# The Usability of C++ Interactive Self-Assessment Quiz (i-SAQ)

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*Abstract*—The rising of technologies these days affected most of the sectors in the country including education. Traditional assessment method gives difficulty to both students and lecturers in term of learning and teaching process. Therefore, this study proposed a usability test of an online quizzes application called i-SAQ (C++ Interactive Self-Assessment Quiz). i-SAQ adopts formative assessment method which the main purpose is to help students and lecturers in their learning and teaching process. The feature of i-SAQ is that it offers immediate feedback while answering the quiz attracts students in having a hassle-free way of discovering knowledge. This feature also helps lecturers in handling large number of students in term of giving the feedback from formative assessment. The usability test of this study was conducted to a group of 64 students using questionnaire which designed based on Nielsen's Attribute Usability (NAU) test. This usability test is important to test the functionality of i-SAQ as a learning support tool toward students' learning process. From the analysis, most of the students gave highest points for every questionnaire usability factor which shows that i-SAQ is a useful and interesting learning support tool. The feedback from this usability test will be taken into account for further functionality improvement.

*Keywords*—online quizzes; i-SAQ; formative assessment; immediate feedback; C++ programming language; usability test; NAU

## I. INTRODUCTION

THE word 'Digital Native' is given to the youngsters who brought up in the digital technology world and familiar with the digital devices and technology in their early age. This community apparently adopts these technologies in their daily lifestyle which also affected the delivery of education across the world. The tendency to these technologies drives the development of various interactive learning tools to fulfill the needed and desire of this community towards 21st century learning and teaching framework.

In this study, we proposed a usability test of an interactive application which focusing on formative self-assessment tool for C++ course. This application, called "C++ Interactive Self-Assessment Quizzes" (i-SAQ) was proposed as one of the online learning support tools to cater problems that arose from traditional assessment method. From student's perspective, traditional assessment method needs them to carry a lengthy, expensive and heavy textbook to check for the correct answer and explanation for each of the answers every time they answer the quizzes. On the other hand, from lecturer's perspective, traditional assessment method leaves them difficulty to respond to each of the questions from students due to limited class time and frequently repeated explanation to different students is also time-consuming.

i-SAQ is a lightweight online quiz application that offers interactivity, prompt response and review feature for C++ programming students. This application provides an immediate confirmative response for the correct choice or corrective response for the incorrect choice. i-SAQ also offers easy access

feature where this application is accessible by topic, load faster and work on all devices, either desktop (Windows or Mac) or mobile (Android, iOS or Blackberry). After taking the quiz, the results, question reviews, and explanations will be sent to the students and the lecturer via registered email address for further revision.

This study is focusing on the syllabus from C++ Programming course, CSC128 (Fundamental of Computer Problem Solving) which is typically taken by second semester Civil Engineering students and fourth semester Mechanical Engineering students from Universiti Teknologi Mara (UiTM) Pasir Gudang Campus.

## II. LITERATURE REVIEW

Assessment which is referring to the various tools to evaluate the performance and understanding of the students towards the lesson is important due to the strong impact on learning [1]. Assessment basically can be divided into two, which are formative assessment and summative assessment. Formative assessment is a part of an instructional process which provides ongoing feedback to adjust and improve teaching and learning process for both students and lecturers [2-3]. Feedback helps students to improvise their learning process by modifying it and then make decisions [4]. On the other hand, summative assessment is an accountability measure which given periodically by comparing student's understanding against some standard or benchmark [2].

Even though feedback from formative assessment able to improve student's learning achievement, it left difficulty to the lecturer due to a large number of students, time and workload constraints as well as lengthy pieces of work [5]. In order to cater to this problem, merging of formative assessment and technology is needed to fulfill the 21st century teaching and learning framework. Online formative assessment is characterized by a diversity of approaches that can enhance learning experiences and outcomes through immediate and ongoing formative feedback [6]. The studies of online formative assessment have been carried out by many researchers which demonstrate the benefit of

this assessment towards student's learning process [7–9]. According to the studies, online formative assessments are recognized as one of the learning support tools that improve students' knowledge and encourage self-directed learning based on their learning needs and style.

Applying online quizzes, which is a part of the formative assessment in teaching and learning is in accordance with the 10 Shifts in Malaysia Education Blueprint 2015-2025 (Higher Education). The ninth shifts of the blueprint emphasized on globalized online learning which focuses on the transformation from a mass production delivery model to technology-enabled innovations in education which offer a more personalized learning experience to all students [10]. According to Kauffman, online learning is more convenient and flexible compared to face-to-face traditional classes especially for students who balancing work, school, and family [11].

Online quizzes are said to be effective due to some reasons. Firstly, the questions from online quiz help students to learn more effective and they can answer the quiz more than once [12]. Secondly, the immediate online feedback for the incorrect answer and explanation for the correct answer provide just-in-time learning. This kind of learning process gives the opportunity to the students to verify the corrected methodologies before retaking the quizzes [12] and increase the awareness to correct their misconceptions about the subject as they are incorporated into the learning process [13]. Besides that, just-in-time learning with the repeat-exposure helps students to understand better and providing improved retention [12]. Online quizzes also allow students to work in a group where they can help each other to learn the content which can attain higher levels of learning [12].

In this study, we have to consider the usability of the application as one of the learning support tools. Usability test is an evaluation of the developed applications which are the response to the increasing relevance of users' requirements in order to deliver successful products and increase individual productivity [14]. The usability analysis of this

study was conducted by applying Nielsen's Attribute Usability (NAU) questionnaire [15] which involving 64 respondents from Universiti Teknologi MARA (UiTM) Pasir Gudang Campus. These respondents are the second semester Civil Engineering students and fourth semester Mechanical Engineering students who are required to take the CSC128 course for that particular semester.

NAU questionnaire is one of the most widely recognized and used approach to evaluate the usability of a software or an application [16]. NAU highlighted five main factors to evaluate the usability of the application, which are [15], [16]:

i. Learnability: Systems should be easy to learn. A user-friendly system required minimal time for user to understand and accomplish the tasks.

ii. Efficiency: Systems should be efficient to use. Efficiency is the relation of the accuracy and completeness with which user achieve goals.

iii. Memorability: Systems should be easy to remember. User should be able to use the system proficiently after some period without having to learn everything all over again.

iv. Errors: The system should have a low error rate. User may make few errors when using the system, but they should easily recover from that error.

v. Satisfaction: The system should be pleasant to use. This factor indicates the satisfaction level or positive attitude of the user towards the system.

This study adopts the basic elements of the ADDIE model in which the process is iterative and self-correcting [17]. ADDIE model has been successfully applied in online course design that has been documented in the literature [18]. ADDIE model consists of 5 phases which are; Analysis, Design, Development, Implementation, and Evaluation.

## III. OBJECTIVES

This study aims to: (1) develop an online application that implements the formative assessment method in order to assist students and lecturers in the process of learning and teaching; (2) measure the usability of the application in order to ascertain the developed

application whether it is practical to use and easy to understand by the user.

In order to achieve these objectives, a development of an online application and a testing of application's usability have been carried out. The two matters are further clarified in the next chapter.

## IV. METHODOLOGY

The overall research methodology adopts ADDIE (Analyze, Design, Develop, Implement, and Evaluate) model [19] to achieve and align with the objectives efficiently. This model was chosen because each of the stages was clearly defined and this feature facilitates the implementation of effective training tools.

### A. Analyze

In the first phase, a comprehensive background analysis of available quiz maker is conducted to search the most appropriate application that suits the i-SAQ purpose. After comparing some of the quiz makers, we decided to choose iSpring to develop i-SAQ. iSpring is a rapid learning authoring toolkit used to develop a training course which can be integrated with Microsoft PowerPoint. The output of this application software can be high quality flash movies, HTML5 or ZIP archive.

### B. Design

Design phase involves three main stages. The first stage is to design the questions to be included in the i-SAQ. In this stage, a large question bank which consists of 60 multiple choice questions from five topics of the course were designed along with the explanation of its confirmative responses.

After designing the questions, the second stage is to design the storyboard of i-SAQ implementation flow. The flows of this application are highlighted as below:

i. Choose a topic.

ii. Enter name and email.

iii. Start answering the question. The application then provides a confirmative response for the correct choice or corrective response for the incorrect choice.

iv. Quiz result will be prompted after answering all the questions.

v. Each answered question can be reviewed after the result has been prompted.

vi. A detailed score report will be sent to both student and lecturer via email.

The last stage in this phase is to design the interface of this application. Since i-SAQ is focusing on the immediate feedback of the questions, thus, minimal interface design is put into consideration so that a lightweight self-assessment quiz can be achieved.

*C. Develop*

In the development phase, i-SAQ will be developed based on the designs that were created in the second phase. All the questions were sorted by topic and Fig. 1 shows the i-SAQ's screen flow in Microsoft PowerPoint. Fig.2 and Fig. 3 depicts the screenshot of i-SAQ showing correct and incorrect feedback.
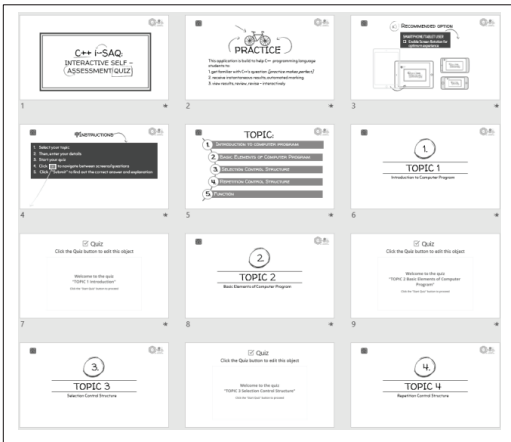


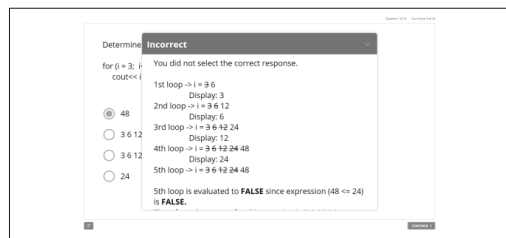Fig. 1. Screen flow of i-SAQ in Microsoft PowerPoint
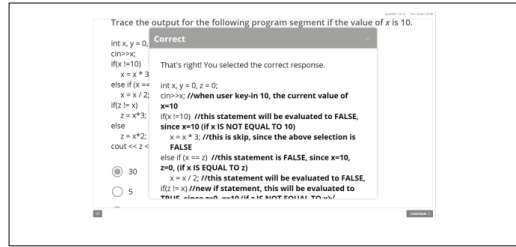


Fig. 2. Screenshot of incorrect feedback in i-SAQ



Fig. 3. Screenshot of correct feedback in i-SAQ

After i-SAQ development is complete, the final output is then uploaded on a free website (https://itch.io) which support HTML5 flash movies. Once i-SAQ is made online, it is accessible on all devices and platform through mobile and personal computers (PC). Upon completion of this phase, i-SAQ will be tested, reviewed and revised accordingly to ensure that the outputs of this application are in line with the planning.

*D. Implement*

The fourth phase in the ADDIE model is the implementation phase where the developed i-SAQ will be tested by the targeted students. A group of 64 students was asked to run i-SAQ from their mobile and PC. The students were from Universiti Teknologi MARA Pasir Gudang Campus who enrolled in CSC128 (Fundamental of Computer Problem Solving) course. 41 students were from Diploma of Civil Engineering semester 2 and 23 students from semester 4 of Diploma of Mechanical Engineering. During this phase, the functionality related to the content and application has to be ensured as a usable learning support tool.

*E. Evaluate*

This evaluation phase involves a series of questionnaires designed for the targeted students as explained in the previous phase. The main purpose of this phase is to gather the useful information regarding the developed i-SAQ. Feedback from the students will then be analyzed in order to provide an improvement to the application. The questionnaire for this phase is constructed based on Nielsen's Attribute Usability (NAU) test [15]. The analysis result and discussion regarding of the test will be discussed in the next section.

## V. RESULT AND DISCUSSION

There are a total of 64 respondents who have tried i-SAQ where 64.1% of them are Civil Engineering students while another 35.9% are Mechanical Engineering students. From the total respondents, 35.9% are male students while 64.1% are female students. Our analysis results are based on Nielsen's Attribute Usability (NAU) questionnaire which evaluated the usability and of i-SAQ based on five different factors that include the learnability, efficiency, memorability, errors or the accuracy and satisfaction upon the usage of the application [15]. The questionnaire has a 7-point Likert scale ranging from 1 for bad to 7 for good as depicted in TABLE 1.

TABLE 1. Summary of i-SAQ Users Responses Base d on NAU

| Scale | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Learnability** | 0 | 0 | 3.1% | 23.4% | 17.2% | 23.4% | 32.8% |
| **Efficiency** | 0 | 0 | 4.7% | 15.6% | 21.9% | 29.7% | 28.1% |
| **Memorability** | 1.6% | 0 | 1.6% | 21.9% | 17.2% | 26.6% | 31.3% |
| **Errors (Accuracy)** | 0 | 4.7% | 3.1% | 31.3% | 15.6% | 17.2% | 28.1% |
| **Satisfaction** | 0 | 3.1% | 6.3% | 15.6% | 15.6% | 26.6% | 32.8% |

As shown in TABLE 1, the usability of i-SAQ is measured by the 7-point Likert scale where 6 and 7 point signifies the scale as good evaluation while 1 and 2 point as bad and the other three points denoted as average. The learnability aspect plays an important role to define the success of i-SAQ where 56.2% of the respondents chosen i-SAQ contents as very easy to learn and 57.8% respondents pleased with the efficiency and effectiveness of i-SAQ. Since there are several faults with the questions and interfaces, only 45.3% respondents evaluate i-SAQ as accurate and free from errors while

the rest of the students concerned with the glitch. Regardless the lower evaluation on the accuracy, 57.9% respondents find the contents and arrangements of the questions and feedback as memorable and a total of 59.4% of the respondents were satisfied with i-SAQ contents and functions. Fig. 4 summarizes user's responses based on NAU questionnaire.
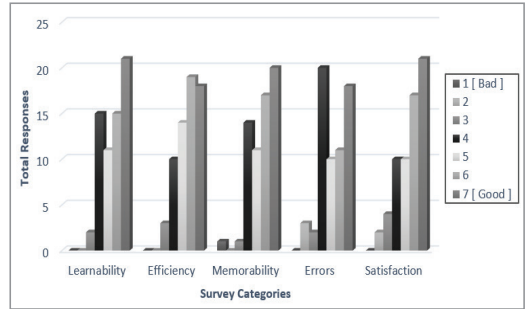


Fig. 4. Graph of i-SAQ Users Responses based on NAU

According to the results of the NAU questionnaire as shown in Fig. 4., only one factor of this application that received the lowest scale point of 1 from one respondent for the memorability aspect and three respondents gave scale point of 2 for the accuracy and there are also two respondents who gave 2 points for the satisfaction factor. Furthermore, the average scale of 3, 4 and 5 show the range of percentage between 37.5% and 50%. The evidence suggests the needed of some improvements to enhance the memorability, accuracy and the satisfaction aspect of i-SAQ. Even though there are some lower evaluation points given, the fact that most of the i-SAQ user has given highest points for every NAU usability factor shows i-SAQ as one useful and interesting C++ self-assessment and learning support tool.

Other than that, we also collected the respondents' comments upon the useful dan valuable aspects of the application for future enhancements and recommendations. There are numerous positive comments saying that this application is very useful and has increased their knowledge upon the topics that were asked and how to answer programming questions correctly. This is due to the ability of i-SAQ as the online quiz application that offers

interactivity, quick review and responses and also the immediate confirmative response for the correct choice or corrective response for the incorrect choice of each question. The answer review gave them the opportunity to learn and understand their mistakes whenever they chose the wrong answer. Some of the students also suggested this application to be introduced earlier from the beginning of the semester for a different type of assessments such as short quizzes, assignments or even the mid semester test and not only focusing on the previous final examination paper questions.

The ability of i-SAQ to be accessed anytime and anywhere by using their smartphone and personal computer make it more reliable and beneficial for the students where they can learn or make a quick revision whenever or wherever they wish individually or together as a group with their friends. The percentage on types of devices use is summarize in Fig. 5.
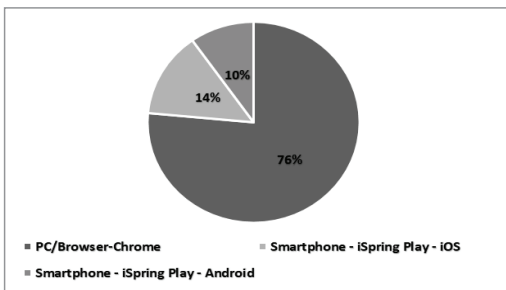


Fig. 5. Percentage on types of devices use to view i-SAQ

Fig. 5. shows the percentage of devices use by the respondents to view i-SAQ. There are three different categories of devices to view i-SAQ where the personal computer (Windows / Mac technology) or browser (Chrome) holds the highest percentage with 76%, followed by the Android smartphones with 14% and lastly the iOS technology mobile phones with 10%. Since the usage of i-SAQ requires them to install iSpringPlay application first, most of the students prefer to view i-SAQ with their personal computer through the Chrome browser.

Despite the positive comments, there are some suggestions about the interface where they want it to be more colorful, the questions

and answers to be displayed on the same page and lastly, they prefer if the part C section (full programming question) able to be zoomed in and out for a clearer view. Despite all the negative comments, the students are all satisfied with i-SAQ application functionality.

## VI. CONCLUSION

The descriptive analysis has shown that proposed i-SAQ has a favorable response in its usability test. Most of the students have given a good impression towards i-SAQ despite the low points given by few students in accuracy due to several faults found in the questions. Since the result of usability is approving, i-SAQ will be continually implemented as learning support tool to achieve successful results of on-going assessments and final examination of subject Fundamentals of Computer Problem Solving (CSC128) in Universiti Teknologi MARA (UiTM) Pasir Gudang Campus.

For future work, researchers of this study will continue their study in comparing the results of the student who are using i-SAQ and who are not to demonstrate how i-SAQ is beneficial towards students and lecturers involved in learning and teaching CSC128.

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