Using Real Events for Mathematics Performance Tasks in Primary Schools

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Teachers in any country work within real constraints. In Singapore these include large classes as well as a curriculum with approximate times allocated to different topics in order to complete the curriculum. They also work within an environment where education is valued and students feel it is important to do well. Within this system the question arises as to how teachers can incorporate real-life events into their classroom practice.

This paper describes how two teachers working in Singapore used the recent tsunami to generate a mathematics task for use in the school. It describes the development and implementation as well as the difficulties encountered in the implementation. The task was designed in such a way as to be integrated into the curriculum. The activity was introduced in a seamless manner so the students would be using the mathematics that they would ordinarily be working on in the curriculum. This enabled students and teachers to continue with the curriculum; that is, the task is seen as part of the school programme and not as something that is “material to be covered over and above the curriculum”. Neither did the activity require teachers to take time away from other mathematical work.

The paper also briefly describes the students’ performance on this task and the implications for mathematics teaching and learning.

Introduction
The use of alternative assessment, including authentic and open-ended problems in schools, is a topic that has received considerable attention over the past decade (Smith, Kuhs, & Ryan, 1993; Rutheven, 1994; Berenson & Carter, 1995; Castle & Lewis, 1996; Hopkins, 1999; Sullivan, Warren & White, 2000; Fan, 2003). This literature includes discussion papers, examples of classroom activities as well as research. For a recent comprehensive review of this literature see Annotated Bibliography on Alternative Assessment in Mathematics (Mathematics Assessment Project Team, 2004).

However, alternative assessment cannot just be grafted onto a school curriculum. Teachers have content to cover, timelines to keep to, and so on, and for these tasks to be effectively used by students they must be designed in such a way that teachers feel comfortable with utilising them in the classroom. If we operate on an “everything must be in addition to the present situation” like a restaurant where a price is quoted as “++”, (plus service charge and tax) alternative assessment will not be effectively integrated into the mathematics curriculum.

This paper reports on the use of authentic and open ended tasks. In addition to the value of such tasks in helping develop concepts and problem solving skills, they provide a basis to help students see the value of mathematics in the real world. The paper will focus on the development of one particular task that was developed and used in two primary 4 classrooms. It will present the process followed in developing the task, describe how it was used in the classrooms and discuss the outcome and difficulties faced. It is important to note that the focus on this paper is on the developmental process of designing and implementing such as activity, and the implications for teaching and learning, not on the mathematical outcomes, per se.

Tsunami – The development
There was a strong desire to develop a task that was authentic and relevant to the students’ lives. The researcher had suggested a task based on the Chinese New Year, but while it was relevant and authentic the teachers felt it was too similar to a previous task (planning a party) that had been completed last year. This would have resulted in the task being too limited in terms of enjoyment, predictability, and so on.
The recent tragic tsunami that hit the Asia region became the centre of international and national discussion and, consequently, provided an opportunity to develop a task that would be truly authentic and meaningful. It was not possible to open a newspaper, listen to the radio or television or, for that matter have a discussion with friends without the situation being discussed. An event that happens in the real world provides an opportunity to integrate the students out of school and classroom experiences. This is often done in areas such as social studies, art, music, and so on, but in the authors’ opinions, this integration is limited in mathematics. The teachers involved in the performance task component of the Mathematics Assessment Project were provided with an ideal opportunity to meet the goals of the project, which focused on the use of open-ended and, wherever possible, authentic mathematics tasks. The tsunami provided an opportunity for a task that was real and current. The teachers took this opportunity to develop the project. In addition, the school was running a donation drive for tsunami victims. The task was designed to be integrated into the mathematics programme; not as something that was in addition to their normal mathematics activities.

**Tsunami – The Implementation**

The task was implemented within the regular classroom. A copy of the handout given to each class is attached to this paper. It should be noted that the two classes are different resulting in the implementation being different. The students were banded based on their results in P2. The “better class”, referred to as class A (which contained the best P2 students), were given less direction on how to approach the problem, while the weaker class, referred to as class B (weaker but not weak), were given more guidance.

Before proceeding it is important to note that the customisation of tasks to fit the class is critical to the underlying pedagogical approach employed by the Mathematical Assessment Project. If the performance tasks and their assessment are to be effective the implementation of tasks must vary from class to class. Also, the project was designed so that the teachers were not required to allocate additional time, over and above the designated time within the scheme of work, to the topic associated with the task (although, as will be seen later, this did not always turn out to be the case). The following paragraph gives a brief overview of the general approach used to implement the tsunami task in the classes.

As with any class the details of the explanations and discussions reflect the teacher’s orientation to teaching the particular class; however, the general approach used by both teachers was parallel. The teacher started by explaining the task which included putting the need for help into a humanitarian context. This was followed by an opportunity for the students to suggest what might be needed and appropriate to purchase, but the students were not told what items were needed to be purchased. The students were then put into groups and they made the decision on what to purchase, what was needed for a day, week, and so on. It is particularly important to note that the teachers stressed the need to organise in a manner that was clear to any reader. In class A, no guidance on how to present the data was given, while the teacher in class B suggested some general approach but did not mandate any specific presentation. Once completed the task followed followed-up with the opportunity for the students to refine their work.

**Tsunami - The outcome**

The mathematical “product” was a list of suggestions of what goods the rescued people needed. In undertaking this task it was expected that students would apply their computational skills (including multiplication that was being taught/practised at that time) as well as use estimation skills. The students had little difficulty doing the calculations, but there was limited evidence of the use of estimation in their calculations; most used “exact” calculations.

However, the outcome was not just a list of goods. One of the primary goals was to see if students could organise their work in a coherent manner so that other people could read and understand what they did. Such a “skill” is important in terms of the goals of mathematics since in many real situations the format and structure of the final product is not given. The mathematician, in this case the student, has to make his or her own decision or how to organise a presentation of the data. Real problems do not “tell you how to present”; this is the student’s decision.

Below are four examples by different groups illustrating different levels of organisational skills. They show the ability to organise and present data in a manner that can be understood by a reader. There are a few sample items to illustrate the type of data the students used, but it is the general format that we want to stress rather than the individual items included.
Example 1 (Excellent presentation)

<table>
<thead>
<tr>
<th>Items Needed</th>
<th>Per person</th>
<th>Whole village per day</th>
<th>Whole Village per week</th>
<th>Whole Village per month</th>
<th>Whole Village per six months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Aid</td>
<td>2 rolls</td>
<td>440 rolls</td>
<td>3080 rolls</td>
<td>12400 rolls</td>
<td>74 000 rolls</td>
</tr>
<tr>
<td>Powder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food</td>
<td>4 bottles</td>
<td>880 bottles</td>
<td>6200 bottles</td>
<td>24 700 bottles</td>
<td>148000 bottles</td>
</tr>
<tr>
<td>Old Clothes</td>
<td>1 T-Shirt (unisex)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Pants (unisex)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Example 1 is well organised and has all the data so the reader knows how to interpret the information without the need for additional input.

Example 2 (Good presentation)

<table>
<thead>
<tr>
<th>Tsunami</th>
<th>Things they need</th>
<th>Quantity</th>
<th>One week</th>
<th>One month</th>
<th>One year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water (Bottle 1 L)</td>
<td></td>
<td>2080</td>
<td>8320</td>
<td>99840</td>
</tr>
<tr>
<td></td>
<td>Tent (very big size)***</td>
<td></td>
<td>88</td>
<td>132</td>
<td>176</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*** seems to imply the realisation that some tents might need replacing, or number of people might increase, but clearly does not just multiply by 4 and 12.

Note: Example 2 is well organised but because of the calculations it is unclear how they decided on some of the numbers
Example 3 (Satisfactory presentation)

<table>
<thead>
<tr>
<th>Relief Aid for Tsunami Victims</th>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canned Food</td>
<td>880 Cans</td>
<td></td>
</tr>
<tr>
<td>Mattress</td>
<td>220</td>
<td></td>
</tr>
<tr>
<td>Tents</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>Milk Powder</td>
<td>100 tins</td>
<td></td>
</tr>
</tbody>
</table>

Note: Example 3 has satisfactory organisation and given the numbers in most cases it is possible to work out how the numbers were calculated. However, whereas a mattress might last many months, the period for canned food is not clear, there are limits on the presentation.

Example 4 (very poor presentation)

1) clothes x 50000
2) food x 50000
3) money x 5000

Note: Example 4 is both poorly organised and cannot be interpreted.

In this paper it is not possible to present all the levels of organisational skills shown by the groups. These examples just illustrate the wide range of organisation. They illustrate a wide variety of ability to both organise the data representation as well as include sufficient information so the reader can make sense of the data. The last example has been included so the reader does not get the impression that all students can do this task, but it should be noted that the majority were able to present the data in a coherent manner, but with varying degrees of detail. The authors will now include some brief comments regarding the performance of each class.

Class A – Some specific comments

The groups in class planned their organisation and presentation of the data well. They organised and presented in a clear and concise manner so a reader could understand what was being presented. So the objectives of applying calculation skills and organisation planning and presentation were met except that the students did not use estimation. It should be noted that this activity involved more than mathematical concepts, per se. There was evidence that they had difficulty with ideas, such as what was “needed” versus what was “wanted” by survivors; this will be discussed later. Also, as would be expected there were some unrealistic suggestions such as the need for lots of surgeons, but these were in the minority.

After the initial presentations the teacher went through the activity and the students were able to present a second solution. The teacher discussed their solutions and asked for suggestions on how the presentation could have been improved, could they chose better items, and so on. In addition she added an additional challenge asking students to justify their selection. This resulted in an improved set of suggestions and, in particular, improvement in their organisation (headings, categorisation) and selection of items (realistic).

Class B – Some specific comments

As the comments on Class A indicate there were few problems with this task in that class. Class B had more problems as well as had a different perception of the value of the task. Basically, while most of the presentations were organised they were not as well organised and presented as with class A (it should be noted
that the importance of presentation is not stressed as much in class B. There were also spelling and calculation errors that did not appear in class A’s work. On the positive side they found the task helped them plan, understand concepts, learn about tsunami victims, and so on. However, some students indicated that they found it boring (6 students), while some individual students indicated that it was difficult, too hard, must do a lot of “times tables” and so on. There are two points in the comments worth special attention. First, some of students who were not positive about the task indicated that they did not find it enjoyable because they had to “think”. Second, they did not like the follow-up designed to improve their performance; it is too much like “drafts in English”. This would seem to reflect a more general view of “mathematical activity” rather than an assessment of the tsunami task.

The initial follow up focused on things such as the need to be specific in their items. However, many did not hand back the revised work. When a second follow-up was undertaken where they had to complete a specific worksheet involving 4 items and they were given a period the completed worksheets were returned. The presentations improved from the initial attempt by the class.

Overall, while there were positive results from both classes the task was more successful with class A in terms of the outcomes. The implications of the differential performance will be discussed later in the teacher reflection components, since the authors believe that the comments and difficulties faced raise some generic points relating to the use of these tasks.

Tasks – Reflections from the teachers

While some of the comments expressed in this reflection relate directly to the tsunami task, many go beyond that task, per se, and have implications for the use of performance tasks within the Singapore classroom. Although both teachers did not specifically mention all the following points, they are general concerns and need to be considered in this more global context. They have been presented in point form.

(a) *Time for implementation.* The implementation and follow-up on the tsunami task took considerable time. It meant taking time away from other components of the curriculum. This makes it difficult to implement tasks and cover the work allocated for the year, particularly when many performance tasks have to be implemented. Overall, taking time away from other subjects is not really fair on the students or teachers.

(b) *Noise and conflicts.* These tasks involve considerable discussion among the students and teachers need to be able to handle both the noise and conflicts generated by the discussions.

(c) *Time for planning.* The tsunami task was developed by the teachers completely independent of the researcher. This took considerable time for planning and designing the task. Even when tasks are designed by the researcher and given to the teachers they need to be modified to fit individual classes (as implied earlier this is inherent in the use of performance tasks; a one size fits all model is not appropriate). Consequently, time is needed to allow teachers to develop and modify tasks.

(d) *Beyond mathematics.* The tsunami task involved more than mathematics; for example, it involves National Education. The authentic tasks have to be seen as accomplishing more than mathematical objectives.

(e) *Challenge.* The tasks provide a challenge for the better students but tend to be difficult for weaker students. A task can be considered challenging but appropriate for one class and too difficult for another; not challenging for one class and difficult for another; appropriate for one class and too easy for another; and so on. This means the implementation within the school curriculum needs to be carefully considered. This applies to both the authentic tasks as well as ones that were just open ended.

(f) *Assessing performance.* Students give detailed answers. Assessment takes more time, even if rubrics are available.

This is not meant to be a comprehensive list of all the points raised when reflecting on the use of authentic tasks, but highlights some of the key issues.
Conclusion – Using Performance Tasks – Their value and implementation problems

In some ways this is the most important part of the paper. The use of these tasks has been undertaken for over a year and it is useful to reflect on their value. It is time to reflect on the question as to whether or not such task should be an integral part of the curriculum. Should they be for everyone? If they are of value, what are the implementation difficulties, and so on?

Valuable – Yes, but for whom? How often?

The use of such tasks would appear to be of value for many students. They broaden the students’ experience, provide an opportunity to link mathematics to other subjects/topics, such as National Education, and extend the mathematical knowledge, skills and understanding of our students. Not all students will benefit; but this is true of whatever we, as teachers, try to do in our classrooms, so this cannot be considered a reason not to introduce these tasks in a coherent way into our schools. There is no single “best” type of task or approach to use with all students in a class.

As the previous comments indicate not all students benefited equally from the experience. There is no question that better students benefit more and should have the opportunity to work on such tasks. However, for the weaker students it was clear that sometimes they did not benefit and did not always see the value. If nothing were to change from the present situation in terms of things such as the curriculum and assessment, then the use of these tasks would have to be severely limited and be more oriented to the better students. No recommendation is made on how often tasks should be used and to whom they should be targeted. Rather what is being said is that they are of value and certain questions need to be addressed to make them part of the normal classroom environment. Only within the context of the recommendations that follow can a decision be made on how often tasks should be used.

If teachers accept that this type of task can be considered valuable, then what follows deals with implementation issues. The following are put in the form of recommendations.

Recommendation 1: The content must be reduced and assessment changed.

This recommendation has been labelled the first recommendation. Unless this is seriously addressed this type of task will not become an effective component on the mathematics curriculum. There are a variety of reasons that the current situation limits the use of this effective educational tool.

The effective utilisation of these tasks involves considerable student time. The need to discuss the ideas and follow-up means that teachers must create the time for the task. A crowded curriculum means that teachers feel the pressure to cover the syllabus. In order to effectively implement the task a teacher must, particularly for weaker students, take time away from curriculum subjects; take time away from other mathematics activities, rush other topics; or these tasks become additional work. None of these is an acceptable option. This may be best summarised by a paraphrase of the recent statement by the Minister of Education; we do indeed need to Teach Less to Learn More.

Within the Singapore context the performance on the PSLE examination is of critical importance. In addition, students’ performance on CA/SAs are a significant component of both students’ perceptions of their performance and the assessment of a teacher’s effectiveness. The general expectation (parents, schools, and so on) is for students to get the highest possible marks at all times. The current assessment stresses “skills and knowledge”. If we are to argue that other components such as creativity, organisational skills, seeing the value of mathematics in the real world are important they must be reflected in the formal assessment of students. If not, given the critical importance of PSLE results, students and teachers will see these important mathematical activities as marginal activities.

Recommendation 2: Teachers need to believe in the worth of these tasks.

This may seem obvious but is highlighted as the second recommendation. This type of task will not be effectively integrated into the curriculum unless teachers believe in the value. It is realised that teachers cannot be expected to believe in all tasks for all students. Overall, it is necessary that the teachers believe that this type of task benefits their students. This cannot be done without the implementation of recommendation 1.
Recommendation 3: Different tasks are needed for different classes

The experience clearly indicates that the classes reacted differently to the different tasks. If tasks are to be effective then one cannot mandate a set of tasks that must be used by all students in all classrooms. The best that can be done is to generate a set of tasks that need to be adapted by each teacher to fit the needs of each class. This leads to recommendation 4.

Recommendation 4: Teachers need to be given time to develop and modify tasks.

It is clear from experience that it takes considerable time to modify tasks even when the outline and structure are given to the teacher. If the implementation of these tasks is to be effective the teachers must have the time, otherwise they cannot fully utilise the value of such tasks. They could only do very few in a year.

In conclusion, it is hoped that ideas, comments and recommendations outlined in this paper will help teachers better assess the extent to which this type of task can best be implemented in the curriculum.

References

Annotated Bibliography of Alternative Assessment in Mathematics (2004). Mathematics Assessment Project Team: Centre for Research in Pedagogy and Practice; NIE/NTU.
Background: We have read about the tsunami disaster and how it has affected the lives of many in Asia. Different organizations have come forward to conduct donation drive and collection of useful items that can be distributed to people of the affected countries.

Situation: The Ministry of Education has assigned your school to conduct a smaller scale collection drive for all the schools in the West Zone on useful items that can be distributed to a small part in Acheh or Sri Lanka.

Status of selected villages in Acheh and Sri Lanka
- a small village with about 220 rescued people.
- many orphaned children
- many are still having wounds which need to be treated.
- hygiene is a concern

Your Task: Work in groups of four and decide on the following.

a) The items that can or should be collected.
   (Items which need to be purchased can also be listed.)
b) Work out the quantity of the items on a daily basis then followed by weekly.
c) Present your data in a manner which would be easy for others to capture the details.

Note: You are allowed to use estimation in your numbers.