

# Introducing Chemical Instruments through Quick Response Code (QR-Code) Based Website

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**Abstract:** Understanding how to work in a chemical laboratory involving instruments is important for students in doing their research. Therefore, we need an effort to make students capable of operating certain fundamental instruments in a chemistry laboratory. This study aims to produce QR Code-based instructional website to introduce chemical instruments and assess the feasibility of the media. This is a research and development (R & D) employing a model of ADDIE. The subjects were 18 students who enrolled in the course of chemical laboratory management at a state university in Aceh, Indonesia. Data were obtained from questionnaires and a system usability scale instrument. The website contains a pH meter, Evaporator, UV-Vis spectrophotometer, refractometer, and Oven. The validation score of the abovementioned features was 94.33, 95.83, 93.5, 95.16, and 94.16% respectively. The validation score of the websites was 95%. The SUS Score for the web-based media QR-code was 83.75%. The QR-Code as a web-based media is very feasible to use.

**Keywords:** Instruments; QR-Code; Website; Laboratory.

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## Introduction

Quick response code is a two-dimensional picture that represents the data, especially the data in text form. (Narayanan, 2012), QR Code was introduced by Japanese company Denso-Wave in 1994 as a code that allows to load the data and can be directly and rapidly translated (Rouillard, 2008) and the QR=Code have been widely used in various sectors (Iirmi et al., 2019; Narayanan, 2012; Rouillard, 2008). The use of QR Code in teaching could generate new learning experience for students and can promote the utilization of modern devices in learning (Meenakshi, 2013). The mobile device is suitable for applying the context-aware because with the help of a mobile device, a teacher will be able to extend the learning environment of the digital world into the real world (Nazar et al., 2020).

The introduction of chemical instruments is essential to be understood properly in order minimize

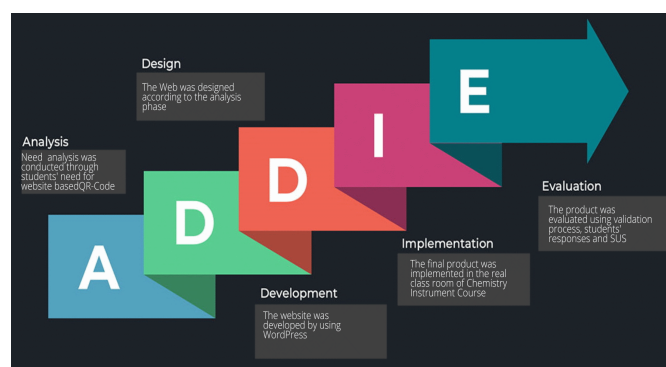
accidents that may occur in the laboratory and to avoid damage to the instrument. Balbach & Bliss (1991) explain their ignorance of the functions of the existing tools and laboratory instruments, with familiar tools and materials so that it can carry out stage-by stage so that it runs smoothly. Currently, the learning for the introduction of material chemistry instruments is done using textbooks. In practice the material introduction of chemical instruments, lecturers invited students to a laboratory to introduce instruments that exist in laboratory and explain how it works, but not directly to practice how to process such instruments when used, and the material obtained by the student is not up because the deadline of meeting do not make all the material on the instrument can be explained, as well as of information students have followed the meeting has not been sufficient understanding of the material related to the introduction of chemical instruments.

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Relevant research shows that QR Code technology as a learning medium obtained positive responses from the students, this is evidenced by research conducted by (Mustakim, 2013). The use of the QR Code on the material elements of the periodic system on an experimental class is superior compared to the control class seen from the difference in scores of learning outcomes. This compares favorably with conventional learning media. Another study conducted by (Rikala & Kankaanranta, 2013) implicated that the learning process by connecting QR code and mobile devices into the classroom could improve the personality, suitability and authentic learning experiences for students. As well as research conducted (Kris, 2014) introduced a system of QR code to determine the function and use of existing tools in laboratory, lab activities run efficiently and process guided even more effective, this research has not been any discussion of further material on how to use laboratory equipment right and wrong, the importance of learning resources / media that discusses how to use the equipment to avoid accidents that may occur. In this paper, we report the development of Web-Based Quick Response Code as a Learning tool for Introducing the chemical instruments in the Chemical Laboratory at a state university in Indonesia.

## Method

The approach used in this study is a qualitative approach. This is a Research and Development (R & D) employing the ADDIE model, the ADDIE model is a famous development model used by many researchers in generating educational technology and instructional design because it's straight forward and easy to use (Aldoobie, 2015; Habibati et al., 2019; Prammanee, 2016). The flow of developing process is given by figure-1.



**Figure-1.** The flow chart of ADDIE model employed in developing the QR-Code based website

### Data collection technique

Data was collected using questionnaire of need analysis that given to students enrolled in a course of Laboratory Management. The data of validity was collected through expert judgement. While the usability

of the developed system was assessed by using a System Usability Scale (SUS).

### Data analysis technique

The data was processed using descriptive statistical analysis by taking into account aspects related to the design of instructional media as QR Code. Assessing the feasibility of web-based QR Code for material identification chemical laboratory instruments analyzed based on the percentage of eligibility.

For the usability assessment, a questionnaire consisting of 10 questions, System Usability Scale (SUS) was used. The 10 questions divided into five positive questions and 5 negative questions (Pudjoatmodjo & Wijaya, 2016). The results of SUS were analyzed according to the following rules: (1) For item No. 1,3,5,7 and 9 the value obtained is the reduced scale to 1; (2) For item No. 2,4,6,8 and 10 value obtained is 5 reduced scale; (3) The scores obtained and do the calculation process yield value multiplied by 2.5 to get the value of the overall score of SUS.

The SUS score has a value range of 0-100, to determine the usability of the software, a chart percentile rank against SUS with achieving a score of 0-50 (F), 51-60 (D), 61-70 (E), 71- 80 (B), 81-100 (A) was referred (Nathan, 2012).

## Result and Discussion

### Need analysis

The need analysis was conducted with the identification of the problems that exist at the University. Data was collected by a needs analysis in the form of information obtained by distributing questionnaires to the needs of students who follow courses of Chemistry Laboratory Management. Based on the recapitulation questionnaire needs information was obtained that (1) the medium used in the meeting is the media with environmental classification, (2) the respondent in desperate need of a web that contains information about chemical instruments, (3) the majority of respondents never use the QR Code, (4) respondents had never tried using the QR Code in the instrument introduction chemistry instructional media, (5) the respondents require QR Code 300px, without the addition of animation in the mold of the QR Code.

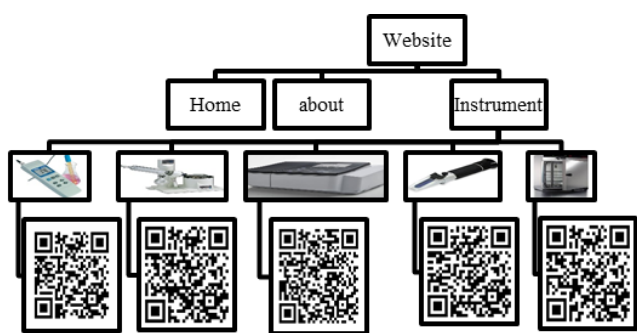
Table 1 shows the need assessment conducted before developing the desired QR-Code based website. When asked about how often the lecturers utilized learning media in the course of chemical instruments, all students agree that lecturers are using learning media all the time. The responses also indicated that lecturers usually ask students to use internet resources while learning or doing assignments. When asked about a need of specific website for introducing chemical instruments, majority of students agreed. Furthermore,

most of them have ever used QR-Code before and they agree that the QR-Code could be helpful for them in accessing internet easily and effectively.

**Table 1.** Need Assessment Results

Questions	Yes	No	Do not know
Do your lecturers utilize learning media in the course of chemical instrument?	18	0	0
Do you have sufficient internet access on campus?	18	0	0
Do lecturers require students to access internet for learning purposes?	8	10	0
Is the special websites about chemical instruments needed?	17	1	0
Have you ever used QR Code?	13	5	0
Do you think QR code would help you access internet easily?	14	4	0
Do you think the QR Code is the right tool to access a web?	18	0	0
Do you prefer a background behind the QR-Code?	0	12	6
Do you think accessing internet would be efficient and effective using QR code?	18	0	0

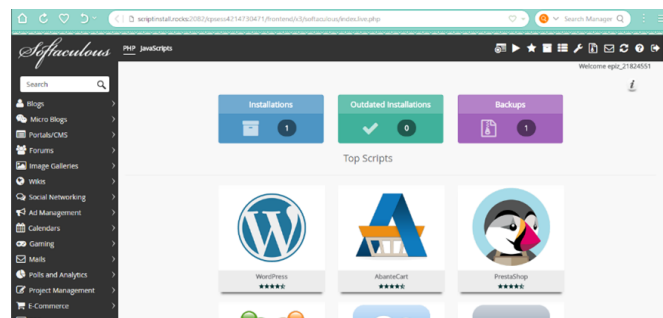
Based on the need analysis assessment, we decided to develop the QR-code based website with the following criteria: (1) The QR-Code is designed for chemical instrumentation including the pH meter, evaporator, UV-Vis Spectrophotometer, refractometer, and Oven; (2) The QR-Code size is designed at minimum resolution of 300 px; (3) The website is designed using WordPress; and (4) The hosting is website [www.hicampus.cf](http://www.hicampus.cf), which is a free hosting website.



**Figure 2.** QR-Code based website framework

Website creation process generally consists of two basic elements, namely the website server (hosting) and website address (domain). Server website can be interpreted as a CPU connected to the Internet as the service provider's website to support and store the data of the website. The website address can be understood to mean as the home address, so when someone want to

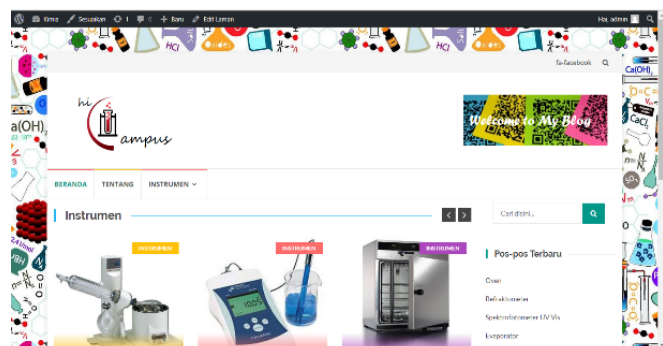
visit a website, once should only type the website address to the address bar. The domain (website address) can be purchased or free. The domain of website used in this work is a free domain: [www.freenom.com](http://www.freenom.com) and the free hosting used is [www.infinityfree.net](http://www.infinityfree.net). Furthermore, Softaculous installer app was employed to enable WordPress templates. The view of WordPress template is depicted by Figure 3.



**Figure 3.** WordPress in cPanel with Softaculous Apps installer

The website with the WordPress template that has been created can be set according to the needs of the website. The main steps of the website is a dashboard view to reviewing the menus to be displayed on the website. Website [www.hicampus.cf](http://www.hicampus.cf) is a free website although there are a few free facilities provided by WordPress so but it can produce a professional website. (Laily, 2014) stated that a website needs to recognize the size of the device (responsive) the feature is available on the website with adequate facilities.

QR Code is a web-based media have several design improvements in materials and media aspects. In order to improve the system, some works have been performed include fixing some typing errors, adding some required social media icons and sharing options, and modifying page navigation column, font color modification, as well as the general layout of the website.



**Figure 4.** The Final Design of QR Code based-Website

After going through the development process, web-based media QR code is validated by two validators assessing both the instructional aspects of media and

material aspects. These aspects are considered in the validation process QR Code web-based media, among others presenting the linguistic component, software engineering, visual display and audio components, the content and learning components. Validation was carried out to ensure the content validity and appearance in order to proceed to the implementation phase. The validation is very important part of development that determined the quality and feasibility of the website and the QR-Code (Martins et al., 2015; Rahmawati & Lutfi, 2018). The validation of web-based media QR Code on a material aspect and the aspect of media was conducted by two expert judges by giving the score as depicted in Figure 5.

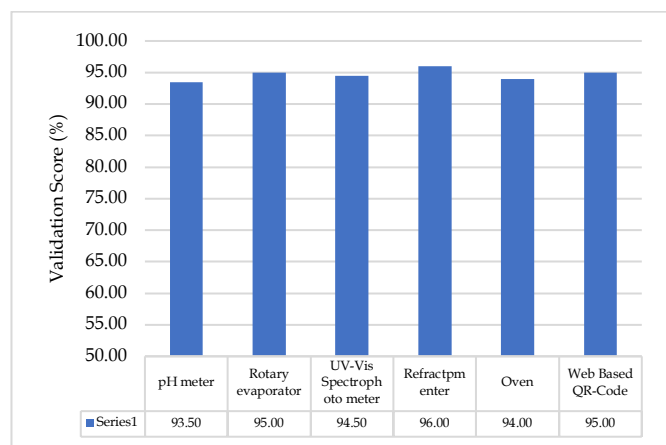


Figure 5. Validity Score of instruments and the QR-Code based Website.

Figure 5 shows the validity score of each instrument page and the QR-Code in general. The score was obtained through expert judgement. The score for each page was found to be over 90%. Based on the validity

assessment as shown in Figure 5, it can be concluded that web-based media QR Code is qualified to be proceeded to the implementation phase. Qualification eligibility refers to Arikunto (2010) with a score of very decent feasibility of teaching materials (81-100), decent (61-80), sufficient (41-60), less viable (21-40) and are not eligible (0-20), with consideration of the feasibility rubric.

Implementation Phase

The implementation phase of QR-Based website took place in the laboratory of Chemistry Faculty of Teacher Training and Education Universitas Syiah Kuala, Banda Aceh. 18 students who enrolled in the course of chemical laboratory management took an opportunity to operate and use the QR-Code based website. The test was conducted by putting a QR Code printed in the respective instrument then respondents would perform a scan using a smartphone to pages on the website. All students were given 20 minutes to use the website and subsequently after they finish visiting all pages in the website, we delivered the System Usability Scale questionnaire to assess the usability of the QR-Code based website. SUS as developed by (Brooke, 1996) was used as an instrument.

According to (Bangor et al., 2008), SUS is the ultimate system assessment since the tool usually provide a very good assessment results. Many researchers and web developers have been intensively using the SUS to evaluate the usability of their products (Ependi et al., 2019; Kortum & Sorber, 2015; Martins et al., 2015). The SUS contained five positive responses and five negative responses that could optimally assess the interaction between users and the system (Bangor et al., 2009). The SUS score of the website is given by Table 2.

Table 2. SUS score of the system

User	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Score
1	4	3	5	2	4	2	4	2	5	1	80.00
2	4	2	4	1	5	3	5	3	4	2	77.50
3	4	2	5	2	4	2	5	2	4	2	80.00
4	5	2	5	1	5	1	5	1	5	1	97.50
5	5	1	5	1	5	2	5	2	5	1	95.00
6	4	2	4	1	4	3	5	1	4	1	82.50
7	4	3	4	2	4	2	3	2	5	2	72.50
8	4	2	4	3	5	3	4	2	4	2	72.50
9	5	3	5	2	4	3	5	1	4	2	80.00
10	4	2	4	2	4	2	5	1	4	1	82.50
11	5	3	5	2	5	3	5	2	4	1	82.50
12	4	2	4	2	5	1	5	1	4	1	87.50
13	4	2	5	2	4	2	4	2	4	2	77.50
14	4	2	5	1	4	2	5	1	3	1	85.00
15	5	3	5	1	3	3	5	1	5	1	85.00
16	4	2	5	1	4	1	5	1	5	2	90.00
17	3	1	5	1	4	1	5	1	5	1	92.50
18	4	2	4	2	5	1	5	1	4	1	87.50
Tot.	-	-	-	-	-	-	-	-	-	-	83.75

Table 2 shows usability score of the system given by a small group of students. Overall score is 83.75 which is considerably as acceptable scale as shown by Figure 5. The usability of a system like a website is crucial because users of websites usually prefer quick and smooth system that enable accessing much information at short time (Peres et al., 2013). Therefore, a website should appear as a simple system but consist of useful information for the targeted users (Narayanan, 2012). SUS is considerably powerful in assessing a website, mobile app, and other computer system (Nazar & Zulfadli, 2018).



Figure 6. System usability criteria (Smyk, 2020)

## Conclusion

Based on the development process and the evaluation results, can be concluded that the QR-Code based website generated by using WordPress template is valid and also feasible to be used by students in learning the instruments in the Chemistry laboratory.

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