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## **The use of performance tasks (authentic and/or open-ended) in a neighbourhood school**

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### **Abstract**

Traditionally, assessment in our local schools is largely confined to written tests or examinations where students are mainly assessed on their mathematical knowledge defined in the syllabus and textbooks, and the mastery of procedural skills in solving routine problems. As assessment is one of the key motivators of student and teacher behaviours, it is therefore not uncommon to find a high percentage of school-based assessment, modelled after the eventual national examinations where students are thoroughly prepared by constant practice of past examination papers (Menon, 2000). Such traditional mode of assessment offers very little scope for students to demonstrate their communication skills, ability to solve non-routine problems and creativity in problem-solving. To achieve a more holistic evaluation of the students, many researchers have advocated the use of alternative assessment strategies (see Cai, 1997; Clarke, 1997; Kulm, 1994; Stacey & McCrae, 1998), such as journal writing, project work, performance tasks and self-assessment. This study<sup>1</sup> investigates the effects of integrating performance tasks, specifically authentic and/or open-ended tasks in the mathematics classroom of a neighbourhood school, as an assessment strategy. The findings seem to suggest implicitly the positive influence of this new assessment strategy towards the learning of mathematics. In particular, the mathematics teacher noted that students persisted in their efforts to engage in solving the non-routine tasks despite experiencing difficulties.

Key words: alternative assessment, authentic and/or open-ended performance tasks

### **Introduction**

Assessment is integral to the process of teaching and learning (CPDD, 2000; CPDD, 2004). Well designed assessment allows students' progress to be monitored, learning gaps to be diagnosed and appropriate instructional materials to be designed, so that the underlying learning needs are addressed. Traditionally, assessment in Mathematics has been 'measurement-driven' (Niss, 1993). The units of measurement for such conventional mode of

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assessment are usually in the form of assigned numerical value or grade that served many purposes. One core function of assessment was for making educational decisions on student placement into different courses with a differentiated curriculum, leading to different educational pathways. Over reliance by parents and educators on that 'numerical value or grade' may adversely affect the students, especially when results from high-stake examinations are explicitly used for the above purpose.

Zawojewski and Lesh (1996) voiced their concern with the inadequacies of this superficial means to describe the students' mathematical abilities, as they have irregular profiles of strengths and weaknesses. Ginsburg et al. (1992) held similar views and advocated the use of a variety of assessment techniques so that information from multiple modes of assessment could be integrated to form a more complete picture of the student's mathematical ability. Berenson and Carter (1995) maintained that the 'numerical value or grade' on the traditional test motivates students to expend their efforts in the pursuit of grades rather than encourages them to cultivate an appreciation for the subject.

Given the limitations of the traditional mode of assessment, Clarke (1992) called for the use of alternative assessment strategies to provide meaningful feedback to teachers and students, thereby empowering both. Many researchers have also advocated the use of alternative assessment strategies (see Cai, 1997; Clarke, 1997; Kulm, 1994; Stacey & McCrae, 1998), such as journal writing, project work, performance tasks and self-assessment, to achieve a more holistic evaluation of the students.

This study investigates the effects of integrating an alternative assessment strategy, specifically authentic and/or open-ended performance tasks in the mathematics classroom of a neighbourhood school. The research spanned over a period of about eighteen months and was experimental in design. The performance tasks were used as an instructional and assessment tool in the mathematics classroom, to promote effective teaching and learning. As an assessment tool, it helped to provide clear feedback to students on their performance and at the same time engaged them in monitoring their own learning. The performance tasks were also used as an instructional tool to extend students' thinking and promote meaningful learning.

## **Participants**

A class of forty Secondary One students from the Express stream with thirty boys and ten girls was nominated by the school administrator to be the experimental group (group E). Similarly another Secondary One class in the same stream comprising of twenty-three boys and seventeen girls was selected by the school administrator to serve as the control group (group C). The Secondary One level was chosen as it was deemed the turning point for most pupils when they progressed from primary to secondary education. In the local education system, students are placed in classes that offer different subjects combinations to match their learning abilities and interest, when they proceed to the upper secondary level. This streaming is based on the students' academic achievement in Secondary Two. As the research spanned approximately over eighteen months, introducing the new assessment strategy at Secondary One would be most appropriate so as to avoid the later complications of streaming when students proceeded to Secondary Three(Upper Secondary). Hence for a period of eighteen months, the authentic and/or open-ended performance tasks were integrated in the mathematics instructional practice by the mathematics teacher (Teacher E) of group E while no intervention was carried out by the mathematics teacher (Teacher C) with group C.

### **Methodology**

Ten performance tasks (authentic and/or open-ended tasks) were implemented within the timeframe of eighteen months in the study. The performance task, in this study was defined as a problem assigned to a student or groups of students that challenged them to demonstrate their mathematical understanding and ability. Besides solving the problem, students had to communicate mathematically, the approach and reasoning as well as provide supporting evidence to show how they arrived at the answers. The performance tasks included two salient features: authenticity and open-endedness. The 'openness' of the performance task referred to multiple approaches to the task which allowed students to use different pathways to solve the problem and multiple acceptable answers to the problem – depending on their cognitive ability and level of understanding to begin working on the problem. The other feature of the performance tasks used in this study was authenticity – which referred to representations of real-life situations. The word 'authentic' is a relative concept and holds varied meanings for different researchers. In this study, the word, 'authentic' did not refer to the creation of mathematical models needed to solve complex 'real world' problems. Instead the context of the tasks came from real life situations which were deemed relevant to the student. In this way, engaging in this form of assessment becomes a more meaningful experience for the students.

All performance tasks crafted consisted of two parts: – A and B. The first part served as a warming-up exercise to familiarise students with the context of the question, while the second part was the open-ended task. The questions in part A were scaffolded to help students reviewed the relevant mathematical concepts and skills before being exposed to the more difficult portion of the task in part B. To attempt a smooth integration of this new strategy, rather than artificially grating it into the mathematics lessons, all performance tasks were designed to align with the topics covered in the syllabus and specially tailored to fit in with the scheme of work of the experimental group (group E). Classroom observations and videotaping were made with the permission of the teacher when interventions were carried out.

In the implementation process, students were initially requested to attempt the warming-up questions individually, based on their own understanding. Group discussion followed and students were encouraged to share their solutions within the group. The discussion enlarged to form a class discussion with students volunteering their solutions - explaining and showing their workings on the whiteboard. The workings presented then became a focal point for further discussion among the students - where they evaluated the strategy, solution and occasionally, the processes of the solution. Other strategies or procedures which varied from those presented were also discussed in the class. Students who were unable to complete the entire performance tasks within a two-period timeframe would finish it as homework. Answer scripts were collected on subsequent days as instructed by Teacher E.

All performance tasks were graded by two raters separately using a task- specific rubric. No sample answer scripts were available for the purpose of benchmarking. Before finalising the different levels of attainment for the three criteria of each task, the raters would meet briefly to discuss answers which deviated from the prescribed solution produced by the researchers, or points excluded from the task-specific rubric. The finalised scores for the ten interventions based on the three criteria - approach, solution and presentation were entered into an excel file for record-keeping.

### **Data collection**

The instruments designed for this study include: pre- and post- surveys; the pre- and post-‘new strategy’ tests; interviews with teachers and students of group E; school-based semestral examination results and classroom observations when the interventions were carried out. However due to the extent of the study, only part B of the post-intervention questionnaire

survey which examined the students' views on the interventions and the interviews would be discussed in this paper.

A total of sixteen questions were designed in part B of the post-questionnaire survey to examine the students' views on the performance tasks. The question items centred on the following three main aspects:

1. the students' perception of on the use performance tasks
2. the challenges they face with this new strategy
3. the perceived benefits derived from working on performance tasks

Numerals ranging from 1 to 9 were also assigned to the nine-point Likert-type scale with '1' as 'disagree totally' and '9' as 'agree totally'. The mean value of the response for each item was calculated using the assigned numbers. The number of responses on the scale for each item in the questionnaire survey was also converted to percentages. In addition, the analysis of the question items for Part B of post-questionnaire survey was triangulated with data from the interviews.

At the end of the intervention programme, interviews were conducted with teacher E and six students from group E. The interviews were carried out using a set of structured questions prepared by the MAP team and all interviews were audio recorded and transcribed. The objective of the interviews was to gather further information on the students' perceptions of authentic and/or performance tasks, in addition to the other sources of data for the purpose of triangulation and reaffirmation of findings. The students were scheduled to be interviewed in groups of three, to provide a more supportive environment. Each session lasted approximately thirty minutes to an hour. To have a representative group of varied abilities, six students from group E: two high performing, HP1 and HP2, two average ability students, AA1 and AA2 and two low performing students LP1 and LP2, were randomly selected, based on their End-of-Year Examination 2004 results. HP1, HP2 and AA1 were initially scheduled to be interviewed as a group. However, due to some school commitments, AA1 requested to be the first interviewee so that he could leave early to perform his duties. HP1 and HP2 were then interviewed together immediately after AA1 on the same day. The other three students were interviewed as a group on another date.

Teacher E was interviewed separately using another set of structured interview questions designed explicitly for teachers by the MAP team. The focus of the interview was to obtain information on her perceptions of performance tasks and issues related to its use in the classroom.

## Results and Discussion

### 1. Views on Performance Tasks

Five items in part B of the post-questionnaire survey were designed to examine the views of group E on the use of performance tasks. By combining all the percentages starting from ‘Agree a little’ to ‘Agree totally’, it was observed that about 26% of the students in group E liked the feature on multiple solutions, while 56% responded that they enjoyed working on questions with multiple approaches. About 26% felt that they were good at solving performance tasks and only 12.8% liked more performance tasks in their lessons. Table 1 shows the response of group E to the individual items.

**Table 1: Views on Performance Tasks**

	<b>Group E</b> (No of students =39)	Disagree totally	Disagree a lot	Disagree	Disagree a little	Neither disagree nor agree	Agree a little	Agree	Agree a lot	Agree totally	mean
Q23	I like to solve maths questions which have more than one correct answer.	17.9%	5.1%	23.1%	12.8%	15.4%	7.7%	10.3%	2.6%	5.1%	4.10
Q26	I like to do maths questions which could be solved using different methods.	7.7%	2.6%	7.7%	12.8%	12.8%	12.8%	28.2%	7.7%	7.7%	5.56
Q30	I like to do maths questions which involve the real world	7.7%	2.6%	0.0%	12.8%	25.6%	15.4%	17.9%	7.7%	10.3%	5.64
Q34	I am good at doing maths performance tasks.	17.9%	2.6%	10.3%	17.9%	25.6%	17.9%	5.1%	2.6%	0.0%	4.18
Q36	I would like to have more maths performance tasks for my maths lessons	33.3%	2.6%	12.8%	7.7%	30.8%	5.1%	7.7%	0.0%	0.0%	3.46

In the interviews conducted with six students from group E, all revealed that they found the performance tasks more challenging as compared to routine problems in the textbooks - which they deemed only required the application of procedural knowledge. The students also acknowledged that the open-nature of the problem demanded them to spend more time thinking about the different approaches and situations as they worked out multiple solutions.

Slightly more than 50% of the students liked mathematics problems that relate to real world situations. Triangulating this information with the interviews, LP1 in particular, explained that performance tasks challenge her to think more deeply and she preferred performance tasks because the contexts relate to real-life situations.

LP1: The performance tasks are more challenging. We have to think harder. There are different and more ways of solving the problem and there are more answers.... I prefer the questions because it relates to our everyday life.

Another student, AA1 voiced his preference for open-ended tasks because he believed the skills acquired through solving authentic and open-ended tasks could be transferred to other courses.

AA1: In the future, when we attend certain courses, we can use these types of skills for other courses..... For example, if I want to be a designer for a building, I could use these types of skills to help me design a building.

## 2 Challenges Students’ face in solving the Tasks

Five items in part B of the post-questionnaire survey were designed to examine the challenges group E faced on the use of performance tasks. 46.1% of the students felt that working on performance task was difficult and approximately the same percentage felt lost when doing performance tasks. In the interview, LP2 reported a sense of frustration and felt discouraged when his attempts at solving the performance tasks failed.

**Table 2: Challenges Face in Solving Performance Tasks**

	<b>Group E</b> (No of students =39)	Disagree totally	Disagree a lot	Disagree	Disagree a little	Neither disagree nor agree	Agree a little	Agree	Agree a lot	Agree totally	Mean
Q24	Doing mathematics performance tasks is difficult to me.	0.0%	2.6%	17.9%	5.1%	33.3%	10.3%	15.4%	0.0%	15.4%	5.54
Q28	I have to think harder when I am doing maths performance tasks	0.0%	0.0%	2.6%	5.1%	15.4%	20.5%	30.8%	10.3%	15.4%	6.64
Q29	I feel lost when I am doing maths performance tasks	2.6%	0.0%	12.8%	12.8%	25.6%	25.6%	7.7%	5.1%	7.7%	5.38
Q33	I need hints to help me do maths performance tasks	0.0%	0.0%	2.6%	10.3%	30.8%	20.5%	20.5%	7.7%	7.7%	6.00
Q35	Doing performance tasks takes more time than doing other maths questions usually done in class.	0.0%	5.3%	2.6%	2.6%	21.1%	2.6%	34.2%	13.2%	18.4%	6.61

LP2: Some of the questions require me to think very hard. I will try. If I can that is very good. But If I cannot, I call myself lousy and I will ask the teacher for help.

Researcher: Why do you think you are lousy?

LP2: Because I cannot do the performance task.

About three quarters of the students acknowledged the demands to ‘think harder’ in solving performance tasks and about 56% of the students expressed that they needed hints to solve the question. The teething problems faced as reported by LP1, LP2 and AA2 ranged from understanding the context of the question, the goals of the question to adopting an appropriate strategy to solve the problem.

LP1: Sometimes it is difficult to get the first step. If you can overcome the first step to a question, then it is easier to get the rest of the question. if you cannot overcome the first step, then the teacher has to explain to you.

- LP2: When I come across the question for the first time, I usually don't understand even though I read the question a number of times. I must ask the teacher what to do and the steps needed to solve the problem.
- AA2: Oh, sometimes I can't make out what they want to find.

In a separate interview, Teacher E reaffirmed the range of difficulties faced by her students. She said: "Most of the time they will actually ask me to explain what the questions are asking. .... and how to do it?"

Though in the earlier part of the interview, some students had mentioned that Teacher E pitched her lessons at a level beyond them and they had difficulties understanding her explanation, she remained the dominant figure whom students sought for assistance if they were still unable to overcome their problems in the performance tasks. LP2 said: "First thing I mean I ask the teacher. Then I try out what she had asked me. If I don't understand, I will ask her again. From there also, I learn new methods, and from the new methods, if my friends don't know, so I teach them. So we learn together". However, for the last 4 tasks, both LP1 and LP2 professed that they had found the performance tasks much easier.

Both high performing students and one of the average-ability students AA1, remained positive about working on performance tasks after the intervention period. They declared that they had no objections if performance tasks were integrated in the mathematics curriculum for the next semester.

- AA1: Manageable. Sometimes there are difficulties but I think we can manage with a little help.
- Researcher: If I were to carry on next year, would you mind having performance tasks?
- HP1 & HP2 : No.
- Researcher: You still want to do it despite all the challenges?
- HP1 & HP2 : Yes.

However, some students were undecided. In particular, AA2 expressed that performance tasks were too difficult and he needed to seek his friends' help. Despite discussing with his friends, AA2 maintained that sometimes he still could not understand their explanation.

- AA2: I don't really learn something new because it is too difficult. I have always asked my friends for help..... Sometimes I can't understand."
- Research: But when your friends helped you, do you benefit?
- AA2: Not really ah.



However, in the later part of the interview, there was a change of view. All three students: two low performing students and the average ability student expressed that they did not mind having performance task at the end of each topic as a form of revision.

AA2: I think it is better to do it after every chapter.

LP1: Yes, it's like attempting a performance task after we have completed a chapter based on what we learned.

On the whole, all six students interviewed were positive about the use of performance tasks as an instructional tool in the mathematics classroom, in particular the two high performing students, HP1 and HP2, as well as the average ability student, AA1. One possible reason could be their sense of confidence with their own mathematical competence to solve authentic and/or open-ended performance tasks even though they had found the tasks challenging. For the other students, AA2, LP1 and LP2, they were apprehensive about continuing with the use of performance tasks but agreed to have performance tasks at the end of each chapter because they understood the benefits.

### 3 Students' Perceived Usefulness of Performance Tasks

In addition, 38.5% of the students perceived that doing performance tasks helped them to develop a more systematic approach to learning mathematics. This is in concurrence with one of the criteria in the rubric for grading performance tasks. With regard to the benefits, about 43.5% of the students believed they could learn mathematics by engaging in performance tasks. Student AA1 reaffirmed the same point in the interview when he said: "I think these problem tasks are good for students, especially at our age we need to be exposed to different types of problem-solving". Table 3 shows their responses to the 6 items designed to examine their beliefs on the usefulness of performance tasks.

**Table 3: Perceived Usefulness of Performance Tasks**

Q	Group E	Disagree totally	Disagree a lot	Disagree	Disagree a little	Neither disagree nor agree	Agree a little	Agree	Agree a lot	Agree totally	Mean
Q25	Doing performance tasks helps me to learn maths.	5.1%	0.0%	12.8%	12.8%	25.6%	20.5%	17.9%	5.1%	0.0%	5.13
Q27	Doing maths performance tasks help me to be more creative in problem solving.	12.8%	0.0%	10.3%	7.7%	23.1%	20.5%	20.5%	5.1%	0.0%	4.97
Q31	Doing maths performance tasks helps me see more connections between maths and daily life.	5.1%	0.0%	7.7%	0.0%	30.8%	28.2%	10.3%	12.8%	5.1%	5.72
Q32	Doing maths performance tasks helps me to become more systematic when I am solving maths problems.	2.6%	0.0%	7.7%	7.7%	43.6%	10.3%	20.5%	5.1%	2.6%	5.44
Q37	Doing maths performance tasks makes me learn maths better.	7.7%	5.1%	7.7%	17.9%	41.0%	12.8%	2.6%	2.6%	2.6%	4.56
Q38	Doing maths performance tasks is a waste of time.	2.6%	2.6%	7.7%	10.3%	30.8%	7.7%	7.7%	7.7%	23.1%	5.95

About 56% of the students were positive that working on authentic and/or open-ended performance tasks helped them to perceive ‘more connections between mathematics and daily life’. However, about 46% of the students regarded working on the tasks as ‘a waste of time’ and only approximately 23% disagreed with the statement.

In the interview with Teacher E, she expressed that students were concerned with the syllabus coverage for the semestral examination. Despite the knowledge that all performance tasks were designed to align with the syllabus, some students had misconstrued that performance tasks were carried out at the expense of the mathematics content and were concerned with the preparation for their semestral examination. She said: “.....they were asking why we are doing this? Why are we not doing the normal things? This is because they are quite concern with their work. They are scared that ....this is at the expense of their syllabus.”

The pragmatic mindsets of the students about academic achievement may have stemmed from many sources such as expectation of parents and the inherent structures present in the system, like edusave scholarships that reward individuals who excel. It seemed, to the researcher that the negative feelings towards performance tasks may be attributed to the mistaken belief that the interventions were implemented at the expense of the syllabus coverage which in turn may undermine their performance in the school-based examination.

Teacher E also reiterated the same point in a separate interview about the students’ concerned with their academic achievement and would show greater enthusiasm if the scores in the performance tasks were reflected in the assessment score cards. She explained: “They will be interested because of the marks. They are quite a practical batch you know.....They are certainly not intrinsically motivated.”

### **Conclusion and recommendations**

To conclude this section, three quarters of the students in group E responded that working on performance tasks challenged them to think harder and encouraged them to adopt different approaches in solving the task. A quarter of the students in group E felt that they were good at solving mathematics problems and slightly less than half viewed performance tasks as beneficial towards the learning of mathematics. Teacher E remained the main person whom the students sought for assistance, though some students had expressed in the earlier part of the interview that her explanation was pitched beyond their learning ability and they would rather

seek help from their friends. Despite the challenges that the two low performing students faced in the initial part of the intervention programme, they nonetheless found the last four tasks to be much easier than before. Less than half of the respondents in group E regarded working on the tasks as 'a waste of time'. The pragmatic viewpoints of the students towards academic achievement might have contributed to the negative feelings towards the tasks.

The researcher believed that exposure to authentic and/or open-ended performance tasks helped students to acquire problem-solving skills. This was also consistent with London's (1993) findings, who noted that non-routine problems which were not included in the traditional curriculum imbued students with higher-order problem-solving. In addition, he commented that students developed a sense of mathematical maturity when they laboured through a sequence of non-routine tasks. Hence, the ripple effect of integrating performance tasks might be felt through long term usage when the students were engaged in solving the tasks.

The study also suggested that teachers play a crucial role in the implementation of the new assessment strategy. It would be beneficial if the study was extended to investigate the teacher-related variables that helped to promote its use in the mathematics classroom such as:

- the teachers' beliefs about the teaching and learning of mathematics and how these are related to the implementation of alternative assessment. For example, a teacher who believes that her primary mission is to teach mathematics so as to prepare students for the impending examinations, may not be enthusiastic in the way she implements the tasks;
- the teachers' experience in the classroom, such as the length of service and even the amount of exposure to the new assessment strategy prior to the study, may influence their actions in the integration of such tasks in their lessons.

Further studies on the 'teacher related factors' may help to shed light on how authentic and /or open-ended performance tasks can be effectively implemented in the mathematics classroom.

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