**Kahoot: Application in Test Instrument Development on Mathematics Learning**

**Sri Sulasteri, Firdayana Makmur, Baharuddin, Fitriani Nur, Andi Dian Angriani, and Andi Halimah**

Universitas Islam Negeri Alauddin Makassar, Indonesia

sri.sulasteri@uin-alauddin.ac.id

**Abstract**. This research aims at finding out the development process and assessing the quality of test instruments which are assisted by Kahoot application in Mathematics Learning. This research applied Research & Development (R&D) using Formative Research (Tessmer) development model that consists of four stages, namely; preliminary, self evaluation, prototyping, and field test. The research instruments used were online tests assisted by Kahoot Applications, and response questionnaires for students and teachers. Data analysis techniques used were the form of expert validation sheet analysis (media, language, material), analysis of students’ response questionnaires, teachers, and analysis of the test item quality. The validation results from the experts of media, materials, and language were obtained ‘very feasible’ category. The results of response questionnaires analysis for students and teachers obtained ‘very interesting’ category. The results of the test analysis for students after working on Kahoot application assistance questions were in ‘medium-skilled’ category. The analysis results of the test items were obtained the average of validity and reliability of the test items in valid and reliable categories. The analysis results of the difficulty level of the test items are in the moderate category, and the difference of each question is in good category. Therefore, Kahoot application-assisted test instruments meet ‘good’ quality.

Keywords: Test Instruments, Mathematics Learning, Kahoot Application

1. **INTRODUCTION**

Education is the activity of protecting, guiding, and teaching maturity to the students [1] and extending the influence to increase human resources in order to involve in various environments and social groups activity [2]. Education is then expected to grow up and develop the potential that exists in humans such as attitudes and behaviors creatively, innovative in science, behavior, and skills. Nowadays, schools as the place of formal educational institution and the place of learning process which carried out by teachers must be ready to face a digitized education system. Bennet believed that the challenges that the teacher faced is to maintain and implement digitized education system in a creative way to fulfill the information and decision-making requirements in a changing education system that requires teachers to develop themselves [3]. Furthermore, Cifrian et al. suggested that teachers must plan teaching activities systematically based on the rules and contain the learning objectives that need to be achieved. The teachers must also be able to choose the appropriate method of learning materials in order to create effective learning and make students easier to understand the lesson. Teachers should be able to determine the right evaluation tools in assessing students' learning outcomes, because assessments, learning methods, and experiences that gained students to be able to contribute in improving learning outcomes and quality in teaching and learning process [4]*.*

Learning can become very complex activity if it relates to the students' learning outcomes. Batari et al. believed that learning outcomes are used to measure material mastery and to find out the teacher's success in teaching [5]. Moreover, Primi et al. argued that learning mathematics can be very important because mathematics plays a major role in daily life and it has been an indispensable factor for personal and economic success [6]. Therefore, it is revealed that mathematics as the basic science underlie other sciences and become useful in every life aspect so that mathematics subjects need to be extended to all students in order to encourage them think logically, analytically, and creatively, as well as cooperatively [7].

Many students find difficulty to learn mathematics at the present time. Rofiyarti et al. assumed that students believed that mathematics as a lesson provides formulas which have to be memorized [8]. Moreover, Rakhmawati et al. underlied that mathematics is considered as a difficult lesson due to the abstract of mathematics which caused many of them get difficulty in understanding various concepts and in answering mathematical questions [9]. Due to the observations made by researchers in grade VIII of Gowa State MTs (State Islamic Junior High School, Gowa), South Sulawesi, it is found that students often have difficulty in understanding mathematics materials and due to the teaching methods of teachers do not vary which caused students have low motivation in learning mathematics. Another case is the teachers have never used technology as a learning medium and evaluation tools such as interactive quizzes or online tests. This is proven based on the data provided by teachers that the mathematics results of semester 1 grade VIII of the school year 2018-2019 revealed that there were 55% of students whose grades are below the Minimum Completeness Criteria (KKM) which is set by the school about 78.

Based on the problem description above, Behren and Dicerbo offered solution to create an evaluation tool that utilizes technology. Through digital technology revolution, digital instrumentation is needed to be used in educational assessments [10] which indicates that teachers must be able to prepare assessments that relevant to the times development. One of the most important factors based on the assumption of McCulloch et al., digital technology should be considered in using technology as a learning medium or evaluation tool is the way of aligning with learning objectives and also considers the easy way of technology used for teachers and students [11]. The evaluation tool that utilizes the technology is a Kahoot Application-Assisted Test Instrument that can be used as a quiz assessment, daily replay assessment, and final semester assessment.

Kahoot as the interactive game-based learning platform can be used for formative assessments in classrooms that engage students in a fun way. Dellos revealed that Kahoot does not only foster and focus on a fun learning environment, but it also challenges the students in the learning process [12]. This application can provide new experiences to the students, make the mathemathics learning process become more interesting, and can foster learning motivation that will impact the students’ learning outcomes. Ismail and Mohammad defined that Kahoot is known as a formative assessment tool which is promised, feasible, and practical, as well as makes the learning fun and usable and encourages the students to learn [13]. This is in line with research conducted by Toth and Logo that [14] created quizzes using Kahoot applications can become an important part and learning experience effectively towards a better learning experience.Using education system can cause positive results on the students’ engagement, motivation, and the overall learning experience.

Furthermore, the implementation of interactive quizzes based on Kahoot application is considered as a valuable active learning strategy [15]. The use of technology in mathematics learning process can increase the students’ involvement in which the mathematics leads to the students’ increasing who want to expand their mathematics knowledge that impact positively to the students’ learning outcomes [16].

Rakhmawati et al. [9] revealed that the development of test instruments using Kahoot application as an evaluation tool is very feasible to use. Then research conducted by Licorish et al. [17] revealed that Kahoot enriches the quality of students’ learning and can minimize distractions in the classroom. Furthermore, the research conducted by Iwamoto et al. [18] showed the significant differences in the test scores of the students who used Kahoot compared to the students who did not use Kahoot. Furthermore, research by Wang and Tahir [19] revealed that the use of Kahoot can have a positive effect on learning performance, students and teacher attitudes, and classroom dynamics. Another research by Goksun and Gursoy [20] who found that learning activities equipped with Kahoot applications have a positive impact on academic achievement and students’ involvement.

Therefore, the research about the development of Kahoot application-assisted test instruments is very important due to the aims of helping teachers develop test objectives in accordance with learning objectives that can produce valid and reliable evaluation results so that they can be used as evaluation tools in the learning process which can provide new experiences to the students in the form of the test instrument which is different from the previous test instruments.

**RESEARCH METHOD**

The researchers applied Research and Development (R & D) using formative research (Tessmer) model that consists of four stages namely preliminary, self evaluation (curriculum analysis, material analysis, students analysis, and design), prototyping, and field test. The development procedures as the following:

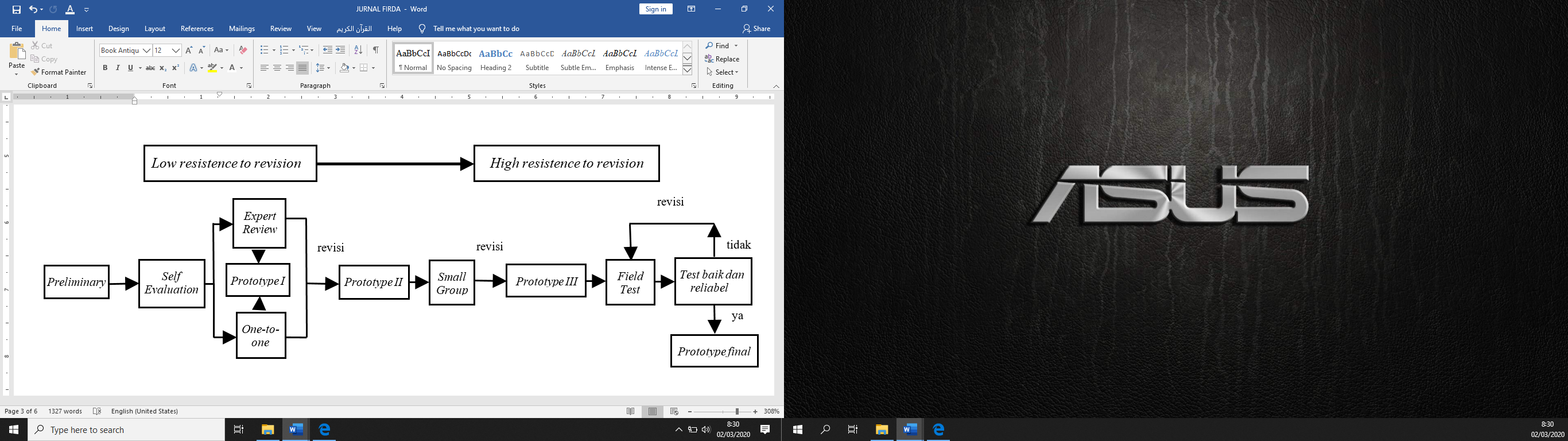


Figure 1. Formative Research Development Model (Tessmer)

The eight grade students of Gowa State MTs (State Islamic Junior High School of Gowa) the try-out subject of this research. The tests and questionnaires of students and teachers were used as the data collection technique. The research instruments used consist of test instruments, students' response questionnaire instruments, and test instrument validation sheets. The data analysis technique consists of the analysis of experts’ assessment sheets, the analysis of the students and teacher responses, test item validity, reliability test, difficulty level test, and the item discrimination test (index facility).

FINDINGS AND DISCUSSION

**The Development Process of Kahoot Application Assisted Test Instrument**

The development of Kahoot application-assisted test instruments by using formative research (Tessmer) development model has series of stages including preliminary stage, self evaluation, and field test stage which results a product of Kahoot application-assisted test instruments. Prior to the development process, researchers should have established an instrument quality criterion that can be used as a guideline in determining the extent to which the success of the developed product.

The first stage of formative research model is preliminary stage which means that the researchers firstly collected references about Kahoot application-assisted test instruments. Having made pre-observations at MTs Negeri Gowa and conducted interviews with math teachers, information then was obtained about the school’s condition that has Wi-fi network facilities, computers, and students’ conditions are allowed to bring Androids (Smartphone) to support the learning process. Unfortunately, in the process of learning mathematics, all facilities have never been utilized and used well due to the teachers still used conventional methods and they have not utilized technology when teaching in the classroom. This information becomes the rationale for choosing State MTs of Gowa as the research site and selects grade VIII students as the research subject.

Another stage is Self Evaluation stage in which the researchers conducted curriculum analysis, learner analysis, material analysis, and designed and developed Kahoot application-assisted test instruments into grids form, created and designed questions test, answer keys, and other research instruments. The results of the development of Kahoot application-assisted test instruments were consulted with the supervisor lecturer that resulted in prototype I.

Prototyping stage becomes the next stage which includes expert review, one-to-one, and small group assessments. The result of Prototype I is given to validators to be assessed. Kahoot application-assisted test instruments that have been assessed by experts (validators) were tested to three students (one-to-one) in class VIII3 of Gowa State MTs for test instruments assisted by SPLDV material Kahoot applications, and for material test instruments number patterns, cartesius coordinates, relationships and functions, as well as straight line equations were tested to 12 students in grade VIII2 which means that each of three participants was educated for 1 material. Assessment results from validators and one-to-one are used to revise prototype I that will produce prototype II. Moreover, prototype II then was tested on six small group class VIII2 of Gowa State MTs for SPLDV material test instruments and for number pattern material, cartheticular coordinates, relationships and functions, as well as the ‘Straight Line Equations’ tested to 24 learners in grade VIII1 (6 students). The results of the small group are used to revise prototype II which then resulted in prototype III as the field tests.

Formative research (Tessmer) development model was applied as the last stage in the field test stage. Kahoot application-assisted test instruments that have been developed are then tested on the research subjects namely all grade VIII1 in Gowa State MTs Gowa which consisted of grades VIII1 to VIII5 so that the test instruments tested by each class are the questions from different materials.

The question material of each class is selected randomly. The test instruments that are tested in class VIII1 are the question of relationship and function materials, the question of ‘straight-line equation’ material is tested in class VIII2, the question of the material of ‘two variable linear equations’ system is tested in class VIII3, and the question of ‘coordinate material kartesius’ is tested in class VIII4, as well as the question of the number pattern material is tested in class VIII5 of Gowa State MTs. Having Kahoot application-assisted test instrument was tested at the field test stage, the researchers then shared a questionnaire of the teacher's response and a teacher response questionnaire which need to be filled then it was analyzed in order to assess the practicality of the Kahoot application test instrument for the grade VIII students in the odd semester.

The results of the analysis of students' response questionnaires revealed that the mean score of students' response questionnaires percentage is 82.81 with a very interesting category and the percentage of teacher response questionnaires is 97.5% with a highly agreed category, so that the test instrument can meet practicality criteria. This is in line with research by Lee et al. [21] who explained that the application of Kahoot can increase learning motivation and attract the students’ attention. Moreover, Wang [22] argued that the use of new learning technologies in the classroom provides enthusiasm and excitement from both students and teachers. Furthermore, he assumed that using media and technology in both learning and evaluation processes with greater frequency can support the learning process in accordance with the learning objectives to be achieved as well as improve mathematics knowledge and provide technology experience to the students.

Furthermore, the validity of Kahoot application-assisted test instruments can be seen based on the validator assessment which consists of two mathematics education lecturers and a mathematics teacher of Gowa State MTs. The validator assessment results can be seen on the following table:

Table 1. Expert Validation Results

|  |  |  |  |
| --- | --- | --- | --- |
| No. | Expert Validation | Mean Score (%) | Categories |
| 1. | language | 88.67 | Highly Proper | |
| 2. | media | 88 | Highly Proper | |
| 3. | material | 88 | Highly Proper | |

The table indicates that the interpretation results from the experts' assessment of Kahoot application-assisted test in the mathematics subjects at Grade VIII semester 1 of Gowa State MTs have met the criteria of validity and proper to use.

Then, the effectiveness criteria of the test instrument development can be seen from the students’ test results. The following is the percentage table of the students' test results:

Table 2. The Students’ Test Results

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Material | Class | Total  (Students) | Complete  (Students) | Percentage  (%) | | Incomplete  (Student) | Percentage  (%) | Student Grades |
| Number Pattern | VIII5 | 28 | 17 | 60.71 | | 11 | 39.29 | 70 |
| Kartesius Coordinates | VIII4 | 31 | 24 | 77.42 | | 7 | 22.58 | 74.68 |
| Relations and Functions | VIII1 | 32 | 23 | 71.88 | | 9 | 28.12 | 74.53 |
| Straight Line Equations | VIII2 | 33 | 21 | 63.64 | | 12 | 36.36 | 68.48 |
| SPLDV  Two-Variable Linear Equation System | VIII3 | 31 | 23 | 74.19 | | 8 | 25.81 | 70.48 |
| Total | | 155 | 108 | 347.84 | | 47 | 152.16 | 358.17 |
| Mean Scores | | | **21.6** | | **69.57** | **9.44** | **30.43** | 71.63 |

The table shows the students’ learning outcomes after working on online questions using Kahoot application. The results show that there are 108 students who achieve completed grades with the percentage of 69.57% and there are 47 students who receive incomplete grades with the percentage of 30.43%, which means that there is a significant increase in students’ test results that are initially based on the data obtained from the teachers that the mid-test at semester 1 of 8th grade is 55% of the students who obtained score below the Minimum Completeness Criteria (KKM). Furthermore, the mean score of the students’ learning ability is 71.63. It means that the eight grade students’ ability of Gowa State MTs is in moderate category and it actually meets effective criteria. The above description reveals that the process of developing Kahoot application-assisted test instruments in grade VIII mathematics subjects of Gowa State MTs meets valid, effective, and practical criteria.

**The Analysis of Question Items Quality**

Validity of Question Items

The question item validity is viewed based on the the students’s scores after answering the questions using Kahoot application. The validity mean scores of the question items from every chapter are as follows:

Table 3. The Validity Mean Scores of Kahoot Application-Assisted Test Instrument

|  |  |  |  |
| --- | --- | --- | --- |
| No | Sub Chapter/Unit | Validity Mean Scores rxy | Category |
| 1. | NumberPattern | 0.572 | Valid |
| 2. | Kartesius Coordinates | 0.574 | Valid |
| 3. | Relations and Functions | 0.542 | Valid |
| 4. | Straight Line Equations | 0.554 | Valid |
| 5. | Two-Variable Linear Equation System | 0.545 | Valid |
| Total Mean Score rxy | | 0.557 | Valid |

Based on the table 3, it is obtained that the total mean score of the question item validity level Kahoot application-assisted test instruments in grade VIII of the first semester mathematics material is = 0.557 with 0.1638. This means that indicates that the instrument is valid, so that the question items are actually able to measure precisely and carefully in accordance with the indicators that need to be measured.

**The Analysis of Question Items Reliability**

Table 4. Reliability Test

|  |  |  |  |
| --- | --- | --- | --- |
| No | Sub Chapter/Unit | *Reliability statistics* | |
| *Cronbach’s Alpha* | *N of Items* |
| 1. | Number Pattern | 0.881 | 20 |
| 2. | Kartesius Coordinates | 0.885 | 20 |
| 3. | Relations and Functions | 0.869 | 20 |
| 4. | Straight Line Equations | 0.888 | 20 |
| 5. | Sistem Persamaan Linear Dua Variabel  *Two-Variable Linear Equation System* | 0.867 | 20 |
| Total Mean Score | | 0.878 | 20 |

Based on table 4, it is obtained that the reliability level mean score of Kahoot application-assisted test instruments in mathematics material at the grade VIII of first semester is 0.878, because Cronbach's Alpha > 0.6 value indicates that Kahoot application-assisted test instruments are defined as reliable or consistent.

**The Analysis of Question Items Difficulty**

Table 5. The Analysis of Question Items Difficulty

|  |  |  |  |
| --- | --- | --- | --- |
| No | Sub-Chapter | The Mean Score of Questions Item Difficulty | Category |
| 1. | Number Pattern | 0.7 | Medium |
| 2. | Kartesius Coordinates | 0.75 | Easy |
| 3. | Relations and Functions | 0.74 | Easy |
| 4. | Straight Line Equations | 0.68 | Medium |
| 5. | Two-Variable Linear Equation System | 0.7 | Medium |
| Total Mean Score rxy | | **0.7** | **Medium** |

Based on Table 5, it is obtained that the mean score of questions item difficulty of Kahoot application-assisted test instruments material for the first semester is p = 0.7. It means that is in medium criteria.

**The Analysis of Question Items Discrimination**

Table 6. The Analysis of Question items Discrimination

|  |  |  |  |
| --- | --- | --- | --- |
| No | Sub-Chapter | Mean Score of Item Discrimination | Category |
| 1. | Number Pattern | 0.39 | Good |
| 2. | Kartesius Coordinates | 0.303 | Good |
| 3. | Relations and Functions | 0.3 | Good |
| 4. | Straight Line Equations | 0.58 | Very Good |
| 5. | Two-Variable Linear Equation System | 0.32 | Good |
| Total Mean Score rxy | | **0.38** | Good |

Based on the students’ test results above, it is obtained the item discrimination calculation results from each question item of the test instruments assisted by Kahoot application for the first semester materials of 0.38. It indicates that the question items discrimination is in ‘good’ category.

**The Objectivity of Kahoot Application-Assisted Test Instruments**

A test is named as objective there are no subjective factors affecting in manufacture and implementation of the test. It is actually happened with scoring systems. In this research, the test used is a multiple choice form test, so it is definitely ‘objective’ because the students who choose the wrong answer, they do not get the score and if they choose the correct answer then they get the score. Therefore, it can be concluded that this Kahoot application-assisted test instrument is objective.

**The Practicability of Kahoot Application-Assisted Test**

A test can be named as practicability if the test is practical and easy in administration. In this study, Kahoot application-assisted test instruments are easy to be implemented because of school facilities, such as LCD, Wifi, computer, and students are allowed to carry Smartphone Android, now that all of these things are very supportive to carry out the test using Kahoot application. Checking the results of students' answers is also easy because the results are automatically in the application. The question is also equipped with clear instructions. Therefore, the test instrument assisted by Kahoot application is practical.

**The Economic Kahoot Application Assisted Test Instruments**

Economical means that the test implementation does not require expensive costs, a lot of energy, and a long time. It is shown when the researchers experience in the research process, it spends lot of money during the research time.

Arikunto [24] assumed that a test is categorized as ‘good’ if it meets the requirements of the test namely validity, reliability, objectivity, practicability, and economy. The above description shown that, Kahoot application-assisted test instruments in mathematics subjects at first semester are considered as ‘good’ test instruments because they meet the requirements that have been specified, making them proper to use. This is in line with the research of Rakhmawati et al.[9] that Kahoot application-assisted test instruments as evaluation tools are eligible for use. Another research conducted by Zainuddin et al. [25] who revealed that e-quiz is effectively used in evaluation process and becomes an alternative solution for formative assessment especially after completing each learning topic. Brezovzsky et al. [26] found that that students' responses toward the use of Kahoot applications succeed increasing the involvement, motivation, and students’ learning after being repeatedly used.

**CONCLUSION**

The process of developing test instruments assisted by Kahoot application in mathematics subjects through four stages, namely preliminary, self evaluation, prototyping, and field test. The results obtained meet valid, effective, and practical criteria. The validity of the test instrument valued from the validator assessment includes of validation of media experts, material experts, and language experts getting the final percentage in succession of 88%, 88.67%, and 88% which means that all three validation results of the test instrument assisted Kahoot application are very feasible to use. The effectiveness of the test instrument can beanalyzed through the students’ test results after working on Kahoot application-assisted questions which averaged 71.63 categorized as moderate ability. The practicability of the test instrument is seen from the analysis of the students and teachers’ response successively by 82.81% and 87.5%, which indicates that students and teachers give excellent response to Kahoot application-assisted test instruments. Based on the results of the analysis of validity, reliability, difficulty level, question items discrimination, objectivity, practicability, and economy can be concluded that the quality of test instruments assisted by the application of Kahoot for mathematics subjects fulfill good quality.

**REFERENCES**

[1] F. Ramadhani, S. Nahar, and Syaukani, “Konsep Evaluasi Pendidikan dalam Qur’an Surah Az-Zalzalah Ayat 7-8 dan Al-Baqarah Ayat 31-34,” *EDU RILIGIA J. Ilmu Pendidik. Islam dan Keagamaan*, vol. Vol 2 No2, pp. 183–197, 2018.

[2] A. Kadir, *Dasar-Dasar Pendidikan*. Jakarta: Kencana Penada Media Grup, 2012.

[3] R. E. Bennet, “Preparing for the future: What educational assessment must do,” *Teach. Coll. Rec.*, vol. 116, no. 11, 2014.

[4] E. Cifrian, A. Andres, B. Galan, and J. R. Viguri, “Integration of different assessment approaches: application to a project-based learning engineering course,” *Educ. Chem. Eng.*, vol. 31, pp. 62–75, 2020.

[5] T. Batari, Nursalam, and A. D. Angriani, “Pengembangan Instrumen Tes Untuk Mengukur Kemampuan Koneksi Matematis,” *AULADUNA J. Pendidik. Dasar Islam*, vol. 5, no. 1, pp. 1–12, 2018.

[6] C. Primi, A. Bacherini, C. Beccari, and M. A. Donati, “Assessing math attitude through the Attitude Toward Mathematics Inventory – Short form in introductory statistics course students,” *Stud. Educ. Eval.*, vol. 64, no. January, p. 100838, 2020.

[7] Nursalam, *Strategi Pmbelajaran Matematika Teori dan Aplikasi Bagi Mahasiswa PGMI*. Makassar: Alauddin University Press, 2013.

[8] F. Rofiyarti and A. Y. Sari, “Tik Untuk Aud: Penggunaan Platform ‘Kahoot!’ Dalam Menumbuhkan Jiwa Kompetitif Dan Kolaboratif Anak,” *Pedagog. J. Anak Usia Dini dan Pendidik. Anak Usia Dini*, vol. Vol 3 No 3, 2017.

[9] D. R. Rakhmawati, Mujib, and C. K. Dewi, “Alat Evaluasi Menggunakan Kahoot pada Pembelajaran Matematika Kelas X,” *Indones. J. Sci. Math. Educ.*, vol. Vol 1 No 2, pp. 163–171, 2018.

[10] J. T. Behrens and K. E. Dicerbo, “Technological implications for assessment ecosystems: Opportunities for digital technology to advance assessment,” *Teach. Coll. Rec.*, vol. 116, no. 11, 2014.

[11] A. W. McCulloch, K. Hollebrands, H. Lee, T. Harrison, and A. Mutlu, “Factors that influence secondary mathematics teachers’ integration of technology in mathematics lessons,” *Comput. Educ.*, 2018.

[12] R. Dellos, “Kahoot! A digital game resource for learning. INSTRUCTIONAL TECHNOLOGY, 49.,” *Int. J. Instr. Technol. Distance Learn.*, vol. 12, no. 4, p. 49, 2015.

[13] M. A.-A. Ismail and J. A.-M. Mohammad, “Kahoot: A Promising Tool for Formative Assessment in Medical Education,” *Educ. Med. J.*, vol. 9(2), pp. 19–26, 2017.

[14] A. Toth, P. Logo, and E. Logo, “ The Effect of the Kahoot Quiz on the Student’s Results in the Exam,” *Period. Polytech. Soc. Manag. Sci.*, 2019.

[15] W. Sumanasekera, C. Turner, K. Ly, P. Hoang, T. Jent, and T. Sumanasekera, “Evaluation of multiple active learning strategies in a pharmacology course,” *Curr. Pharm. Teach. Learn.*, 2020.

[16] C. Attard and K. Holmes, “‘It gives you that sense of hope’: An exploration of technology use to mediate student engagement with mathematics,” *Heliyon*, 2020.

[17] S. A. Licorish, H. E. Owen, B. Daniel, and J. L. George, “Students’ perception of Kahoot!’s influence on teaching and learning,” *Res. Pract. Technol. Enhanc. Learn.*, vol. 13(1), 2018.

[18] D. H. Iwamoto, J. Hargis, E. J. Taitano, and K. Vuong, “Analyzing the efficacy of the testing effect using Kahoot??? on student performance,” *Turkish Online J. Distance Educ.*, vol. 18(2), pp. 80–93, 2017.

[19] A. I. Wang and R. Tahir, “The effect of using Kahoot! for learning – A literature review,” *Comput. Educ.*, vol. 149, no. January, p. 103818, 2020.

[20] D. Orhan Goksun and G. Gursoy, “Comparing success and engagement in gamified learning experiences via Kahoot and Quizizz,” *Comput. Educ.*, 2019.

[21] C. C. Lee, Y. Hao, K. S. Lee, S. C. Sim, and C. C. Huang, “Investigation of the effects of an online instant response system on students in a middle school of a rural area,” *Comput. Human Behav.*, 2019.

[22] A. I. Wang, “The wear out effect of a game-based student response system,” *Comput. Educ.*, 2015.

[23] D. Rosenfeld *et al.*, “A curriculum supplement that integrates transmedia to promote early math learning: A randomized controlled trial of a PBS KIDS intervention,” *Early Child. Res. Q.*, 2019.

[24] S. Arikunto, *Dasar-Dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara, 2010.

[25] Z. Zainuddin, M. Shujahat, H. Haruna, and S. K. W. Chu, “The role of gamified e-quizzes on student learning and engagement: An interactive gamification solution for a formative assessment system,” *Comput. Educ.*, 2020.

[26] B. Brezovszky *et al.*, “Effects of a mathematics game-based learning environment on primary school students’ adaptive number knowledge,” *Comput. Educ.*, 2019.