ASSESSING STUDENT LEARNING IN COMPUTER GRAPHICS

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INTRODUCTION

Computer Applications (CPA) is a subject designed to nurture students as effective end-users of computer-related technology and software applications for word processing, multimedia presentation, computer graphics, spreadsheet, web browsing, desktop publishing and database management. The subject is available to students from the Normal Technical course in Grades 7 – 10 (aged 13 – 16 years) in Singapore. The Normal Technical students are generally visual learners who are best engaged when there are hands-on learning activities and practical work in the computer laboratory. For the modules on software applications the students are assessed on their ability to follow instructions and complete the assigned practical tasks.

COMPUTER GRAPHICS

The computer graphics module aims, among other learning outcomes, to enable students to:

- understand the task requirements
- plan how the drawing could be done
- create the graphic (drawing) using basic graphic elements such as lines, curves, polygons and circles
- manipulate graphics by using software features such as copy and paste, duplicate, move and arrange, resize, flip, skew, rotate, skew and group.
- select colours for the outlines and fill of objects
- edit pre-designed graphics to compose a drawing
- save and print the drawing

In this component, students are assessed on their ability to plan, and then select and use appropriate tools and skills to produce a drawing that is as close as possible to a given drawing. Students are also given opportunities to use and develop higher-order thinking skills through the given drawing. The mastery of skills and concepts is evident when the drawing produced is nearly identical (in terms of likeness and proportions) to the given drawing. Grading is based on printouts.

This paper describes a qualitative analysis of students' work (at grade 7) in computer graphics and how this analysis has provided insights into the way

activities could be designed and used to improve classroom instruction and student learning.

SAMPLE

The sample of 330 first year (grade 7) male and female students in the Normal Technical course from five secondary schools had no prior experience using the computer graphics software. They were instructed in the software tools, skills and commands for drawing. When the drawing task was administered in Jul/Aug, the students had completed at least 14 hours of instruction on basic skills and tools for drawing a computer graphic but had not completed the module of study.

DRAWING TASK

Herman, Aschbacher & Winters (1992) recommended that tasks be designed with an aim to elicit established outcomes so that test results could be used to refine assessment, improve curriculum and instruction and provide feedback to students, parents and the community.

The drawing task thus designed to assess the grade 7 students is in Figure 1. It shows the arrangement of 3 objects: greeting card, ribbon and cylindrical gift. The intent was for the ribbon to be between the greeting card and cylindrical gift. The greeting card is right in front while the cylindrical gift is at the back. The drawing task was formulated to involve thinking and the 3 objects were carefully chosen and purposefully arranged in an ordered (layered) manner so as to measure the desired learning outcomes as well as surface gaps in knowledge, understanding and learning.

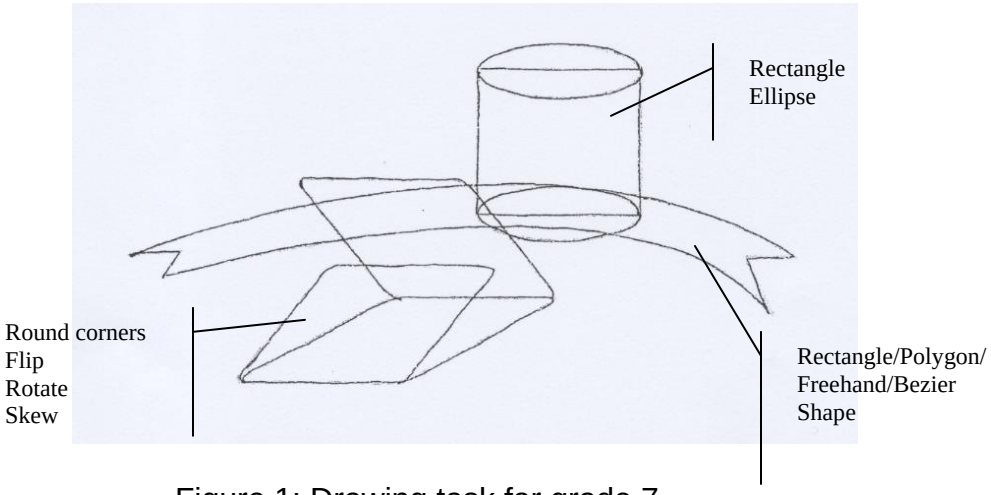

Figure 1: Drawing task for grade 7
The ribbon is between the greeting card and cylindrical gift (original intent).

Assessment objectives

The purpose of the assessment is to determine whether and to what extent students have learned specific knowledge and skills (content goals); and to diagnose student strengths and weaknesses and plan appropriate instruction (process goals). Specifically, students were assessed on their ability to use software features and work independently on a practical task to

(i) Draw greeting card
- round the corners of a rectangle
- skew a rectangle
- duplicate and flip a rectangle
- duplicate and rotate a rectangle
- arrange the rectangles to form the greeting card

(ii) Draw ribbon
- draw curved and straight lines
- manipulate the curves and lines to form the ribbon

(iii) Draw cylindrical gift
- use the rectangle and ellipse tools
- remove/colour outline(s)
- form the cylinder

(iv) Compose the drawing
- arrange the three objects (greeting card, ribbon and cylindrical gift) in the manner shown
- fill all three objects with colour

Performance criteria

Table 1 shows the mark scheme for grading the drawing.

Table 1: Mark scheme for grading a drawing

Performance criteria	**Max marks**	**1 mark**	**2 marks**
Draw tools and skills		Evidence shown:	
▪ greeting card	1	Corners are rounded.	
	1	Rectangle is slanted.	-----
	1	Rectangle is rotated.	
	1	Rectangle is flipped.	
	1	Drawing is similar to given.	
▪ ribbon	2	Curves are kinky or jagged.	Smooth curves.
	1	Drawing is similar to given.	
▪ cylindrical gift	1	Ellipses (not circles) are	

Performance criteria	Max marks	1 mark	2 marks
	1	drawn. Outlines (rectangle) coloured or removed.	-----
▪ relative size of these three objects	2	One object is not in relative proportion.	The sizes of objects are proportional to one another.
▪ fill (excludes black and white)	2	One object is not filled with colour.	All the objects are filled with colours.
Position/placement ▪ objects in whole drawing	2	One object is not as positioned.	All the objects are positioned as in the given drawing.
▪ parts in greeting card	2	One part is not as aligned.	All the parts are well aligned to form the greeting card.
▪ parts in cylindrical gift	2	One part is not correctly placed.	All the parts are in the correct position.
TOTAL	**20**		

CONDUCT OF TASK

The task was given as a class test and students were given 1 hour to complete the task. Students wrote down the skills and tools they would use to create the drawing on the planning sheet. After planning, students were asked to create the drawing using a computer graphics software package. The drawings created were printed for grading. Students were asked to grade themselves and then submit their drawings for the teacher to grade as well.

In the post-lesson reviews, the teacher checked students' understanding of the task. The teacher explained how the grading was done, the interpretation of the mark scheme with respect to the drawing and the marks awarded to the work done. Students were encouraged to check their interpretation of the mark scheme, grading of their own work, understanding of the tools and skills needed for the drawing and to raise questions.

ANALYSIS OF STUDENTS' WORK

Periodic analysis of work processes and strategies could provide an insight into the developmental progress or non-progress made by students in their learning. In the case of student performance in practical work, there is a need to assess both knowledge and use of skills, and levels of competency attained.

Analysis of the planning sheets revealed that most students were able to use strategies such as drawing from basic regular shapes for simple objects

(such as the greeting card and cylindrical gift) and drawing from irregular shapes for complex objects (such as the ribbon). They could associate the features of the drawing (e.g. curve and rounded corners) with the software facility to use (e.g. Bezier/Freehand and round corner tools). Figure 2 shows a typical plan for the task.

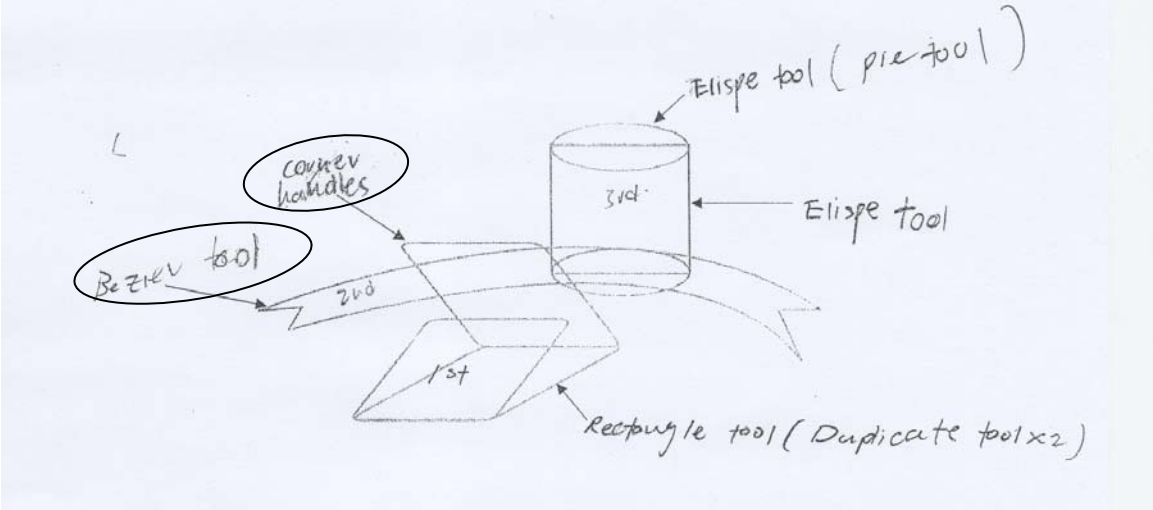

Figure 2: Planning of the task

The strengths and weaknesses that surfaced from analysing printed drawings are described below, followed by implications for teaching and learning.

Greeting card

A major difficulty encountered by students was in getting the same dimensions for the three rectangles so that the sides would match and be accurately aligned to form the greeting card (e.g. Figure 3, item a). A second difficulty was in getting the rectangles skewed/slanted at the correct angles (e.g. Figure 4, item a). A third difficulty was in rotating the rectangle(s) so that all three rectangles can be manipulated into place to form the greeting card (e.g. Figure 5, item a).

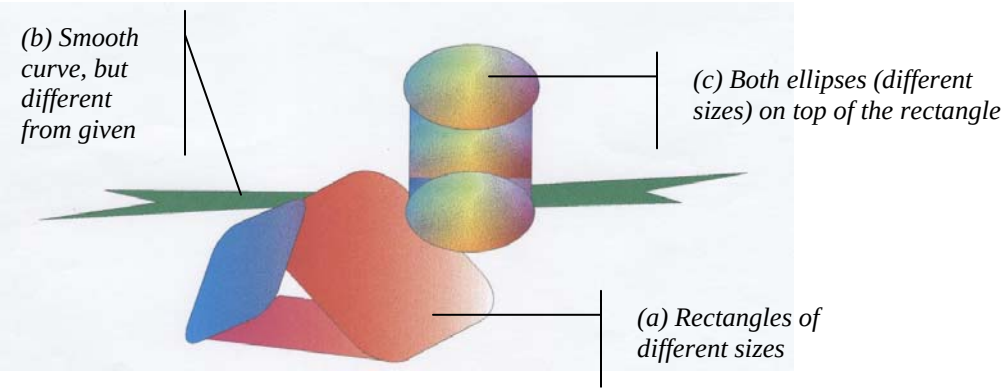

Figure 3: Sample 1

It was observed that there were students who did not duplicate the rectangles and it was possible that they did not know or understand that the 3 parts of the greeting card should be equal in size. The analysis revealed that one-third of the students (110/330, 33.3%) were unable to orientate the rectangles to form the greeting card. Among those who could compose the greeting card, 70 did not round the corners of rectangles either because they forgot to do it or had forgotten the skill to do it.

Ribbon

There are several ways to draw the ribbon. One way is to use the Bezier (or Freehand) tool to draw. Another is to draw a basic shape, say a long rectangle, and then shape it into a ribbon. Yet another way, commonly used by students in the sample (but incompletely done), is to connect several line segments together and then "combine" and "shape" them into the form of the ribbon. Many of them drew straight and segmented lines for the ribbon as shown in items b of Figures 4, 5 and 6. However, they did not proceed to re-shape the lines into the form of the ribbon; possibly due to their lack of knowledge and skills.

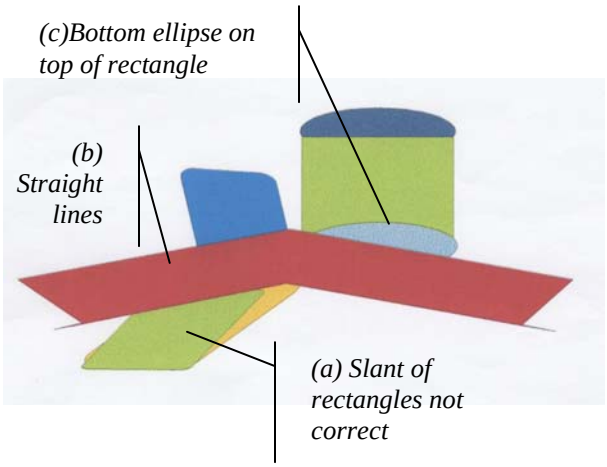

Figure 4: Sample 2

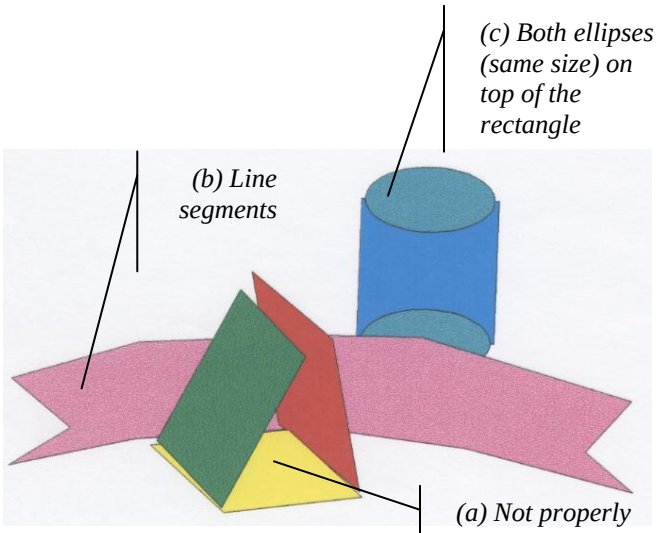

Figure 5: Sample 3

Among those who were able to draw curved lines, there were some who were not able to shape the ribbon into something similar to that given (e.g. Figure 3). There were some who attempted to draw curved lines. These students were still not proficient with using the software features and mouse control and ended up with "kinky" or "knotty" curves at the sides and/or both ends of the ribbon (e.g. Figures 7 and 10).

Generally, most students could fill the ribbon with colour (either solid fill or texture fill) thereby demonstrating that they had started out with the correct technique for drawing the ribbon.

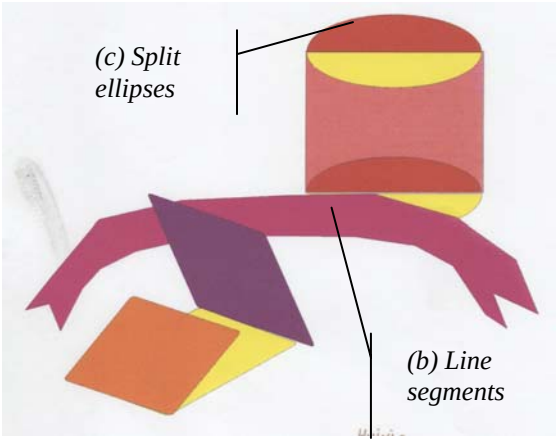

Figure 6: Sample 4

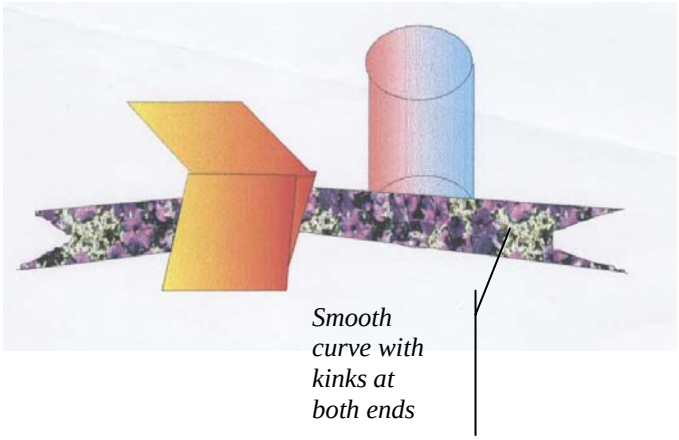

Figure 7: Sample 5

Cylindrical gift

A major difficulty was in conceptualising the image of a cylinder due to the need to position the two ellipses correctly. About two-thirds of the students (214/330, 64.8%) positioned the two ellipses on top of the rectangle to form the image of a cylinder (Figures 3 and 5, item c). An interesting "phenomenon" was that 18 students intentionally drew horizontal lines across the ellipses after that.

2.1% (7/330) created the cylilnder as shown in Figure 4, item c where the ellipse at the bottom is on the rectangle which is in turn on the ellipse at the top. 12.4% (41/330) created it as shown in Figure 8 where the rectangle is on top of both ellipses. Only 8.2% (27 students) could get the cylinder right. The base of the cylinder was partially covered by the ribbon in 12% of the printed outputs.

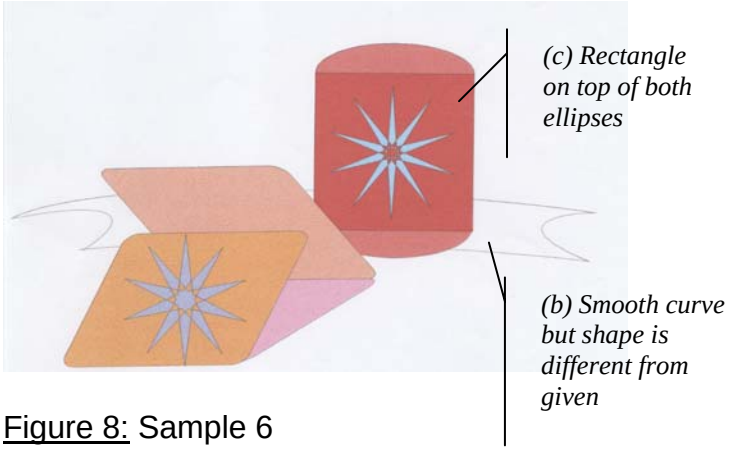

Figure 8: Sample 6

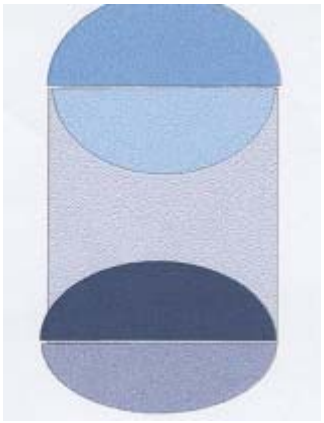

Figure 9: Split ellipses

Also, it did not occur to 58 students (17.6%) that an efficient way to create the second ellipse is to copy and paste (or duplicate) rather than draw another ellipse (e.g. Figure 3, item c and Figure 9). A handful (7) drew circles instead.

Two rare ways of composing the cylinder surfaced in the analysis. One is shown in Figure 9 (and also Figure 6) where the student had tried to split the ellipses to produce the top and bottom surfaces of the cylinder. Her work is incomplete though. The other is shown in Figure 10 where the student had rounded the corners of the rectangle that formed the body of the cylinder to blend with the bottom ellipse that was placed behind it to get the curved base.

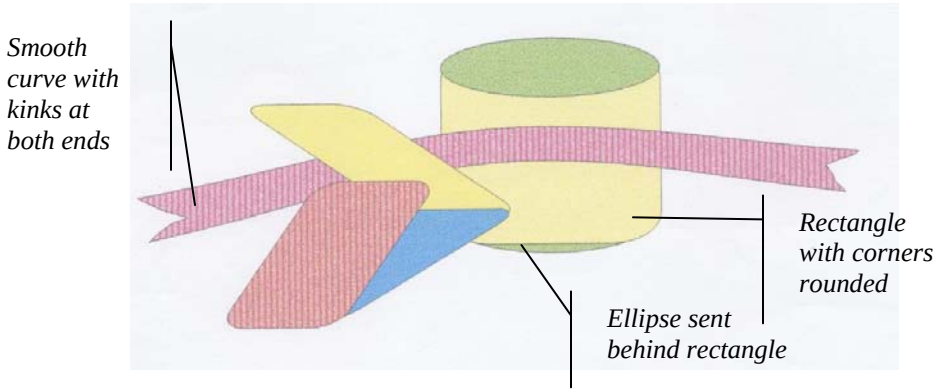

Figure 10: Rectangle with rounded corners for cylinder body (4 students)

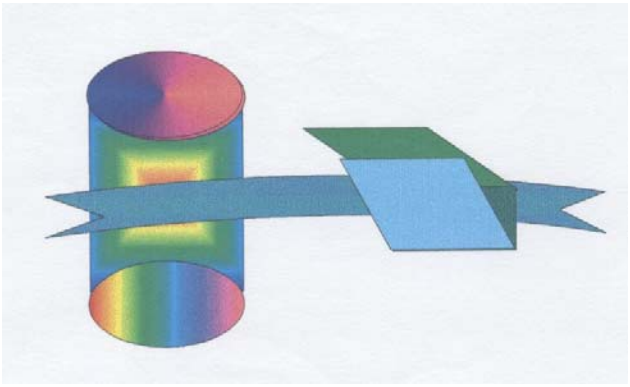

Figure 11: Composed drawing with cylinder on the left (1 student)

Composition of the drawing

The three objects drawn were to be put together to compose the given drawing. The arrangement of the 3 objects was not described in the question paper. As a result, students provided a variety of outcomes (Figures 3, 4 and 8), much to the discomfort of the teachers, when it was time for grading. Teachers did not know whether they should penalise their students if the ribbon was not drawn between the greeting card and the cylindrical gift.

Out of the 330 students, one student composed the drawing differently as shown in Figure 11. He had put the cylinder on the left instead of on the right. When asked, the student said that he did not compare his drawing with the given drawing and thought that the cylinder should be on the left. His teacher indicated difficulty in assessing his work. The descriptors in the mark scheme were refined.

IMPLICATIONS FOR PEDAGOGY

Students' achievement or non-achievement of the performance criteria provided the basis for teachers to plan learning opportunities and activities for them to acquire the necessary skills and knowledge and to improve learning. At the same time, teachers are also alerted to students' understanding of the task, interpretations of performance criteria, and understanding and use of software features for drawing.

Direct implications for pedagogy that arose from the analysis were that students should be taught to visualise objects and the concept of ordering or layering individual parts in order to compose an object (such as the ellipses and rectangle for the cylindrical gift); to remove or colour the outlines of the parts/objects in order to create the desired effect; and to rotate and orientate shapes. It is necessary to provide clear instructions and ample practice in using meaningful colours for the outlines of objects, in removing outlines of objects and perhaps in thickening the outlines of objects in some situations. In working with rectangular shapes, students would need instruction and more practice to skew and rotate these shapes to form the desired object. Students would need to work on more drawings involving curves so as to hone their skills in shaping objects.

Teachers need to learn to use the results of assessment to refine and define performance criteria and to design instruction to move students forward at a good pace. Teachers should continuously adjust classroom instruction based on the results of classroom assessment and engage students in regular self assessment so that students can watch themselves grow over time and feel in charge of their own learning and success. When students understand the mark schemes or performance criteria, they are able to use these to assess their own work. The score on each of the performance criteria will enable the students to understand where they have gone wrong and what they need to improve in.

The involvement of students in self assessment and the use of the assessment results and teacher feedback will enable students to self monitor; self manage and become self-directed learners, so as to lay a foundation for life-long learning. A first step would be for teachers to try to involve students in more self evaluation and peer evaluation activities. Students could be given opportunities to explain their evaluations and/or present their work to the class. The next step would be for teachers and students to close the knowledge gap through active teaching and learning, and practical work for the mastery of skills.

The specifications for the arrangement of objects in the composed drawing could be made explicit in the question paper so that students know what is to be expected from them. The assumption that students would know that the three parts of the greeting card are equal in size must also be addressed in the question paper. The ribbon needs to be re-positioned so that the arrangement of the bottom ellipse could be visible from the printouts.

There is also an urgent need to improve the design of teaching materials and instructional approaches to bring about learning and assessment that is desired, engaging and meaningful to students. Till now, most teacher preparation programs have taken little note of competence in designing assessment tasks and the need for assessment literacy to enable teachers to engage in assessment for learning. Few practising teachers took up the challenge of gaining and mastering these competencies for assessing the various computer applications-based tasks, and to enhance students' learning through classroom assignments, assessment and systematic self evaluation by students.

CONCLUSION

Continual class assignments and assessment will no doubt continue to provide the evidence of success on the part of students, teachers and the system. However, teachers must learn how to use appropriate assessment at the right time as a teaching and learning tool to advance student learning. When teachers assess for learning, they are using the classroom assessment process and the continuous observation of student achievement to understand and articulate the learning outcomes for students.

Teachers can become assessment literate and design tasks and performance criteria that could accurately reflect student learning and achievement. Good assessment information provides an accurate measure of student performance and enables teachers to make appropriate decisions to improve or further student learning.

In learning with technology, the development of skill proficiency in the use of the relevant software application package is essential to the successful completion of a practical task on the part of the students and to successful instruction on the part of the teachers.

REFERENCE

Herman, J.L., Aschbacher, P.R., & Winters, L. (1992). *A practical guide to alternative assessment*. Alexandria, VA: Association for Supervision and Curriculum Development.