# DEVELOPING EVALUATION INSTRUMENT FOR MATHEMATICS EDUCATIONAL SOFTWARE

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## Abstract

The rapid increase and availability of mathematics software, either for classroom or individual learning activities, presents a challenge for teachers. It has been argued that many products are limited in quality. Some of the more commonly used software products have been criticized for poor content, activities which fail to address some learning issues, poor graphics presentation, inadequate documentation, and other technical problems. The challenge for schools is to ensure that the educational software used in classrooms is appropriate and effective in supporting intended outcomes and goals. This paper aimed to develop instrument for evaluating mathematics educational software in order to help teachers in selecting the appropriate software. The instrument considers the notion of educational including content, teaching and learning skill, interaction, and feedback and error correction; and technical aspects of educational software including design, clarity, assessment and documentation, cost and hardware and software interdependence. The instrument use a checklist approach, the easier and effective methods in assessing the quality of educational software, thus the user needs to put tick in each criteria. The criteria in this instrument are adapted and extended from standard evaluation instrument in several references.

***Keywords**:* mathematics educational software, educational aspect, technical aspect.

## INTRODUCTION

Nowadays, development of technology has influences on teaching and learning processes in the classroom. Computers as the product of the development of technology can be used as teaching media. Research studies show that students get better achievement by using computers in the classroom than students who are taught by using usual methods (House, 2002). However, it has also been argued that many products are limited in quality. Some of the more commonly used software products have been criticized for poor content, activities which fail to address some learning issues (Squires & Preece, 1999), poor graphics presentation, inadequate documentation, and other technical problems (Dorman, 1992). The challenge for teachers is to ensure that the educational software used in classrooms is appropriate and effective in supporting

intended outcomes and goals. Therefore, the evaluation of educational software is an important process in order to achieve positive outcomes and maximum advantage.

The evaluation process can happen during either the development of the software or the use of complete package (Squires and McDougall, 1994). The evaluation instrument developed in this paper is to help teachers in selecting appropriate mathematics software particularly secondary schools level. This instrument is to evaluate the quality, effectiveness and efficiency of complete packages of mathematics educational software. This instrument intends to be used by teachers as the appropriate evaluators to select the software since they know the pedagogical aspects of students and the instructional objectives (Heller in Squires and McDougal, 1994).

The challenge is that many aspects should be considered during evaluation process. Some experts, such as Quinn (1996), Silius, Tervakari, & Pohjolainen (2003), Zaharias (2006), believe that usability is one of the important issues in software evaluation. However, in educational contexts, evaluation of usability is not enough; we need to pay attention to educational aspect as well (Quinn, 1996; Albion, 1999; Squires & McDougall, 1994), such as classroom interaction, learning theories, curriculum issues (Squires and McDougall, 1994).

This essay will develop evaluation instrument for mathematics educational software evaluation focus on educational and technical aspects which include usability by using a checklist approach.

This instrument is intended for teachers by using a checklist approach. A checklist is an acceptable, well-developed, and effective approach in the evaluation of educational software (Squires & McDougall, 1994). The evaluators can decide whether they will use the mathematics educational software or not by considering factors related to the mathematics educational software.

This checklist consists of three main parts. Firstly, educational criteria consist of content, teaching and learning skill, interaction, and feedback and error correction. Secondly, technical criteria including design, clarity, assessment and documentation, cost and hardware and software interdependence. Finally, considerations comprise the strengths of mathematics educational software, the weaknesses of mathematics educational software and other comments about software. Some of the items are adapted

and extended from Henderson (2007), Squires and McDougall (1994), Sloane, et al (1989), and Truett and Gillespie (1982). Each item has two options, "Yes" and "No", in order that the evaluators could make a clear assessment about the software. All the items use positive statements. In the last part of this checklist, considerations, there is a chance for evaluators to present their overall analysis of the software.

## METHODOLOGY

The criteria are built up to assist the evaluator in examining educational software. These criteria, which are a framework to create the evaluation instrument, are adapted and extended from Henderson (2007), Squires and McDougall (1994), Sloane, et al (1989), and Truett and Gillespie (1982). These references have been used for many years as framework in developing evaluation instrument in some of foreign countries.

The criteria on the evaluation instrument of mathematics educational software in this paper consist of:

1. Educational Criteria
    a) Content

        Sloane, et al (1989) explain that the content of educational software has to match instructional objectives. It is an essential aspect in evaluating educational software. As Polandian (1997) argues that the applicability of educational software should be accompanied with up to date content, suitable for variety ability level and filling the curriculum requirements. Therefore, evaluators have to notice whether the content of the software matches syllabus, supports the curriculum and suitable for intended students or not.

    b) Teaching and Learning Skill

        Mathematics educational software can be used as teaching media. It motivates students in constructing their mathematics knowledge (Yushou, Bokhari, & Wessels, 2004). Appearances and the ways of the software in presenting lesson materials encourage students to think mathematically. Visualisation helps student in understanding mathematics concepts. Computers can be an instrument to increase students' ability in problem solving and investigation

(Beilby, 1987 in Yushou, Bokhari, & Wessels, 2004). For instance, the program can guide students to work out a formula.

c) Interaction

Sloane, at all, (1989) point out that the educational software has to be able to interact with students, who are involved in running the software. Students' activities in a particular section determine how the program will run, and the program gives response to students' input. Squires and McDougall (1994) explain that activities inspired by the software can encourage students to work together. Moreover, students' involvement have important role in learning mathematics to achieve meaningful learning.

d) Feedback and Error Correction

Feedback has significant impact on the learning process especially to motivate students (Hazari & Schnorr, 1999; Hattie & Timperley, 2007). The feedback should be informative and constructive, and it also declares whether students are right or wrong (Sloane, at all, 1989).

2. Technical Criteria

a) Design

Sloane, at all, (1989) explain that badly designed mathematics educational software can be boring, in contrast well design mathematical educational software can be motivating. Good mathematics educational software is well designed in order to perform its role effectively in teaching and learning. Well designed mathematics educational software has logical sequences, good visualisations that can illustrate mathematics concepts, graphics, sound and colour used effectively, and information displayed in appropriate amount neither too dense nor too empty.

b) Clarity

The mathematics educational software has to have clear instructions and information to help the users in exploring the software and to avoid misinterpretation and confusion (Sloane, at all, 1989).

c) Assessment and Documentation

The computer is an instrument that can collect, save, fix and analyse data, therefore the mathematics educational software can be used to provide the information to assess students' ability and individual instructional programs based on the students' progress (Sloane, at all, 1989). Mathematics educational software can be used by teachers as teaching media and instruments to observe students' achievement.

d) Availability of Hardware

The main things have to be considered when selecting educational software is whether it is could be run or not. Furner and Daigle (2004), assert that the availability of hardware and operating system, the understandable of the instructions and reliability are essential things to be considered. Moreover, the educational software must be easy to use both to set up and to operate. It also have to be user-friendly, it is mean that its design and navigation are familiar and easy to operate by the students. Another aspect in technical factor is adaptability of the educational software which means it allows teachers to adapt and to modify the software to suit with students' levels for example, talented students, average, or even for students with special needs (Poladian, 1997). Some software producers allow the users to make multiple copies; some will permit to create several copies in limited circumstances; while other producers forbid their costumers to make a copy of software (Sloane, at all, 1989).

## HOW TO USE THE INSTRUMENT

The evaluation instrument of mathematics educational software can be used by mathematics teachers individually or in a team.

The steps of evaluating educational software are teachers fill in the checklist first; afterwards they can analyze the data by using the appropriate formula. They analyze each criterion of the software as a consideration to analyze the whole mathematics educational software. For applying in a group, teachers can use Microsoft Excel to help in calculating and analyzing data.

If the evaluators choose the "Yes" option, it means score for the item is one point, while if the evaluators choose the "No" option, it means score for the item is zero. Here is the formula used in analyzing data from the checklist.

**1. Analyzing a particular criterion of the mathematics educational software**

The objective of analyzing a particular criterion is to get information about the strengths and the weakness the software in certain aspect.

The formula below can be use in analyzing process.

$$q = \frac{t}{e \times m} \times 100\%$$

$q$ = quality of the software on this criterion

t = total score for the particular criterion from all evaluators

$e$ = number of evaluators

$m$ = the highest score for the particular criterion

According to Sloane, at all, (1989), if the quality of the software on the criterion is 35% or less, the software has a weakness on the particular criterion. If the quality of the software on this criterion is between 35% and 65%, the software is in a neutral position on the particular criterion. If the quality of the software on the criterion is 65% or more, the software has strength on the particular criterion.

**2. Analyzing the quality of the mathematics educational software in general**

In analyzing the quality of the mathematics educational software, we need to consider the strengths and the weaknesses of the software that have been got from analyzing a particular criterion of the software.

The formula below can be used to "count" the quality of the software.

$$Q = \frac{T}{e \times M} \times 100\%$$

$Q$ = quality score of the software

$T$ = total score for all criteria from all evaluators

$e$ = number of evaluators

M = the highest score for all criteria

Sloane, at all, (1989) divide three categories of the score:

- If the quality score is 50% or less, the software is not appropriate to be used in teaching and learning mathematics.
- If the quality score is between 50% and 75%, the software will be considered to be used in teaching and learning mathematics by thinking about the strengths and the weaknesses of the software and other comments about software.
- If the quality score is 75% or more, the software is appropriate to be used in teaching and learning mathematics.

## CONCLUSION

The instrument on this paper is designed for mathematics teacher to evaluate the educational software in order to select the appropriate software. It is focus on educational and technical issues. This evaluation instrument can be used individually or in a group of teachers. The evaluation instrument of mathematics educational software will assist mathematics teachers in choosing appropriate software for teaching and learning mathematics.

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## APPENDIX

### 1. Educational Criteria

#### a. Content

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | The content fit with mathematics curriculum | | |
| 2. | The content is realistic and accurate | | |
| 3. | The content meet students' objective | | |
| 4. | The aim and objective of the content is clearly stated | | |
| 5. | The content is appropriate for the intended students | | |
| 6. | The content has logical sequence | | |
| 7. | The content can be modified | | |
| 8. | The content is free of gender racial, ethnic, and other stereotypes | | |
| 9. | The content is free from spelling, grammatical, and punctuation errors | | |
| 10. | The content is free from violence | | |

**Additional comment on the content:**

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#### b. Teaching and Learning Skill

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | The software help students to understand the material | | |
| 2. | The software motivates students to learn mathematics | | |
| 3. | The software helps students to construct their mathematics knowledge | | |
| 4. | The software has various levels of difficulty according to students' skill level | | |
| 5. | The software requires various levels of speed according to students' skill level | | |
| 6. | The task or test are suitable with the material | | |
| 7. | There are tests that match the material presented | | |
| 8. | Teacher can easily apply the program in the classroom | | |
| 9. | Teacher can modify the program | | |
| 10. | The software encourage students to compete with other students | | |

**Additional comment on Teaching and Learning aspect:**

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**c. Interaction**

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | The software involves students in active learning | | |
| 2. | Users can check the instruction any time | | |
| 3. | Users can control the sequence of presentation | | |
| 4. | Users can control the speed of presentation | | |
| 5. | Users can control levels of difficulty | | |
| 6. | Users can enter the program at different points | | |
| 7. | Users can stop in the middle of an activity and begin at that stop point in the next session. | | |
| 8. | Users can exit the program any time | | |
| 9. | Users can undo their activity | | |
| 10. | The software provide save button | | |

**Additional comment on interaction aspect:**

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**d. Feedback and Error Correction**

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | The feedback is related to student responses | | |
| 2. | The feedback is relevant to student class levels | | |
| 3. | The software has a immediate feedback | | |
| 4. | The feedback has explanations why student responses are true or false | | |
| 5. | The feedback can be measured so students know the number or the percentage of their correct response | | |
| 6. | The feedback are appropriate and pleasurable (both for the bright and weak students) | | |
| 7. | The feedback to error avoid derision or rebuke | | |
| 8. | The software gives a quick instructional response if there is a problem | | |
| 9. | The software gives a quick reaction if there is wrong input | | |
| 10. | The feedback is used effectively | | |

**Additional comment on feedback and error correction:**

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## 2. Technical Criteria

### a. Design

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | The screen formatting is clearly presented and easy to read | | |
| 2. | The information is presented effectively | | |
| 3. | The procedural instructions can be understood easily | | |
| 4. | Appearance of texts and instructions are appropriate | | |
| 5. | The software has various responses to students' activities | | |
| 6. | The software has visualisations that can illustrate mathematics concepts | | |
| 7. | Graphics and audio are suitable to content | | |
| 8. | Graphics and audio are used for appropriate instructional reasons | | |
| 9. | Graphics, audio, and colour motivate students | | |
| 10. | The software has understandable visualisation to help student in enhancing their mathematics knowledge | | |

**Additional comment on the design aspect:**

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### b. Clarity

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | Instructional statements are clear | | |
| 2. | The sequence is clear | | |
| 3. | Error messages are clear | | |
| 4. | The software provides helps if there are some difficulties | | |
| 5. | Presentation shows clearly where the students should focus their notice | | |
| 6. | The presentation is neither too crowded nor empty | | |
| 7. | The explanations of materials are clear | | |
| 8. | Graphics are clear | | |
| 9. | Visualisation of mathematics concepts can be easily understood | | |
| 10. | Colours are used appropriately and not distracting | | |

**Additional comment on the clarity aspect:**

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**c. Assessment and Documentation**

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | Correct and incorrect student responses can be documented | | |
| 2. | Students' performance can be accessed easily by teachers | | |
| 3. | The software can show the progress of students | | |
| 4. | Data in student records can be changed | | |
| 5. | New data can be added to the records | | |
| 6. | Student records can be sorted | | |
| 7. | Students records can be presented on the screen | | |
| 8. | Student records can be printed | | |
| 9. | The software can show students' weaknesses on materials presented | | |
| 10 | Student progress records can be saved safely | | |

**Additional Comment on the assessment and documentation aspect:**

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**d. Availability of Hardware**

| No. | Items | Yes | No |
|---|---|---|---|
| 1. | Schools can afford to buy the software | | |
| 2. | Schools can afford to buy the software license for their students | | |
| 3. | The software producers allow to make copies of the software | | |
| 4. | The software is compatible with various computers | | |
| 5. | Capacity of memory is available for the software | | |
| 6. | The computers have devices required to run the software | | |
| 7. | Software can handle multiple users | | |
| 8. | Students can run this program | | |
| 9 | The software can be operated without programming skills or prior computer knowledge | | |
| 10 | The software can be run easily in the computers | | |

**Additional Comment on the availability of hardware:**

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**3. Considerations**

**a. Describe the strengths of the software in general**

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**b. Describe the weaknesses of the software in general**

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**c. Give your other comments about the software in general**

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