Supporting Student Development in Graphical Education through Holistic Judgement

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Abstract

When considering the emphasis on the development of numeracy and literacy, it can be argued that the graphicacy is significantly underdeveloped in terms of general education. Aldrich and Sheppard (2000) describe the agenda regarding graphicacy as implicit, with students expected to 'pick it up as the go along' (pg.1).

This paper, set in domain specific teacher education attempts to highlight the issues that underpins the need to re-evaluate graphical education and in particular the assessment of graphical capability. The relationship between learning objectives, assessment measures and inference is explored by taking a retrospective analysis of students responses to a summative assessment instrument.

The limitation of criterion referenced assessment is highlighted and compared to professional judgement based on the evidence of student work. The paper argues the need for assessment to capture a richer source of data representing a holistic view of capability, with the student as an integral part of defining the relationship between the assessment instrument and the inference.

Introduction

Graphical education is a contested term and for the most part is contextualised in domain specific education. Generally the aim of graphics is applied in nature with emphasis on the embedded disciplined knowledge. As a result the value of graphics as a general education is somewhat underdeveloped. Recently, a number of research agendas have emerged to explore the value of graphical education form a variety of perspectives. The contribution of Norman and Seery (2011) initiated the discourse surrounding a contemporary view of both the importance and relevance of graphicacy and modelling. Danos (2011) specifically set the agenda to investigate the impact of graphics on the curriculum, while a number of studies have begun to investigate the fundamental concepts that underpin graphical capability (Steinhauer 2011; Sorby 2009). Furthermore, research into graphical skills that support and develop cognitive process as a general capability (Lane et al. 2012(a), 2012(b), 2011) have given new meaning to the potential of graphical competencies. Within this context, this paper explores the development of students in a graphics module that supports applied problem solving to ensure the development of general and transferable capabilities. The paper focuses on the inference that we draw from assessment measures and discusses the qualities that are indicative of a graphically capable person.

Assessment

All assessment is based on the inference of an assessor on qualities that are relevant to the task or performance in question. Criteria, in terms of assessment, are described as a distinguished property or

characteristic of work that can be used to judge or estimate its quality (Sadler 1987; Orsmond et al. 2000). Criteria-referenced assessment measures student competencies, establishing to what level they can or cannot do something. This measure requires definite statements of outcomes and levels of attainment or quality. Decision making in assessment, whether analytically or holistically, requires reference to some form of criteria in order to be explained (Sadler, 2005). Therefore, having criteria that align with the qualities of capability is critical for a valid assessment.

Sadler (2009) presents the argument for using criterion-referenced assessment by identifying two distinct educational and ethical benefits. The first is that students are graded on the basis of the quality of their own work without normative reference to others that engaged in the assessment activity. The second benefit is that students can be provided with the criteria at the beginning of the task, allowing them to develop their work in line with what will be valued by assessment. However Sadler (2009) describes many uses of criterion-referenced assessment as sub-optimal, limiting both the teacher and student in the learning and assessment process. Depending on students' perception of the relevance and purpose of the learning activity there are generally two outcomes, pragmatic and epistemic approaches to learning (Kirsh and Maglio, 1994). The pragmatist acts to address the given activity, while the students using epistemic actions augment their cognitive process. Both approaches will potentially affect the objectives and outcomes of the educational experience.

Sadler (1987) and O'Donovan et al. (2004) argue that despite best efforts, the articulation of standards in assessment, are difficult to capture, often fuzzy in nature, open to interpretation and context. The critical finding from their work was that providing explicit descriptors of assessment criteria and standards alone did not ensure meaningful transfer of knowledge of the assessment criteria and standards to the students. Sadler (1987) describes academic standards as being "essentially in unarticulated form inside the heads of assessors, and are normally transferred expert to novice by joint participation in evaluative activity". O'Donovan et al. (2004) outline that there is both an explicit and tacit nature to the development of standard and criteria and students must be exposed to both for effective learning and assessment.

Holistic Approach

Sadler (2009) outlines two problems with traditional criterion referenced assessment. The first is that the sum of the parts may not always reflect the intuitive or holistic mark of the teacher and the second is that there may be criteria missing from an assessment rubric that are important or set the particular work aside as exemplarily. The difficulty with these anomalies is that they are structural and cannot be addressed by making assessment rubrics more explicit or elaborate. Sadler presents holistic judgement as an appropriate assessment for work with open and divergent responses using skilled judgement based on multiple criteria. Such responses are determined as demonstrating sophisticated cognitive abilities, integration of knowledge, complex problem solving, critical reasoning, original thinking, and innovation (Sadler, 2009). Considering a broader range of information to help determine and differentiate capability supports both pragmatic and epistemic actions. Therefore, when assessing capability the judgement of evidence is then based on the appraisal of qualities that relate to appropriate criteria (Kimbell et al. 1991; Sadler, 2009). The

flexibility in the holistic approach allows the assessor to call on more evidence where necessary to make a value judgement rather than being bound by fixed and predetermined criteria (Hager and Butler, 1996). As a result, judgements cannot be reduced to a set of individual measurements to be reconstructed to arrive at the correct appraisal, but rather is based on holistic recognition of the intellectual processing of the relationship between qualities observed as a whole (Sadler, 2009).

Method

This study focused on a retrospective analysis of Year 3 students' performance in a summative assessment task. The rationale for the study was to focus holistically on incorrect responses, so as to help understand the student's perception, comprehension and assumptions that defined their approach to the problem. It is important to note that the analysis was not restricted to failing or low achieving students, as the focus was on the analysis of elements of a 16 part assessment instrument. Therefore the sample taken was random and included students work from across a range of grades.

The assessment instrument was designed to examine students' comprehension of core graphical principles in the area of solid and descriptive geometries through the completion of applied and abstract problems. Questions were designed based on the principal of variance and invariance (Johnson –Wilder and Manson, 2005) where the learned principle was varied, for example in terms of set-up, orientation, strategy and given constraints, while accepting the invariance of the geometries. This allowed the measure of comprehension through the application of declarative knowledge when problem solving. The assessment was implemented through a 2.5 hour examination where students were required to technically draught their solution.

Observations

The analysis of the incorrect responses was independent of the marking criteria and was based on a holistic interpretation of graphical capability. This section focuses on examples of two issues that became apparent, evidence of students breaching fundamental principles/understandings and a lack of strategic thinking.

It is assumed that students at this stage are conversant in projection systems and one element of the assessment instrument was designed to explore the students' ability to solve a relatively complex intersection of surfaces problem. Figure 1 illustrates a student's response to this problem which is indicative of the type of incorrect responses presented in the assessment. The solution illustrates the projection of an auxiliary view and the identification of generators to determine the intersection of the cylindrical geometry – a correct approach that should be rewarded by marks established by explicit criteria. The difficulty arises when you consider the students rationale for taking this approach. The projection of the auxiliary view served to derive the orthogonal view (true shape) of the intersecting geometry (in context) and yet their solution illustrated the construction and completion of an inclined view. This could not serve any purpose in solving the given problem and suggests a lack of more rudimentary knowledge associated with auxiliary projection. The same approach to solving the problem is shown in the solution presented in Figure 2 but in this case the student indicates a clear understanding of the problem and the principles that were employed to reach the solution.

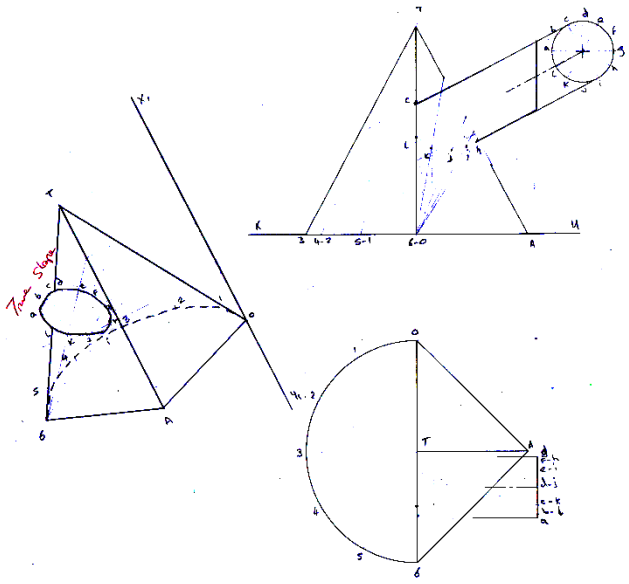

Figure 1 – Solving Intersection of Solids through Auxiliary Projection

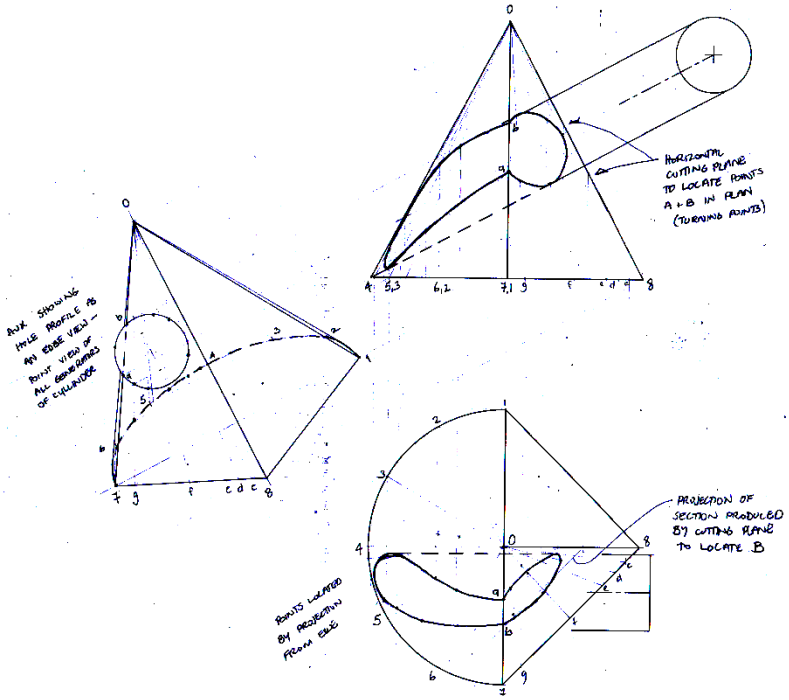

Figure 2 – Correct Solution to Solving Intersection of Solids through Auxiliary Projection

A second example, again built on the fundamentals of projection systems, requires students to envelop an oblique cone (nappe) with an elliptical label (given). Figure 3 illustrates a student's response that suggests an assumption that required them to re-draught all geometries. In fact, the completion of the oblique development relative to the given label would have produced the geometry required to complete the elevation and plan. Although criteria could reward elements of this response, its capacity to capture the obvious oversight is a failing.

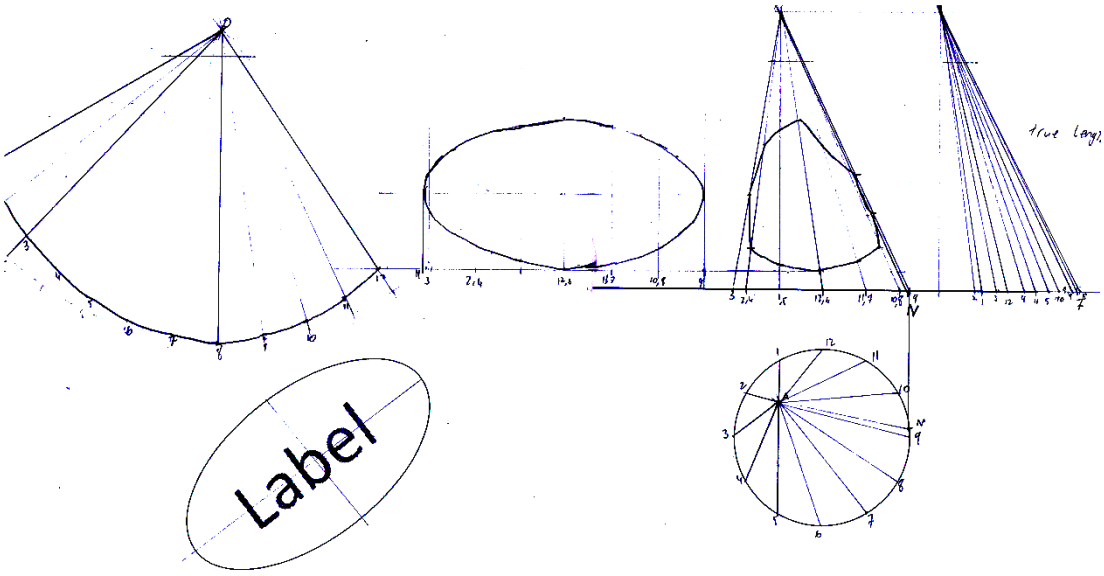

Figure 3 – Envelopment of an Oblique cone

A different response to the same element of the assessment instrument is shown in Figure 4. This clearly illustrates a more sophisticated strategy that linked the relationship between the label and the flattened geometry. The difficulty with this response is with the inaccuracy of the projections back to the principal views. Although, this could be explained by inaccuracy or poor technical skills, the concern arises with the lack of self-auditing that is evident in the response. Did the student know that the solution in elevation was incorrect and that the label should not have breached the x-y line? Did they not know and choose not to draw it to the attention of the assessor? Or did they not know? The solution shown in figure 5 shows a similar approach to the problem but illustrates a clearer understanding of the geometry of the solid and the projection of the enveloped label.

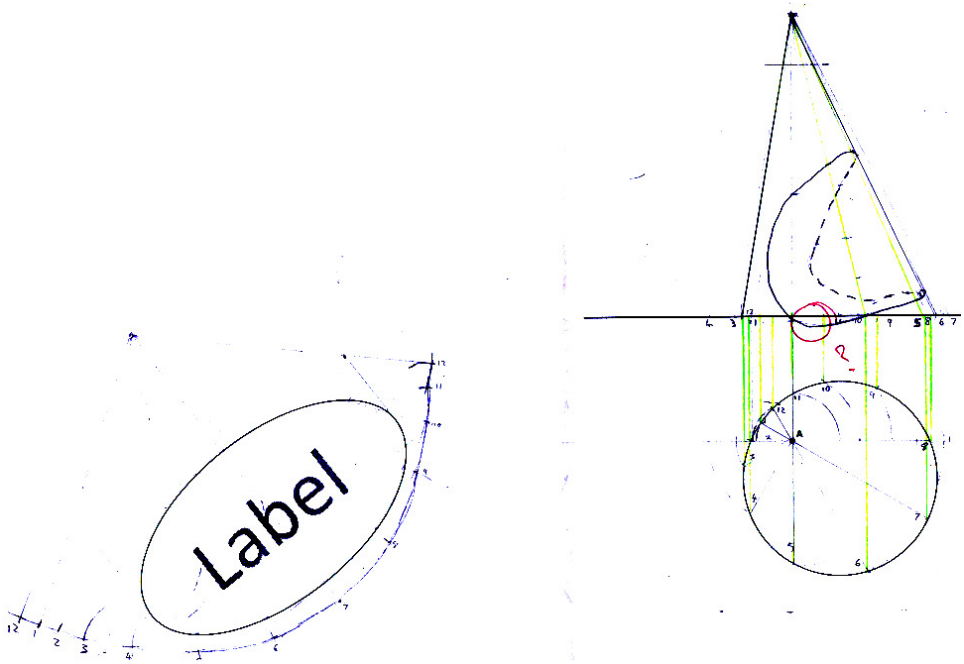

Figure 4 – Envelopment of an Oblique cone

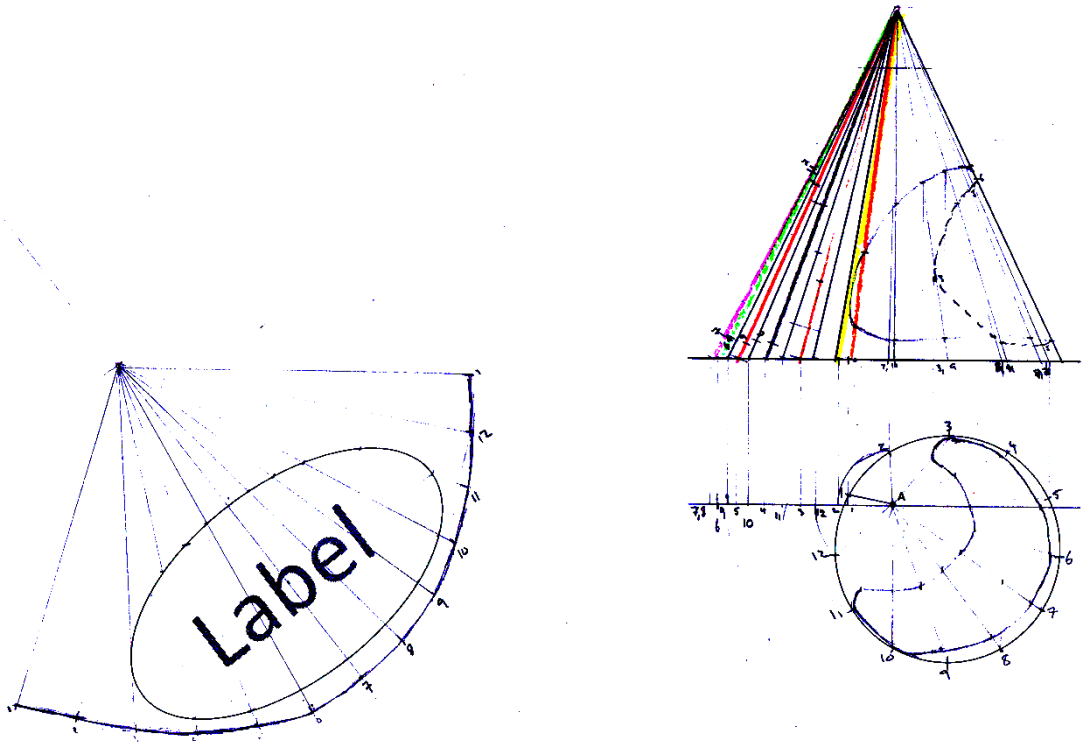

Figure 5 – Envelopment of an Oblique cone

Discussion

There is recognition that students learn from making mistakes (Claxton 2008), however mistakes and assessment criteria are irreconcilable in high risk assessment. As a result the nature of the test either becomes standardised or students employ a pragmatic approach to aligning with their interpretation of the criteria. Either way, there is a narrowing of the educational experience that predicates students demonstrating their evidence of capability in the summative assessment.

This paper looks at objective evidence based on the assumptions that students make about the summative approach. Students actions that are in response to criteria can lead to the sum of the evidence suggesting a lack of more rudimentary comprehension. When confronted with an advanced task, the strategy (if it is strategic) of relaxing governing principles in an attempt to demonstrate higher competency seems unorthodox. The lack of a self - auditing capacity raises serious questions about the nature of the qualities that are assumed (by the student) to be of value. However, it is unreasonable to criticise the pragmatic approach to summative assessment, when the system often rewards disjointed elements of declarative knowledge and skills through the awarding of makes based on explicit criteria.

The ethical and equity arguments that support an explicit statement of learning (that is measurable) and criterion for measure are quite defendable. However, determination of capability must acknowledge that the construct of marking that is declarative can produce arbitrary outcomes with little or no relationship to competency and capability. Holistic assessment is not a panacea, but will support a broader identification and interpretation of qualities. It then becomes the responsibility of the assessor to define the concept of quality, measure capability and make inference about capability. For the assessor to be supported the data source must be richer than that of a criterion approach.

Rethinking the assessment instrument and focusing on the need to support students in developing skills of appraisal while searching for meaning are essential elements of a general graphical education.

In conclusion, this paper proposes that capability in the context of transferable and general education must acknowledge the potential of holistic assessment based on the qualities determined by professional judgement.

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