Computer-Assisted Assessment Model to Decrease Math Anxiety And Increase Mathematical Self Efficacy of Junior High School Students

S H Nasution, A Qohar, and Susiswo
Mathematics Department, Universitas Negeri Malang, 5 Semarang Street, Malang, Indonesia
syaiful.hamzah.fmipa@um.ac.id

Abstract. The purpose of this research was to produce a computer-assisted assessment model as valid, practice, and effective to decrease math anxiety and increase mathematical self-efficacy of junior high school students. The product that would be gained was assessment computer-assisted that using Moodle and GeoGebra Software. This research referred to ADDIE development model that had five stages, they were Analysis, Design, Develop, Implementation, and Evaluation. The data collection techniques of this research were using students’ anxiety questionnaire and students self-efficacy questionnaire. The validator stated that the product which was developed was valid without revision. Product trials was done to 30 trials subject and gained that there was a decrease in anxiety level from medium anxiety (the anxiety average score 23.73) to lowest anxiety (the anxiety average score 10.3) and there was an increase to the self-efficacy average score from 27.13 (medium self-efficacy) became 37.36 (high self-efficacy).

1. Introduction
In the learning process, an assessment was an important thing that must be done by a teacher. The assessment was done to help the teacher to know the weakness and the strangeness of the students in studying. In general, the form of assessment that was mostly done by the teacher was a test with paper and pencil. The test was given was contained of questions to measure students’ ability to certain material. One of the obstacles faced by students in doing the test was anxiety.

The anxiety faced by students in mathematics was called math anxiety. [1] defines that math anxiety as a feeling of tension, fear or worries that can affect the student's performance or mathematics achievement. The research done by [2] shows that students’ achievement which indicated about mathematics anxiety is lower than students who do not indicate mathematics anxiety. It shows that mathematics anxiety has a negative impact on students’ achievement. The mathematics anxiety when doing a test can be caused by students’ unpreparedness in facing the test [3]. This unpreparedness was partly due to a lack of understanding of the material being tested. This lack of understanding in material that caused by anxiety could cause mathematics self-efficacy of students were low.

[4] defines self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to manage prospective situations”. The research done by Paul R Pintrich and Dale H Schunk shows that students who have high self-efficacy are more mastering the material/concept than students who have low self-efficacy [5]. High self-efficacy in mathematics encourages the students to
be diligent, striving earnestly to learn and solve mathematics problems [6]. Therefore, high mathematics self-efficacy encouraged the students’ achievement in mathematics to be better.

Based on an interview with one of the seventh-grade junior high school teachers in Malang, information was gained that most of the seventh-grade students in their school experienced anxiety when facing an exam. The anxiety experienced by these students was generally classified as moderate anxiety. Research done by [7] and [8] shows that computer use can help students in understanding material and motivate students also improve students’ learning outcomes. From those explanations above, the researcher developed a computer-assisted assessment model to reduce mathematics anxiety and increase mathematics self-efficacy of junior high school students.

2. Method

2.1. Development Method

The development method of this research referred to ADDIE development model. There were some stages of the ADDIE model development, they were analysis, design, develop, implementation and evaluation. In the analysis stage, done the study on KD, formulations of indicators and determination of learning purpose. After doing those step, designed tasks that appropriated with the indicators and could measure the achievement of learning purpose. In the analysis stage also done the study about the ability of trials subject (students of secondary school) in operating computer. Besides, the researcher conducted a literature review related to aspects of students’ anxiety and self-efficacy. From this step, gained information that students did not experience difficulties in operating the computer, and aspects that affect students anxiety in doing mathematics tasks they were unpreparedness of students, lacked mastered the material that would be tested, did not sure with their ability, and fear of getting a bad score.

The next step was designed to stage. In this stage, the researcher processed the information that was gained from the analysis stage and compiled a prototype design of a computer-assisted assessment to reduce anxiety and increase the students’ self-efficacy. The assessment design that was chosen was using GeoGebra software. The purpose of giving this interactive simulation was to make students were not nervous when they solved the problems that were given, and students could do simulations/trials to get a solution. This was expected to decrease students anxiety levels and increase the level of self-efficacy. The prototype that had been developed was validated by an expert validator. The validator stated the media that had been developed was valid, there was no revision, and able to be used in research.

After the computer-assisted assessment prototype had been finished to be developed and validated in the develop stage, the researcher did trials to the implementation stage. The trials were done twice, it was trialed in a small group that consisted of 5 subject trials and trials in a large group with 30 trials of junior high school students. When the trials of the large group had been finished, an evaluation was conducted to find out whether the assessment model developed was effective and practical to reduce anxiety and increase students’ self-efficacy.

2.2. Data Collection Technique and Data Analysis

The researcher collected the data by giving anxiety questionnaire and self-efficacy also interviewing the students. To find out the validity of computer-assisted assessment model, the prototype that had been developed was validated by the expert validator. Product validity assessment scores used the following formula.

\[
V_a = \frac{\sum_{i=1}^{n} \sum_{j=1}^{m} A_{ij}}{mn}
\]

With \( V_a \) states the average validation score, \( n \) the total of aspects validity indicator, \( m \) the validator total, \( A_{ij} \) stated the indicator aspect score to the -i validator-j. Then, the average validation score was converted into the validity criteria as presented in Table 1.
Table 1. Product Validity Criteria

| Interval          | Validity Criteria | Explanation               |
|-------------------|------------------|---------------------------|
| $1 \leq V_a < 1,75$ | Invalid          | Revise all               |
| $1,75 \leq V_a < 2,5$ | Less valid       | Don’t revise all          |
| $2,5 \leq V_a < 3,25$ | Valid enough     | Don’t revise all          |
| $3,25 \leq V_a < 4$ | Valid            | Did not need to be revised|
| $V_a = 4$         | Very Valid       | Did not need to be revised|

To find out the effectiveness of computer-assisted assessment model in decreasing anxiety and increasing the self-efficacy, the researcher gave a questionnaire and did an interview with the subject of the trial. The anxiety scale was presented in Table 2 and self-efficacy scale in Table 3. In Table 2, $S_a$ showed the level of anxiety score, and Table 3, $S_{SE}$ showed the self-efficacy score.

Table 2. The Anxiety Level Score

| Anxiety Score Range | Explanation |
|---------------------|-------------|
| $S_a \leq 12$       | Lowest      |
| $12 < S_a \leq 20$  | Low         |
| $20 < S_a \leq 28$  | Average     |
| $28 < S_a \leq 36$  | High        |
| $36 < S_a \leq 40$  | Highest     |

Table 3. Self Efficacy Score

| Self Efficacy Range | Explanation |
|---------------------|-------------|
| $S_{SE} \leq 15$    | Lowest      |
| $15 < S_{SE} \leq 25$ | Low       |
| $25 < S_{SE} \leq 35$ | Average   |
| $35 < S_{SE} \leq 45$ | High      |
| $45 < S_{SE} \leq 50$ | Highest   |

3. Result and Discussion

3.1. Finding of The Development Computer-Assisted Assessment Model

The development of computer-assisted assessment model was using ADDIE development model. That development model consisted of five stages, they were: Analysis stage, design, develop, implementation, and evaluation. Computer-assisted assessment model prototype was made by using GeoGebra and Learning Management System (LMS) Moodle. GeoGebra software was used to make an interactive illustration. In research [9,10,11], GeoGebra-assisted geometry learning is effective to increase mathematics learning achievement, creative thinking, increasing students self-efficacy, motivating students, increasing curiosity and interest of the students. LMS Moodle was used to manage to do a task by the student. Before prototype was tested on a large scale (30 students), the prototype was validated first and tested on a small scale (5 students).

The tasks that would be presented in computer-assisted assessment model prototype consisted of a three-story task with five questions. The task form that was developed in the computer-assisted assessment model prototype was a story question. Every question was given an interactive illustration that could be used students to help to answer the question. The purpose of giving the interactive illustration was making the student could do an experiment/simulation, helping the student to think and reduce anxiety in doing the task. The student who forgot with the concept, could construct the concept through interactive illustrations. So that the students’ mathematical self-efficacy was expected to increase.
Figure 1 presented the display of question number 1 that accompanied by an interactive illustration. Question number 1 measured students’ ability in understanding the broad concept. There were three questions in question number 1, they were: (a) If the total of grass swath that needed to cover the field was field area, how square-feet the area of Mr. Budi’s field that could be planted grasses?, (b) How did you get the answer from point (a) above? Explain. And (c) From questions (a) and (b) above, if there was a rectangle that had size length p and width l, how to decide the area of rectangle?. Students were able to drag and drop grass swath (green box) to answer the questions number 1. By existing this interactive illustration could help the students to reduce students’ anxiety. From the researcher observation when the students did question number 1, the student was not looked nervous and was not burdened. From the students’ interview result was gained information that by the existing interactive illustration and presenting a task in story form could make the students did not feel to be tested. They felt comfortable and confident that they could answer the questions in task number 1.

Task number 2 was questioning to measure the students’ understanding of rectangle area. The interactive illustration was given in this task to help the students were able to answer task number 2. The students were able to drag and drop the blue box (as a unit box) into a worksheet (green box). There was information that presented the remaining box and the reset button to place the unit box in the starting position. Based on researcher observation, the students were not looked nervous, was not burdened, and enthusiastic in doing task number 2. Based on the students’ interview result were gained information that the students needed more much time than other tasks. The display question number 2 was presented in Figure 2.
Figure 2. Question Display Number 2

Task number 3 contained question to measure the students’ ability in applying area concept and perimeter of the rectangle. In task number 3 there were two questions. Task number 3 was also equipped with an interactive illustration in slider form to decide the length and the width of the rectangle. The rectangle that had been formed would have a size that matched with the size of the slider. The display question number 3 was presented in Figure 3.

![Figure 3](image)

Figure 3. Question Display Number 3

3.2. The Result of Effectiveness and Practicality Testing

To decide the effectiveness and practicality, the computer-assisted assessment model prototype was tested to trials subject, they were 30 of junior high school students. The effectiveness and practicality testing were done in two stages, they were: Before using computer-assisted assessment model and when using it. After testing was done, students were asked to write down the anxiety self-efficacy questionnaire. The anxiety questionnaire result was presented in Table 4.

### Table 4. The Anxiety Questionnaire Result

| Deskripsi                          | Skor Tingkat Kecemasan ($S_i$) |
|-----------------------------------|---------------------------------|
|                                   | $S_i \leq 12$                   | $12 < S_i \leq 20$ | $20 < S_i \leq 28$ | $28 < S_i \leq 36$ | $36 < S_i \leq 40$ |
| The level of anxiety score amount before using Assisted-Computer Assessment | 0                               | 7                   | 21                  | 1                   | 1                    |
| The level of anxiety score amount after using Assisted-Computer Assessment | 25                              | 4                   | 1                   | 0                   | 0                    |

Based on the questionnaire result, information that could be gained as follow: before using computer-assisted assessment model there were 7 students had low level of anxiety, 21 students had an average level of anxiety, 1 student had the high level of anxiety, and 1 student had a very high level of anxiety. After using the computer-assisted assessment model there were 25 students had a very low level of anxiety, 4 students had a low level of anxiety, and 1 student had an average level of anxiety.

Before using computer-assisted assessment model, the average score of anxiety level of the trial subject was 23.73. If it was converted in Table 2, then the score 23.73 was included in the level of average or moderate anxiety. After using computer-assisted assessment model, the average score of anxiety level of the trial subject was 10.3 (the anxiety level was very low according to Table 2). From this trial could be stated, that there was a decrease in the average score of anxiety level from 23.27 to 10.3 (reduced 56.6%). It could be concluded that the assessment model that developed was effective to
decrease the math anxiety of students. The average score of math anxiety level score of the trial subject was presented in Figure 4.

![Score Average of Anxiety Level](image)

**Figure 4.** Score Average of Anxiety Level

The result of questionnaire *self-efficacy* showed that before using the computer-assisted assessment model of self-efficacy students, there was 9 students who had low self-efficacy levels, 20 students had an average of the self-efficacy level. After using the computer-assisted assessment model, there were 11 students who had average self-efficacy, and 19 students had high self-efficacy. The result of self-efficacy questionnaire was presented in Table 5.

| Description | Self Efficacy Score($S_{SE}$) |
|-------------|--------------------------------|
|              | $S_{SE} \leq 15$ | $15 < S_{SE} \leq 25$ | $25 < S_{SE} \leq 35$ | $35 < S_{SE} \leq 45$ | $45 < S_{SE} \leq 50$ |
| The amount score of Self Efficacy before using computer-assisted assessment | 0 | 9 | 20 | 1 | 0 |
| The amount score of Self Efficacy after using computer-assisted assessment | 0 | 0 | 11 | 19 | 0 |

Based on Table 5, information that was obtained about a high increase for students with a high level of *self-efficacy*. The average score of the *self-efficacy* students before using computer-assisted assessment model was 27,13. The average score of the *self-efficacy* students after using computer-assisted assessment model was 37,37, it was increasing as much as 10,24 (increase 37,7%). The average score of the *self-efficacy* students was presented in Figure 5.
Based on practicality questionnaire, all of the subject trial students stated that computer-assisted assessment model was easy to be used. The interview result with some students showed that there were no difficult things when using computer-assisted assessment model. It could be claimed that the computer-assisted assessment model that developed was practical.

Based on the trial effectiveness and practicality, concluded that computer-assisted assessment model that developed was effective to decrease the students' math anxiety and could increase a mathematical self-efficacy, it was also easy to be used. Using GeoGebra software in LSM Moodle to present the interactive illustration to help students reduce math anxiety and increase the mathematical self-efficacy of students. It was supported [12] that using interactive software able to increase the students' ability in mathematics, decrease math anxiety also decrease the boredom of mathematics.

4. CONCLUSION
Based on the trial, concluded that computer-assisted assessment model could decrease the math anxiety of student and increase the mathematical self-efficacy. Presenting a task in applicative form with a redaction task that was appropriated with the students cognitive level was making the students challenged to finish the task. Presenting the task using LMS Moodle that accompanied with an interactive illustration in each task able to increase the students' self-confidence in doing the task. Interactive illustration could motivate the students, increase the student’s curiosity, the students' interested, and increase the spirit of students in solving a mathematics problem.

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