Assessing authentic learning using performance tasks: Experience at Crescent Girls' School

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This paper documents the implementation of the Integrated Curriculum for all the Secondary One students in Crescent Girls' School involving three subjects, namely Science, Mathematics and Geography. The main objective of this programme is to allow the students to see the connections between natural and seemingly disparate bodies of knowledge and skills, and between students' experiences and what they learn in school. Through the use of performance task, the students were engaged in authentic learning to assess their understanding of content knowledge, process skills in problem solving and creativity to address the task requirements. The paper also shares the assessment rubrics that the teachers had designed to evaluate the quality of the students' work and how this was used to further refine the task for future implementation. Feedback and student reflections were gathered from the students and these have become essential resources in the school's continuing effort to improve student learning through alternative assessment approaches to teaching and learning.

KEY WORDS: Integrated Curriculum, Teaching and Learning, Assessment

Introduction

Curriculum integration is a powerful vehicle which calls for the development of connections between natural and seemingly disparate bodies of knowledge and skills, and between students' experiences and backgrounds and they learn in school. Fogarty (2002), the advocate of curriculum integration, echoes four major changes that drive curriculum integration, namely, the ideas of educational theorists, the challenges of the practitioners, the concerns of parents and the perspective of the students. The theorists keep us informed of data on teaching, learning and the human brain which supports a more connected and integrated approach towards curriculum.

However, practitioners are dissatisfied with test-driven curriculum. Similarly, parents are more concerned with student preparation for real world issues rather than preparing them for exams. Most importantly, students themselves are often frustrated because they feel learning in school is mostly irrelevant and unrelated to their lives. In a similar vein, Martin-Kniep (2000) describes four reasons for propelling curriculum integration in schools: (1) growing support for learning and assessment experiences that require the application of knowledge rather than memorization and accumulation of facts; (2) increasing understanding of how brain processes information through patterns and connections with an emphasis on coherence; (3) emerging awareness that knowledge is neither fixed nor universal, and that problems of real significance cannot be solved out of a single discipline of knowledge; and (4) the belief that an Integrated Curriculum can help teachers and students overcome rigid and arbitrary perceptions of subject boundaries (p. 8).

Assessment in education has traditionally focused on the retention of knowledge and its application in limited contexts measured by standardized tests (Wiggins, 1993). However, over the last few decades, many start to question whether such tests are sufficient to determine students' understanding and their active use of knowledge in complex, authentic contexts (Herman, Aschbacher & Winters, 1992). With the growing dissatisfaction with traditional testing methods, the use of alternative assessment has proliferated in the hope of addressing the three basic goals of education, namely retention, defined understanding and active use of knowledge (Perkins, 1991). Garcia and Pearson (1994, p. 355) point out that these alternative assessments include "efforts that do not adhere to the traditional criteria of standardization, efficiency, cost-effectiveness, objectivity and machine scorability." Fogarty and Stoehr (1995) note that many schools that move towards an Integrated Curriculum continue to use traditional assessment measures, but these measures do not always match holistic learning models, and so portfolio and performance assessments are recommended to supplement traditional measures to achieve more authentic and holistic assessment of students.

Hence, when Crescent Girls' School introduced curriculum integration in 2008, the team found it necessary to develop performance tasks to supplement traditional tests to assess students' authentic learning more holistically. These performance tasks require students to complete complex tasks that tap on students' prior knowledge, what they have learnt recently, and apply relevant skills they have acquired to solve authentic issues.

Exploration and Preparation

This section describes the exploratory and preparatory stage before the implementation of Integrated Curriculum (IC). Towards the mid of 2007, our team began extensive research and literature review on suitable models to use for the IC design. Eventually, the team decided to use the model of Integrated Curriculum by Fogarty (2002), and selected the Understanding by Design framework by Wiggins and Mctighe (2005) because of its robust design in terms of student learning outcomes, assessment and learning activities. Furthermore, the team used another pedagogical principle by Fogarty to design the Integrated Curriculum.

Integrated Curriculum by Fogarty

The team used the webbed and integrated model by Fogarty (2002) to identify the theme, "Nature", for the 5-week Secondary One Integrated Curriculum. This was achieved by completing the curriculum mapping for the three subjects identified for integration – Science, Mathematics and Geography. Figure 1 illustrates the Venn Diagram drawn to find the common overlapping theme for the overall unit.

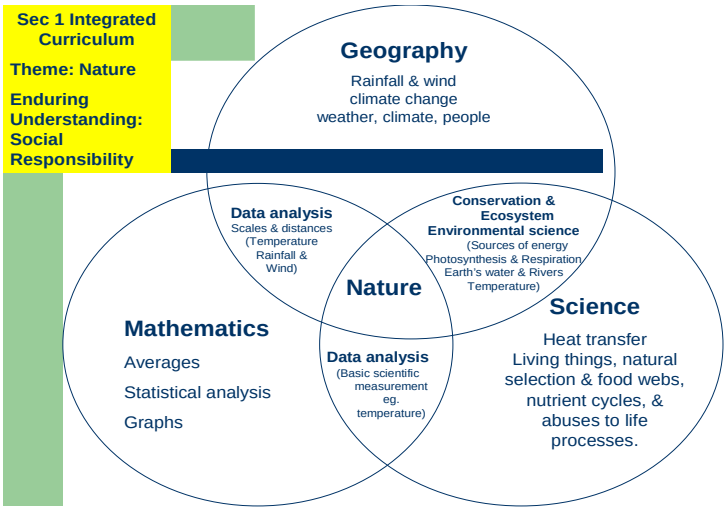

Figure 1: Identify the unifying theme through curriculum mapping

Understanding by Design (UbD)

Essentially, there are three important stages in adopting the UbD framework. The steps taken to design the IC are briefly described in the following section:

(1) **Identify desired results** (Understanding, Essential Questions, Knowledge and Skills)

The team identified the enduring understanding that students should have at the end of the programme. This was done by studying the curriculum and syllabus requirements and matching them with desired outcomes of students learning. After many sessions of brainstorming and discussions, the team crafted "Social Responsibility" as the enduring understanding. This ties in closely with the theme, "Nature", that was identified for the curriculum design. The goal for this stage of planning helped the team to focus on the desired results that we hope to achieve in the students' learning. Beyond content mastery, we hope students can build stronger connection with Nature and understand that all of them need to be socially responsible towards their environment.

(2) **Determine acceptable evidence to assess/evaluate desired results** (Types of performance tasks and other evidence)

The next stage in the UbD model is to determine the evidence used to assess whether students attain the desired learning outcomes. The team explored various methods of assessment, employing both traditional and alternative assessments to capture students' learning. On-going formative assessments within each of the 3 subjects were used, which include student observations, class presentations and written work. The team also designed a performance task to evaluate the application and integration of knowledge learnt across the three subjects in the IC unit. More details on the performance task are provided in the next section.

(3) **Plan learning experiences and instruction** (Learning activities)

The teachers proceeded with lesson planning once the theme, enduring understanding, and assessment tasks were identified for the overall unit. The team continued to have discussion sessions to further strengthen the content and fill gaps to integrate the three subjects seamlessly. Lesson activities were planned to avoid repetition so that each subject connects with one another smoothly. As this paper focuses on assessment, it will not go into further details on the learning activities.

The Performance Task

This section describes the specific performance task and specifications used in IC to assess students' understanding of content knowledge and process skills in problem-solving in addressing the task requirements. The team used the UbD GRASPS framework to aid the crafting of the performance task (the crafting of the performance task can be found in Appendix 1).

The performance task can be found in Appendix 2. Table 1 shows the performance task specifications.

Table 1: Performance Task Specifications

Criteria	Your leaflet should include the following:
Using Data (i) Organisation and representation of data (ii) Interpretation of data Max = 5 marks	Descriptions and explanations of how you use data to organise, represent and interpret information from the Carbon Footprint.
Problem Solving (i) What and Why of contributing sources of carbon emissions (ii) How to reduce carbon emission Max = 5 marks	Identification and explanation of the top two contributing sources of carbon emissions. Descriptions of ways to reduce carbon emission.
Applications (i) Application of heat transfer (ii) Improving efficiency of an appliance Max = 5 marks	Application of heat transfer principles to illustrate how you improve the efficiency of an appliance.
Authenticity of pamphlet (i) Awareness of audience (ii) Use of language (iii) Effective communication of messages (iv) Design of pamphlet Max = 5 marks	Presentation of information clearly to the targeted audience.

Submit a short account of how your team worked together to complete your performance task.

Teamwork (i) Assignment of roles (ii) Cooperation Max Bonus Marks = 2 marks	Description of how the work is distributed in your team and how well you work together as a team.

Assessment Rubrics

To assess the different components of the improved version of performance task (refer to Appendix 1), teachers designed 3 separate rubrics to assess each subject specific knowledge. Table 2 shows the assessment rubric for assessing mathematical concepts in the performance task (Items 1 to 4).

Table 2: Assessment Rubric for Assessing Mathematical Concepts

Criteria	Exceeding Expectation	Meeting Expectation	Below Expectation
Main CO_2 emission contributors based on energy, travel and consumption / waste. • Organisation and tabulation of data (8 students) • Calculation of central tendencies for each individual component and explanation for the choice of the most suitable central tendency • Statistical representation of CO_2 emission of all components and explanation for the choice of representation	Organisation of data is correct with correct calculation of central tendencies **and** statistical representation **and** reasonable explanation is provided **for either one** [4] Organisation of data is correct with correct calculation of central tendencies **and** statistical representation **and** reasonable explanation is provided for **both** [5]	Organisation of data is correct with correct calculation of central tendencies **or** statistical representation and incorrect/no explanation [2] Organisation of data is correct with correct calculation of central tendencies **and** statistical representation and incorrect/no explanation [3]	No attempt, **or** no answers to the two questions are correct [0] Organisation of data is correct but incorrect calculation of central tendencies and statistical representation and incorrect/no explanation. [1]

Table 3 shows the rubric to assess the geography component of the performance task. The rubric is used to assess item 5 of the performance task.

Table 3: Assessment Rubric for Assessing Geographical Concepts

Task	1	2	3	4	5
Description	Identifies and lists the top two factors from their data compilation.	Provides an explanation of the link between the factors identified and carbon emission.	Provides a detailed elaboration of the link between the carbon emission and how it results in global warming.	Provides an elaboration on ways to reduce carbon emissions.	Suggests relevant alternatives to factors identified with the purpose of reducing carbon emission.
Example	E.g : from the pie chart, the two sources of carbon emission are the use of electrical appliances and traveling by plane	E.g traveling by plane for long distances consumes a large amount of fuel which releases large amounts of carbon dioxide into the atmosphere.	E.g the carbon emission increases the amount of greenhouse gases in the atmosphere, resulting in more heat being trapped and rising global temperature. Thus, global warming is a result of traveling by plane over long distances.	E.g the use of more efficient fuels for planes can reduce carbon emission. Reducing the need to fly for international conventions and business may reduce flights.	E.g instead of traveling long distances for business meetings, virtual conferences can be adopted by companies to reduce the need to travel by plane and this will thus reduce carbon emission.

Table 4 shows the rubric to assess the applications of heat transfer in Science principles to improve the efficiency of an appliance.

Table 4: Assessment Rubric for Assessing Science Concepts

Criteria	Exceeding Expectations	Meeting Expectations	Below Expectations	Example
Description of heat transfer		Correctly describes the heat transfer by referring to: • Type of heat	No attempt. [0]	Electric iron - conduction - metal base plate, good conductor

		• Materials involved [1,2]		
Method suggested does improve or reduce heat transfer		Science concepts are used to control the heat transfer • Correct concept used [3] • Correct description of how it will lead to better heat transfer or less heat loss [4]		Reduce heat loss from the clothes by having a shiny ironing board to reflect back the heat. Shiny surface is a poor radiator of heat.
Method suggested is practical	Improvement can be done by students [5]			Surface of board can be easily replaced / covered.

Implementation and Refinements

The team began the teaching of Secondary One IC in Term 2 of 2008. The team underwent post-lesson reflections and discussions to improve on the performance tasks and assessment rubrics. They were further refined after feedback was gathered from the students and teachers. The new task and rubrics described above were used in Secondary One IC implementation in 2009. Evaluation of IC was carried out using quantitative data gathered from an instrument called PETALS and qualitative data gathered from the students' journal writings and teachers' feedback and reflection. Due to space constraint, only the qualitative results are presented in the next section.

The new performance task (shown in Appendix 1) reflects distinctive applications of mathematical, geographical and science knowledge in various components. This allows students to make direct applications of statistical concepts when they use their Carbon Footprint data to identify the top two contributing sources of carbon emissions and explain how these contribute to global warming. The improved task guides the students in using the Carbon Footprint Calculator to identify the sources of carbon emissions and ways to represent the data effectively to justify their answers. In addition, the students also have the opportunity to apply their science concepts to suggest a way to improve the efficiency of an appliance in their home.

The team experienced some difficulty when applying the 2008 rubrics (refer to Appendix 3) to assess students' applications of mathematical, geographical and science concepts in the performance task. For example, it was not clear that what defines "lifestyle factors" and students generally gave very general and vague answers, taken mostly from internet research. The team was not satisfied that the rubrics did not address

specific contributing factors and explanations based on students' personal experiences using Carbon Footprint Calculator. The improved versions of the new rubrics described in the previous section (Tables 2, 3 and 4) now consists of 3 separate components, each addressing different aspects of the performance tasks. It consists of criteria assessing specific skills and contents relevant for the subject area. The team is able to assess these components separately by departments, hence giving a fairer assessment in different areas. The team keeps the rubrics for "Authenticity of pamphlet" and "Teamwork". The next section will describe the qualitative results gathered from the study.

Evaluation – Qualitative results

The team used several methods to evaluate the IC programme qualitatively. This section will discuss the results from the evaluation of students' learning using tools such as students' reflections, teachers' reflections, students' work and teachers' interviews.

Students' learning – Are students more socially responsible towards their environment?

The theme identified for the Integrated Curriculum is "Understanding Nature through Social Responsibility" with the intended goal that students learn about the impact of temperature changes on the environment and understand the roles that man plays in influencing the ecosystems through human activities. Through students' reflections, we are able to elicit information about their thought processes with regard to IC. The following abstracts provide insights into students' thoughts about IC:

- ✓ We can relate each thing we learn from each subject to warn ourselves that we are in danger and how to do analysis and think of ways to prevent them.
- ✓ We must all learn to take care of the earth, saving electricity, etc. so that future generations can also enjoy the beauty of Mother Nature.
- ✓ IC helped me understand more about Global Warming and its threats. I think I am more Earth-friendly now.
- ✓ I learnt how people's actions are affecting the Earth. I could learn more on the actions we can take to make Earth a better place for us to live in.

The pamphlets created by the students provided rich information about their learning. Students understood the impact of temperature changes on the environment and were able to draw information from various disciplines to explain the effect of greenhouse gases on global warming.

They were also creative to think of ways to minimize impact on their environment. Some groups thought of creative and innovative ways to cut down their carbon footprint. Below are some examples of their ideas obtained from the pamphlets (Samples of students' work can be found in Appendix 4):

- ✓ Use energy saving appliances such as low energy light bulbs, buy energy efficient appliances, use rechargeable batteries rather than alkaline batteries.

- ✓ Develop good habits – turn off all electrical appliances after use, turn off fans on a windy day, switch off lights in the morning and early afternoon, turn off your computer or the TV when you are not using it, unplug chargers when not in use.
- ✓ Reduce, Reuse and Recycle – reduce waste by buying minimally packaged goods, choose reusable products over disposable ones; if your car has an air conditioner, make sure its coolant is recycled whenever you have it serviced.
- ✓ Reduce car journeys, car pool and take public transport.

Students learnt to work in teams to complete their performance tasks. They discussed how they shared the responsibilities to complete their work. These are taken from their reflections about teamwork:

- ✓ After discussing it in class, we delegated the tasks and later on at home, we came on MSN. My friend sent me some links to useful information and another one typed out the notes. We discussed the cover design and I printed out the final product.
- ✓ For each criterion, our group would conduct research and discuss our findings. Then we would draw out a draft and assign one of our group members to do the final piece. We would repeat the same thing for the rest of the criterion but assign other members to do the final piece. Every one of us contributed by giving our opinions for each discussion.
- ✓ We met up a few times during the week to discuss how we were going about it. Next, we did the planning and decided on the colour of the pamphlet… Then, we surfed the internet for information… we gathered all the information and combined them together…

Teachers' views and opinions on the aspects of performance task and IC that have engaged and inspired students in their learning

Teachers offered their views and opinions through the IC unit and overall curriculum reflection. They also provided feedback to affirm the usefulness of the performance task and ways to refine the assessment rubrics for more accurate and fairer assessment. Several suggestions obtained from the teachers' feedback in 2008 were used to improve upon the performance task and rubrics in 2009.

For example, one teacher reflected that "Authentic and relevant data is given to the students for calculating the percentage of each greenhouse gases contributing to the greenhouse effect which eventually leads to global warming." This is a positive comment on the usefulness in using authentic data from the Carbon Footprint Calculator so that students can use the real life data in making inferences to address the performance task.

Another teacher expressed the importance of incorporating questions in the lesson and the performance task requiring the students to apply their mathematical concepts in real-life context. He said: "Students are thrown with various questions which required them to think and discuss instead of having the usual drilling practices on Maths problems like any other lessons." The teacher also shared his observations that "the actual

data and the graphical presentation of data make the lesson more interesting and engaging."

Another teacher commented on the "flow of information of the data" that students were able to "link from 'awareness' to 'cause'", hence promoting students' understanding in making connections between the mathematical concepts and geographical concepts as designed in the performance task.

In terms of the improvements on the performance task, one teacher recommended that the performance task should be "simplified by focusing on depth instead of breadth". This resulted in refining the performance task to enable students to apply their statistical concepts in data analysis and representation to make meaningful inferences to address the issues of global warming.

In summary, many teachers observed many positive responses from the students as they incorporated the performance task in the IC lesson to raise students' awareness and applications of concepts. These quotations are taken from the teachers' reflections:

- ✓ I am glad when I heard one of the girls said this: "Now I see that Geography, Mathematics and Science are interlinked!"
- ✓ The real data, relevance and the room for discussion that is created. It triggers thoughts about the environment as well as how subjects can be interlinked not as individual modules.
- ✓ The field activity, the worksheets based on climatic data downloaded from world meteorological stations and the animations of conventional rain from internet website allowed the pupils to see the connectivity in the 3 different subjects.
- ✓ Students showed great enthusiasm in outdoor learning. They were able to gather sufficient evidence and verbalise their findings by applying the concepts they have learnt.

Conclusion

The planning, implementation and evaluation of IC are labour-intensive as each stage requires careful planning. However, the research team has derived much satisfaction and fulfilment from the overall experience. The enthusiastic responses from the students during lessons and their feedback are very much encouraging. The teachers too have gained tremendously. In particular, teachers feel that there is better communication among teachers from different departments. There are more opportunities for sharing and learning from one another. The school continues to provide the teachers with necessary structural and administrative support to carry out collaborative lesson planning, lesson observations and post-lesson feedback and reflections. This has spurred the team to continue with this journey to make learning more engaging, meaningful and interesting for the students.

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Appendices

Appendix 1: Design of Performance Task using GRASPS

GRASPS	Description of Task
Real World Goals	The students are required to submit a pamphlet to a panel from the National Environment Agency, illustrating ways of handling the problem of increasing global temperature.
Authentic Roles	Students take on the roles as student representatives from the School Environmental Club.
Audiences	Students address the public to raise awareness about global warming and ways to reduce the problems. The designed pamphlet will be submitted to a panel from the National Environment Agency for evaluation.

Situations	The global temperature is increasing. Students need to think of ways to address the problems.
Products and Performances	Students design a pamphlet to communicate their message to the public to raise awareness about global warming. Refer to Appendix 2 for the description of the task.
Standards	Students are given Performance Task Specifications which spell out the criteria and necessary steps to follow in their task. Refer to Table 1 for the Task Specifications.

Appendix 2: Performance Task Descriptions (Improved Version)

Objective:
To recognize how you personally impact global warming and ways you can contribute to minimize its impact.

Save It or Lose It !

You are a group of 4 student representatives from the School Environmental Club. You are going to submit a leaflet to a panel from the National Environment Agency, illustrating ways to handle the problem of global warming. What will you do?

You will include in your preparations:

1. Use the Carbon Footprint Calculator (http://www.clevel.co.uk/homecalc.html) to find out how much CO_2 you emit, based on energy, travel and consumption/waste.

2. Collect a total of 8 sets of data (4 from your own group and 4 from another group). In your own group, choose any 2 sources of CO_2 from below to tabulate the carbon footprint in Kg/CO_2 per year which is emitted. The sources of CO_2 are as follows:
   a) Electric
   b) Gas
   c) Motor Vehicle
   d) Flights
   e) Train/Bus
   f) Consumption and Waste

3. Using the data tabulated in (2),
   a) decide which central tendency would best represent each of the 2 chosen sources of CO_2 ,
   b) explain the choice of central tendency used in part (3a),
   c) find the central tendency of the 2 chosen sources of CO_2. E.g. if your group has chosen mode as the central tendency for Motor Vehicle, then your group is only required to find the mode.

4. Choose one student's data from your group.
   a) Represent her CO_2 emission using an appropriate statistical diagram.
   b) Explain your choice of statistical diagram.

5. By now, you'll realize that the main sources of carbon dioxide emission include one and/or more of the following:
   a) Use of electrical appliances
   b) Gas
   c) Motor vehicle
   d) Flights
   e) Train/Bus
   f) Consumption and Waste

   Based on your calculations of carbon footprint (individually and/or in your respective groups) earlier, identify the top two contributing sources of carbon emissions and explain clearly how they might contribute to global warming. In light of this, suggest and elaborate ways in which such emission levels may be reduced (individual/collective levels).

6. Your electricity consumption contributed to the carbon footprint that you have calculated. Heating appliances at home usually use more electricity than other appliances. This includes appliances such as heaters, irons and electric cookers. Such appliances use concepts of good conductors and insulators to improve or impede the flow of heat energy.

   In your leaflet, give one example of such an appliance. Suggest a way to improve the efficiency of the appliance such that less electricity is used but can still do the same job. The suggestion should be practical such that you can do it at home. Your description of the various aspects should show sound use of science concepts.

Appendix 3: Performance Task 2008

Objective: To recognize how you personally impact global warming and ways you can contribute to minimize its impact.

Save It or Lose It !

You are a group of student representatives from the School Environmental Club. You are going to submit a pamphlet to a panel from the National Environment Agency, illustrating ways to handle the problem of increasing temperature globally. What will you do?

You will … include in your preparations:

i. Illustrate ways in which you and your family can play a part to minimize your impact on global warming. Use the Carbon Footprint calculator to find ways to minimize your impact and how to make the right product choices in the future.
   To find out more information about Carbon Footprint, access the following website: http://www.carbonfootprint.com/calculator.aspx

ii. Greenhouse gases are main contributors to global warming. Find out more about greenhouse gases and issues related to climate changes from the following websites:
http://en.wikipedia.org/wiki/Greenhouse_gas
http://www.ipcc.ch/index.htm

The annual greenhouse gas emissions are illustrated in the following website:
http://en.wikipedia.org/wiki/Image:Greenhouse_Gas_by_Sector.png
Using the given data, represent the information using another form of statistical representation. Explain your choice.

iii. Using the information obtained from (1) and (2), prepare a pamphlet to raise awareness of the problems on increasing temperature globally. The pamphlet should outline the effects of increasing temperature, the major factors that contribute towards global warming and the ways in which you and your family can help to minimize the impact.

iv. Describe how the work was shared by all members in your team.

Appendix 4: Samples of students' work