Al-Ishlah: Jurnal Pendidikan
Vol.15, 4 (December, 2023), pp. 5243-5252
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v15i4.3658

Development of Quick Response Code-Based Teaching Material for Educational Statistics Courses

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ARTICLE INFO

Keywords:

Educational statistics;
QR Code;
teaching material

Article history:

Received 2023-02-28
Revised 2023-04-05
Accepted 2023-12-07

ABSTRACT

This study aimed to develop interactive teaching materials based on Quick Response (QR) codes for the Education Statistics Course at a State Islamic Institute in Sinjai. The ADDIE model (Analysis, Design, Development, Implementation, Evaluation) was used to ensure the teaching materials' validity, practicality, and effectiveness. The teaching materials and learning videos underwent a validity test, which found that all aspects were valid, scoring 3.58. The media validation was very valid, with an average validator score of 3.68. The developed teaching materials were practical, with an average respondent rating of 92.07%. Respondents also found the teaching materials effective, with a proportion of 89.63%. These teaching materials will provide students with the knowledge and skills required for their final projects, including proposal preparation, research, data analysis, and thesis compilation. The hope is that these materials will improve the quality of education statistics learning and research, making students more competitive. In conclusion, this research successfully developed interactive teaching materials based on QR codes for the Education Statistics Course, which were found to be valid, practical, and effective.

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1. INTRODUCTION

The COVID-19 pandemic caused enormous changes to the learning system not only in Indonesia but also in the world (Onyema, Sen, & Alsayed, 2020). This change requires that the education system be implemented using an online system to prevent the spread of the virus (Anshori & Illiyyin, 2020). However, many students complain about the online learning system because it requires a lot of internet quota because it is always connected to the internet (Ningsih, 2020). In addition, students find it difficult to understand the material (Cahyawati, 2020), and there is a lack of interaction between lecturers and students (Ningsih, 2020). Another difficulty that students complain about is the large number of assignments given by the lecturer, so students find it difficult to know which answer is correct from the practice questions given by the lecturer (Maulana, 2021). Therefore, online learning is still perceived as

less effective by some people due to issues such as excessive internet usage, difficulty in understanding the material, and lack of interaction with lecturers.

Additionally, the difficulty of online learning is not only felt by students. Many lecturers also find it difficult to teach online. This is because it is difficult to explain the material to students because it is constrained by space and time. In addition, the number of assignments given to students makes it difficult for lecturers to check these assignments (Barrot, Llenares, & del Rosario, 2021; Heng & Sol, 2021; Nambiar, 2020). It takes a relatively long time to check the questions manually. In tertiary institutions, almost all lecturers in all subjects experience this difficulty (Napitupulu, Sidebang, Napitupulu, & Simaremare, 2021).

One of the courses that are difficult to teach online is the Education Statistics course because the material in it discusses the statistical theory and small things related to analysis that will be carried out when researching to complete a thesis (Sa'idah, 2016). Therefore, interactive teaching material that can be used as a source for online learning but makes it easy for students to understand the material is needed (Zedadra et al., 2019).

Educational statistics is a field of study that examines the collection, analysis, and interpretation of educational data. It includes statistical methods used in educational research to understand phenomena such as teaching effectiveness, student performance, and factors that influence educational success (Hair Jr, J. F., Black, W. C., Babin, B. J., & Anderson, 2018; Johnson, R. B., & Christensen, 2017). The role of educational statistics is crucial in generating good decisions in the field of education. Educational statistics are used to analyze educational data, identify educational problems, and make evidence-based decisions. Statistical analysis also aids in curriculum development, improving teaching quality, program evaluation, and educational planning (Popham, 2014; Suherman, E., & Mardapi, 2018)

These three learning styles exist in everyone, but some are more prominent than others (Wahab & Nuraeni, 2020). These three learning styles can be accommodated in interactive teaching materials based on the proposed QR Code. The teaching materials referred to here are expected to help students learn more independently without being limited by space or time. In addition, the teaching materials are equipped with questions whose answers can be accessed immediately when you finish answering the questions. This interactive teaching material can be developed using the QR code (Ataji & Kaunang, 2019). QR Code is a two-dimensional matrix that can store various types of data and easily access online information (Nurhidayah, Firdaus, Amaliah, & Atirah, 2021; Wasito & Novian, 2020).

There are several studies on QR Codes, including (Ataji & Kaunang, 2019; Nurhidayah et al., 2021; Salma, 2020). All three studies examine the development of learning resources using QR Codes, with only the terminology of the learning resources differing. In terms of the use of QR Codes themselves, (Nurhidayah et al., 2021) only use them to display images, which seems to be only useful for visual learners. Meanwhile, the study conducted by (Salma, 2020) integrates QR Codes with alternative information such as legislation, articles or current news relevant to the learning material, as well as official websites from government agencies. The study conducted by (Ataji & Kaunang, 2019) only uses QR Codes to access materials available on the internet.

Until now, if there are studies discussing the development of teaching materials using QR Codes, most researchers only include image-based materials, use hyperlinks or pathways to internet-based materials, or open news from government sites. It is believed that the function of QR Codes can still be developed in such a way to obtain interesting teaching materials, develop student motivation in learning, and improve student understanding, even though teachers/professors cannot conduct face-to-face learning.

In this study, QR Codes are used to integrate pre-made learning material videos so that students can feel as if the instructor is present anytime and anywhere, they need assistance (such as when they do not understand the reading material or when they need oral explanations) simply by scanning the QR Code. When students scan the QR Code in the teaching material, a video of the lecturer will appear explaining the material contained in the teaching material. Thus, the lecturer is in the middle of the students. After paying attention to the lecturer's explanation, another QR Code in the exercise section

allows students to find out the answers to the questions they have just worked on. Thus, this interactive teaching material can become an effective and efficient learning resource for online learning, especially in all Educational Statistics courses, and can even be used in tertiary institutions. Therefore, researchers are interested in conducting research entitled "Development of QR Code-Based Interactive Teaching Materials in Educational Statistics Courses."

The research problem formulation in this study consists of three questions, namely: How to develop a valid interactive teaching material based on QR Code for Educational Statistics course? How to develop a practical interactive teaching material based on QR Code for Educational Statistics course? and how to develop an effective interactive teaching material based on QR Code for Educational Statistics course?

2. METHODS

This study employs Research and Development (R&D) in accordance with the ADDIE methodology (Analysis, Design, Development, Implementation, Evaluation) (Sugiyono, 2017; Suwiwa, Astra, & Pasaribu, 2022). During the analysis phase, the researcher identifies problems (needs) using interviews, surveys/observations, and a review of the literature (relevant research results) (Arnidah, D, Sinaga, & Aswan, 2022). In the design phase, the researcher creates a product design (blueprint) for the QR Code-based interactive educational material to be manufactured. At this stage, researchers generate an initial concept that will subsequently be used to develop interactive instructional materials. During the development phase, researchers perform numerous measures. These are the measures: validity test, Product/Model Revision Phase and Phase of socialization (simulation). In the implementation stage, the teaching materials that have been created are taught to the students according to the existing subject matter. At the evaluation phase, an application is tested to determine its practicability and efficacy.

Totaling 86 individuals, the subjects of this study were 4 lecturers who taught the education statistics course and 82 students who programmed the education statistics course in the odd semester of the 2022/2023 academic year. The data collection techniques used in this research are observation and the use of questionnaires. The instruments used in this research are a needs analysis questionnaire, a student evaluation questionnaire for interactive teaching materials, as well as validation sheets for each questionnaire. To answer the research questions, some of the data analysis techniques employed are:

2.1 Validity Test

The application holding the initial product design (prototype product) is next evaluated or content validated by an expert (validator). The goal of validator evaluation is to validate the previously developed product. The validator conducts a review and suggests improvements to the product. The validator's inputs and suggestions are then incorporated into the product's revision. The formula for calculating the average validation results is as follows: The subjects in this study were lecturers who taught the education statistics course and students who were programming the education statistics course, a total of 126 people (Syaharuddin & Mandailina, 2017).

$$\bar{X} = \frac{\sum_{i=1}^{n} \bar{V}_i}{n}$$

Where $\bar{X}$ denotes the total average, (V) the average of each validator, and n the number of validators. For the expert validation exam, Table 1 employs the following categories.

Table 1. Validation Test Criteria

The Average	Criteria
$3{,}5 \leq \bar{X} \leq 4$	Very valid
$2{,}5 \leq \bar{X} < 3{,}5$	Valid
$1{,}5 \leq \bar{X} < 2{,}5$	Quite Valid
$\bar{X} < 1{,}5$	Not Valid

2.2 Practicability analysis

At this step, an application is tested to determine its practicability and efficacy. Students' data analysis strategies for evaluating the applicability of this study were determined using quantitative and descriptive analysis. To analyses the practicality of teaching materials, the following steps are taken:

1. Assign a value to each answer consisting of strongly agreeing (5) or agreeing (4). average (3), disagree (2), and strongly disagree (1).
2. Next, look for the total number of indicators.
3. Calculate the practicality value with the following formula:

$$P = \frac{f}{N} \times 100\%$$

Where:
Q : Practical value
F : Score Acquisition
N : Maximum Score

The practical criteria for interactive teaching materials can be seen in Table 2 below:

Table 2. Table of Practicality Criteria for Teaching Materials

Percentage Intervals	Criteria
$80 < P \leq 100$	Excellent
$60 < P \leq 80$	Very Good
$40 < P \leq 60$	Good
$20 < P \leq 40$	Fair
$0 < P \leq 20$	Poor

(Akbar, 2016)

2.3 Test of effectiveness

After conducting practicality tests, the next step is to test the effectiveness of teaching materials. The following actions were done to examine student response data:

1. Counting the number of students who provided correct responses based on question components.
2. Determine the proportion of the initial step
3. The categories in which students respond actively are determined by comparing the percentage results to the established standards.

In addition, the data were examined using the following modified percentage formula (Hobri, 2010).

$$\%Students\ Perception = \frac{Total\ score\ of\ data\ collection\ results}{Total\ Criteria\ Score} \times 100\%$$

A conversion is conducted before determining the effectiveness of this application. The overall score of the percentage outcomes is converted into the effectiveness criterion table using this way. (Hobri, 2010). The criteria for the effectiveness of instructional materials are detailed in Table 3.

Table 3. Table of Application Effectiveness Criteria

Percentage Interval	Criteria
85% - 100%	Very effective
70% - 84%	Effective
50% - 69%	Quite effective
0% - 49%	Not effective

3. FINDINGS AND DISCUSSION

The outcomes of each research and development phase can be stated as follows:

3.1 Need Analysis

Observing and giving the necessary resources to undertake a need assessment for students majoring in educational statistics at the Tarbiyah Faculty and the Teaching Science Faculty were the initial steps in the analysis phase. This pilot investigation includes classroom observations and student responses. The objective of doing a needs analysis is to collect information regarding student needs analysis. The following is the data result of the needs analysis.

Table 4. The Data Result of the Needs Analysis

No	Survey Results on Student Needs for Educational Resources	Percentage
1	Students who still need patent-protected educational resources for statistics courses	93.6%
2	Students who have training resources but need optimization	6.4%

After reviewing the student needs survey, it was determined that 93.6% of students still need patent-protected educational resources for statistics courses. The remainder, 6.4%, already have training resources, but their utilization must be optimized, rendering them ineffective. In the need's questionnaire, there is also a question about whether they require this instructional material.

A second measure assesses student interest in integrated learning materials and videos. In this question, 95.7% of students indicated that they would be satisfied if the content included learning videos. Based on the questionnaire, it was also determined that around 97.9% of students believed that conventional teaching materials should be utilized in educational statistics. In addition, the results demonstrate a dire need for instructional resources to support the understanding of educational statistics, so that students can investigate information that will be relevant while completing their final project.

3.2 Design

The researcher developed a design (blueprint) of QR Code-based interactive teaching materials Education statistics course during the design phase. During this phase, the researcher develops a plan that will subsequently be used to create instructional materials. However, before creating the teaching materials, the researcher created indicators about the materials taught in educational statistics courses, which were subsequently incorporated into the QR Code-based interactive teaching tools. This content is derived from the semester learning plan created by the course coordinator and lecturer. Thus, researchers may rapidly create instructional materials.

After creating a design strategy, instructional materials with educational statistics are created. The design is still in its infancy, still in the form of a cover and a raw table of contents that need to be supplemented with information on the rules of educational statistics.

Figure 1 depicts the design of the initial appearance of teaching materials and the quick response code for first material.

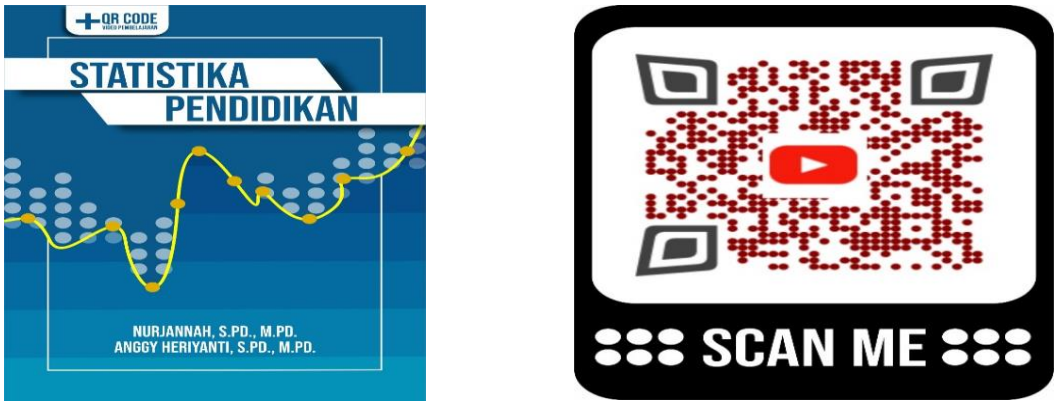

Figure 1 Initial Appearance of QR Code-based teaching materials in the Education Statistics course

3.3 Development

The development stage follows the analytic and design stages, and comprises numerous activities such as expert validity testing, model revision, socialization (model simulation), and empirical testing (limited trials) of the instrument.

3.3.1 Educational Statistics Material Validation Test Results

The material validation procedure begins with sending a validation sheet, including material and questions linked to Educational Statistics material, to validators for evaluation based on predetermined criteria. The material validation test findings are reported in Table 4 below.

Table 5. Summary of Material Validation Results

No	Rated Aspect	Average value ($\overline{X}$)	Description
1	Material	3,50	Valid
2	Tutorial Video	3,67	Very Valid
	Average	**3,58**	Very Valid

The results of the analysis from Table 5 can be clearly shown as follows that the total validity of the indicators for material aspects has an average value of $\bar{x}$= 3.50. When the average value is translated to the instrument validity criterion, it is classified as valid (2.5 - 3.5). Thus, the existing materials are declared valid. The total average value of indicator validity for the Learning Video aspect is $\bar{x}$ = 3.67. If the average value is converted to the instrument validity criteria, it is included in the very valid category (3.5 – 4.0). Thus, the learning videos contained in teaching materials are stated to be very valid. Overall, based on the results of the material expert validation, the average of the two experts was 3.58. If this average value is converted to the instrument validity criteria, this value is included in the very valid category (3.5 - 4.0). Therefore, the learning materials and videos contained in the teaching materials are very valid.

3.3.2. Media Validation Test Results

The media validation process begins with submitting a statement validation sheet about the media to the validators, who will evaluate the validity based on established criteria. Table 5 summarizes the findings of the media validation test.

Table 6. Summary of Media Validation Results

No.	Rated aspect	Average value ($\overline{X}$)	Description
1	Size	3,75	Very Valid
2	Design Quality	3,65	Very Valid
3	QR Code Efficiency	3,67	Very Valid
	Average	3,68	Very Valid

The following are the clear results of the analysis from Table 6 are the average total media validity value for the size aspect is $\bar{x}$ = 3.75. When the average value is converted to the instrument validity criterion, it falls into the category of very valid (3.5 – 4.0). As a result, the media size chosen is considered legitimate. The average overall validity of instructional materials for design quality characteristics is $\bar{x}$ = 3.65. When the average value is converted to instrument validity criteria, it falls into the very valid group (3.51 – 4). As a result, the validity of the media design is reported to be very high. For the QR Code efficiency aspect, the average value of overall validity of teaching materials is $\bar{x}$ = 3.67. When the average value is converted to instrument validity criteria, it falls into the very valid group (3.51 – 4). As a result, the efficiency of the QR Code created is reported to be extremely valid.

3.3.3 Revision Stage of Teaching Materials

The instruments in the form of materials and questions connected to educational statistics in this study were judged legitimate based on the results of the validator's review of the prepared educational statistics materials. However, several things, according to experts, still needed to be improved.

3.3.3.1 Media Revision Stage

Based on the results of the validator's evaluation of the media that has been generated in this study, it has been determined that the media is valid; nonetheless, there are specific parts that, according to experts, still require improvement.

3.3.3.2 Socialization Stage (simulation)

Prior to deployment, many members of the Faculty of Tarbiyah and Teaching Science were familiarised with the results of the previous phase's model validation and revision through socialisation or simulation (IAI). This technique aims to fairly and accurately portray the intended instructional content. During this occasion, socialisation and simulation activities will be carried out with students from the Islamic Religious Education Study Programme class C, as well as students from the Mathematics Education programme, Faculty of Tarbiyah and Teaching Science. During the initial phase of socialisation, students provide feedback and contribute to teaching materials by eliminating elements from them. The recommendations and opinions from this stage are subsequently employed to enhance subsequent models. The current phase is characterised by the implementation of a revision model, commonly known as the 3 (three) revision model.

3.4 Implementation

Currently, the teaching materials include input materials and a QR Code that links the reader to instructional films on YouTube, providing further explanation of the content. Currently, the instructor utilises pre-made interactive teaching material based on QR Codes to teach the Education Statistics course.

3.5 Evaluation

The evaluation stage describes the success of QR Code-based teaching materials in Educational Statistics course. The adoption of teaching materials at the previous stage has a great impact on the efficacy of teaching materials. Thus, the evaluation stage is the final stage that determines whether or not the QR Code-based teaching material is effective. Data collection instruments in the form of questionnaires were employed to analyze the effectiveness of educational materials, namely:

3.5.1 Analysis of Teaching Material Practicality Assessment

Analysis of the practicality assessment of teaching materials was carried out by distributing questionnaires to respondents which contained 4 aspects, namely attractiveness, interest/motivation, ease of use, and functionality. The results of the practicality analysis can be summarized in Table 7 below:

Table 7. Analysis of Teaching Material Practicality Assessment

No.	Rated aspect	Average value ($\overline{X}$)	Percentage	Description
1	Attractiveness	3,63	90,86%	Very Practical
2	Interest/Motivation	3,58	89,40%	Very Practical
3	Ease of Use	3,69	92,18%	Very Practical
4	Functionality	3,83	95,83%	Very Practical
	Average	**3,68**	**92,07%**	Very Practical

The aim of this study was to develop interactive teaching materials for the Education Statistics Course in the form of Quick Response (QR) codes. The ADDIE model was used to design and develop these materials through the stages of Analysis, Design, Development, Implementation, and Evaluation. The study ensured that the teaching materials and learning videos were valid, practical, and effective, with the generated media also validated for its effectiveness. The respondents then evaluated the training materials to measure their practicability and efficiency.

The study findings indicate that the generated teaching materials meet the criteria of validity, practicability, and effectiveness. The validity test verified that all features of the teaching materials fell into the valid category, with an overall score of 3.58. The media validation received an average validator rating of 3.68, placing it in the very valid category. The average respondent rating for this educational

material was 92.07%, indicating its high quality. The respondent assessment also showed that the instructional material was effectively used, with a proportion of 89.63%, making it suitable for use in educational statistics courses.

Developing this teaching material is expected to enhance students' understanding of educational statistics and serve as a foundation for their final project, from proposal preparation to research and data analysis to thesis compilation. This will not only improve the quality of educational statistics learning but also enhance research quality and competitiveness among students. This practicality indicator is crucial in the development of teaching materials. This is following research conducted by (Vidiasti, 2019) that when assessing the practicality of media or teaching materials, the thing that must be considered is the attractiveness that exists in the media/teaching materials in order to be able to increase student motivation to learn.

3.5.2 Analysis of the Effectiveness of Teaching Materials

The effectiveness of teaching materials was analysed by distributing questionnaires to respondents, which contained three aspects: material, practice questions, and learning videos. The practicality analysis results can be summarized in Table 8 below:

Table 8. Analysis of the Effectiveness of Teaching Materials

No.	Rated aspect	Average value ($\overline{X}$)	Percentage	Description
1	Material	3,57	89,15%	Very effective
2	Exercise	3,55	88,87%	Very effective
3	Tutorial Video	3,64	90,88%	Very effective
	Average	3,67	89,63%	Very effective

In this Educational Statistics course, students examine three factors of instructional materials using QR codes. The assessment results were based on data from 86 respondents. The material aspect received an average rating of 3.57 from student assessments, which translates to 89.15% and falls into the category of "Very Effective." In terms of practice questions, the typical student scored 3.55, equivalent to 88.87%, and falls into the "Very Effective" category. Lastly, the average student rating for the learning videos was 3.67, with a percentage of 90.88%, also placing it in the "Very Effective" category.

Therefore, the overall average score for the effectiveness analysis of instructional materials is 3.67, with a corresponding percentage of 89.63%. Based on classification, the student assessment falls into the "Very Effective" category. These results demonstrate that the QR Code-based teaching materials used in the Education Statistics course are highly effective in terms of student assessment, meeting the criteria for effectiveness.

Based on the results of the three indicators of effectiveness above, it can be concluded that teaching materials based on QR Code in Educational Statistics courses are effective. This conclusion is in line with the theory put forward by Akker that: (1) experts and practitioners, based on their experience, state that the product is effective; (2) operationally, the product gives the expected results (Nurjannah, Heriyanti, & Kaswar, 2022).

4. CONCLUSION

Based on the study findings, the teaching materials produced have met the criteria for validity, practicality, and effectiveness. The validity test conducted on the materials confirmed that all features scored 3.58, falling under the valid category. The media validation was also very valid, with an average validator score of 3.68. The respondent rating for the educational material was 92.07%, indicating that it was effective based on their assessment, with a proportion of 89.63%. These results suggest that the teaching material is suitable for use in educational statistics courses, and can help students in preparing their final project, from proposal preparation to data analysis and thesis compilation. The development of this teaching material is expected to not only improve the quality of educational statistics learning, but also improve the quality of research, enabling it to compete with other students. However, the

study's weakness is the limited coverage of materials, which only includes ANOVA. Therefore, future researchers may add more comprehensive materials to the teaching materials.

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