Developing the Computer-Based Test (CBT) on the basic chemistry throughout a web-based application

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Abstract. Nowadays, the development of technology emphasizes the educators to be able to utilize the technology greatly in teaching and learning processes, including the learning assessment. In fact, the implementation of the technology, such as the utilization of an online-based test, seems to develop in the process of learning assessment. Hence, this present research proposes to develop the computer-based test (CBT) application for the comprehensive test of basic chemistry in measuring the higher order thinking skill (HOTS) of the undergraduate students in the major of chemistry education department. Furthermore, to facilitate their necessaries in optimizing the computer-based test (CBT) application, it seems to indicate that the application needs a new innovation in the certain parts in terms of the design itself and the simplicity of the online test that enables to be accessed either from the mobile phones or the students’ laptops. Notably, the development of the computer-based test application in the present research attempts to use the programming language PHP and MySQL in producing the database. Moreover, the author administrates five phases in promoting the application, such as developing the devices within the preliminary study, planning, creating the product design, testing the limited product, and revising the limited product testing. As the result, the findings of the research are expected to become the primary component in developing the online assessment. In other words, it enables to measure the learners’ competencies in comprehending the learning materials of basic chemistry and the higher order thinking skill for the undergraduate students of chemistry education department.

1. Introduction
The development of the information technology seems provide the significant impacts in enhancing the quality of the education in terms of the academic field, administration, and also management. In accordance to the objective of the education, it confirms that the learning process relates to how the educators facilitate the learners with the appropriate technology of information and communication in order to boost the pupils’ efficiency and the learning effectiveness [1]. Importantly, the teachers’ pedagogy knowledge and the use of technology can be exploited as the instructional tool and included as one of the major factors in helping the teachers and educational institutions towards the students’ enhancement of the 21st Century skills [2].

Furthermore, chemistry is one of the important subjects to learn in the scope of science. Nevertheless, some students tend to face some difficulties in completing the chemistry problems in the learning
process. For the example, the students only seem think about how to understand the learning materials well, while they tend to disregard the productive interaction during the learning process [3]. What is more, it is argued by some pupils that learning chemistry needs more efforts to conceive a number of representation levels in describing and explaining the chemistry phenomena. Therefore, they are required to possess a higher order thinking skills in the learning process [4]. To be more specific, the Higher Order Thinking Skills (HOTS) is the process of thinking that elaborates a series of in-depth procedures, such as analysing, evaluating, and creating [5]. Likewise, it does not only point how to remember the phenomena or facts, but it also concern to the process of retelling the information that has been listened [6]. Moreover, the assessment of the Higher Order Thinking Skills (HOTS) presents various serious problems which necessitate problem solving skill to accomplish a certain obstacle [4].

In terms of the interview result with the chemistry lecturers, they asserted that the implementation of the Computer-based Test in examining the pre-service teachers’ competencies tend to use the common method without utilizing the online-based application. Also, they explained that the pre-service teachers require the Higher Order Thinking Skills in which combines with the application of Computer-based Test to assess the undergraduate students’ capabilities towards the basic chemistry in the comprehensive form. Furthermore, the Computer-based Test (CBT) does not only evaluate the measured materials, but it also rates the learners’ knowledge of the basic chemistry itself [7]. Importantly, the developed Computer-based Test application will be administrated throughout world wide web (WWW) which offers text, sounds, pictures, videos, and animation. Besides, it can be represented in the form of hypertext and be accessed within the browser [8]. To finalize the software components, the application is supported with the programming language which optimizes PHP (Hypertext Preprocessor) and MySQL (My Structured Query Language). Substantially, the Hypertext Preprocessor is a script of programming language created for building the web application, being called from the browser, and being written with PHP and parsing in the web server by the interpreters [9]. What is more, the basic principle of the PHP is yield similar to HTML (Hypertext Markup Language) that processing the data from the web server and sending all of them to the PHP machine. After that, all of the information in the PHP machine will be processed and showing the result as HTML codes to the web server. On the other hand, MySQL is utilized as the software for conducting the database management system in the application. It possesses several unique characteristics that establish users to use MySQL in developing the web application [10]. Moreover, the research also applies some software tools to create the application, such as the Sublime text 2.0.2, Xampp 3.2.1, Google Chrome 49.0.2623.87, Microsoft Office 2019, and MySQL designed by using Laravel framework. Notably, Laravel is the Hypertext Preprocessor framework which employs the Model-View-Controller (MVC) in its design development. To be more specific, it is commonly found in building up the website of a certain application [11].

The development of Computer-based Test (CBT) focuses on the basic chemistry which is convenient to the learning objectives, learning outcomes of the study program, and learning outcomes towards the subject itself. Particularly, the undergraduate students will learn about the material properties and measurements, atomic structure, periodic system of elements, chemical bonds, stoichiometry, concentration and colligative properties of solutions, chemical and acid-base equilibrium as well as pH. In light of the needs analysis, the present research attempts to develop the Computer-based Test (CBT) and also Higher Order Thinking Skill in the form of online-based application. Further, the advantage point from the use of computer media as the learning assessment is that offering the feedbacks either to the lecturers or the undergraduate students [12,13]. Therefore, a developmental design is still exist to pursue in the present research emphasizing on the use of the online-based test for testing Higher Order Thinking Skills (HOTS).

2. Research methodology
The authors administrated the research by utilizing several methodologies, such as the literature studies and the observation. The literature studies were beneficial to find and collect the references from a number of resources and related books about the research problems. Additionally, the observation was also required to add the data regarding the development of computer-based application. It was carried
out at UIN Jakarta in the form of focus group discussion. Moreover, the research organized the need analysis in the preliminary research to find out the clear information about what were going to observe [14]. Furthermore, the research proposed a developmental design by adapting the development model by Borg & Gall which consisted of ten steps [15]. Notably, the current research had been modified into five phases. For instance, a preliminary research, planning, designing the product design of computer-based test within the programming language of PHP (Hypertext Preprocessor) and MySQL (My Structured Query Language), testing the limited product and revising the result of limited product testing.

3. Findings and Discussion

3.1. Preliminary analysis

In the first phase of the research, the authors identify the requirement specification by observing users and communicating to them directly as well as providing the questionnaires to obtain the related data. The literature analysis confirms that the assessment of Higher Order Thinking Skills (HOTS) through the online-based application tend to affect the successful of learning outcomes and prompt to be the interested media in teaching and learning process for the chemistry pre-service teachers [13]. Additionally, the authors also conduct a focus group discussion with the lecturer who teaches basic chemistry to discuss comprehensively about the developed product [15]. Based on a deep investigation throughout focus group discussion, it can be said that basic chemistry tends to be one of the significant subjects in department of chemistry education because it connects to the learners’ competencies in apprehending another learning subject. To date, there is still no any application that supports the test of basic chemistry specifically for investigating the pupils’ understanding the subject for the comprehensive test.

3.2. Planning

The second phase of the research development is planning which explains about the time limitation and related information of the research. These two components are useful to arrange the schedule of the research and determine the appropriate tools for conducting the research [16]. What is more, the research also applies some software tools to create the application, such as the Sublime text 2.0.2, Xampp 3.2.1, Google Chrome 49.0.2623.87, Microsoft Office 2019, and MySQL designed by using Laravel framework. Notably, Laravel is the Hypertext Preprocessor framework which employs the Model-View-Controller (MVC) in its design development. To be more specific, it is commonly found in building up the website of a certain application [11]. Substantially, the research attempts to apply a series of hardware’s to support the development of web system in the application including laptops and servers, while the authors involve some components for the web hosting, such as Intel Core i3, memory 4GB RAM 1GB [17].

3.3. Designing the product of computer-based test for basic chemistry by using HOTS

After completing all of the structured plannings for the application development, the authors continue the research by analysing the required software needs and designing the procedure in the developed system, interface, and the supported features in the application [17]. Furthermore, the Computer-based Test for the basic chemistry which optimizes the Higher Order Thinking Skill (HOTS) can be presented within Figure 1.
Figure 1. Class diagram.

Figure 1 explores the class diagram from CBT application which includes the Higher Order Thinking Skills (HOTS) questions in the basic chemistry subject. It is intended to offer the description of the system structure in terms of the class definition in building the system. What is more, the class definition presents the login button which can be divided into three main gates, including from the administrator, lectures, and the undergraduate students. The product design initiates 4 different user interfaces to support the application initial displays. It can be seen clearly from Figure 2 up to Figure 5.

Figure 2. Landing page.

Figure 3. Login page.

Figure 4. register page.

Figure 5. Comprehensive test page.

Figure 2 indicates the product design in the form of a landing page. It proposes a menu display for the users who do not have an account or even those who have the account. Then, the authors include instruction to carry out the comprehensive examination in accordance with the time limitation and the explanation that the test takers only can do the test in one time. Finally, the landing page includes the contact person if they confront a crucial problem. On the other hand, Figure 3 explains the appearance of the login before carrying out the exam and respondents are required to have an account by filling out the form as like Figure 4. After that, the users can login by filling the e-mail address and password which
has been registered. Additionally, Figure 4 involves the register display that describes the students’ name and students’ identification number, gender, institution, and e-mail address. Therefore, Figure 5 shows the example of comprehensive test after transferring to the website. The product design involves the admin menu that indicates several main features to manage the system, so the software system can run based on the objectives [17]. The product design can be seen clearly from Figure 6 and Figure 7.

Figure 6. User management.

Figure 7. Institutional management.

Figure 6 and Figure 7 explain the important features in the product design, such as user management, institutional management, and test management. It is notable that user management feature is intended to organize the users in terms of changing the name and student’s identity card with the up to date data. To be more specific, the institutional management can be used to add the educational institutions who implement the comprehensive test. Lastly, the test management is proposed to manage all of the tests by adding some information, revising, and deleting the unnecessary data regarding the users’ data, the undergraduate pupils’ data, questions data, and scoring data.
3.4. Testing the limited product

The forth step of the developmental research is testing the limited product within the assessment from three experts who possess a related knowledge about the issue of the research. Then, all of the inputs will be gathered in several phases, such as the general properness of media, the analysis of the assessment from the experts regarding each aspect and each indicator [18]. The results of the analysis from three experts who examine the basic chemistry test with the Higher Order Thinking Skills (HOTS) through online-based application are declared to be suitable or valid. The indicators used in this assessment are two aspects, namely: 1) aspects of software use and 2) aspects of communication, visual and media. The results of the analysis of media experts can be seen in the following Table 1.

Table 1. The result of validity assessment from experts’ teams.

| No. | Indicators of the Assessment                              | Examiners | Total Scores | Scores (%) | Explanation |
|-----|----------------------------------------------------------|-----------|--------------|------------|-------------|
|     |                                                          | Experts 1 | Experts 2    | Experts 3  |             |
| 1   | Efficient in utilizing the learning media in terms of    | 4         | 4            | 4          | 12          | 100         | Very Good |
|     | the time allocation (the program does not need RAM and   |           |              |            |             |            |            |
|     | harddisk in the large size)                             |           |              |            |             |            |            |
| 2   | Effectiveness (the program can respond fast)            | 3         | 4            | 4          | 11          | 92          | Very Good |
| 3   | Reliable (the program expertness)                       | 4         | 3            | 4          | 11          | 92          | Very Good |
| 4   | Easy to use                                             | 4         | 4            | 4          | 12          | 100         | Very Good |
| 5   | The accuracy in choosing the type of software of         | 3         | 4            | 3          | 10          | 83          | Good       |
|     | application to develop                                   |           |              |            |             |             |            |
| 6   | The documentation on the instructions of the media       | 4         | 3            | 4          | 11          | 92          | Very Good |
|     | utilization can be understood                            |           |              |            |             |             |            |
|     | i) Aspect of the Communication, Visual, and Media       |           |              |            |             |             |            |
| 7   | Communicative                                           | 3         | 4            | 3          | 10          | 92          | Very Good |
| 8   | Creative in expressing the ideas and thoughts            | 4         | 4            | 4          | 12          | 100         | Very Good |
| 9   | Visual (layout design, background should be related to   | 3         | 4            | 4          | 11          | 92          | Very Good |
|     | the contrast colours)                                    |           |              |            |             |             |            |
| 10  | The quality of the picture on the material              | 3         | 4            | 3          | 10          | 83          | Good       |
|     | Total                                                    | 35        | 38           | 37         |             |             |            |
|     | Percentage (%)                                          | 87,5      | 95           | 92,5       |             |             |            |
|     | Further Explanation                                     | Good      | Very Good    | Very Good  |             |             |            |

Based on Table 1, it can be seen that from the three expert teams which rated an average rating of expert 1 was 87.5% (good), expert 2 was 95% (very good) and expert 3 was 98% (very good). Aspects of the use of software obtained ability can be implemented as measured include how the indicator statement in the form of efficient use of the application, effectiveness in responding quickly, reliably, ease of maintenance of applications, accuracy of selection of application types, compatibility, documentation on media usage instructions, aspects of communication, visual and media with indicators in statements [19]. The second aspect is the communication, visual and media aspects. In this aspect measured how
in the form of communication, creative in ideas and capturing ideas, visuals, interactive layouts, accuracy of letter selection, and image quality in the material in the application.

3.5. Revising the limited product testing
Testing the product is aimed to observe the implementation of the application development. Notably, testing the results of implementation using a single notebook or laptop. With Windows 10, 1 GB RAM and 320 GB hard drive and this system is ready to be tested on chemistry education study program students. Small scale test stages were carried out on 42 chemistry education students at UIN Jakarta. The purpose of the trial is that the resulting problem is a good measurement tool [20]. Based on the results of small group trials obtained information related to the time required for respondents to solve problems too quickly with the number of 40 questions worked on, there are unclear pictures in the problem, there is a problem or error warning appears on the campus server computer so that access experiences blank students experience difficulty when logging in the application. This can be overcome by using a hotspot network through the cellular telephone of each student.

4. Conclusion
The present research has succeeded promoting the computer-based test application for comprehensive test of the basic chemistry and also online higher order thinking skill. Specifically, the testing results from three experts show that the average points of the application indicate a very good average scores. What is more, the findings of this research can be able to be applied as one of the fundamental subjects in designing the evaluation towards the students’ understanding of basic chemistry and other competencies which relate to the chemistry education department

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