Exion Math: An Interactive Digital Question Bank Design for Middle School Mathematics

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Abstrak

Penelitian ini dilatarbelakangi oleh kurangnya kumpulan soal terpadu yang dapat diakses siswa dengan mudah. Bahan ajar yang dimiliki siswa di sekolah tidak dapat memberikan umpan balik berupa skor akhir dan pembahasan dari setiap soal. Terlebih lagi lembar soal yang sering dimiliki siswa memiliki tampilan kurang menarik. Penelitian ini bertujuan untuk menghasilkan bank soal matematika SMP berbasis digital dan interaktif yang valid dan layak digunakan siswa. Bank soal tersebut berupa website yang dapat diakses oleh seluruh siswa tanpa berbayar. Penelitian ini merupakan penelitian design research tipe development study yang terdiri dari preliminary design dan formative evaluation. Data diperoleh melalui angket dan dianalisis menggunakan kategorisasi penilaian. Subjek penelitian terdiri dari dosen, guru, dan siswa sesuai tahap penelitian. Hasil penelitian menunjukkan web bank soal bernilai valid berdasarkan penilaian validator dan dapat digunakan oleh semua kalangan secara terbuka.
Kata Kunci: Evaluasi Pembelajaran; Website; Bank Soal Digital.

Abstract

A question bank is an accessible website provided for all students free of charge. This study was initiated due to the lack of a accessible collection of integrated questions banks. Teaching materials at school did not provide feedback such as a final score and explanation of each question. Furthermore, the question sheets showed an unattractive interface. This study aimed to produce interactive and digital-based math question banks for junior high school that met the validity and appropriateness for students to use. This design study was a development study encompassing preliminary design and formative evaluation. The data were obtained through questionnaires and analysis using assessment categorization. According to the research stages, the participants were lecturers, teachers, and students. The study results showed that the question bank web was valid based on the validator's assessment and able to be used by all groups openly.
Keywords: learning evaluation; question bank; website.

I.   INTRODUCTION

The rapid development of technology began with the introduction of the internet. The development of internet has made all lines of progress. The term digitalization is also increasingly being used and affects changes in individual activities, transforming the traditional forms to electronically connected ones (Danuri, 2019; Jamil, Sa'dijah, & Susanto, 2022). Due to the high demand of technology, education, with no execption, is also affected by digitalization. Today's digitalization is required to be accepted and exposed to all parties (Cristiana, 2021; Syaputra, Hidayati, & Hasanah, 2023).

Preparing an outstanding and technology-based education is a challenge for teachers (Munawaroh & Nurpala, 2020; Permatasari & Afriansyah, 2022). This issue was gaining abundant attention during the post-pandemic recovery period. Teachers who are now getting used to technology must develop their skills in teaching and evaluating to move away from the conventional learning. Studies stated that transitional learning that involves technology increases students' interest in learning (Arifin et al., 2022; Firmadani, 2020; Rahim et al., 2019; Widianto, Edi., Husna, Alfina Anisnai'l., Sasami, Annisa Nur., Rizkia, Ezra Fitri., Dewi, Fitriana Kusuma., and Cahyani, 2021; Mahardika, Gumilar, & Retnaningrum, 2022; Aprilia & Diana, 2023). As the result, students who have been exposed to technology in the learning process, in suburban or urban areas, become dependent on the technology for their independent learning and concept understanding. This phenomenon also shows that the role of technology in the learning evaluation process needs to be explored (Purnasari & Sadewo, 2021; Silalahi, 2022).

The role of teachers in evaluating learning includes developing effective and appropriate instruments that describe the learning achievements of each student (Suyata et al., 2011; Nanang & Sukandar, 2020; Toheri, Kismeina, & Persada; 2022). The assessment instrument prepared by the teacher should form practice questions that allow students to do the activities independently either individually or in group (Jiwandono et al., 2020; Effendi, Ummah, & Cahyono, 2023). The practice questions also need to utilize current technology so that students are able to easily access the set questions independently anytime and anywhere (Habibah et al., 2020; Firdausi & Suparni, 2022).

Based on the findings of the need analysis given to the mathematics teachers in Lampung province, it was found that more than 90% of teachers had used mobile phones and laptops to evaluate the learning process. While the rest still use blackboards and books. The platforms used also vary, ranging from e-learning, google classroom, liveworksheet, whatsapp, quizziz, and other digital-based media. The platform had not yet provided

a complete evaluation process that could be accessed for free and deliver immediate scoring along with the discussion of the item questions. However, of the respondents from 31 different schools, as many as 63% stated that the platforms took up a lot of space on the memory of their smartphones and laptops. This means that there was a demand for a platform that could be used as a tool to evaluate math learning without taking up a lot of memory space on the evaluation process.

The technology support to construct the learning exercises is possible by creating interactive digital question banks (Sembiring et al., 2018). Interactive digital question banks are an option to assist students enhance their skills and attain the results easily. The advantages of interactive question banks are that they can be accessed anytime and anywhere. (Anggraini, 2013; Faiziyah, Hanan, & Azizah, 2022). One of the platforms that can be utilized to create interactive digital question banks is an interactive website.

The question bank website contains a collection of math questions in the form of multiple choices and essays for junior high school level. This website was created to wrap practice questions as it contains a collection of all junior high school math materials from grade seven to nine. In addition, the scoring system will appear automatically once the student has finished working on the items. The discussion section appears if the student

answered incorrectly. The randomization system prevents the students from cheating on friends' answers while working.

The research and studies on question banks have been limited to designing applications and question banks on certain submaterials and the studies of mathematics subjects have not covered the entire mathematics subject matter of junior high school grades 7, 8, and 9. First, a design plan on web-based question banks (Chaniago, 2016); second, investigating the quality of the web-based question bank system in vocational schools (Triyani, 2016); Third, the design of the application system of question banks for web-based online examinations (Munawaroh & Nurpala, 2020); fourth, the implementation of linear congruent method for question randomization in website-based question bank applications (Fauseh et al., 2021). There have not been many studies that develop interactive digital-based question bank designs on websites that include all junior high school mathematics subject matter. Therefore, this study responded to the previous studies of the development of interactive question banks using development study approach, which was believed to be valid and feasible to use as a support to measure the learning achievements of each student in mathematics subjects.

Based on the above problems, the research aimed to produce a design of an interactive and digital-based question

bank website that was valid and feasible for junior high school mathematics subjects called exion math, namely explore and literation mathematics.

II. METHOD

This study is a development study. The research design adopted the Tessmer model with preliminary and formative evaluation stages (Tessemer, 1993). The formative evaluation stage included self-evaluation, prototyping (expert review, one-to-one, and small group), and field test. The participants consisted of teachers and students in Lampung Province as the users. Using purposive sampling technique, the samples used in this study were junior high school teachers and students. The final product was an interactive digital-based question bank website design covering all junior high school mathematics subject matter for grades VII, VIII, and IX.

The data analysis techniques were adjusted to the type of research instruments. In the validation and pilot questionnaire instruments, the feasibility of the products produced was analyzed. Furthermore, the data from the user responses were analyzed to determine the feasibility of the product developed. The feasibility assessment category of the developed product was categorized based on the reference in Table 1.

Table 1.
Categorization of product feasibility assessment

Interval	Description
$80\% < x \le 100\%$	Highly feasible
$60\% < x \le 80\%$	Feasible
$40\% < x \le 60\%$	Moderate
$20\% < x \le 40\%$	Less feasible
$0\% < x \le 20\%$	Not feasible

III. RESULT AND DISCUSSION

A. Preliminary Design

1) Preliminary Study

A preliminary study was conducted before designing the question bank website through an assessment process of teachers' needs for the current evaluation model involving a digital technology. A questionnaire with 11 items of open and closed questions was given to the mathematics teachers in Lampung province using google form. The questionnaire aimed to investigate teachers' opinions on the evaluation models they had previously used and their future evaluation needs. From the results of the questionnaire, it was found that teachers required an effective evaluation tool that could be easily accessed with lighter size to keep some space on their devices. The various *platforms* that teachers had used were in the number of evaluation tools, but had not been effective to measure student performance results.

2) Literature Review

After analysing the results of the questionnaire, a literature review was conducted to find out the difficulties that teachers encountered in conducting

learning evaluations, the types of question bank designs, public websites with free access, and the effectiveness of the question bank website. The results of the study revealed that some websites were available for paid users and did not provide feedbacks for the students' incorrect answers. Furthermore, from the results of interviews with teachers, it was implied that teachers required a platform to conduct the evaluation process that could be accessed by the students independently.

Furthermore, curriculum analysis was carried out to find out all junior high school mathematics materials of which evaluations would be made. The results of the analysis identified 22 mathematics materials for grades 7, 8, and 9. All of these materials contained evaluative activities of 15 multiple choice questions. The items provided all indicators on the basic competencies that would be tested on the students. In other words, all of these questions were possible to be used by any junior high school math teachers to measure student learning outcomes.
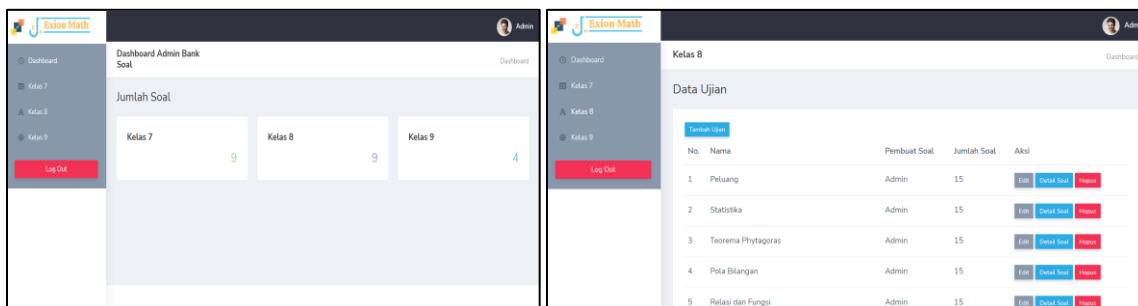
3) Question Bank Website Design

In this stage, the website design was constructed by applying interactive principles and open for everyone to access. Some of the results are presented in the following image, Figure 1, 2, and 3.
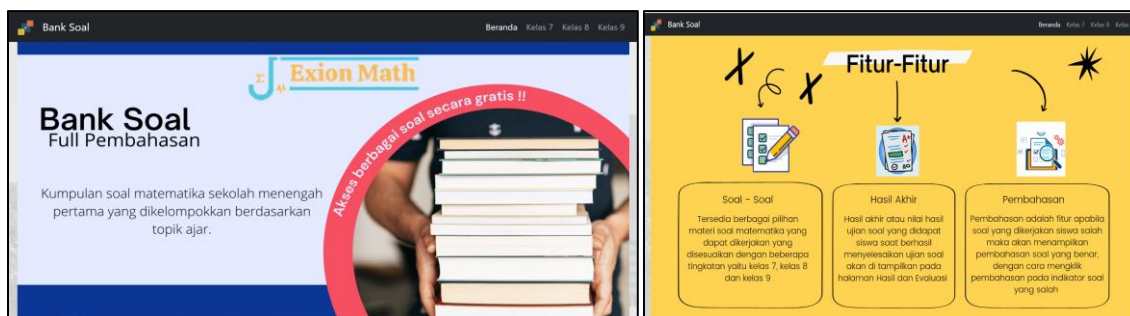
(a) Home Interface "Bank Soal"   (b) Home Interface "Fitur-Fitur"

Figure 1. Home Interface

(a) Administrators Dashboard Interface "1"   (b) Administrators Dashboard Interface "2"

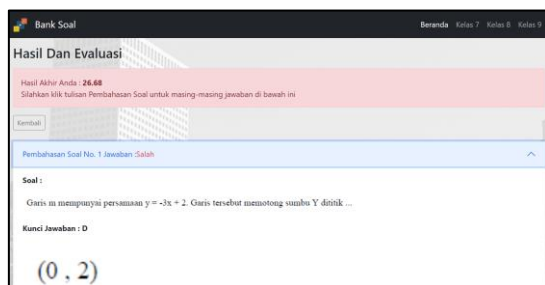Figure 2. Administrators Dashboard Interface

Figure 3. Feedback Interface

After finishing the design, the web was registered as a subscription website with the url http://exionmath.com/. All junior high school math materials for grades 7, 8, and 9 were included on the web. There were 15 multiple choice questions for each material along with the discussion that would be available when the students answered incorrectly. The students would be able to receive their final score after completing the tasks on each material.

B. Formative Evaluation

1) Self Evaluation

In the first stage of formative evaluation, the researchers assessed the question bank website that had been created. Researchers reviewed the menu and button functions as well as the questions that had been inputted. The number of questions in each material, the variety of answers in multiple choice, and the accuracy of the discussion were reviewed to ensure there were no errors when the students worked on the questions. The results obtained at the self-evaluation stage are called prototype 1.

2) Expert Review

Prototype 1 was examined by experts at the expert review stage. This stage was carried out to test and determine the feasibility of the product that had been developed and then revisions were made to improve the product quality. The validity of the developed question bank website was assessed in terms of content, construct, and language. This validation stage was carried out by four validators who were experts in their fields.

The aspects of contents examined were the appropriateness of the material with the basic competencies of junior high school mathematics, the accuracy, and the sophistication of the material. The two content validators gave an assessment by filling out an instrument through a questionnaire specially designed for content expert validators. The validators' assessment was calculated as the average score of each indicator to see its feasibility.

The results of the assessment by material experts showed that the aspect of the material appropriateness to the basic competencies generated an average score of 4 which meant feasible, the accuracy of the material was at average score of 4.2 which meant very feasible, the sophistication of the material was at an average score of 4 which meant feasible, and the aspect of encouraging student curiosity was at an average score of 3.5 which meant feasible. The overall results

considered that the contents were appropriate to use.

There were some feedbacks given by validators regarding the developed question bank, namely: (1) the questions presented were quite suitable for junior high school students, representing basic competencies and varied (2) the next development design was equipped with high school mathematics material (3) adding essay questions (4) adding cartesian coordinate material for grade 8.

The suggestion of adding essay questions was not possible as the question bank website system was not designed to include questions with a description type of answer. Meanwhile, the addition of high school material had been planned for the next website development after the development of junior high school material completed.

The aspects of construction to be examined were question presentation techniques. In addition, the validity was also examined in the design of the question bank and the functionality of the menus and buttons on the website page. The results of the assessment by the validators revealed that the feasibility of the presentation technique was at an average score of 4, meaning that both aspects of the assessment were highly feasible. The aspect of assessment on supporting presentation was 4.83 in average or highly feasible. The question bank design assessment aspect obtained an average score of 4.43or highly feasible.

The results of the overall construct assessment were highly feasible to use. However, there were some feedbacks from the validators, namely poor proportions of the question interface, especially between questions and answers. It would be better if there were more illustrations to explain the meaning of the question.

In terms of language, the aspects to be examined were the straightforwardness of the language used, sentences that were easy to understand and did not cause multiple interpretations, as well as the appropriate language to the students' development and grammar.

The language assessment contains five aspects, after being calculated, that revealed that the straightforward, communicative, and interactive dialogical aspects scored 4 in average, which meant feasible. The aspect of the appropriateness to the students' development scored 4.5 in average or highly feasible. The aspect of conformity with grammatical rules scored 3 in average or feasible. The total of the assessment aspects by linguists scored 3.9 in average, or feasible. The results of the validation of the language aspects implied that the questions presented met the good criteria so that there were no revisions in terms of language.

3) One-to-One

In line with the validaty assessment carried out by the experts at the expert review stage, one-to-one trials were also

carried out on the students of grades 7, 8, and 9, one each. This trial aimed to examine the functioning of the question bank website from the students' perspective. Three students worked on the questions on the website according to their grade level. From the results of this stage, it revealed that in the data presentation material of grade 7 there were three questions without answer options. Furthermore, revisions were made to address the issue .

4) Small Group

At the small group stage, the revised results from the expert review and one-to-one stages were called prototype 2. The trial at this stage was conducted by 6 students in grades 7, 8, and 9. Each grade level group was represented by 2 students. The six students in groups held discussions while working on the questions. From the results of the discussion, several improvement notes were obtained, namely (1) in the material for linear equations of two variables there were questions with the same answer choices (2) in the material for grades 7 and 8 there were several questions with incorrect answer keys and incomplete explanation of the questions (3) in the data presentation material, there were only 10 questions provided which did not meet the required number of questions for each materials.

5) Field Test

In the field test stage, the revised results from the small group stage were

called prototype 3. This stage involved 31 grade 9 students. All of these students worked on questions on the question bank website as a drill for the final exam. The results obtained at this stage were the students' responses stating that the question bank website provided great benefits as a medium for practicing and recalling material of grades 7 and 8.

In this study, prototype 1 and 2 products were revised by the researchers themselves based on the suggestions and feedbacks from the validators at the expert review stage and the students at the one-to-one stage. Prototype 1 was the initial design of the web question bank made in accordance with the development of core competencies and basic competencies of junior high school mathematics. From the self-evaluation conducted, the initial product had sufficient standards to be directly disseminated to users. However, a quantitative assessment was required to ensure that the components of the question bank met the needs of students and teachers. Therefore, an assessment was conducted by validators who were selected based on their respective fields to assess the feasibility of the question bank.

Prototype 1 had a decent category on content, construct, and language criteria. These results were in line with Triyani's research (2016) who showed that the question bank he made on average met good standards from the six qualities (functionality, reliability, usability,

efficiency, maintainability, and portability) tested. Unfortunately, the question bank was unable to be accessed openly so that researchers could not compare the content of the assessment instrument made by the teachers of SMK Muhammadiyah 1 Bantul with the content on the exion math web. Despite the decent category, some suggestions from validators to improve the quality of the question bank were still being made. In line with the validators' assessment, an assessment was carried out on the students at each grade level. This aimed to examine the quality of the question bank from the students' point of view, then based on the feedbacks from the students, revisions were made.

The revised product of the expert review and one-to-one stages was called prototype 2. The prototype at this stage was distributed to six students who were asked to assess the question bank using the discussion technique. This was done to explore the students' point of view when they worked on the questions by discussion. The discussion section allowed the students to be thoughtful. From this stage, several revisions were made as described in the small group stage. Assessment of categorization techniques met average score criteria. The researchers were required to make evaluations and improvements in order to get good criteria. This math question bank product was in line with research conducted by Napiah et al. (2020). The

results of this study were a web-based and interactive high school question bank. The development carried out by Napiah was a question bank presenting the material and collecting assignments such as *e-learning*. The question bank presentation system was stated to provide convenience for teachers and students in modern learning.

The final stage of this development study was to provide the question bank to one class of students at grade 9. The selection of this class was based on the experience of the students who had learned all junior high school mathematics materials as well as means of trials for the final exam. The results of the questionnaire showed that grade 9 students found it quite easy to operate the question bank and were interested in the functions of the question bank menu. The average score obtained certainly required the researchers to make revisions based on the suggestions given by students to achieve good or very good score The results of the study by Chaniago (2016) showed that the question bank made was effective, efficient, and facilitated the learning process. However, because the purpose of the question bank was not intended for school activities, the development of the exionmath question bank was a novel study. The results obtained from Chaniago's were similar to the results of current study, namely making it easier for students to evaluate with the direct benefit experience by the students.

The final product of this development study is a web-based question bank that could be accessed openly through the link http://exionmath.com/index.php. After going through the assessment and revision stages, the final product called prototype 3 was generated. Prototype 3 had been considered valid by the validators and feasible for use by the students through questionnaire assessment.

The advantages of this question bank website were 1) free access, 2) light size to save up space on the student' devices, and 3) provide answers and discussions after doing the tasks. The weaknesses as well as the limitations possessed by this question bank were that the questions were limited to multiple choice formats and the need of internet quota to access.

IV. CONCLUSION

This study indicated that the developed question bank website had great benefits for the students as users. Simple web design and easy-to-use menu functions were the main points of the advantages of this digital question bank as well as the free access. Expert assessment also pointed valid results, meaning that this question bank website was suitable for use by junior high school students. It was expected that this question bank website would be disseminated to junior high school students and developed further to provide high school material.

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