call, this SLR was conducted to identify mobile seamless learning research that focus on the implementation of mobile seamless learning at pre-higher educational levels: K-12, primary, or secondary schools. The main aims of this study were to gather information on educational and learning contexts, research areas and focus, emerging research trends, methodologies employed, data collection techniques, mobile technology used, learning outcomes, and issues in the field of mobile seamless learning (MSL). This was done in order to develop a comprehensive grasp of the subject matter. The research objective guides the investigation of the following research questions:

RQ1: What are the educational and learning contexts?

RQ2: What are the research areas and research focus?

RQ3: What are data collection techniques used?

RQ4: What are the mobile technology used?

This review encompasses a collection of papers that exclusively focus on the topic of MSL. In order to present a current and thorough examination of the most recent advancements in MSL, the SALSA checklist was employed to assess scholarly articles released between the years 2018 and 2023. The papers underwent a thorough evaluation based on rigorous inclusion and exclusion criteria, which will be further elaborated in the subsequent section. The subsequent sections of this work are structured in the following manner: firstly, the methodology employed for the SLR will be presented; secondly, the findings derived from the synthesis and analysis of the data obtained from the literature review will be discussed; and finally, concluding observations will be provided.

METHODOLOGY

The review protocols utilized in this SLR are derived from the SALSA framework, as proposed by [1]. The SALSA framework consists of five distinct phases, including protocol, search, appraisal, synthesis, and analysis. The elucidation of each phase is provided in the subsequent sections:

Protocol

The initial stage of the SALSA methodology is referred to as the "protocol" phase, during which the scope of the SLR is established and delineated. The utilization of the PICOC framework, a well-established approach for formulating research inquiries, was employed in this study to establish the breadth of the review, as illustrated in Table 1.

Table 1. PICOC Protocol Outlines

P	Population	School teachers, students
I	Intervention	Data collection technique, mobile technology used
C	Comparison	Similarities and differences in implementation at the pre-higher education and higher education level.
O	Outcomes	Details on the implementation of mobile seamless learning strategy in school, specifically the state of mobile seamless learning strategy implementation, objectives, design, and findings.
C	Context	School (k-12, primary and secondary)

Search

Following the identification of the scope of the SLR, the subsequent phase entails conducting a comprehensive search. In this phase, the researcher conducts a comprehensive search for pertinent sources of information related to the topic. Initially, the sources pertaining to search databases and search engines are enumerated, followed by the explication of the search string, which is formulated based on the context identified in PICOC. Subsequently, the search query is entered into each respective database in order to access the relevant sources. The outcome of this protocol is as follows:

- a. Database: Scopus, Google Scholar, Mendeley, ScienceDirect, Web of Science
- b. Search String: “Mobile seamless learning” AND (schools OR K-12 OR primary OR secondary)
- c. Retrieved Sources: The result of search and retrieve is as depicted in Table 2.

Table 2. Search String and Retrieved Sources in Each Database

Search String	Database	Date	No of Sources
TITLE-ABS-KEY("Mobile seamless learning" AND schools OR K-12 OR primary OR secondary)	Scopus	1/4/2023	10
“Mobile seamless learning” AND (schools OR K-12 OR primary OR secondary)	Google Scholar	1/4/2023	512
"Mobile seamless learning" AND (schools OR K-12 OR primary OR secondary)	Science Direct	1/4/2023	5
"Mobile seamless learning" AND (schools OR K-12 OR primary OR secondary)	Springer Link	1/4/2023	55

Appraisal

During this stage, the sources obtained from the designated database and search engines are assessed to determine the relevance of the papers to the research questions of the study. The evaluation of sources in appraisal determines the inclusion and exclusion of sources based on criteria in the Table 3.

Table 3. Sources Inclusion and Exclusion Criteria

Type	ID	Statement
Inclusion	I1	Studies that present discussion about MSL implementation in school
	I2	Studies that present discussion about MSL implementation in K-12
	I3	Studies that present discussion about MSL implementation in primary education
	I4	Studies that present discussion about MSL implementation in secondary education
Exclusion	E1	Studies before 2015
	E2	open access, has abstract, has full text
	E3	Subject: education, computer science
	E4	Does not meet any of the inclusion criteria
	E5	Remove duplicates

The result of appraisal is as shown in Table 4.

Table 4. Result of Sources Evaluation in Appraisal

Database	Search result	E1	E2	E3	E4	E5
Scopus	10	9	2	2	0	0
Google Scholar	438	348	7	4	0	0
ScienceDirect	5	4	1	1	0	0
Springer Link	55	54	4	4	0	1
Total	508	415	14	11	0	10

Table 4 presents the identification and selection of 10 studies, which were chosen through a rigorous appraisal process. Table 5 presents an overview of the selected research, providing details such as the title, author, year, and country of each study.

Table 5. Overview of Selected Studies

Nu	Title	Author(s)	Year	Country
1	Teachers' reflection in early stages of diffusion of an innovation	[17]	2015	Singapore

2	Seamless flipped learning: a mobile technology-enhanced flipped classroom with effective learning strategies	[18]	2015	Taiwan
3	Attuning a mobile simulation game for school children using a design-based research approach	[19]	2015	Netherland
4	Leadership for learning in technology-rich upper secondary school classrooms	[20]	2017	Norway
5	Integrating educational theories into a feasible digital environment	[21]	2019	Saudi Arabia
6	The implementation of mobile seamless learning strategy in mastering students' concepts for elementary school	[22]	2019	Indonesia
7	A critical review of mobile learning: Phoenix, fossil, zombie or?	[23]	2021	UK
8	A Systematic Literature Review on the use of Mobile- assisted Language Learning (MALL) for Enhancing Speaking Skills in Chinese EFL context	[24]	2021	Malaysia
9	Waking Up In the Morning (WUIM): A Smart Learning Environment for Students with Learning Difficulties	[25]	2021	Greece
10	Systematic Review of Mobile-Assisted Task-Based Learning Based on Wos (2013-2022)	[26]	2022	Malaysia

Synthesis

The synthesis phase encompasses two key components: the extraction and classification of pertinent data from the chosen studies. These activities are undertaken with the aim of deriving information and conclusions that effectively address the research questions at hand. Thematic synthesis was employed at this phase. The chosen studies are carefully reviewed multiple times to identify and extract pertinent data in accordance with the specified scope outlined in the PICOC framework. This process is undertaken to establish the foundational topics upon which subsequent analysis will be conducted. The identified themes in relation to the study topics are as follows: (a) educational and learning contexts, (b) research areas and research focus, (c) data collection techniques, and (d) mobile technology used. The data pertaining to each theme was extracted and organized in an Excel spreadsheet for subsequent data processing.

Analysis

The analysis phase involves the assessment and manipulation of the synthesized data from the preceding phase. The process comprises of four distinct steps: identification and extraction, thematic analysis, results and discussion, and conclusion. The procedure of analysis is performed manually using the Microsoft Excel software. The findings of this phase are thoroughly given and discussed in the subsequent section.

RESULTS AND DISCUSSION

A comprehensive review of the literature identified a total of ten articles that were subsequently included in the SLR. Based on the studies overview in Table 5, the implementation of mobile seamless learning strategy were demonstrated mostly in several countries like Singapore, Taiwan, Norway, Saudi Arabia, Indonesia, Netherland, UK, Greece and Malaysia. Noticing from the date of publication (mostly in 2015 and 2021), this evidence substantiates the assertion that the implementation of mobile seamless learning strategy in school (K-12, primary, secondary) is lacking and has only emerged in developed countries. Furthermore, several learning

contexts have been found, among which informal learning emerges as a relevant environment for students to cultivate their skills in learning. The subsequent findings are derived from the synthesis and analysis that have been provided and discussed in accordance with the research questions of the study:

Educational and Learning Contexts (Research Question 1)

The observed data illustrates the distribution of educational levels among learners, specifically one (10.0%) papers on secondary or middle school students [8], three (30.0%) in other institutions, i.e., elementary school students [17], [10], [14], and six (60.0%) paper on both primary and secondary school [39],[12],[25],[33],[41],15].

According to the data shown in Table 6, approximately 40% of the studies were conducted in learning environments that encompass both formal and informal contexts. Three studies [39], [33], [15] were conducted in only informal contexts, and two studies [25], [10] were conducted in formal contexts. One study [17] did not specify the learning contexts.

Table 6. Educational and Learning Contexts

Contexts	Subcategories	Study
Educational Contexts	Secondary or middle school	1
	Primary or elementary school	3
	Kindergaten	-
	Both primary and secondary school	6
Learning Contexts	Both formal and informal	4
	Formal	2
	Informal	3
	Not specify	1

Research Areas and Research Focus (Research Question 2)

Table 7 presents several examples of the research area with all 10 papers on learning. Learning strategies (LS) ($n=5$) is the research area that is most commonly investigated, followed by learning environment (LE) ($n=3$), Mobile-assisted Language Learning (MALL) ($n=1$), and Mobile-Assisted Task-Based Learning (M-TBL) ($n=1$).

Table 7. Research Area by Languages and Authors

Research Area	Focus	Paper
Learning	Strategies	[39], [12], [8], [10], [33]
	Environment	[25], [17], [15]
	MALL	[41]
	M-TBL	[14]

Four research focus were identified. The predominant research focus revolved around *learning behaviour* ($n=3$). Other research focuses were addressed once ($n=1$) (Table 8).

Table 8. Research Focus and Subcategories by Authors

Research Focus	Subcategory	Paper
Perceptions	Integrating mobile technology into TBL	[14]
	MALL	[41]
Learning differences	Learning difficulties	[15]
Evaluation	Mastering students concept	[10]
Learning behaviour	Student engagement, participation, teachers reflection	[39], [11], [8]

The research focus *perception* includes integrating M-TBL [14], learning and MALL [41]. *Learning differences* included learning difficulties [15]. *Evaluation* is focusing on mastering students concept [10]. *Learning behaviour* (student engagement, participation, and teacher perfection) [39], [11], [8] was thoroughly researched in order to analyze its correlation with the process of learning.

Data Collection Technique (Research Question 3)

The researchers seem to gather data by several methods, including the distribution of questionnaires ($n=2$), pretest and posttest ($n=1$), interviews ($n=2$), observation ($n=1$), and other instruments ($n=7$), such as field notes, videos, audio recordings, and lesson design artifacts (Table 9).

Table 9. Data Collection Technique by Authors

Data Collection Technique	Authors	Numbers
Questionnaires	[39], [17]	2
Pretest - Posttest	[10]	1
Interviews	[39], [8]	2
Observation	[39]	1
Other Instruments	[39], [12], [25], [33], [41], [19], [14]	7

Mobile Technology Used (Research Question 4)

This section provides an overview of the mobile technologies used in the evaluated papers, which may be broadly classified into two categories: mobile devices and mobile platforms. iPads or iPods ($n=1$) and smartphones ($n=4$) are prevalent mobile devices in current usage, one paper [8] did not specify the type of mobile device that was adopted. There are two distinct types of platforms that are commonly utilized, namely mobile learning platforms and social media platforms. (Table 10).

Table 10. Mobile Technologies Used

	Mobile Technologies Used	Papers
Mobile Devices	iPads/iPods	1

	Smartphones	4
Mobile Platforms	Mobile Learning Platforms	4
	Social Media Platforms	1

Summary of Findings

This paper summarizes the findings of a systematic literature review (SLR) conducted on a collection of research focused on the implementation of mobile seamless learning in primary and secondary schools. The goal is to understand the implementation of mobile seamless learning in current teaching and learning practices [37], [20]. The SLR identified (a) educational and learning contexts, (b) research areas and research focus, (c) data collection techniques, and (d) mobile technology used, and discussed the findings derived from the selected studies [13], [3].

First of all, it is found that the results of the SLR support arguments concluded in previous studies, which are: (1) the implementation of mobile seamless learning is still at an early stage in school teaching and learning [32], [18]; (2) the implementation occurs mostly in developed countries [13], [29]; and (3) there is a lack of research studying the implementation of mobile seamless learning at the primary and secondary education levels [37], [20].

However, a critical examination of these findings reveals several important implications. From the perspective of the Technological Pedagogical Content Knowledge (TPACK) framework [21], the slow adoption of mobile seamless learning may be attributed to teachers' limited integration of technological, pedagogical, and content knowledge, which remains a significant barrier in classroom implementation [16], [5]. Many teachers may possess basic technological skills but lack the pedagogical strategies required to effectively embed mobile technologies into meaningful learning experiences.

In addition, when viewed through the SAMR model (Substitution, Augmentation, Modification, Redefinition) [9], current practices of mobile seamless learning in schools appear to be largely confined to lower levels of technology integration, such as substitution and augmentation [24]. This indicates that mobile technologies are often used to replicate traditional teaching methods rather than to transform learning processes. Such limitations highlight the need for instructional redesign that leverages the transformative potential of mobile seamless learning to reach higher levels of modification and redefinition.

Furthermore, the Unified Theory of Acceptance and Use of Technology (UTAUT) provides insight into the contextual and behavioral factors influencing adoption. Factors such as performance expectancy, effort expectancy, social influence, and facilitating conditions may explain why the implementation of mobile seamless learning is more prevalent in developed countries, where technological infrastructure and institutional support are stronger [34], [31]. In contrast, developing contexts may face constraints related to access, training, and policy support, which limit effective adoption.

Moreover, the limited focus on primary and secondary education indicates a research gap that may hinder the development of age-appropriate pedagogical models for younger learners. Most existing studies tend to emphasize higher education or pilot-based interventions, which may not accurately reflect real classroom complexities. This suggests a need for more longitudinal and context-sensitive research that examines not only the effectiveness of mobile seamless learning but also its sustainability and scalability in diverse educational settings [27], [29].

Therefore, future research should move beyond exploratory studies and focus on developing robust pedagogical frameworks, teacher professional development models, and policy-driven approaches that support meaningful integration of mobile seamless learning. Integrating insights from TPACK, SAMR, and UTAUT can provide a more holistic understanding of both pedagogical and contextual challenges, ensuring that mobile seamless learning is not only adopted but effectively transformed into impactful educational practices.

Currently, there is a dearth of systematic reviews pertaining to the implementation of MSL. This study contributes to the current corpus of knowledge and offers valuable references for scholars who are interested in this particular domain. The synthesis of the publications yielded findings that contribute to the advancement of knowledge in the field of MSL studies:

1. The focus of all ten papers is on the topic of learning, with particular emphasis on the field of LS, which has been the subject of extensive research. Furthermore, a significant proportion of these studies have been undertaken in developing countries.
2. In educational research, students are often the subject group that is more extensively examined in comparison to teachers. Moreover, the learner-centered approach is predominantly employed in various learning activities.
3. Informal learning has emerged as a crucial educational context, with significant academic attention directed towards investigating learning strategies and the learning environment as primary areas of study.
4. There has been a noticeable rise in research on MSL and cognitive perceptions during the last decade.
5. There are several primary methods for collecting data, which encompass questionnaires, pretests and post-tests, interviews, observations, and various instruments like field notes, videos, audio recordings, lesson design artefacts and etc.
6. In terms of mobile technology utilization, the most prevalent mobile devices are iPads, iPods, and smartphones. Mobile learning platforms and social media platforms are widely recognized as the two predominant mobile platforms. However, it has been previously noted that there is a lack of research that has integrated these two platforms in order to promote language acquisition.

CONCLUSION

This paper emphasizes the need for comprehensive empirical research on the implementation of mobile seamless learning in primary and secondary school settings [37], [20]. The utilization of mobile seamless learning strategies in primary and secondary education has great promise and generates considerable excitement [27], [18]. Having clear visions about (a) different types of educational and learning contexts, (b) research areas and research focus, (c) data collection techniques, and (d) mobile technology used is crucial in planning and designing instruction in classrooms [32], [3].

To ensure the successful and sustainable adoption of learning strategies, evaluation, and decision-making in teaching and learning, it is recommended to enhance teachers' concerns, improve school supporting environments, and optimize learning system features [5], [31]. Hence, it is advisable for teachers to pursue courses, training programs, and workshops to enhance their understanding and proficiency in the implementation of mobile seamless learning within educational settings [16].

Further investigation is necessary to enhance pedagogical practices and maximize student learning capabilities in the digital realm by focusing on the development and implementation of mobile seamless learning strategies in instructional processes [13], [29].

Limitations

The primary constraint of this study is evident in the search procedure, which solely targeted articles encompassing the particular database specified in the SLR methodology. This may potentially result in the exclusion of research from alternative databases that could provide descriptions of more effective implementations of mobile seamless learning methodologies in primary and secondary schools. Furthermore, a number of publications exhibited a dearth of information regarding the study's objectives. Consequently, certain studies were assigned labels such as "no available" within specific categories that were subjected to analysis in the SLR. However, despite the limited relevance to at least one research question, these papers were still chosen for inclusion.

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