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Developing an approach to assessment for the elementary science and technology curriculum of Ontario

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Abstract

This paper describes how teachers taking part in the Elementary Science and Technology Partnership based at Queen's University, Ontario were introduced to a model of assessment and how the use of this model will be implemented and evaluated. A brief description of the Ontario Ministry of Education and Training science and technology curriculum for grades 1 – 8 students is presented to provide the context for this work.

Keywords: assessment, learning, primary, secondary, teacher development

Elementary science and technology in Ontario

In September 1998 the Ontario Ministry of Education and Training mandated a new science and technology curriculum for all Grade 1-8 students (MET, 1998). Its intended purpose is wide-ranging, including providing students with:

The scientific and technological knowledge and skills that will enable them to be productive members of society.... To develop attitudes that will motivate them to use their knowledge and skills in a responsible manner.... [To] develop ... skills that are ... important for effective functioning in the world of work ... [and] learn to identify and analyze problems and to explore and test solutions in a wide variety of contexts. (p 3)

The three goals of the curriculum are:

- To understand the basic concepts of science and technology;
- To develop the skills, strategies, and habits of mind required for scientific inquiry and technological design; and
- To relate scientific and technological knowledge to each other and to the world outside the school.

The learning expectations for science and technology are organised into five strands, defined as "the major areas of knowledge and

skills" (p 7). These are (a) Life Systems, (b) Matter and Materials, (c) Energy and Control, (d) Structures and mechanisms, and (e) Earth and Space Systems. (MET, 1998:7)

In early 1999 five members and a graduate student of Queen's University Faculty of Education proposed to three local school boards the establishment of a three-year partnership to support teaching the new MET science and technology curriculum. The project, now underway, involves a small number of teachers (20 in Year 1, 20 more in Year 2, and 40 more in Year 3) who, through in-service work initiated by faculty, develop the expertise to answer questions for themselves about teaching and learning elementary science and technology. These innovators will then share their experience and understanding with other teachers. In this way the partner school boards will develop a significant group of teachers with expertise in teaching science and technology.

Achievement levels in the MET science and technology curriculum

MET 1998 identifies four areas of achievement to be assessed:

- Understanding basic concepts;
- Inquiry and design skills (including skills in the safe use of tools, equipment and materials);
- Communication of required knowledge;

- Relating science and technology to each other and the world outside the school. (p 12)

At each grade these areas are assessed according to four levels of achievement. The level statements for each area of achievement are identical for all grades, but the level of sophistication of the student responses changes. Consequently, teachers will need to use considerable professional judgement in assessing students' work and using this assessment to assign an achievement level.

Considering relevant ideas

The Elementary Science and Technology (EST) Partnership organised a seminar to discuss ideas about assessment that teachers could use to develop the expertise necessary to assign levels of achievement. The following issues were discussed: (a) the purposes of assessment, (b) the nature of evidence that might be available, (c) the importance of holistic assessment, (d) relating holistic assessment to the four areas of achievement and (e) establishing a shared view.

(a) The purposes of assessment

Three broad categories of assessment were identified: diagnostic, formative and summative.

- Diagnostic
To let the teacher know a student's current level of achievement
- Formative
To let the teacher know how well a student is doing
To let a student know how well he/she is doing
To help the teacher and student work together in helping the student improve
To tell others how well a student is doing
To tell others what they can do to help a student improve
- Summative
To evaluate achievement

It was noted that a teacher could use a single observation of student performance for any or all of these purposes.

(b) The nature of evidence that might be available

Two broad categories of evidence were identified: transitory and permanent. Transitory evidence is obtained through:

- teacher observation of student(s) operating autonomously;
- teacher observation of student(s) whilst interacting with student(s).

Transitory evidence is often left as a gestalt impression of the student(s) inside the mind's eye/memory of the teacher. So it is only available to the teacher but open to scrutiny if some attempt at record keeping is made.

Permanent evidence is generally obtained in two ways. First, as a student's story of the process in a design diary or lab book with extras – a working collection. This should be an authentic real-time record, not a retrospective justification of activities long forgotten. It needs to have the ring of truth; rawness; edge; bits that take your breath away. It should only have high production values when these are important. It should be relevant, uncontrived, intimate, individual and above all show that it was useful in helping the student make the necessary decisions required in conceiving, developing and realising a product or conducting a scientific investigation. If the design diary or lab book meets these criteria it is likely to endorse the impression left by the transitory evidence.

A second type of permanent evidence is developed through the process. In technology education this will be the product of a designing and making assignment (DMA). The following points were noted: it is easy to be seduced by the product, especially if you haven't been involved in the teaching or are unfamiliar with the other evidence; it is important not to confuse quality of design with quality of manufacture.

In science education the "product" is the answer to a big question. Answering a big question will require students to use science knowledge and concepts and an understanding of science processes, to collect, organise and analyse data in order to produce a reasoned argument based on scientific evidence. Students may use data from their own investigations or from secondary sources.

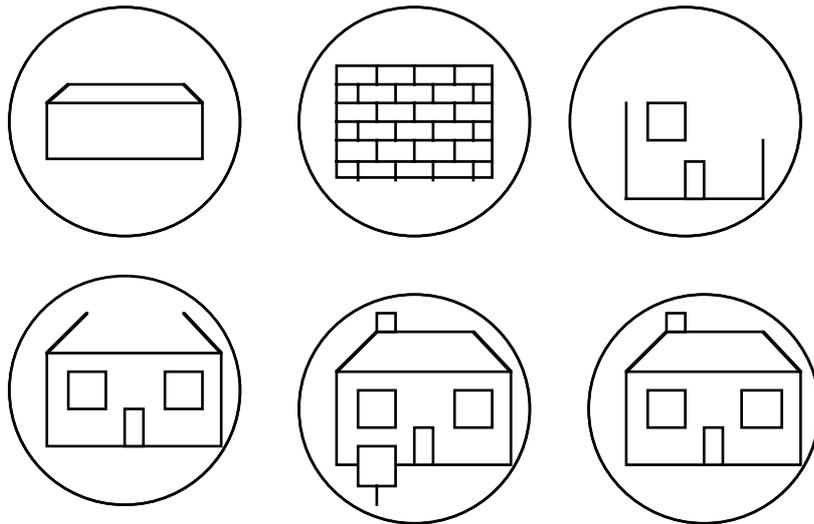


Figure 1 An analogy for holistic assessment: if you are interested in houses there is little point in looking at bricks

The product may be in a variety of forms, including a research report, experiment report, physical model or multimedia presentation.

(c) The importance of holistic assessment

The concept of holistic assessment was introduced through the analogy of how a person might decide whether a house is for sale. A person wouldn't look at single bricks in the house or even a wall of bricks. She would look at the house as a whole and could see instantly whether it is in the process of being built, almost complete, complete but unoccupied or complete and occupied (Figure 1). In short, it was noted that there was little point in focussing on bricks when you are interested in houses.

It was further noted that there is research evidence (Kimbell, 1997) that teachers have little difficulty in using the evidence from assessment (both transitory and permanent) in putting student's work in order of performance. The judgements are usually both reliable and valid; reliable in that different teachers put the work in the same order, valid in that the criteria they bring to bear are relevant to students' achievement. In the case of science and technology the work a teacher would put into order of performance could be the response of the students to the big task: the designing and making assignment or the answer to a big question.

The teachers debated whether the response to the big task alone could provide all the evidence necessary to assign a level of achievement. Interestingly the analogy was further developed by some teachers who said that a better analogy would be, not whether the house was up for sale, but how well it had been built: hardly started, incomplete, complete but not well finished, complete and well finished. Here the teachers argued that it might be necessary to use some evidence of achievement in support tasks and use this with the evidence of achievement that is in the response to the big task. This point was taken up later in the seminar.

It was emphasised as essential that the work carried out in the topic leading to a designing and making assignment or answering a big question meet the requirements of the topic as described in the Ontario Curriculum for science and technology. Moreover, the way it was taught should provide all students with the chance to achieve and reveal their full potential.

(d) Relating holistic assessment to the four areas of achievement

Ranking students' work into an order of achievement is only a first step in assigning a level of achievement, and the seminar moved on to discuss how this rank order could be inspected to identify the levels of achievement within the overall order. The teachers were introduced to a model to show the

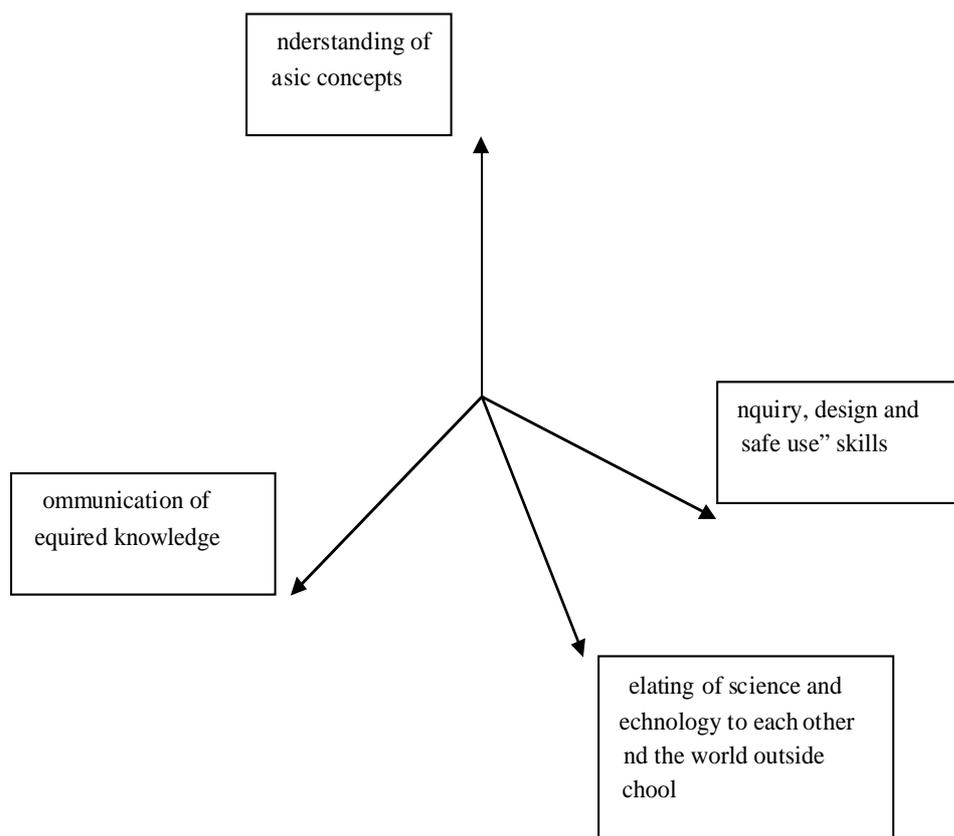


Figure 2 The “structure” of a big task in terms of the contributing areas of achievement

contribution made by each of the areas of achievement to the overall achievement of the student in a big task (Figure 2).

A big task that calls equally on each of the areas of achievement would look as shown in Figure 2. If, however, one or more of the areas of achievement are under-represented, perhaps by giving insufficient time being given to teaching this element, or treating it in a trivial manner, then the structure ceases to be regular and is distorted as shown in Figures 3

and 4. It was noted that as the EST Partnership develops units to support the curriculum, it will be important to monitor the “structure” of the big tasks to ensure that they are broad and balanced in the way they utilise the areas of achievement.

The scene was now set for identifying a set of questions that teachers could use to estimate the level of performance in each of the areas of achievement. The teachers were introduced to the set of questions shown in

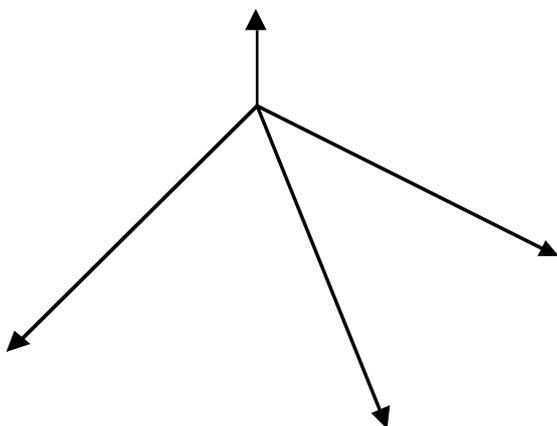


Figure 3 The “structure” of a big task with one area of achievement under-represented

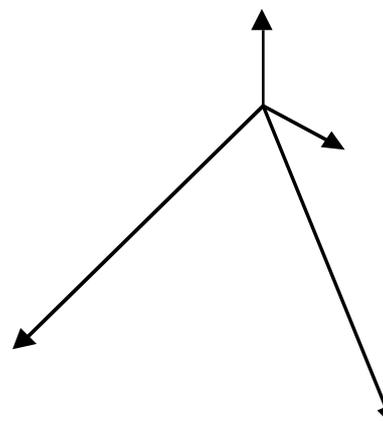


Figure 4 The “structure” of a big task with two areas of achievement under-represented

- Understanding of basic concepts
 - What concepts are important?
 - Where is there evidence of understanding?
 - How extensive is this understanding?
 - Can I now assign a level?
 - Do I need to look outside the big task for evidence?

- Inquiry, design and “safe use” skills
 - What are the skills?
 - Where is there evidence of their use?
 - How effective is their use?
 - Can I now assign a level?
 - Do I need to look outside the big task for evidence?

- Relating of science and technology to each other and to the world outside school
 - What connections are important?
 - Where is the evidence of connections being made?
 - What is the significance of these connections?
 - Can I now assign a level?
 - Do I need to look outside the big task for evidence?

- Communication of required knowledge
 - What communication took place?
 - What range of communication media were used?
 - How effective was it?
 - Can I now assign a level?
 - Do I need to look outside the big task for evidence?

Panel 1 Questions to find evidence of performance in the areas of achievement

Panel 1. It was here that teachers returned to discussing the role of evidence from support tasks. Several teachers noted that they had been disappointed in the weaker students' written answers to Big Questions. They felt that from the evidence they had amassed over the teaching of the topic, much of it transitory, they had expected a better performance. This led to the idea of the importance of a discussion with each student about their response to the big question or the designing and making assignment and that the final pieces of evidence for assigning a level might be in these conversations rather than in the preliminary support task work.

(e) Establishing a shared view

The seminar moved on to discuss how teachers could be sure that a level assigned by one teacher would be equivalent to the same level assigned by another teacher; put starkly, “Is my level 3 the same as yours?” It was emphasised that assessment rubrics

would only have meaning in terms of what students actually do and that interpreting a student's work in the light of the rubric would require teachers to use professional judgement. This judgement would need to be informed by the evidence from the assessment activity and a shared appreciation of what such evidence might mean. This shared appreciation could only be achieved if the following requirements were met:

- The units of work having been written and piloted, providing some assessment evidence.
- Teachers having the opportunity to teach these units of work and look for the assessment evidence in their students' work.
- Teachers having the opportunity to share the assessment evidence they have collected with other teachers.

This led to a discussion of the work to be carried out if these three conditions were to be met.

Implementing and evaluating this model of assessment

In Year 1 of the EST Partnership 20 teachers have each written a unit. A few of these teachers felt that while they would aim to get the unit they were writing piloted, in some cases this would be unlikely. However this was not considered a serious problem because at the end of the first year of the Partnership all the teachers would have access to 20 units that had been developed and they each could be involved in teaching some of these units during the second year. During Year 2 the first cohort of teachers will focus on assessment requirements of the units. They will be in a position to identify both transitory and permanent evidence, keep a record of this evidence and how they use it to assign a level. Teachers in the Partnership receive 6 days release from teaching each year. For the teachers in the first year who take part in Year 2 this time can be used to implement and evaluate the model of assessment that has been developed by the Partnership.

There are three parts to the implementation and evaluation. In part 1, the teachers will assemble a portfolio of assessment evidence exemplifying performance at different levels of achievement. In part 2, the Year 1 teachers will meet to share the portfolios of evidence with one another and begin to come to a shared view of the assessment evidence that is typical for particular levels of achievement. In part 3, the Year 1 teachers will meet with Year 2 teachers and share the portfolios of evidence. Faculty members of the Partnership will provide on-going support for each part of this process with a view to ensuring that the evidence collected is robust and can be used in the Teacher's Guide that will accompany the units when they are published. Working with both Year 1 and Year 2 teachers faculty members will be responsible for developing the assessment evidence collected into a set of achievement level related exemplars of student's work presented in a way that shows the evidence that allowed the level to be assigned. This will go some way to addressing the challenge of provincial standards. Kimbell (1997) indicates that the issue is one of moving to a position where the assessment judgements made by teachers are "the same nation-wide" (p 234). In addition Faculty

members of the Partnership will also be responsible for monitoring the process and the resultant exemplars in ways that will allow for the experience to be reported at conferences and in academic journals concerned with assessment in elementary science and technology education.

Conclusion

While it is too early in the Partnership to be sure that the approach to assessment will be successful, there are indications that it has started well. The teachers were able to engage in the debate about the purposes of assessment and the nature of the evidence that might be available. More significantly, they were able to take an analogy used to explain holistic assessment and adapt it to their particular purposes. Some of them were able to reflect on their own assessment experiences and suggest the sorts of evidence required to supplement the evidence acquired through an holistic approach to assessing students responses to designing and making assignments in technology or big questions in science. This has placed the Partnership in a strong position to develop a program in Year 2 to implement and evaluate the approach to assessment that the Partnership has developed to date.

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References

- Kimbell, R. (1997), *Assessing technology: international trends in curriculum and assessment*, Open University, Buckingham, UK.
- Ministry of Education and Training (1998), *The Ontario curriculum grades 1-8: science and technology*, Queen's Printer for Ontario, Toronto, Canada.