

The comparison of “HotQuiz”, a newly developed authoring tool, with Scientific Notebook

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Abstract

The authors are mathematics & engineering teachers in Singapore. Many of their students have a very weak foundation in mathematics. The students need a lot of drilling practice to strengthen their fundamental algebra concepts. Many schools in Singapore use some authoring tools to code exercises for practice as well as assessment purposes. One of the popular authoring tools is Scientific Notebook (SN). However, SN has the following weak points:

1. Teachers cannot monitor the progress by using SN alone.
2. If the teacher wants to conduct a test in a lab, the school has to buy many copies of SN (or site license) for individual students.
3. Each student has to purchase SN in order to do SN exercises at home through the web. Not many students can afford.
4. Teachers have to learn how to use SN before they can code exercises. Many busy teachers hesitate to learn.

The Ngee Ann Polytechnic developed another similar authoring tool “HotQuiz”. It enables students to do exercises anywhere through the web. Each student is given an account with password. The students can use the exercise for self-learning. At the same time, teacher can also monitor their progress easily for assessment purpose. Furthermore, HotQuiz can import directly questions written in html. There is no need for teachers to learn a new way of entering the question items. The authors feel that “HotQuiz” is more appropriate for secondary school students.

HotQuiz can accept multiple-choice questions as well as free response type. It has attracted the interest of many high schools in Singapore and the feedback is promising.

In their presentation, the authors will do a comparison between the Scientific Notebook and the “HotQuiz”. They will also explain why “HotQuiz” is more appropriate for the assessment of high school students.

BACKGROUND AND INTRODUCTION

In the recent years, Ngee Ann Polytechnic (NP) in Singapore is offering on-line assessment services to Hong Kah Secondary School (HKSS) and other high schools. In the past, Scientific Notebook (SN) was one of the tools being used to code the assessment exercises. The results were very satisfactory. For self-learning purpose, students can practise their exercises anywhere in the school campus and even outside school. For assessment purpose, students can have tests and examinations in the laboratory. Students can get the feedback and scores immediately after their work. Invigilation can be done by video camera and no printing of examination paper is necessary. A lot of manpower and money could be saved.

In the early part of the coding of the exercises, tests and examinations, all the questions are in the format of multiple-choice type. Multiple-choice questions in mathematics have a very serious weak point. Students can use the choices to work backwards. For example, if a student is asked to do an integration. He can differentiate the four choices one by one and find the key easily without having any knowledge of integration. It becomes essential to code free-response questions to the item bank.

However, Scientific Notebook can only provide good multiple-choice questions. Its free-response questions have some weak points. Teachers have tried different way to overcome them but it was found that this is not a long-term solution. Another main reason makes HKSS to be reluctant to use SN is that every end-user has to purchase the SN. It is too expensive for the school to purchase the site license. Students also feel difficult to afford if they want to use SN at home.

In 2002, the Mathematics Department of HKSS noticed that there was another authoring tool called "HotQuiz" ("HQ") developed by NP. NP was approached and was asked for help in developing some quiz questions. After some trial runs, HKSS decided to implement it at the first semester in 2003.

MULTIPLE CHOICE QUESTIONS

Multiple-choice question is good for analyzing of results. From the responses, teachers can identify the weak points of the students. However, multiple-choice questions are not ideal for mathematics assessment. The correct answer of a multiple-choice question is displayed as one of its choices. Smart students can identify it by different non-traditional ways. For example, if a student is asked to do an integration problem, he can differentiate the choices one by one to identify the key. As a result, he can solve all the integration problems without knowing any integration technique. Another example is that students can identify the key by substitution without solving the equation. In many cases, multiple-choice question has some weak points in testing of mathematics concepts. Sometimes we also have to provide free-response questions to fit different needs.

DEVELOPMENT OF FREE RESPONSE QUESTION SOFTWARE

The development of software for free-response questions is not as easy as multiple-choice questions. There are two difficulties, which need a lot of effort to overcome. A user-friendly toolbar of mathematical symbols is needed for the students to input their answers. The software needs to be intelligent enough to accept algebraic expressions, which are mathematically equivalent to the correct answer.

In some software, students have to use the keyboard to input the mathematical symbols. (For example, in some languages we use “^” to input power and in some other languages we use “**” to input power). This is strongly criticized by educators as they think that students should not spend time and effort to learn and to memorize a special way of input for any particular software. The way of input has nothing to do to students’ improvement of mathematical concepts. As a result, in early stages of most software, teachers can only design questions with numerical answers, or linear expressions without any mathematical symbols.

The second problem is more difficult to be solved. Students should be allowed to write an expression in their own way. Educators expect the software can be intelligent enough to determine whether the input expression is mathematically equivalent to the correct answer. An engine is needed to perform this function. Unfortunately, most engines are not suitable for this purpose. Some engines are too intelligent and blindly accept some answers, which are not simplified. For example, the answer is $2x+1$. The engines accept $x+x+1$ as correct because it is mathematically equivalent. However, teachers become upset because they feel that this unsimplified answer is not acceptable at all. These authoring tools also should be able to entertain additional requirements from the teachers. If the question requests an expression to be answered in ascending order, most authoring tools (e.g. SN) will not be able to take care of it.

SCIENTIFIC NOTEBOOK

SN is a Computer Algebraic System. It contains an important part called Exam Builder which can be used as an authoring tool. Exam Builder has the following strong points:

1. It has user-friendly toolbars which enable the users to input many special mathematical symbols.
2. It can import picture files easily.
3. Its graph plotting feature is convenient and user friendly.
4. It works in a Windows based environment. It can also be run in the Web environment with plug-in of SN. (However, the trial period plug-in is only 30 days)

The weak point of Exam Builder is:

The Exam Builder in Scientific Notebook 4 can deal with multiple choice question items well. It claims that we also can use it to code free response question items. Unfortunately the engine behind this authoring tool is too powerful to do the job. The engine will accept any correct answer in any format. As a result, the coder cannot control the expected format of the answer. In an extreme case, if a student is asked to simplify an expression, he can just copy the question and paste it into the input box to obtain a correct score. Another commonly quoted example is that when student is asked to express an algebraic expression in ascending order, SN accepts expressions in any order.

REASONS OF CHOOSING “HotQuiz”

“HQ” includes the following strong points of SN:

1. It has a user-friendly toolbar.
2. It can provide immediate feedback after students’ assessment.
3. It can input pictures and graphs easily.
4. The parameters can be randomized.
5. It can provide multiple-choice questions.

“HQ” also has the following functions:

1. Teachers can use key in questions without difficult training.
2. Teachers can control the acceptable answers.
3. Students’ work can be monitored and controlled easily.
4. Its free response question features do not have the weak points of SN.

APPROACHES OF “HQ”

SN is a powerful Computing Algebraic System (CAS) backup by the Maple engine. It compares the student’s response with the correct answer to see whether they are mathematically equivalent. That is why it accepts all mathematically equivalent responses even though they are not simplified.

We do not need a CAS for “HQ”. We include all the acceptable answers as text and “HQ” will compare the student’s response with these answers. If the response equals to one of these answers, HQ will mark the response to be correct.

UNFORSEEN DIFFICULTIES IN IMPLEMENTING “HQ”

IN the early stage, “HQ” was not perfect. The authors worked with the development team of “HQ” closely. They provide feedback and suggestions to improve “HQ” from time to time.

1. Teachers are reluctant to learn new software. They complained that it was not easy to develop new questions using “HQ” though the “HQ” was already designed in such a way that it was very user friendly to teachers. The authors felt that it is good to let the teachers to code the question using a language, which they are already familiar with. The teachers then will not need to learn any new things. As a result, the “HQ” development team designs “HQ” in such a way that it allows teachers to supply their questions in MicroSoft Word format and the “HQ” team will help them to upload the questions into “HQ”.
2. “HQ” expects the teacher to list out all possible acceptable answers. However, the numbers of correct answers in some questions are large. For example, there are 16 answers in the factorization of the expression: $ax+2ay+2bx+4by$. It was suggested to the teachers to create some conditions to reduce the number of answers. In the example we just mentioned, we can modify the question to be: $(x+2y)$ is a factor of $ax+2ay+2bx+4by$, find the other factor.

CONCLUSION

“HQ” provides an alternate choice to the teachers. Its approach is completely different from SN hence it does not have the weak points of SN. It has another strong point that there is no need for the end-user (students) to purchase the software. However, there is still some room for improvement. For example, students can only see the correct answers and their answers to each question in a quiz. There is no feedback column for the teacher to supply explanation of the answer to each question. The next stage of development is that we will include the detail solutions in the question so that the student can review his mistakes after the test.

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