

# Implementation QR-Code for Introducing Optical Instruments

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**Abstract:** The laboratory is one of the important facilities and supports the implementation of learning in tertiary institutions. However, in carrying out practicum activities, students are often constrained by information regarding names, functions, and steps for using instruments. Therefore, the need for information about laboratory equipment is quite important for students. This study aims to produce a website based on a QR code to provide information about the instrument to users and the steps to use it. This research uses research and development methods with the ADDIE model (Analysis, Design, Develop, Implementation, and Evaluation). The questionnaire is used to measure user responses regarding the QR code and its application. Based on the analysis of the problems found, the QR code was successfully created. This QR code was validated by media experts and instrument content experts and obtained valid results. Users show a positive response regarding the use of the QR code for introducing of Refraction Laboratory instruments. Thus, a website-based QR code can be used to provide optical instrument information to users. However, socialization about its use is very necessary for laboratory users.

**Keywords:** Laboratory; Optical instruments; QR-code

## Introduction

The laboratory is one of the important facilities and supports the implementation of learning in universities. Government through Peraturan Pemerintah Number 19 of 2005 states that every educational institution is required to have facilities including furniture, educational equipment, educational media, books and other learning resources, as well as other equipment needed to support an orderly and continuous learning process, and also every educational institution is required to have adequate infrastructure includes land, classrooms, leadership rooms, educator rooms, administrative rooms, library rooms, laboratory rooms, workshop rooms, power and service installations, places for exercise, places of worship and other spaces needed to support an orderly learning process and sustainable (Pusat Pendidikan Tenaga Kesehatan, 2010). The laboratory is a room designed according to the need to carry out activities related to the functions of education, research, and community service.

Optometry is one of the study programs in the field of eye health science. This science is an applicative form of physics, especially optics. Therefore, the laboratory in the Optometry Study Program is dominated by optical instruments. The Optometry Laboratory at Bakti Tunas Husada University consists of four laboratories, namely clinical refraction, dispensing, surfacing, and contact lenses. For Optometry students, because the core of science is the skill of doing refraction examination, most of the lab work activities are carried out in the Refraction Laboratory. The Refraction Laboratory provides various kinds of instruments that can be used by students and lecturers to support refractive examination activities.

Before students do the laboratory work, students will be given an introduction to the instruments by the laboratory assistant and assistant lecture. This introduction aims to provided prior knowledge to students so when they using the instruments for the actual purpose, they do not feel foreign anymore and can get accurate results. Laboratory assistant and assistant lecture usually explained the name, function, and steps

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of using the instrument, and ask students to touch and try the instrument directly under supervision. The introduction of this instrument is even allocated to the course. However, due to time constraints, not all of these materials are delivered. As a result, students did not have sufficient knowledge of optical instruments and was found doing errors when using the instruments. Balbach et al. (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. Based on these problems, one of the solution proposed is to integrate technology into the instruments. One of the technology proposed was in the form of a Quick Response (QR) Code.

The Quick Response (QR) Code was first developed in 1994 by the Japanese automatic data capture equipment company - Denso Wave (Law & So, 2010). The QR code symbol consists of printed black lines and patterns (Eriya, 2020). QR codes function as an information delivery system and thereby provide users with information that is predetermined and regulated (Traser et al., 2015). QR code continues to grow along with the development of smartphone technology (Ucak, 2019). The use of QR code allows for embedding variables such as website URL, contact, text, etc. (Narayanan, 2012). The instrument needed to read it also quite easy, only requires a smartphone equipped with a camera and QR scanners.

Nowdays, QR codes have been widely used in various sectors (Nazar et al., 2022) including education and laboratories. QR code can be used in learning process as a means of presenting information in limited space (Anggraeni et al., 2022). Learning using QR code assisted by smartphone media also can make learning more interesting and motivate students to learn, hence they can increase their interest in learning.

Cataloglu and Ateskan (Ucak, 2019) stated that QR codes could be used in educational activities in two ways. First, QR codes help the student reach online applications, and second, after QR codes are scanned, the student may have the desired information without any need for the Internet connection. Therefore, the use of QR code can teach the digital literacy concepts to the students. Digital literacy is the ability to obtain, use, create, and develop digital information as a solution in doing work (Anggraeni et al., 2022).

Several studies have been conducted regarding the use of QR codes in the classroom and laboratory. Research regarding the use of QR code in the classroom was conducted by Anggraeni (2022) used QR code on physics learning module. She stated that QR code-integrated module can increase interest in learning. Meanwhile in the laboratory, QR code can be used in

application for Laboratory Clearance Form (Rochmawati et al., 2018), for an inventory of science laboratory equipment (Mamin et al., 2017); to introduce chemical instruments to students (Nazar et al., 2022); and as practicum-teaching material (Rahmah et al., 2023). Based on the research that has been done, it can be seen that the QR code has a positive value in its use in the classroom and laboratory.

The use of QR codes in the classroom and laboratory is something quite new and innovative in making learning more interesting, easy and paperless. QR code in the classroom also can teach digital literacy and other technology-related-skills. Therefore, QR code as learning media is worth to try. The aim of this study was to make QR code to introduce optical instruments in the Refraction Laboratory to the students and users.

## Method

### Research Method

Research and development method was used in this study with the ADDIE model approach. The ADDIE model consists of analysis stage, design stage, development stage, implementation stage, and evaluation stage (Aldoobie, 2015; Husna & Ardi, 2020). This model was chosen because this research aims to produce QR Code to record information about laboratory equipment. In general, the research flow is summarized in the process below:

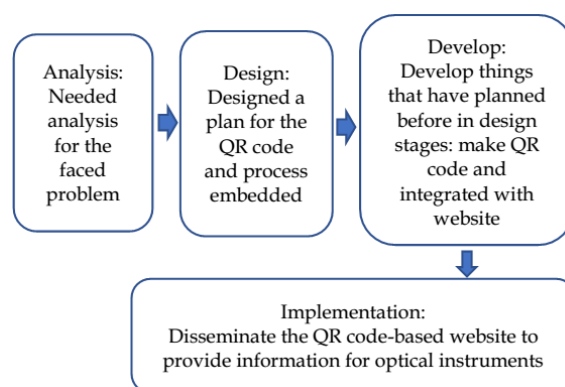


Figure 1. Research flow in ADDIE model

### Research Subject

The subjects in this study were students and users who used the instruments in the Refraction Laboratory, Optometry Department, Bakti Tunas Husada University.

### Data Collection Instrument

The research instruments used in this study were content validation test and questionnaires. The content validation test was aim to ensure that the generated QR Code can be used and there is no misconception. The QR

code product was validated in terms of its readability and accuracy of the information embedded into it. The questionnaires were used to assess user and reader responses regarding instruments image, names, and functions. The questionnaire was made by the researchers and has been validated.

#### *Descriptive Analysis*

The data was collected through questionnaire. The data were analyzed descriptively. The descriptive analysis are used to determine the level of product feasibility resulting from the development of QR Code. The data in the form of number was presented in percentage with the formula:

$$\text{Percentage} = \frac{\text{number of responses}}{\text{highest number of responses}} \quad (1)$$

The basis for determining the level of validity use the following qualifications in the Table 1 (Rompegading et al., 2023).

**Table 1.** Media Eligibility Level Qualification

Percentage (%)	Validity Level Descriptions
84-100	Very valid
68-84	Valid
52-68	Sufficiently valid
36-52	Invalid
20-36	Very less valid

The QR code was evaluated by the validators. The result of the readability of the QR code is 100, which means it can be accessed without problems. For validity of the content of each instruments were 98, which means that improvements are still needed regarding the information content. Both of the readability and content can categorized as valid. Even so, there are some recommendation for the QR code and details from the validator.

## **Result and Discussion**

QR code is another form of 2D barcode. Various information can be embedded into this matrix code such as text and link. This format of 2D bar codes is so popular in Japan and emerges gradually around the world because it has a large data capacity in a small printout size and high speed scan utilities via mobile devices are readily available (Law & So, 2010).

There are some consideration and recommendations regarding QR Code implementations, such as type of information, cleanness, and scanning tips (Diazgranados & Funk, 2013). For type of information, QR codes can be use to provide metadata, label information, supplementary information, and links to

digital resources. For cleanness, QR codes require a “quiet” area around them and prefer black/dark print on a white/clear background. For scanning tips, the device should be kept parallel to the code and as close as possible while still allowing it to focus. Edges of the code must be visible. It requires a few minutes of practice. A QR code can be read from any direction and can read even it is being tilted or on curved surface. The error correction capability against dirt and damage can be up to 30%. The size of a QR code can vary from 21x21 cells to 177x177 cells by 4 cell-increments in both horizontal and vertical direction (Law & So, 2010).

Laboratory inventory activities are carried out to organize facilities and activities in the laboratory. Range of laboratory inventory starts from managing tools and materials, consumables, laboratory human resources, and laboratory activities (Mamin et al., 2017). The activities carried out in this study were limited to one of the details in inventory of instruments. The administration of instruments in the laboratory is usually summarized in instrument card that records the completeness and identity of the instruments. Not only instruments specifications, but also information regarding how to use the instruments.

Inventory management using barcode technology has been used for long time. The demand for a greater inventory management system which can provide a lot of useful information from a single scan has made laboratory inventory management using barcode technology more difficult (Shukran et al., 2017). But, the barcode could not be read if the scanner is not connected to the database or if it does not contain the information of that particular item (Çakıcı et al., 2011). The QR code technology exist to complement the shortcoming of the barcode. The QR code can store information about the item to which it was assigned without the database. It can be read by using smartphone’s camera and display all information about the item although the smartphone is not connected to the internet. The QR code was used for laboratory management inventory, in this term, displaying the instruments’ information.

The Refraction Laboratory in the Optometry Study Program plays an important role in assisting activities related to refractive examination. Based on the standard of room facilities (Menteri Kesehatan RI, 2015), the Refraction Laboratory at Optometry Department, Bakti Tunas Husada University meet the eligibility criteria in laboratory learning. In addition, the instruments in Refraction Laboratory is sufficient to support the teaching and learning process. Large instruments used for refraction purposes are available in the laboratory room, while some small instruments are in the storage room. Based on the identification results, there are nine large tools in this room, namely Trial lens Set, Phoropter,

Auto-Refracto-Keratometer, Manual Lensometer, Eye Anatomy Poster, Projector, ETDRS LogMAR Chart, LCD Chart, and Snellen Chart.

### Analysis Design

Needs analysis was done by observing and interviewing the academic community in the Department. After analysis, it turns out that the problems: For students, in learning, especially to recognize instruments' images, names, functions, and how to use the instruments were not so effective and efficient, because they still had to look for sources from the internet manually. Some students were found to do some errors while using and maintaining the instruments. For the academic community and the public, it was found difficult to obtain complete information about the instruments in the Refraction Laboratory. And even if you do an internet search, it doesn't really answer the question because the source is random.

Based on the results of this analysis, the media in the form of a QR code was chosen. The criteria set out in making this QR code are: 1) QR code is made for large instruments found in the Laboratory; 2) QR code will be made in a small enough size and pasted on the device; 3) The QR code will be linked to the website.

### Design Stage

After identified the problems faced, the QR Code is used as a media to connect the instruments information. The first step is to find a list of instrument that contains the instruments name and image in the Refraction Laboratory along with their functions and how to use them. Next step was determine how the QR code will be created and which website will be linked. The QR code is planned to be generated via the link at <https://www.qrcode-monkey.com/id/#>. The QR code that is created will not only display the QR code, but also will be accompanied by the identity and production year. The website that will be linked is the website of the Optometry Department at the link <https://optometri.universitas-bth.ac.id/laboratorium-refraction-klinik/>.

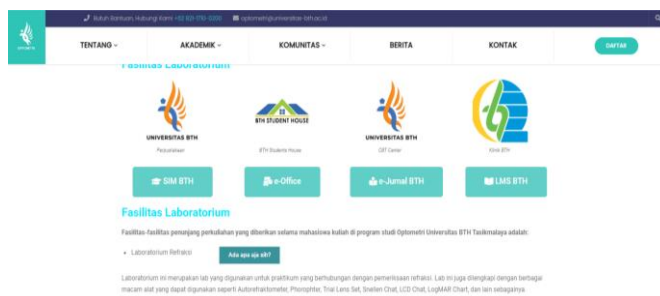


Figure 2. The appearance of the website to be integrated

### Development Stage

At the development stage, the plans from stage before were begin to carry out. At this stage, the inventory of instruments, function, and steps for use in the Refraction Laboratory were recorded. There are nine tools that have been identified and ready to be integrated in the website, namely Trial Lens Set, Phoropter, Auto-Refracto-Keratometer, Manual Lensometer, Eye Anatomy Poster, Projector, ETDRS LogMAR Chart, LCD Chart, and Snellen Chart.

The data of instruments were inputted into the website. Each tool has a specific page. For example, content of the Phoropter were input and publish thorough address <https://optometri.universitas-bth.ac.id/phoropter/>. Likewise for other instruments. Overall, the instruments that are integrated into the QR code can be seen at the link <https://optometri.universitas-bth.ac.id/laboratorium-refraction-klinik/>. Programming code for creating QR codes is freely available, and there are numerous QR code generation package (Diazgranados & Funk, 2013). Programs for making QR codes are called QR code generators, many are available for free and can be accessed online.

The link for each instrument is entered into the QR code generator, QR code image was made, and ready to be downloaded. The downloaded-image of the QR code was edited and equipped with the identity of the instruments name, the name of the maker and the year of production.



Figure 3. Phoropter and QR code

After going through the development process, the QR code-based website was validated by three validators. The three validators assess the readability of the QR code, as well as the accuracy of the content. Validation was carried out to ensure the content validity and appearance in order to proceed to the implementation phase (Nazar et al., 2022). The validation is a very important part of development stage that determined the quality and feasibility of the website and the QR-Code (Martins et al., 2015). Based on the validation that has been done, the result is that the readability of the QR code is 100, which means it can be

accessed without problems. For validity of the content of each instrument range from 98, which means that improvements are still needed regarding the information content. Both of the readability and content can categorized as valid. Content information is revised based on input from the validator.

### Implementation Stage

At this stage, the implementation of the created QR code was carried out. After the QR code is appropriate and can be used, then the QR code was printed on sticker paper and pasted on each instrument (Figure 4). The goal is to make it easier for users to scan the QR code on the instrument. The position of the QR code sticker for each instruments is in accordance with the laboratory's directions. In addition, instruments images and QR codes are made in the form of a catalog (Figure 5).

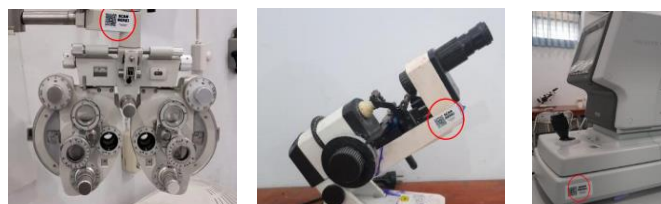


Figure 4. The QR code was stuck to the instruments



Figure 5. Catalog of the QR code and the instruments

The implementation process was carried out in 45 academic communities consisting of lecturers, assistants, and students. The respondents were asked to scan the QR code on each instrument. Before scanning, the researchers asked respondents to install a QR code scanner in their phone for those who don't have one. After installed, the respondents are asked to scan the QR code using the application. On the phone screen will appear a pop-up website that is connected. Respondents could click the website link and wait a while until the destination website open.

User response is an important thing that must be assessed in the application of technology. To find out the user's response regarding to application of the QR Code-based laboratory inventory instruments, a response test was carried out using a questionnaire. The questionnaire was given in the form of a google form that displays a sample QR code and five questions regarding opinions, interests, and the use of QR codes in the laboratory.

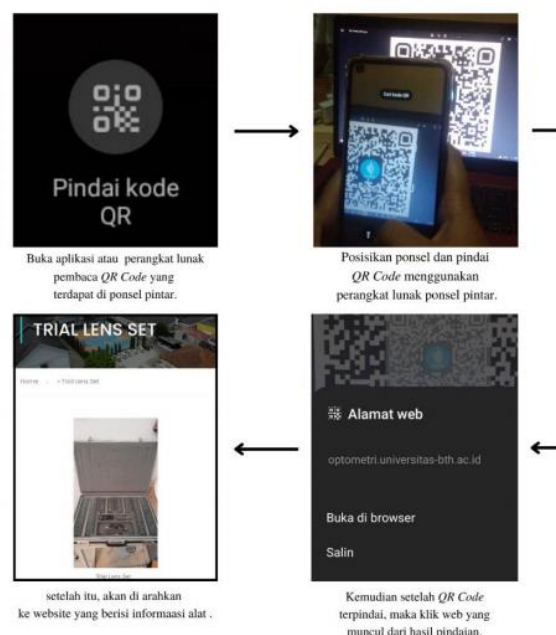


Figure 6. Scanning process on the QR code

The first question section asks about "do you know what a QR code is". From the total respondents, 93.33% answered "yes" and 6.67% answered "no". From this response, it can be seen that almost all respondents already know about the QR code.

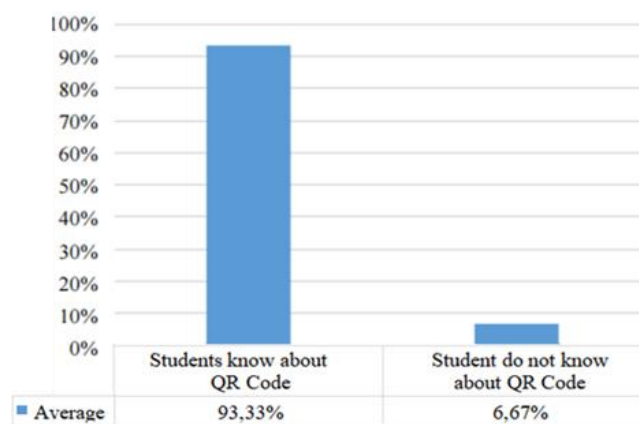


Figure 7. Diagram students' knowledge about QR code

The use of QR codes is quite a new thing in Indonesia. QR codes are usually used as payment and entrance codes to specific venues. All respondents must have seen the form of a QR code but maybe only a few respondents did not know the name.

The next question, respondents were assessed for their interest in the QR code with the question: "When you see the QR code symbol, have you tried to scan the QR code symbol with a smart phone or other device?". Of all respondents 91.11% or 41 people answered "yes", and 8.89% or 4 people answered "no".

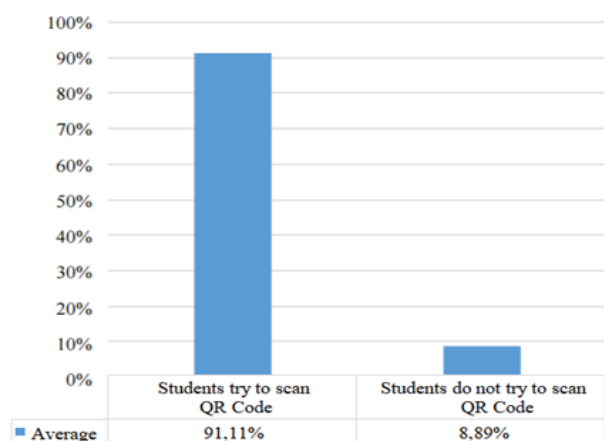


Figure 8. Interest in scanning QR code

The use of QR codes has been quite popular since the pandemic. Respondents will be familiar with the shape of the QR code. So when presented with a QR code, they will try to scan the code. However, one of the complaints raised by respondents against the use of this QR code is the need for a QR code scanner application. This application is usually default on their respective smartphones through Google Lens but there are also those that must be installed independently by the user. Of all respondents it was found that 84% had a QR code scanner application, and the rest did not. Some respondents stated that their smartphones have limited storage, and installing new applications is quite burdensome.

The last question relates to the sustainability of using QR codes. The question asked is "Would you like to see the QR Code displayed on the refraction laboratory instrument?" From this question, it was found that 95.56% of the total student respondents answered "yes". Thus, respondents believe that the existence of a QR Code can make it easier for users to obtain information on the inventory of Refraction Laboratory instruments.

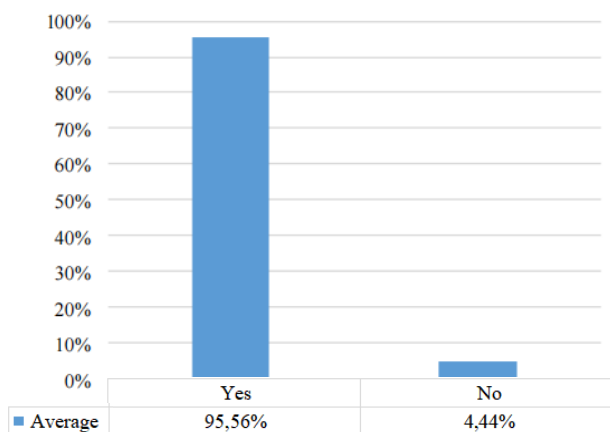


Figure 9. QR code for optical instruments' information

Regarding use the QR code for Refraction Laboratory instruments inventory, some respondents gave a positive response, because most of the respondents believed that the QR Code could make it easier for users to get information on the use of Refraction Laboratory instruments inventory.

The objective of present work was to tag QR code to each of the optical instruments in Refraction laboratory, so that students can scan and learn the materials instantly via smartphone. The use of QR codes in educational and clinical settings is increasing owing to its low cost and adaptability in any learning environment (Law & So, 2010). Furthermore, Jamu et al. (2016) reported that QR codes can be used as Just in Time Learning (JiTT) for multi-professionals in clinical settings, for policy makers, and those constructing clinical guidelines.

The use of QR codes in the laboratory context is currently very limited. Some people have used QR codes as a medium for laboratory management, namely Laboratory Clearance (Rochmawati et al., 2018) and for inventorying science laboratory equipment (Mamin et al., 2017). Apart from laboratory management, QR codes can be used for learning about laboratory inventory and safety.

Nelson in Yang et al. (2022) recommend establishing laboratory safety management systems in university laboratories, including laboratory inspections, emergency plans, student training, and safety regulations and policies. Safety in the laboratory has become the key aspect which emphasizes the importance of following rules that could help to prevent unwanted events (Staehle et al., 2016). Even though the documents of safety in laboratory are complete, if training is not carried out then the implementation of a policy will not become an awareness. Therefore, students training is very important.

To promote the improvement of people's security consciousness, fundamentally it is also necessary to achieve through technological development and institutional improvement (Yang et al., 2022). The application of technology in the lab discussed in this study is the QR code. Starting with placing a QR code on each instrument as a medium to introduce instruments. Optical instruments in the laboratory are one of the resources in studying the scientific concepts of optical physics and refraction examination. QR code can be used as a medium to access information about optical instruments in the Refraction Laboratory. This maximizes access by students and minimizes damage prior to actual use of the tool.

Based on students' responses to the application of QR codes as learning aids, three groups of responses were obtained: self-explorations, suitability for learning,

and enhancements (Mogali et al., 2019). On self-exploration, students were able to access the main exploration about the instruments, explore the key feature, and able to try the instruments step-by-step. On suitability for learning, student will felt the experience that QR code were convenient to use, paperless, and easy to access (Rikala & Kankaanranta, 2012). On enhancements, students can think critically about the use of technology in learning and can suggested some evaluations and improvements. Therefore, well-designed QR core system can increase learning experience (Meenakshi, 2013; Traser et al., 2015). Quick response codes do not offer users the virtual reality experience ("wow effect"), but the present report affirms that it is both a cost effective and effective learning tool (Mogali et al., 2019).

Further use of QR codes can be integrated with various media. Shin (2012) found that the key impetus for QR code use is user interactivity and perceptions. QR code-tagged- instruments could be hyperlinked to other digital resources such as voice over presentations, video demonstrations, imaging platforms, and these can also be linked to questionnaires for formative or summative preparations and dissection schedules (Chen et al., 2013; Traser et al., 2015). The use of multimedia content could complement the teaching of complex concepts, foster engagement, and extend self-learning (Chen et al., 2013; Drake et al., 2009).

Application of QR codes in more advanced can be applied to facilitate safety training. Gummesson (2016) integrated the QR code with Picture Mix Exposure (PIMEX) videos by analyzing attitudes to this safety training method and safety in student responses. The researcher placed a QR code on each instrument. The attached QR code contains information regarding safety measures. Student behavior and environmental conditions were then recorded and analyzed before and after treatment.

The use of QR code is still very limited and still raises the pros and cons of various parties. Therefore its use still requires continuous evaluation and development. QR code indeed makes the presentation of information simpler and more concise. However, the acceptance of the academic community towards the use of QR codes in instrument inventory is still not complete. It is necessary to disseminate information to the academic community regarding the use of QR codes and their use in the laboratory.

## Conclusion

Based on the results of research and development of a website-based QR code, it can be concluded that this website-based QR code is valid and can be used to

provide information on optical instruments to users. Users show a positive response towards the used of QR codes in the laboratory. However, socialization about its use is needed.

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## Conflicts of Interest

The authors declare no conflict of interest.

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