Mathematics Self-Efficacy Scale Based on Computer

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Abstract

The results of the PISA (Program for International Student Assessment) survey in 2012-2015 on the achievement of mathematical competencies of Indonesian students showed a significant increase, but the overall achievement was still below the average of the countries belonging to the Organization for Economic Co-operation and Development (OECD). Furthermore, the results of the Trends in International Mathematics and Science Study (TIMSS) report showed that many students like and feel good about mathematics, but their confidence in their mathematical abilities was quite low. Many studies reveal the close association of Mathematics Self-Efficacy (MSE) with the performance/achievement of students' mathematical competencies. In 2015, the PISA survey was done using computerization except in 15 countries, one of them was in Indonesia. Therefore, the results of this study are to produce the first computer-based MSE scale developed in Indonesia.

Keywords: competencies, computerization, mathematical abilities, survey

INTRODUCTION

The level of mathematics mastery is one benchmark of the progress of a nation (Sukoco & Mahmudi, 2016). Based on the results of international surveys, for example, the TIMSS (Trends in International Mathematics and Science Study) and PISA (Program for International Student Assessment), in 2015, the TIMSS survey was conducted on class IV students while PISA was for students of class IX and class X (age 15 years) in schools randomly selected throughout Indonesia (Mullis at al., 2016).

The results of the PISA survey, in 2012-2015, the achievement of mathematical competencies of Indonesian students increased significantly, but the overall achievement was still below the OECD average. In particular, more than 80% of students are only able to be at level 1, which is the lowest level in PISA assessment (OECD, 2016). In other words, the

level of mathematics mastery of students is not as expected. Furthermore, based on the TIMSS report, it is known that:

a. Sixty-six percent of Indonesian students really like and feel enjoy with math. This number is greater than the International average (45%).

b. The confidence in their mathematical abilities is only 23%. This percentage is relatively lower than the International average (32%) [2].

The description above shows that there are two real phenomena that occur until today. First, students' mastery of mathematics is an important factor. But the reality in the school shows different things. Mastery of material is not the only factor that influences the high or low achievement of student competencies. Indeed, students with good mastery of material have more tendency to obtain good results.

The second phenomenon is that many students like and feel enjoy with mathematics, but their confidence in their mathematical abilities is quite low. Self-confidence or individual perceptions of mathematical abilities are defined as Mathematics Self-Efficacy (Sukoco, et al., 2017). This belief does not mean "the individual believes in what he is going to do" but rather "the individual believes in what he is capable of" (Sukoco & Mahmudi, 2016). Therefore, MSE is an individual belief in dealing with various types of tests, ranging from understanding concepts to solving problems or mathematical problems.

According to the OECD, MSE is closely related to performance in mathematics at almost every level of the participating countries. However, this is not the case for Indonesia, both based on PISA 2003 and PISA 2012. This means that in-depth research needs to be conducted regarding these results (Sukoco, et al., 2017).

Sukoco, et al. (2018) compiled the scale of the Mathematics Self-Efficacy for high school (Mathematics Self-Efficacy for Senior High School / MSESc) as a valid and reliable pilot project. As a follow-up, the MSESc scale was used to see the effect of MSE on the results of students' National Examinations of Mathematics (Sukoco, et al., 2017). The findings are the positive influence of MSE on the results of the Mathematics National Exam. However, the contribution of MSE in influencing the results of the Mathematics National Exam is only 4.193% while the contribution of its covariates (TO Mathematics National Exam) is 95.807%.

Furthermore, to see the effectiveness of the scale of MSESc, Sukoco & Kholifa continue the development of the scale of the Mathematics Self-Efficacy (MSE) for high school levels, the results of which are valid, reliable, and effective (Sukoco & Kholifa, 2016). Furthermore, Bonne (2016) also found the importance of the influence of the Mathematics Self-Efficacy (MSE) on the achievement of students' mathematical competencies in New Zealand. However, the MSE instrument developed is computer based.

Another issue is the 2015 PISA survey which has been computerized except in 15 countries, one of which is Indonesia (OECD, 2016). In addition, the written administration of the scale also creates its own constraints. For example, the possibility of entering data incorrectly. Therefore, the development of computer-based applications will facilitate the administration of scale and be able to reach a wider population so as to strengthen the results of previous studies, especially in Indonesia.

Based on the descriptions above, it is necessary to develop a scale of computer-based Mathematics Self-Efficacy in Indonesia.

METHOD

This type of research is development research. The development design used in this study refers to the ADDIE development model by Reiser & Dempsey namely Analysis, Design, Development, Implementation, Evaluation (Reiser & Dempsey, 2007). The development produced in this research is only in the analysis and design stage.

The application of this computer-based Mathematics Self-Efficacy scale is used to process student data retrieval without using paper or commonly known as a Computer Based Test (CBT) or Computer Assisted Test (CAT). All exam processes are done through computers, starting from the making of scale items, class arrangements, user settings that can fill the scale, teacher/user settings, to data retrieval processes using web technology. The type of scale used is Likert with 4 choices.

The specifications of this application are as follows.
a. PHP with framework: Codeigniter versi 2.x.x;
b. JQuery Javascript, to handle javascript commands, and others;
c. JSON data format for exchanging data between server and client, on AJAX menus;
d. Design UI with a CSS framework, Twitter Bootstrap.

While for the user level the application can be divided into 3, namely:

1. **Admin**, is the highest level of application, can manage data: teacher/lecturer, students, scale, questions/items, and see results;

2. **The teacher**, has access, can manage data: questions/items, scale lists, and see results;

3. **Students**, have access, can take the exam/fill-in items, according to the scale chosen, which is set by the admin level, and see the results.

RESULT

The development result of computer-based Mathematics Self-Efficacy scale follows these steps.

Preparation of Local Files and Servers

The steps for preparing local files and servers are as follows.

a. Download the XAMPP server application and the CAT application

For Windows operating systems, the file needed is XAMPP for Windows. Download it at http://apachefriends.org.

Figure 1. XAMPP Server

Next, download the CAT application from https://github.com/akhwan90/cat
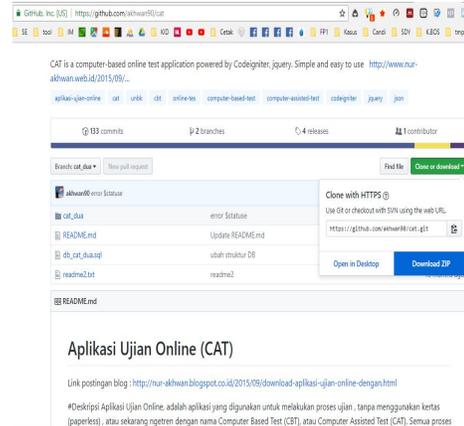
Figure 2. CAT Application

b. Save both XAMPP and CAT files on the local PC, for example, directory D.

c. Install XAMPP by opening and running the file: xampp-win32-7.2.7-0-VC15-installer.exe which is about 126 MB (the name and size of the file will match the latest XAMPP).

The image below is the two files that are needed (CAT and XAMPP), run the XAMPP file by double-click it or press enter.
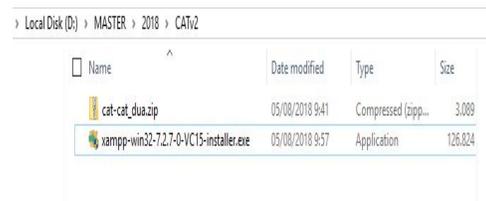
Figure 3. Display of CAT and XAMPP Files

For Windows 10, approve access rights when the initial run, continue by pressing **NEXT** for the next process.
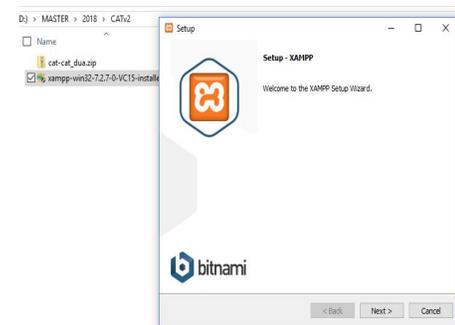
Figure 4. Installing the XAMPP - Step 1

We recommend that you select all files for this server (install by default) then click **NEXT**.
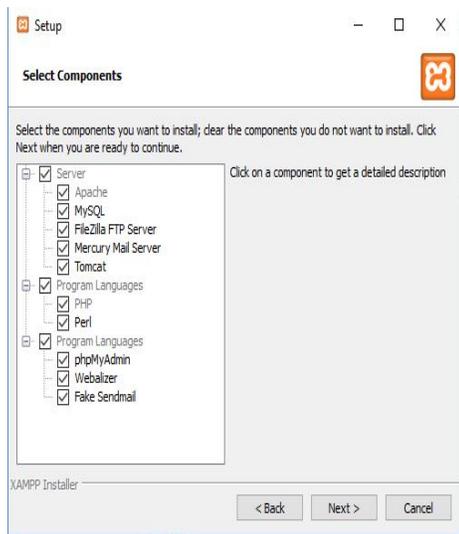
Figure 5. Installing the XAMPP - Step 2

Select the location of the XAMMP installation, in this example, it will be installed on D: \ xampp3, then press **NEXT**.
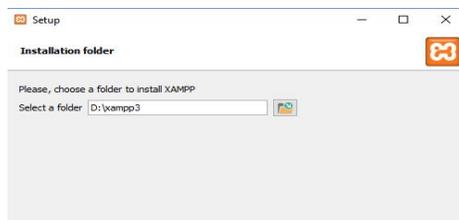
Figure 6. Installing the XAMPP - Step 3
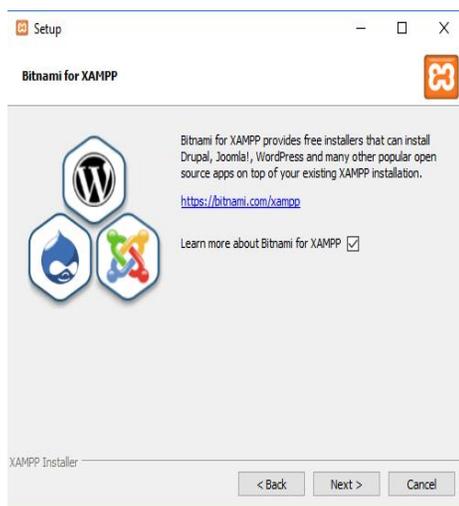
Figure 7. Installing the XAMPP - Step 4
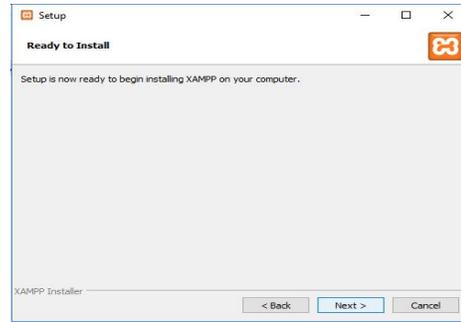
Figure 8. Installing the XAMPP - Step 5

Wait for the installation process to complete.

Figure 9. Installing the XAMPP - Step 6

If there is a firewall notification like below, please Allow Access.
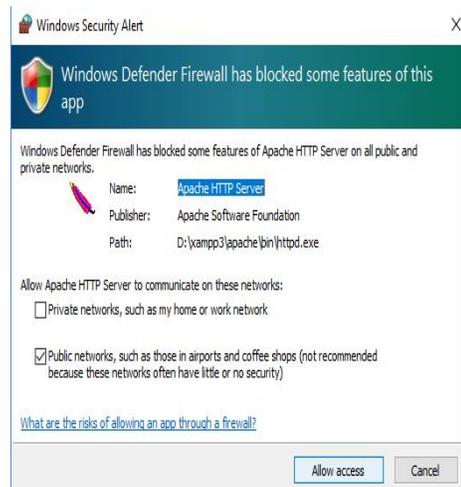
Figure 10. Installing the XAMPP - Step 7

The installation is complete. If the following options are checked, the server panel will appear automatically. If not, you can then open the server panel from the location of the XAMPP installation.

Figure 11. Installing the XAMPP - Step 8

Running the XAMPP

Steps to run the XAMPP:

a. Open the XAMPP installation folder in *D:\\xampp3* and run ***xampp-control.exe***;
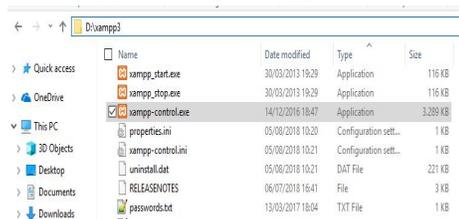
Figure 12. Running the XAMPP - Step 1

b. Run the *Apache* and *MySQL* modules by clicking *Start*;
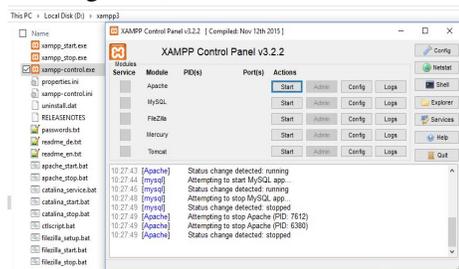
Figure 13. Running the XAMPP - Step 2

c. If *Apache* and *MySQL* are already running on the XAMPP, it will look like the image below. Then you can open the *Browser*.
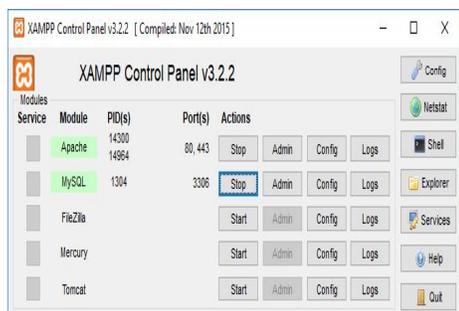
Figure 14. Running the XAMPP - Step 3

d. To test, open a web browser and type http://localhost.

Welcome to XAMPP for Windows 7.2.7
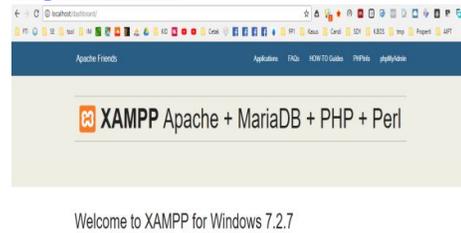
Figure 15. Running the XAMPP - Step 4

Installing a CAT Application on a Local Server

a. The steps for installing a CAT application on a local server are as follows:

1. Copy the catcat_dua.zip file that was previously downloaded to the XAMPP folder at ***D:\xampp3\htdocs***;
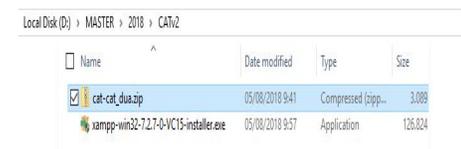
Figure 16. Installing a CAT - Step 1

2. Continue with right-click and select *Extract All*;
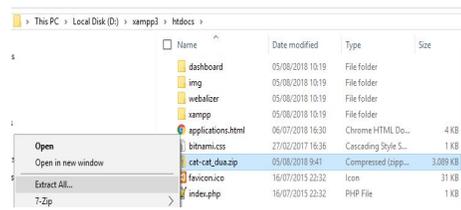
Figure 17. Installing a CAT - Step 2

3. The result of extraction will bring up the new "**cat-cat_dua",** To make it easier to access, rename the file into "**cat"** by right-clicking it then choose rename or click and select the rename menu;
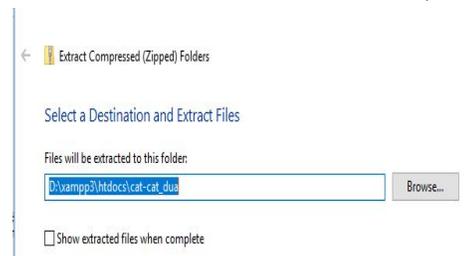
Figure 18. Installing a CAT - Step 3
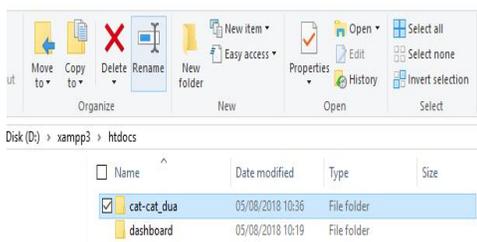
Figure 19. Installing a CAT - Step 4

As a result, the folder has been changed to "**cat**".
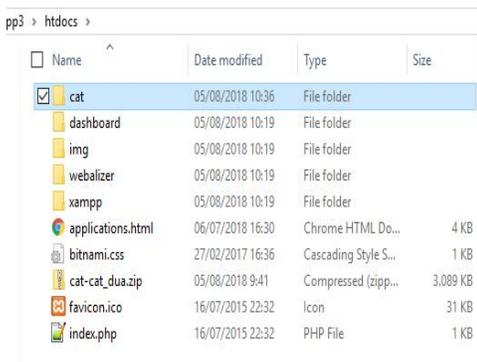
Figure 20. Installing a CAT - Step 5

4. Move all the contents of the file in D:\xampp3\htdocs\cat\cat-cat_dua\cat_dua so that it is directly below D:\xampp3\htdocs\cat\ (using the cut and paste command).
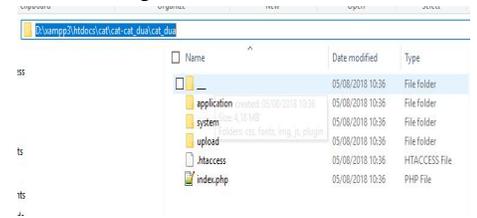
Figure 21. Installing a CAT - Step 6

The new file structure is as follows.
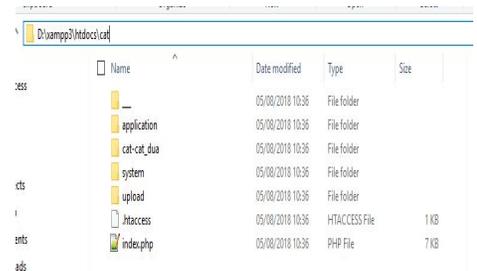
Figure 22. Installing a CAT - Step 7

b. Installing the Databases and Tables

1. Install the database by opening it in the http://localhost web browser and select phpMyAdmin;
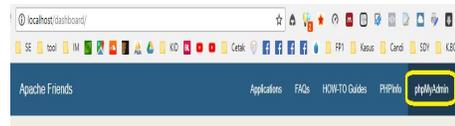
Figure 23. Database Installation

2. Create 1 database with the name **cat**;

Figure 24. Creating a Database

3. Import the database file in D:\xampp3\htdocs\cat\cat-cat_dua\db_cat_dua.sql with the import menu;
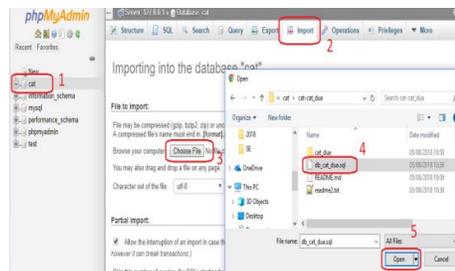
Figure 25. Import Database Files (1)

4. Click the *Go* button as below;

Figure 26. Import Database Files (2)

The results of the table structure that has been stored in the MySQL database.

Figure 27. Table Structure in the MySQL Database

c. Managing the Connection Files

To connect php files with the MySQL database, you need to set the php database connection file in the application in the D:\xampp3\htdocs\cat\application\config. Edit database to **cat** according to what was made before and save it.

Figure 28. Managing the Connection Files

Accessing CAT

To try to access the CAT application, use the http://localhost/cat/.

Figure 29. Display of CAT Applications (1)

Enter the **Admin** username and **admin** password as the application's default password.

Figure 30. Display of CAT Applications (2)

The application is ready to be used locally.

Computer Based Mathematics Self-Efficacy Instrument

a. Guide for Students

This system is stored on the server and can be accessed via the address se.umbyogya.com using a web browser. For participants, log in using the Student Identification Number (NIS) as the default user account and password.

Figure 31. Front Page of Computer-Based MSE Application

After successfully logging in, participants can see the list of available tests or if needed can change the password using the Change Password menu on the top right.

Figure 32. Display for Students

Starting to fill the scale by clicking the Test Menu, the exams that are still available can be followed by clicking Follow Exam. Enter the correct Token and click Start Test.

Figure 33. Exam Menu (1)
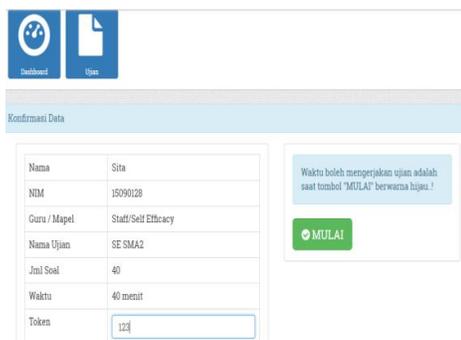
Figure 34. Exam Menu (2)
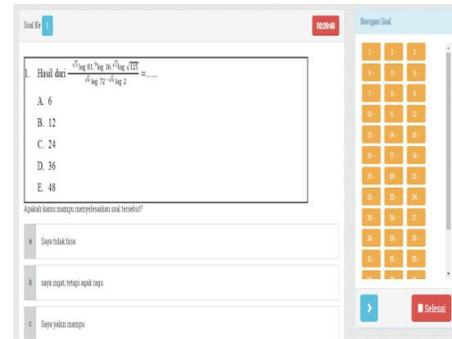
Figure 35. Exam Menu (3)

The exam number that has been or has not been done can be seen using the navigation on the right. When you have finished clicking, you can see the resume.

Figure 36. Exam Menu (4)

If the time is still there and will end the test, use the *Finish* button (marked in red).

b. Guide for Admin

Test users can be added manually or imported using the downloaded template. Here's how to add users manually.

1. Click Student data
2. Add
3. Fill in the required data
4. Save
5. After that, click **Activate User**

Figure 37. Display for Admin (1)

Figure 38. Display for Admin (2)

c. Guide for Teachers or Testing Team

The teacher or testing team can make various tests according to the time or type of test subjects and needs. The list of exams can be seen from the EXAM menu.
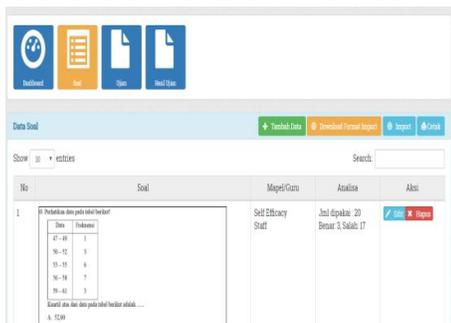
Figure 39. Display of Item Scale Menu (1)

Figure 40. Display of Item Scale Menu (2)

The teacher or the testing team can also make various tests according to the time or type of test subject as needed. The list of exams can be seen from the **EXAM** menu.

Figure 41. Display of Item Scale Menu (3)

Next, the steps to add a new exam are as follows.

1. Add;
2. Fill in the data needed: type of lesson, number, date, limit, and randomization of questions;
3. The test code will be randomly generated.
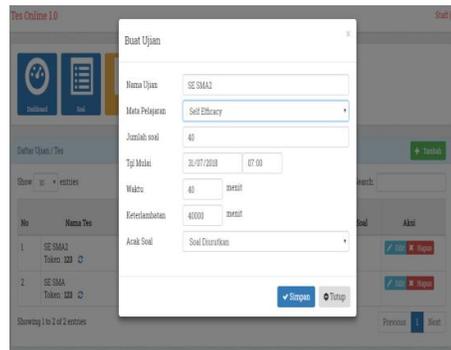
Figure 42. Exam Adds Menu

View the results of the exam using the Test Results menu for details of each click View Results.
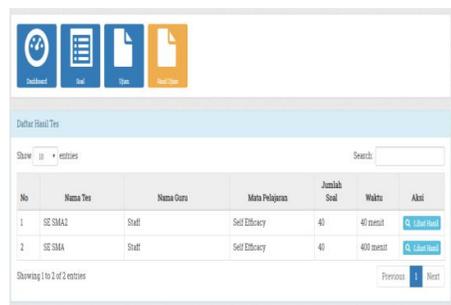
Figure 43. Exam Results Menu

d. Data Analysis

The data stored on the Server in the MySQL database can be retrieved by using phpMyAdmin and then exported to Excel files.

Figure 44. Data Storage Display (1)

Figure 45. Data Storage Display (2)

Figure 46. Data Storage Display (3)

Figure 47. Data Storage Display (4)

The data can be processed with a Spreadsheet (Ms. Excel), the main data needed is the name/student ID and answer list column.

Figure 48. Data Display in Ms. Excel (1)

To separate the data as needed, use the Text to Columns function in the Excel application.

Figure 49. Data Display in Ms. Excel (2)

The following are the results of the report in Excel.

Figure 50. Display of Report Results

CONCLUSION

Based on the results of the study, it can be concluded that the scale of computer-based Mathematics Self-Efficacy has been completed and developed. This means that the application or instrument is ready to use.

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