The Effect of the Aesthetically Mobile Interfaces on Students' Learning Experience for Primary Education

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***Abstract*—Mobile devices such as mobile phones are becoming more important to school students today. This is due to the COVID-19 pandemic, mostly traditional face-to-face learning has shifted to online learning such as learning via a mobile platform. Mobile learning also known as m-learning, is defined as learning in numerous situations through social and content interaction utilizing personal electronic devices. M-learning applications not only need to have efficient functions, but it also has to attract students to learn by providing an attractive interface. An aesthetic of a mobile interface is essential since it could influence the user's learning experiences, but vice versa for non-aesthetic interfaces. User experience (UX) encompasses an extensive range of outcomes of the user-device interaction, including cognitions, attitudes, beliefs, behaviour, behavioural intentions, and affect. However, this study focuses on UX in terms of learnability, satisfaction, and efficiency since most previous studies were not explicitly focused on examining these three (3) UX components. Thus, this study aims to investigate the effect of aesthetically mobile interfaces on the learnability, satisfaction, and efficiency of primary school students, specifically, for *Kelas Al-Quran and Fardu Ain (KAFA)* students. This study found that aesthetically mobile interfaces significantly affected students' learning experiences regarding learnability, satisfaction, and efficiency. In conclusion, the findings of this study could serve as guidelines for future research in the field of mobile interface design.**

Keywords*—Aesthetic; non-aesthetic; mobile interfaces; primary education

I. Introduction

The rapid growth of technology is one of the factors that contribute to incorporating education with technology such as learning online using the mobile application. This is further encouraged by the COVID-19 pandemic, in which most traditional face-to-face learning has shifted to online learning such as learning via the mobile platform. Online learning including mobile learning requires an aesthetic interface to attract students to learning and further could assist students to focus and feel less bored when facing mobile devices for a quite long time during online learning. This is due to online learning, students do not have peers that have a physical presence and this environment could make students feel bored and lose focus.

Mobile learning (m-learning) is the use of ubiquitous portable technologies, in conjunction with mobile phone networks and wireless, to enable, enhance, assist, and expand the reach of learning and teaching [1]. In addition, define M-learning as any learning that occurs when the learner is not in a fixed specified location or uses the learning possibilities afforded by mobile technology [2].

User interface design (UID) is the process of developing interfaces that focus on styling and connectivity. Place the user in control, reducing the user's memory load, and making the interface consistent are three (3) factors for effective user interfaces [3]. The impact of mobile devices today makes creating user interfaces crucial [4]. Designers can use various ideas to create the most efficient design interface for m-learning education that could give a beneficial user experience to learners when using mobile learning devices for learning.

This paper focuses on three (3) user experience components which are learnability, satisfaction, and efficiency. This is because most of the previous studies investigated usability theory including learnability, efficiency, memorability, errors, satisfaction, ease of use, attractiveness, easy access, a user-friendly interface, and others [5][6][7]. On the other hand, in particular, fewer studies focus on learnability, efficiency, and satisfaction [8]. Taken together, this paper focuses on the effects of aesthetically mobile learning interfaces on students' experiences which are learnability, satisfaction, and efficiency.

The paper is organised as follows. The extensive research background is explained in Section II. Next, the methodology adopted for this research is described in Section III, followed by the results and discussion in Section IV, and future works in section V. Finally, conclusion are described in Section VI.

II. Research Background

This part describes the main components of this study which are user interface design and user experience that consists of satisfaction, efficiency, and learnability.

A. User Interface Design

Every technological device lately has an interface through which people can interact with the application [9]. This definition explains how an interface links the user and the content, allowing the content to adapt to the user's needs. Furthermore, the interface design is similar to a quality experience in that cognition, perception, semantics, and ergonomics must be integrated into the design process. Some operations necessitate usability testing to ensure that user interaction is supported [10].

Interface design is a crucial stage in system development because it provides an essential interaction on user experience. In addition, that interface design is linked to interaction design

because both interact to see how interfaces interact and are part of the system development process [11]. As a result, digital information is a critical area for application design interfaces. Designers can employ a variety of approaches to create the most efficient design interface for m-learning education. A graphic designer, a user interface designer, and a programmer typically work together at this stage to create interfaces for mobile applications. Table I summarises research on mobile interface design.

From Table I, it can be seen that most previous studies used various elements in mobile interface design, such as four (4) UID elements, UID patterns, UID framework, called "Mobile Web UI Transformation Framework", design patterns and others. Although there were many studies that have been done on mobile interface design, however, a few study specifically focused on design principles for designing mobile interfaces such as proximity, balance, proportion, and others. Thus, this study applied nine (9) design principles to design m-learning application interfaces for this study which are balance, proportion, simplicity, alignment, movement, hierarchy, consistency, contrast, and proximity for the m-learning application for this study.

TABLE I. LITERATURE STUDIES ON MOBILE INTERFACES DESIGN

Author(s) name and years	The summary of the studies
Kalimullah and Sushmitha (2017)[12]	There are four (4) UID elements: mobile design guidelines, Unitarian Universalist principles, mobile health guidelines, and inclusive design guidelines.
Punchoojit and Hongwarittorrn (2017)[13]	The design applied UID patterns: customization/personalisation, screen design, layout, learning potential, feedback, user control, navigation/orientation, help/support, error, interactivity, time required engagement, and readability.
Oyibo et al. (2018)[14]	Find out how the Canadian and Nigerian cultures perceive various mobile UID, which differ in terms of colours, images and layouts. The design applied a UID framework, called "Mobile Web UI Transformation Framework" or, simply, "Action-Artifact (A2) Framework", to systematically modify the UI design of four hypothetical webpages adapted from existing websites in the market.
Braham et al., (2019)[15]	Examines user interfaces design pattern structures to support the adaptive mobile application that enable a more versatile and powerful organization of mobile interface etems, as well as their adaption to context changes and user requirements in specific scenario.
Bunian et al., (2021)[16]	Introduces visual search framework, that takes as input a UI image (wireframe, high-fidelity) and retrieves visually similar design examples.
Grandi et al., (2021)[17]	Utilizing Virtual Reality (VR) to simulate Augmented Reality (AR), that can design and evaluate the benefits of idealized User Interfaces
Börsting et al., (2022)[18]	Formulated several principles and patterns to simplify User Interfaces design for Augmented Reality (AR) applications

B. User Experience and Mobile Design

The goal of designing user experience is to train the next generation of user experience and interactive system designers [19]. There is already much interest in creating appealing, user-friendly m-learning applications to increase end-user adoption. Table II contains some guidelines for designing user interfaces for mobile applications. These guidelines are based on user interface design criteria and sub-criteria [20] and focus on the interface design of children's mobile educational applications: cognitive load, graphical design, learning potential, readability, engagement, learnability, and satisfaction [21].

TABLE II. USER EXPERIENCE GUIDELINES OF MOBILE DESIGN

User experience elements	Sub criteria	Guidelines
Cognitive Load	Content/ concept	i. Use appropriate language ii. Use appropriate content
Graphical Design (Efficiency)	i. Aesthetic ii. Size/Font style iii. Colours iv. Icons v. Menu vi. Buttons	i. Attractive, simple and organised, the design ii. Use proper size and font style iii. Use bright colours for children iv. Icons with the information have to be relevant v. Provide a proper touch for the screen menu vi. Provide colourful and animated buttons
Learning Potential	i. Ease to learn ii. Education value iii. Suitability	i. Ease of learning ii. Suitable for educational content iii. Suitable for all users and controlling learners.
Readability	No sub-criteria	i. Readability ease ii. Provide appropriate text, size and spacing.
Engagement	Motivation to learn	i. Endorse commitments ii. Provide interesting rewards.
Satisfaction	No sub-criteria	i. Flexibility and efficiency of use ii. Aesthetic and minimalist design
Navigation/ Orientation (Learnability)	i. Easy to navigate ii. Start screen / Main menu iii. Hierarchal menus iv. Scrolling	i. Facilitate orientation ii. Navigation facility iii. Clear and consistent navigation iv. Give clear buttons for navigation i. Provide the main navigation menu ii. Straightforward main menu or start page link i. Hierarchal menu for easy navigation i. Scrolling may be problematic for children to scroll and view when much information is present.

The user experience and sub-criteria of mobile design illustrated in Table II demonstrate that many essential criteria, such as efficiency, satisfaction, learnability, and others, could be considered when designing interfaces.

TABLE III. LITERATURE STUDIES OF USER EXPERIENCES IN MOBILE LEARNING

Author(s) name and year	The use of user experience
Ismail et al. (2010)[10]	Examine learners' students' perceptions of the satisfaction experience using Mobile learning in School of Distance Education, University Sains Malaysia (USM).
Ali et al. (2014)[7]	Investigate two (2) models, which are Model A and Model B, on mobile learning smartphone applications from the user's perspective regarding ease of use, user satisfaction, attractiveness, and learnability.
Popovic et al. (2016)[6]	The development of electronic learning is based on efficient delivery of services by using a Learning Management System (LMS) to provide all the necessary study materials, easy access, and a user-friendly interface.
Joo et al. (2016)[4]	Analyze the relationships among factors predicting online university students' ease of use, perceived usefulness, expectation-confirmation, satisfaction, continuance intention and actual usage of m-LMS.
Kumar and Chand (2019)[5]	Categorised these user experience factors into 15 major factors; attitude, intention, ease of use, enjoyment, learner interest, prior experience, usefulness, learnability, anxiety, personal, technological, social, financial, pedagogical, and readiness.

A gap in the literature refers to a user experience research problem that has not been resolved in the study area. Previous studies have found a few gaps in the literature that can be filled. According to Table III, previous research has made less attempt to specifically focus on learnability, efficiency, and satisfaction. As a result, this study will focus on learnability, efficiency, and satisfaction as user experience criteria that must be investigated. The following sub-sections will explain satisfaction, efficiency and learnability.

1) Satisfaction: Satisfaction is defined as the absence of discomfort and positive feelings about using a product, and it is determined by the content, user guide, and beauty application interfaces [22]. While, satisfaction is the user's level of enjoyment as a result of interacting with the social networking application in a limited context of use in terms of learning the application, using the application, conducting a specific task, finding the attributes, knowledge navigation, trying to recover from error, and completing a task anywhere and at any time [23]. Furthermore, satisfaction is defined as a pleasant feeling experienced when receiving something desired or when performing an action desired, as well as the act of fulfilling (achieving) a need or wish [24]. Satisfaction is challenging to quantify because numerous factors influence it. Many businesses use usability testing to determine customer satisfaction or ask customers to complete a survey. Satisfaction is also linked to end-user confidence, which is especially important in health care due to the need for accurate information. As a result, a health care mobile application must be developed with caution, especially the graphical user interface elements that directly affect the user's ease of use [25].

2) Efficiency: According to definition of efficiency, efficiency in user's completing the task in a given context of use is expressed in actions per second [23]. Efficiency is also defined as the number of resources used to achieve users' objectives with precision and completeness [20]. Furthermore, the less time spent regulating access permissions, the more time there is to capitalise on the value of those sources.

3) Learnability: Some researchers said that there is little agreement on how learnability should be defined [26]. Previously, user interfaces necessitated training and new learnability techniques that allowed users to become proficient with a little trial and error quickly. The term learnability refers to how easy a product is to comprehend. Numerous authors have defined learnability, further discussing a definition applied to various forms of learning, both initial and long-term [27]. A system's learnability also implies that it should be simple to learn so the user can begin working with it quickly [22].

III. METHODOLOGY

This part describes the research methodology used to conduct the research that contributed to the findings in this study. The Cronbach alpha is explained, including the One-way repeated measures (ANOVA). The interfaces are designed using a variety of design principles which are used stimuli of this study.

A. Stimuli

This study considers three (3) pages of learning, including Homepage, Introduction page, and Learning page. Overall, there are 15 mobile interfaces that applied nine (9) design principles: balance, proportion, simplicity, alignment, movement, hierarchy, consistency, contrast, and proximity. Each interface applied three (3) combinations of design principles. Table IV, Table V and Table VI illustrate three (3) design principles for the Homepage, Introduction page, and Learning page, respectively.

TABLE IV. COMBINATION OF DESIGN PRINCIPLES FOR HOMEPAGE

Interfaces	Design principle
1	Balance, Proportion, Simplicity
2	Alignment, Movement, Hierarchy
3	Balance, Consistency, Simplicity
4	Balance, Proportion, Alignment
5	Balance, Consistency, Contrast

TABLE V. COMBINATION OF DESIGN PRINCIPLES FOR INTRODUCTION PAGE

Interfaces	Design principle
6	Balance, Proportion, Simplicity
7	Balance, Contrast, Simplicity
8	Balance, Proportion, Simplicity
9	Balance, Alignment, Proximity
10	Balance, Proportion, Contrast

TABLE VI. COMBINATION OF DESIGN PRINCIPLES FOR LEARNING PAGE

Interfaces	Design principle
11	Proportion, Contrast, Consistency
12	Contrast, Proximity, Proportion
13	Balance, Consistency, Simplicity
14	Balance, Alignment, Proximity
15	Balance, Proximity, Contrast

This study was implemented for Kelas Al-Quran and Fardu Ain (KAFA) students. KAFA is an additional subject for primary schools' students from Year 1 to Year 5 that consists of Jawi, Ibadat, Aqidah, Bahasa Arab, Adab, Penghayatan Cara Hidup Islam, Sirah dan Al-Quran. In year 5, at the end of the KAFA learning, students have to sit for an assessment test called Ujian Penilaian Kelas Kafa (UPKK). However, during the COVID-19 pandemic, KAFA class was also executed online like the other common subjects. Therefore, the KAFA subject needs to transform from a conventional learning approach to online learning, such as learning using a mobile platform. Therefore, this study will focus on the KAFA subject as content materials for this study.

B. Development of KAFA M-Learning

This prototype was created with NetBeans IDE 8.0, which supports language on development for the Java SE 87 specification and JDK 1.8 language features. It also includes a WebLogic server that supports Apache Tomcat. In contrast, a database is a collection of structured data that uses numbers as the primary key in a data relationship and uses the concept of normalisation to detail the data it requires. A database is a collection of data used by a company-owned application system and managed by a database management system [28]. Fig. 1, Fig. 2 and Fig. 3 show KAFA M-learning application interfaces for the homepage, introduction page and learning page.

C. Data Collection

KAFA M-learning application was developed for implementation of this study. The participants were required to use two (2) sets of interfaces, namely Apple and Pineapple, representing aesthetic and non-aesthetic interfaces. The participants were not informed that the Apple interface represents aesthetic interfaces and vice versa to avoid influencing them when answering questionnaires for user experience elements. In addition, the prototype and questionnaire used *Bahasa Melayu* because *Bahasa Melayu* is the national language and the main spoken language in Malay. Thus, it may affect the questionnaire feedback if using the English language.

This study involved 40 participants from primary school students. The range of the participants' ages was from 9 to 12 years. This range of participants was chosen because they were involved in KAFA class. The participants consisted of 25 females and 15 males.

Then, participants are required to answer the questionnaire to investigate the effect of aesthetic (Apple) and non-aesthetic (Pineapple) interfaces on students' experiences which are learnability, satisfaction and efficiency. The questionnaire consists of 15 questions for both interfaces. Furthermore, five (5) questions are allocated for each user experience component. Questions 1 to 5 are learnability questions, Questions 6 to 10 are satisfaction questions, and questions 11 to 15 are efficiency questions. The questionnaire scale ranges from 1 = lowest to 5 = highest.

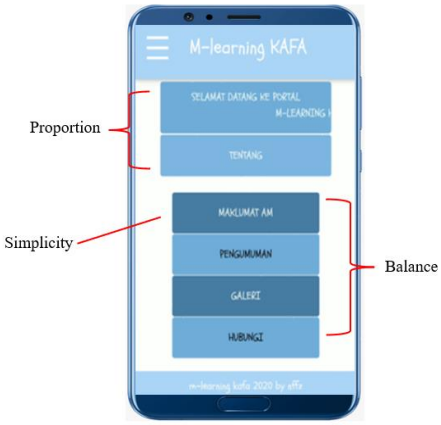

Fig. 1. KAFA M-learning Application Interfaces for Homepage.

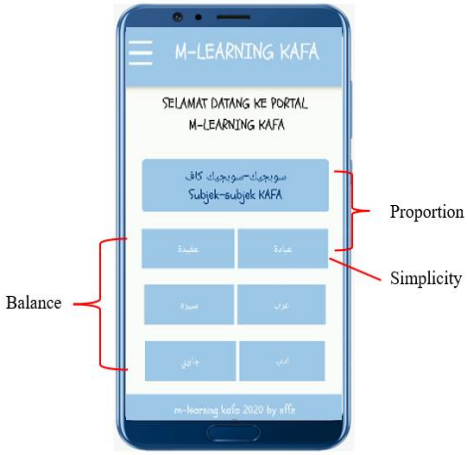

Fig. 2. KAFA M-learning Application Interfaces for Learning Page.

Fig. 3. KAFA M-learning Application Interfaces for Introduction Page.

D. Data Analysis

Two (2) types of analysis are involved in this study which are preliminary analysis and main analysis. The Cronbach's Alpha reliability, skewness, and kurtosis measurements were conducted for preliminary analysis. Further, the main analysis is conducted using the One-way repeated measures ANOVA test. ANOVA test has been done using Statistical Package for the Social Sciences (SPSS) 27.0. ANOVA (also known as a within-subjects ANOVA) is applied in this study to determine whether three (3) or more groups are different, where the participants are the same in each group. This study used the same group of primary school students for three (3) different user experience questionnaires: learnability, satisfaction, and efficiency.

IV. Results and Discussions

The findings of this study are divided into two (2) categories, which are as follows:

- Preliminary results of aesthetics interfaces and non-aesthetics interfaces.
- Main results of the effect of aesthetics interfaces and non-aesthetics interfaces.

A. Preliminary Results

This section explains the preliminary results for aesthetic and non-aesthetic interfaces regarding user experience components such as learnability, satisfaction, and efficiency. Cronbach's Alpha reliability values for aesthetic and non-aesthetic interfaces are 0.654 and 0.651, respectively, as shown in Table VII. From Table VII, it is found that, the aesthetic and non-aesthetic interface scales have acceptable internal consistency reliability, as measured by Cronbach's Alpha greater than 0.6 [29].

Skewness and kurtosis normality tests were performed on user experience components: learnability, satisfaction, and efficiency for both aesthetic and non-aesthetic interfaces. The skewness and kurtosis normality test results for both types of interfaces are shown in Tables VIII and IX.

The skewness values of aesthetic interfaces are shown in Table VIII, which are learnability is -0.298, satisfaction is -0.782, and efficiency is -0.755.

The skewness values of non-aesthetic interfaces are shown in Table IX, which are learnability is -0.450, satisfaction is -0.917, and efficiency is -0.659.

According to the skewness results in Tables VIII and IX, aesthetic and non-aesthetic interfaces are considered an acceptable skewness value for a normally distributed set of test scores because it is very close to zero and is most likely just a chance fluctuation from zero [30]. Kurtosis values in Tables VIII and IX revealed that aesthetic and non-aesthetic interfaces are considered acceptable kurtosis values for a mesokurtic (ordinarily high) distribution because it is close to zero [30].

As a result, skewness and kurtosis for both aesthetic and non-aesthetic interfaces follow a normal distribution. Thus, the parametric test, one-way repeated measures (ANOVA), is suggested as an analytical approach in the main study.

TABLE VII. Cronbach's Alpha Reliability Results for Aesthetic and Non-Aesthetic Interfaces

Aesthetic interfaces	Cronbach's alpha values	No. of items
	0.654	15
Non-Aesthetic interfaces	0.651	15

TABLE VIII. Skewness and Kurtosis Normality Results of Aesthetic Interfaces

User experience	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Learnability	-0.298	0.374	-0.726	0.733
Satisfaction	-0.782	0.374	-0.275	0.733
Efficiency	-0.755	0.374	-0.427	0.733

TABLE IX. Skewness and Kurtosis Normality Results of Non-Aesthetic Interfaces

User experience	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Learnability	-0.450	0.374	0.022	0.733
Satisfaction	-0.917	0.374	-0.016	0.733
Efficiency	-0.659	0.374	-0.475	0.733

B. Main Result: Effect of Aesthetic and Non-aesthetic Interfaces on user Experiences

The repeated one-way measurements: The ANOVA test was used to assess the effect of aesthetic interfaces on user experience, specifically learnability, satisfaction, and efficiency. The multivariate effects of user experience components for aesthetic interfaces are shown in Table X.

Table X depicts there were significant effects on*:*

1) Learnability, Wilks' lambda = 0.486, $F(4, 36)$, $p < 0.0005$, multivariate partial eta squared = 0.514.

2) Satisfaction, Wilks' lambda = 0.187, $F(4, 36)$, $p < 0.0005$, multivariate partial eta squared = 0.813.

3) Efficiency, Wilks' lambda = 0.265, $F(4, 36)$, $p < 0.0005$, multivariate partial eta squared = 0.735.

TABLE X. Significant Multivariate Effects on Aesthetic Interfaces

User experience components	Learnability	Satisfaction	Efficiency
Wilks' lambda	0.486	0.187	0.265
F	9.509[b]	39.029[b]	24.961[b]
Hypothesis df	4.000	4.000	4.000
Error df	36.000	36.000	36.000
Sig.	.000	.000	.000
Partial Eta Squared	0.514	0.813	0.735

TABLE XI. SIGNIFICANT MULTIVARIATE EFFECTS ON NON-AESTHETIC INTERFACES

User experience components	Learnability	Satisfaction	Efficiency
Wilks' lambda	0.371	0.216	0.299
F	15.244[a]	32.596[b]	21.120[b]
Hypothesis df	4.000	4.000	4.000
Error df	36.000	36.000	36.000
Sig.	.000	.000	.000
Partial Eta Squared	0.629	0.784	0.701

Table XI depicts there were significant effects on*:*

1) Learnability, Wilks' lambda = 0.371, F(4, 36), p< 0.005, multivariate partial eta squared = 0.629.

2) Satisfaction, Wilks' lambda = 0.216, F(4, 36), p< 0.005, multivariate partial eta squared = 0.784.

3) Efficiency, Wilks' lambda = 0.299, F(4, 36), p<0.005, multivariate partial eta squared = 0.701.

The summary results of the significant effect of aesthetic and non-aesthetic interfaces on user experiences are shown in Table XI. It was found that, the p-value of aesthetic and non-aesthetic interfaces is less than 0.05, indicating a statistically significant effect [30] for the learnability, satisfaction and efficiency value for Wilks' Lambda are 0.371, 0.216, 0.299, with probability value of 0.000 (which really means p<0.005). Therefore, both aesthetic and non-aesthetic interfaces significantly impact students' learnability, satisfaction, and efficiency.

The findings indicate that the effects of aesthetic and non-aesthetic interfaces on primary school students when using KAFA M-learning application interfaces support the hypothesis that aesthetic and non-aesthetic interfaces of mobile interfaces, have a significant impact on students' learnability, satisfaction, and efficiency. Although all multivariate tests yield the same result, Wilks' Lambda is the most frequently reported statistic. The effect is statistically significant if the Wilks' Lamba value is p<0.0005. This study concludes that the effects of aesthetic and non-aesthetic interfaces are significant because the p-value is less than 0.005. This evidence supports the hypothesis that the similarity of aesthetic interfaces influences the primary student participants' perceptions [30].

V. CONCLUSION

As a conclusion, the primary goal of this study is to investigate the impact of aesthetic and non-aesthetic interfaces on students' experiences of learnability, satisfaction, and efficiency. The survey was carried out with the participation of 40 primary school students. The study findings revealed that aesthetic and non-aesthetic interfaces significantly impact students' learnability, satisfaction, and efficiency.

This study also could help user interface designers by providing guidelines for designing M-learning interfaces that could create better learning experiences for primary school students in terms of learnability, efficiency, and satisfaction. This user experience is essential because M-learning applications need to have efficient functions, but it also needs to attract students to learn by providing an attractive interface. Therefore, the UI designer can use these guidelines in the future to design an aesthetic interface for mobile learning applications.

VI. FUTURE WORKS

It is recommended that further research might explore Analysis of covariance (ANCOVA) for data analysis. This is because ANCOVA has several techniques and models for better solutions. The formulas will help to find the results easily [31]. Besides that in other areas such as business, management, and others, user interface design also can use ANCOVA technique.

ACKNOWLEDGMENT

This research is supported by a grant from the Fundamental Research Grant Scheme (FRGS) and the Ministry of Higher Education (MOHE), reference code FRGS/1/2-18/ICT04/UMT/03/1.

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