Case Study on Prototyping Educational Applications Using Persona-Based Approach

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***Abstract*—In the twenty-first century, many technologies and applications have been developed to support the digital learning environment for teachers and students either physically in class or virtually at home. The need has increased due to the current COVID-19 pandemic, as students must join online teaching and learning at home either they are at primary, secondary, or tertiary levels. Since the requirements are different according to the level of education, some educational applications are not suitable and complicated for lower education levels. Considering various users' needs, persona-based approach has been used in many studies to elicit users' requirements and derive diverse scenarios from user personas before moving to implementation stage. Thus, this case study proposes a persona-based approach to identify students' goals or needs, pains or challenges besides their satisfaction when using educational application prototypes. It involved eight prototypes for learning Computer Science topics and 29 secondary school students. The findings conclude how the persona-based approach can be used to investigate diverse users' needs, challenges, and scenarios as the inputs to design educational applications with digital contents or e-contents for specific topics or subjects.**

Keywords— educational applications, online teaching and learning, digital contents, e-contents, persona-based approach, user persona.

I. INTRODUCTION

The current COVID-19 pandemic era has increased the need for Information and Communication Technology (ICT) as the platform to support various users' activities such as business and education. Thus, adopting ICT can improve job performance and users can complete their tasks more effectively and efficiently especially when the technology is now not an option, but it has become mandatory such as platforms for online teaching and learning. This is very crucial when it involves the development of educational applications to meet current urgent needs, particularly during this post-pandemic period.

Software developers follow the steps in the software development life cycle (SDLC) that involves the process of a software application being developed at each phase and Agile has been one of the methodologies to support rapid development [1] that can support the current high demand for various applications. In tandem with the use of rapid development to meet users' needs, User-Centered Design (UCD) is a popular methodology in many software products, especially in designing user interface and user experience (UI/UX) at the design phase [2]. Siricharoen [3] reports that users' involvement in a software development can support them to design an application themselves. Thus, by implementing UCD, it can improve user requirements more practically, enhance user satisfaction, and reduce application backlog. Persona and scenario are tools in UCD. Persona is a fictional character that was developed to identify the user background as proposed by Cooper et al. [4].

ICT has been defined as a technology, science, application that can input, output, and transmit data automatically [5]. It involves human-computer interaction (HCI) to enable users to interact with software and hardware effectively. Indeed, using persona and scenario in designing software applications mainly for educational purposes that involve the various level of users is crucial. Thus, this study proposes persona-based approach to analyze user persona and scenario besides their satisfaction among 29 secondary school students as the respondents who evaluated eight educational application prototypes with Computer Science e-contents.

II. RELATED WORK

The role of users in a software development is important to represent their point of view, real user behavior, and motivation from a group of target users. Persona was introduced by Cooper et al. [4] in software development to help developers have a good view and imagination about their target users. It aims to learn the problems and concerns

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from the user's point of view and this approach was known as an effective way to solve design problems. Nowadays, personas have been used in designing the user interface and included users' involvement in the activity to get information such as their goal, need, and pain [6]. UCD technique is a modern HCI design philosophy that includes a persona's profile and a problem-solving process to gather and analyze user behavior. Then, it will be transferred into prototypes that can be tested [7]. Persona is a composite image of target users. It cannot represent the whole target users or only one person [8].

Personas are usually used in large-scale industries such as healthcare, education, enterprise, and social services [9]. LeRouge et al. [7], for example, suggest user persona design for the development of customer health applications to collect requirements that suit the application in the healthcare sector. Without implementing personas in software development, design decisions were made by designers who thought like a younger adult. Ignorant to identify personas from older adults causes a low ICT adoption among older adults as compared to younger adults because older adults might have unique and special needs that should be considered [7].

Kelle et al. [10] introduce user persona for new teaching and learning curricula for Massive Open Online Courses (MOOC). When creating a learning application, the idea of personas in learning will assist in understanding a particular viewpoint of the user. In addition, Aoyama [11] introduces a methodology that identifies persona and scenario in a mobile phone product line for communication such as high-speed data and wireless LAN. The study identified a persona who used a particular service frequently based on their scenario that became the primary persona. Thus, persona-scenario approach assists to identify persona requirements for the application design [10]. Persona is a good communication tool between designers and users to produce clear requirements [12].

Furthermore, Matthews et al. [13] state that creating personas should not mislead the requirements, and it is important to identify users' roles that fit the requirement Besides, Bagnall et al. [14] claim that it is important to involve designers and developers in creating persona-scenario. Therefore, our case study has categorized personas based on the respondents' similar background after analyzing and giving the score for each collected data individually. Our persona-based approach also includes user acceptance testing (UAT) where developers communicate with users directly to improve the final version of the educational application prototypes.

III. Case Study

The case study explores users' goals or needs, pains or challenges from 29 secondary level students from five different schools in rural areas using the persona-based approach. The study also includes the analysis on their satisfaction towards eight educational application prototypes that were developed by eight teams of third year Computer Science students at School of Computing, Universiti Teknologi Malaysia. Due to COVID-19 pandemic, the activity was conducted virtually via a combination of online platforms. Fig. 1 illustrates the persona-based approach comprising three main activities: (i) collect persona description and identify personas, (ii) record scenarios based on given tasks and (iii) testing the developed prototypes and measure users' satisfaction.

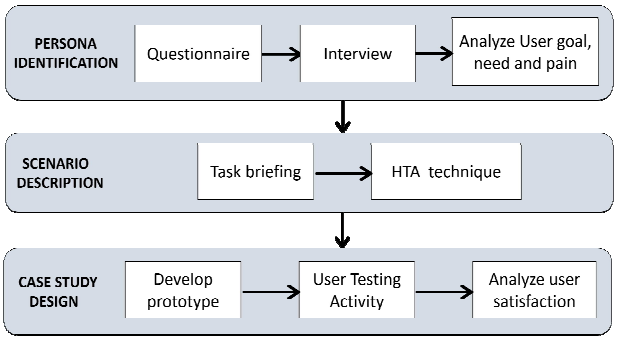

Fig. 1. Persona-based Approah

A. Persona Identification

This activity was conducted to identify the persona characteristic to design integrated Web-Based Application for Learning Computer Science (WALCS) for secondary schools. To develop a persona, a few questions were asked related to the persona background. This study elicited users' demographic, goals, or needs, and pains or challenges when using educational applications. This activity involves categorizing personas into two types which are Form 3 students (55.17%) and Form 4 students (44.83%) as in Table I. These personas are the close target users in developing educational applications for secondary schools. The analysis and findings will be elaborated in Section 4.

TABLE I. Persona Category

No.	Persona Category	F	%
1	Form 3 student	16	55.17
2	Form 4 student	13	44.83

B. Scenario Description

The description of the scenario depends on the application domain [2]. Since this study focuses on educational applications, the participants were briefed on how to perform and use the education applications. Participants were informed to complete five tasks when using applications and recorded their activity to find efficient approach on how they used the application. The tasks that they must complete were register a new account, log in, read a topic and attempt a quiz.

When analyzing the tasks to be completed by the respondents, this study adopted Hierarchical Task Analysis (HTA) technique to observe how participants use the application, whether there are any other ways that participants use to complete the tasks, or they have completed the task efficiently. Table II shows the HTA technique based on the two persona categories. The tasks are almost similar for both categories. The analysis and findings will be elaborated in Section 4.

TABLE II. HTA Technique

Persona Category	HTA technique
Form 3 student	0 Attempt Quiz 1. Register as a new user. 1.1 Enter username and password. 2. Log in. 3. Select the topic and read.

	4. Select the Kuiz button. 4.1 Answer and Submit all answers.
Form 4 student	0 Attempt Quiz 1. Register a new account. 1.1 Enter email and password. 2. Login 3. Select the Kuiz button. 3.1 Answer and Submit all answers. 4. Select the Feedback button and submit.

C. Case Study Design

The study included eight WALCS prototypes covering different topics in Computer Science subjects for Form 3 and Form 4 to study their satisfaction using Net Promoter Score (NPS) [15] when using the educational applications. These prototypes were developed using JAVA technology as Web-based applications. Based on the analysis from the persona identification and scenario description activities, eight different prototypes were developed. The development took almost one semester (14 weeks), then the study continued with the UAT with the respondents. Fig. 2 to Fig. 9 show the prototypes main interfaces.

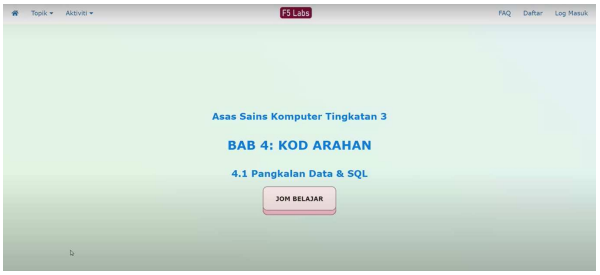

Fig. 2. F5Lab System

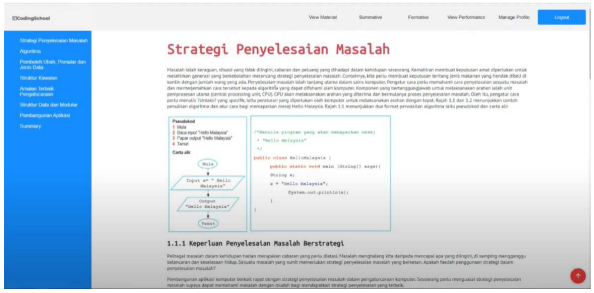

Fig. 3. CodingSchool

Fig. 4. DEBUGZ

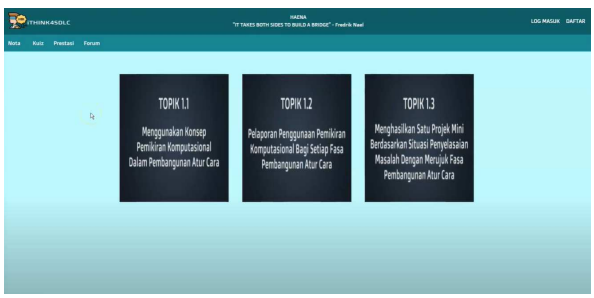

Fig. 5. iTHINK4SDLC

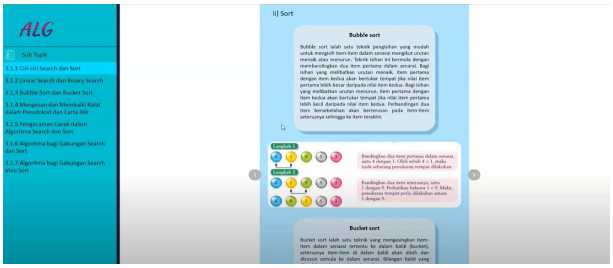

Fig. 6. ALG

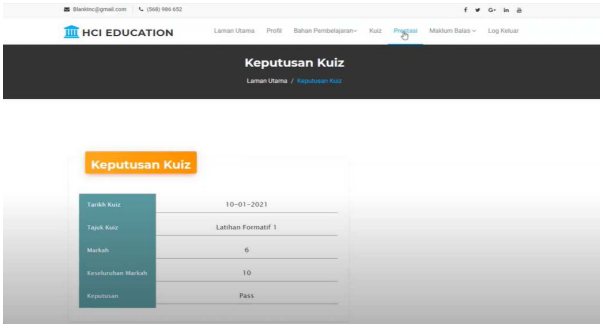

Fig. 7. HCI Education

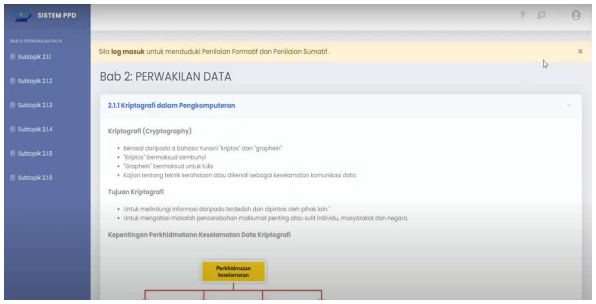

Fig. 8. SistemPPD

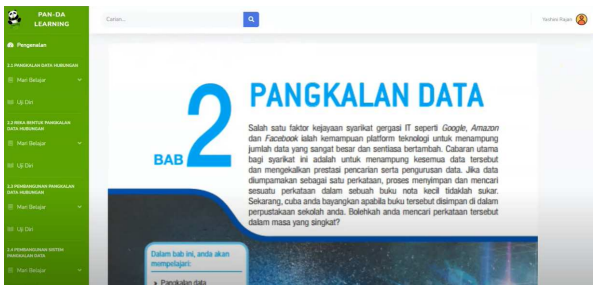

Fig. 9. PAN-DA Learning

IV. Analysis And Findings

This section includes the analysis of persona and scenario, and the case study of the eight WALCS prototypes.

A. Analysis of Persona-Scenario

In this study, personas are divided into two categories which are Form 3 (15-year-old) students and Form 4 (16-year-old) students. The selection of the categories was made based on similar backgrounds among students. The advantage of using personas is it helps to identify users' characteristics [11]. Therefore, Form 3 students can be described as students who use educational applications when they perceived it to be easy to use. Meanwhile, Form 4 students is students who use educational applications when they perceived it useful for their study and task performance.

These findings adopted by Davis et al. [16] as they measured a relationship between the intention and human behavior towards technology used. After describing personas, this study collected the information regarding their goals or needs, and the pain they faced (challenges) in achieving the goal. Table III shows the user goal or need (GN) for the persona for both categories. While Table IV shows the pain or challenge (PN) that they faced when using educational applications for both categories.

TABLE III. USER GOAL OR NEED (GN)

Code	What are their goals or needs?
GN1	The application should have good content for the subject.
GN2	The application should be an interactive design interface.
GN3	The application should have a simple interface.
GN4	The student wants to avoid any downloaded applications.
GN5	The student prefers applications with the easy language used
GN6	The application should have less advertisement.
GN7	The application should provide much information about ICT.
GN8	The application should have a quiz or test

TABLE IV. USER PAIN OR CHALLENGE (PN)

Code	What are their pains or challenges in achieving the goals?
PN1	Even though the student has sufficient devices to access the website, however, the laptop is getting slowed and loading.
PN2	Unstable Internet connection affects the learning process.
PN3	The application should use suitable language and terms
PN4	The application should use easy icon
PN5	The application should avoid too much advertisement
PN6	Current applications did not have sufficient information.
PN7	The information is not suitable for secondary students.
PN8	The website provided less attractive visualization and infographic.

Analysis for each respondent is shown in Appendix A. GN7 (51.72%), GN1 (23.78%), and GN2 (27.59%) are ranked the top three that reflects the importance of contents and interactive design to users. While PN2 (41.38%) and PN3 (13.79%) are ranked the top two that deduce the Internet connection among these rural learners is the highest challenge besides the language used in the applications (Malay language as in textbooks).

For further analysis, Table V shows the list of educational applications used for their learning. It shows that every participant has experienced different applications. However, most of them might have less knowledge about the existence of educational applications for students as most of them (68.97%) only searched the topics of their concerned subjects using Google search engine. This is followed by "Spoken Learning: Learn to talk English" application as experienced by two students (6.90%). Each educational application derived different perceptions and issues by the respondents. These findings indicate the importance to spread awareness about the learning application to students. Ohanu & Chukwuone [17] state that lack of awareness about ICT can become a challenge in adopting learning applications. Thus, teachers and parents play important roles in encouraging students to use learning applications.

Fig. 10 shows the devices used to access educational applications. The chart illustrates 69% of the respondents used smartphones, 26% of them used laptops, 3% of them used iPad (tablets) and 2% of them used computer desktops.

TABLE V. EDUCATIONAL APPLICATION USED BY STUDENTS

Educational App	F	%
Spoken Learning: Learn to talk English [18]	2	6.90
Khan Academy [19]	1	3.45
Wikipedia [20]	1	3.45
Google [21]	20	68.97
FrogSchool [22]	1	3.45
DELIMa [23]	1	3.45
iPendidikan.my [24]	1	3.45
Vschool Trend [25]	1	3.45
BAcfreeschool [26]	1	3.45
Perpustakaan Negara eBook Portal [27]	1	3.45
PTTI Education [28]	1	3.45
Bumi Gemilang [29]	1	3.45
British Council [30]	1	3.45

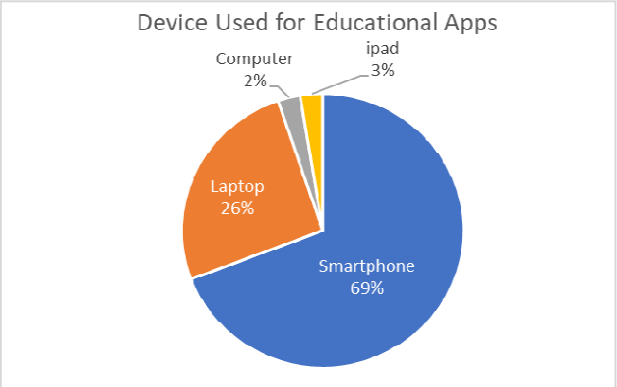

Fig. 10. Device Used for Educational Application

B. *Analysis of Case Study*

Since this activity was conducted virtually, the eight prototypes were deployed to a Web hosting to be accessed remotely. The respondents were divided into eight teams. Then, they used the prototypes based on the tasks given for the UAT purpose. While Table VI shows the score given based on user pain collected from users' personas. The Likert scale for the quality is from 1 (very poor), 2 (poor), 3 (fair), 4 (good), 5 (excellent) to measure whether these prototypes have successfully overcome users' pain with better solutions.

TABLE VI. PROTOTYPE EVALUATION BASED ON USER PAIN

Prototype	Code for User Pain (PN)						Score
	PN3	*PN4*	*PN5*	*PN6*	*PN7*	*PN8*	
F5Lab System	4	5	5	5	5	5	29
CodingSchool	3	5	5	5	5	5	28
DEBUGZ	3	5	5	5	5	3	26
iTHINK4SDL	4	5	5	4	5	4	27
ALG	4	5	5	3	5	4	26
HCI Education	4	5	5	4	5	3	26
SistemPPD	4	5	5	5	5	5	29
PAN-DA Learning	4	5	5	5	5	3	27

The evaluation process was conducted by evaluating the user pain for specific personas based on the assigned prototypes. All applications except CodingScool and DEBUGZ have used a Malay language in their system and help the student to understand the instruction, flow of the system and the content better (PN3) in their mother tongue. The application also uses descriptive icons that could be understood easily by the respondents (PN4) and there is no advertisement appeared on the applications (PN5). They also provide sufficient contents to learn Computer Science subject (PN6) and the content of the application such as

iTHINK4SDLC, SistemPPD, ALG and F5Lab System were developed for Form 3 students. While CodingSchool, HCI Education and PAN-DA Learning have sufficient information and suitable for Form 4 students (PN7).

However, some of the applications have less attractive visualization and information graphic (PN8) such as DEBUGZ, HCI Education and Pan-da Learning as they included a scanned image from the whole page and contents of the textbook. Even though other applications also used a scanned image from the textbook, they managed to crop it and explain each scanned image with a related topic to make it shorter and clearer. The application like iTHINK4SDLC and ALG explained the note in a simple way and easy to understand.

The participants also stated their satisfaction (like, dislike) towards the prototype as shown in Table VII and VIII. The analysis of users' satisfaction is shown in Appendix A. For "Like", L1 has the highest score (31.03%) while for "Dislike", DL4 has the highest score (24.14%). This deduces attractive design is vital while final version of prototypes should have less bugs as much as possible.

TABLE VII. USER SATISFACTION (LIKE)

Code	Like (L)
L1	Attractive design interface
L2	The flow of the system is easy
L3	The menu option provided is useful
L4	Provided notes and quiz to test the level of understanding and allows to re-attempt the quiz multiple times
L5	Language and icon used is easy that can be understand

TABLE VIII. USER SATISFACTION (DISLIKE)

Code	Dislike (DL)
DL1	Want a more colorful design interface
DL2	Hard to understand notes
DL3	Cannot be viewed via phone
DL4	External error including application lagging/bug appeared when accessing the application

V. CONCLUSION AND FUTURE WORK

The case study proposes persona-based approach to elicit users' goal or need, pain or challenge as the input in designing educational applications with the focus on e-content for Computer Science subject known as WALCS. It included eight different prototypes for two types of target user that are Form 3 and Form 4 student. After identifying the personas, the study conducted a scenario activity to analyze respondents completed the given and stated their satisfaction (like and dislike) when testing the prototypes.

For future work, the development of WALCS should consider responsive view and use more colorful design interface to attract users. In addition, the flow of the applications must be clear. It should include users' perspective about the applications and identify factors that can attract them to use such applications.

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APPENIDX A: Analysis for user persona and user satisfaction for each respondent

Student	Goal/Need								F	Pain								F	Satisfaction (Like)					F	Satisfaction (Dislike)				F
	GN1	*GN2*	*GN3*	*GN4*	*GN5*	*GN6*	*GN7*	*GN8*		*PN1*	*PN2*	*PN3*	*PN4*	*PN5*	*PN6*	*PN7*	*PN8*		*L1*	*L2*	*L3*	*L4*	*L5*		*DL1*	*DL2*	*DL3*	*DL4*	
F3-S1							√		1									0	√					1			√		1
F3-S2		√	√		√				3									0	√					1			√		1
F3-S3		√			√				2			√						1		√	√			2					0
F3-S4	√	√	√	√	√				5	√	√							2						0	√	√			2
F3-S5	√	√				√			3					√				1						0					0
F3-S6							√		1		√				√			2						0				√	1
F3-S7							√		1						√			1	√					1				√	1
F3-S8							√		1		√						√	2	√					1					0
F3-S9									0									0	√					1					0
F3-S10							√		1		√							1	√					1					0
F3-S11	√	√	√					√	4			√	√					2	√			√		2					0
F3-S12							√		1	√								1						0				√	1
F3-S13	√								1		√							1						0					0
F3-S14	√								1		√							1						0					0
F3-S15	√								1		√							1						0					0
F3-S16							√		1									0						0					0
F4-S1							√		1		√	√						2	√			√		2				√	1
F4-S2	√						√		2			√						1						0					0
F4-S3							√		1			√						1					√	1					0
F4-S4							√		1			√						1		√				1				√	1
F4-S5		√	√		√				3								√	1						0					0
F4-S6							√		1		√							1				√	√	2					0
F4-S7	√						√		2		√							1		√				1					1
F4-S8									0									0						0					0
F4-S9	√								1		√							1	√					1		√			1
F4-S10	√								1		√							1						0					0
F4-S11									0									0		√				1				√	1
F4-S12		√			√		√		3							√		1				√		1					0
F4-S13		√					√		2				√					1		√				1				√	1
F	10	8	4	1	5	1	15	1	**39**	2	12	6	2	1	2	1	2	**26**	9	5	1	4	2	**12**	1	2	2	7	**12**
%	23.78	27.59	13.79	3.45	17.24	3.45	51.72	3.45		6.90	41.38	13.79	6.90	3.45	6.90	3.45	6.90		31.03	17.24	3.45	13.79	6.90		3.45	6.90	6.90	24.14	

Note: F3-S*n*: Form 3 student, respondent number *n*, F4-S*n*: Form 4 student, respondent number *n*, F=Frequency, %=Percentage