Promoting the Visualizing Instinct through Freehand Sketching within Initial Technology Teacher Education

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Abstract

At a time when technological capabilities are perceived to be critical in redefining effective technological education, the introduction of a new graphics subject titled *'Design and Communication Graphics'* in Irish second level (high) schools has broad implications. Students are now expected to develop the ability to explore applied geometries, integrated with conceptual thinking in addition to developing essential communication skills. Central to this development is the ability to externalize cognitive processes through freehand sketching. This paper presents an overview of the development and implementation of a continuum of sketching activities which promotes the development of sketching expertise within Initial Technology Teacher Education (ITTE).

Introduction

Research (Verstijnen, 1998) claims that there is a lack of scientifically validated models of instruction that promote the development of sketching ability. This paper describes the development of sketching expertise among year three students of ITTE as part of a fundamental graphics module at the University of Limerick. The rationale and purpose of the overall module of study was to contribute to the students' development as graphics teachers, develop problem solving skills in plane and descriptive geometry, develop fundamental 3D CAD modeling skills and to develop critical freehand sketching skills to support visual thinking and complex cognitive processing.

The research described in this paper is primarily concerned with how sketching expertise was developed among over 270 students who undertook the module of study. A model of sketching activities which ranged along a continuum from observation to imagination was applied. A detailed description of this model and the associated literature is provided in the next section.

Method

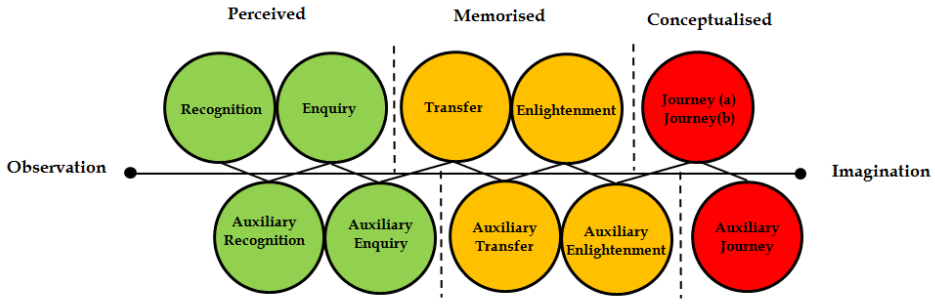


Figure 1 – Core model of sketching activities

The model of sketching activities (Figure 1) was informed by research literature relating to diverse areas such as; sketching across multiple disciplines (Bertoline, 2003; Edwards, 1989; Faulkner, 1983; Hope, 2008; Storer, 2008), central systems of the cognitive architecture (Stillings, 1995), the measurement and definition of sketching expertise (Middleton, 2008) and a number of preliminary studies conducted within initial technology teacher education (Lane et al., 2011; 2012; 2011). The model was designed so that progression was from left to right. The perception focused activities on the left were designed to promote observational drawing skills while simultaneously building graphical libraries in long term memory stores. The memory focused activities were devised to facilitate the shift from observational drawing to conceptual sketching. Finally, the conceptual based activities on the right promote the development of skills where graphical libraries are accessed, manipulated and synthesized through a conceptual journey of interaction between paper and pencil.

In its progression, towards the conceptual activities on the right, sketching skills are synthesized into a maximally reflexive and automatic state (Satpute, 2006; Stillings, 1995). The progression from left to right represents the dichotomy between Goldschmidt's (1991, 2003) *"seeing-as"* and *"seeing-that"* modalities of sketching. The nature of cognitive activity at the left of the model is *"controlled and reflective"* and towards the right hand side it becomes *"automatic and reflexive"* (Stillings, 1995) in nature.

The activities were designed to facilitate active student learning in both classroom and lecture theatre environments (Figure 2). The entire suite of activities were completed over three weeks and lasted eight hours in total. The activities promoted independent student learning and the development of different styles and values. The main roles of the teacher were to demonstrate basic fundamental techniques, to help students critique their own compositions and to stimulate an innovative and creative learning environment. A brief explanation of each activity is provided in the Table 1.

Sketching in the lecture environment

Sketching in the laboratory environment

Figure 2 – Different sketching environments

Table 1 – Brief description of each activity within the model

Recognition The purpose of this observational drawing activity which was conducted in a lecture environment was to enable students to analyse the relationships between regular and irregular geometries presented on a large screen (using a reference grid) and present these through a scaled composition.	**Enquiry** This observational drawing based activity was designed to aid students in drawing a composition of physical 3D geometric models. The students used a specially designed 3D to 2D conversion device to trace the image of each geometric model on to a picture plane. The students then used the skills developed in the previous two activities to transfer the composition from the picture plane to paper.	**Transfer** This activity was somewhat similar in nature to Recognition as it took place in the lecture setting and a composition was presented to the students using a large screen. However, the time was reduced for this activity, the composition was more complex and detailed, no grid reference was given and the students had to conceptually represent a cast shadow.	**Enlightenment** This activity aimed to harness and synthesise the previously developed sketching skills through a series of memory exercises. Students were presented with five separate geometric configurations which they then had to communicate from memory.	**Journey** This was composed of two activities which were conceptually based. Students were required to work in groups to solve conceptually derived briefs in short timeframes.
Auxiliary Recognition This activity was designed to facilitate the cognitive shift away from observational type sketching. The activity promoted students to use figural argumentation to produce a mirror image of presented line drawing. When the mirrored element was drawn, the students were afforded the opportunity to add a conceptual theme using a variety of media that were made available.	**Auxiliary Enquiry** Similar to Enquiry, this activity involved the observational drawing of physical 3D artefacts. All students were given a pocket sized 3D to 2D conversion device which they used to record critical proportions and relationships of different artefacts. The aim of the activity was to develop student's skills to draw a physical composition by imagining a picture and reducing the need to use the 3D to 2D conversion device. This was a task that the students were required to complete at home and they were given one week to complete it.	**Auxiliary Transfer** This activity was designed to promote the students ability to explore, manipulate and communicate the geometry of a simple paper pin. The students were presented with an image of the pin and they were then required to sketch as many orientations of it as possible during a twenty-five minute timeframe.	**Auxiliary Enlightenment** This activity was designed due to a number of concerns expressed by the students about their lack of confidence in rendering sketches. Students were presented with an outline figure which they had to sketch and then render using an example reference.	**Auxiliary Journey** This activity was completed by each student individually. Students were given a number of abstract regular and irregular geometries. They were required to expand on and conceptualise each set of geometries. The only criteria students were given was that their ideas should be creative.

At the end of each activity, the students were required to rate their sketches, rate the value of the activity and provide any feedback through comments. The students' sketches were also assessed by the researcher. All of the ratings were measured along a ten point semantic differential scale. These results and examples of student compositions are provided in the next section.

Results

The findings for the student scores, researcher scores and the student value scores are shown in Figure 3. A broad overview of this graph highlights that the students mean ratings were generally lower than the researcher scores. In addition to this, the mean value that the students placed in the activities was generally higher in the initial activities which were controlled, reflective and observational in nature.

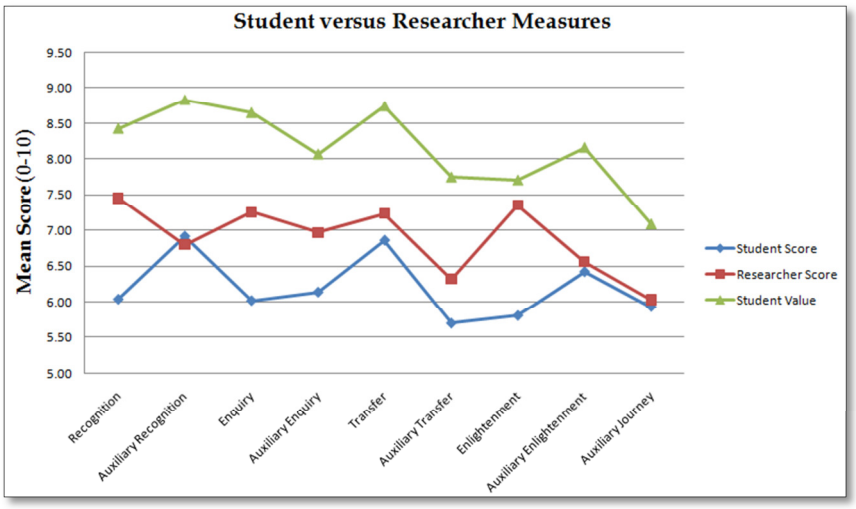
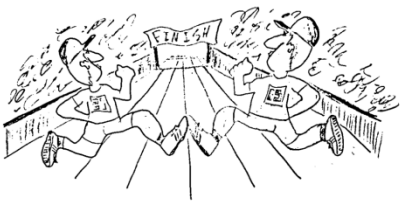
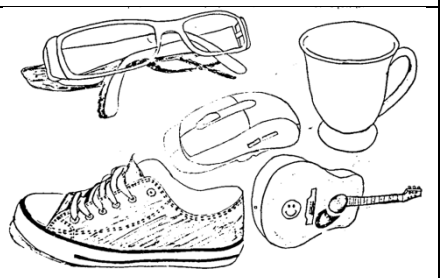
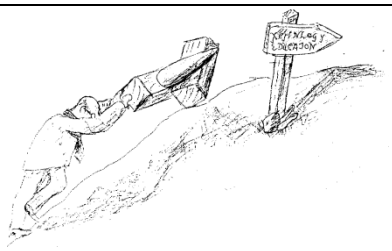
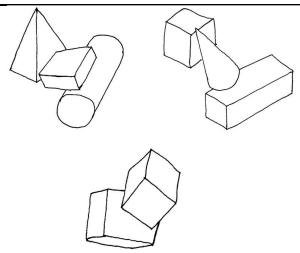


Figure 3 – Overview of student and researcher measures for the entire cohort

In order gain a further insight into the effectiveness of the activities, it was necessary to analyze the qualitative feedback provided by the students in addition to the sketches that were generated. Examples of these are provided in Table 2. For the purposes of this paper, only a selection of activities is presented for analysis. Examination of the sketched examples reveals significantly more detail and precision in the early stages such as Auxiliary Recognition and Enquiry. The comments suggest that the students enjoyed these early activities and this correlates with the higher values illustrated in Figure 3.

Interestingly, as the activities moved progressed towards the conceptual stage of the continuum, the sketches became less precious and more reflexive. This is evident in the sketched examples for Transfer, Enlightenment and Journey (Table 2). The feedback from the students suggested that time became an issue and that some students struggled to think in a reflexive, automatic and creative fashion when the visual stimuli were removed.

Table 2 – Examples of student commentary and sketches

Activity	Comment	Example of sketch
Auxiliary Recognition	Really enjoyed both activities. Nice change to standard measured drawings – **Student 125** I enjoyed this drawing as using the pencil to measure was a great method of measurement – **Student 131**	
Enquiry	Really tested my sketching ability. Highlighted problem areas. Eye opener of an exercise - **Student 125** Think the exercise was a bit big – took too much to fill the page. It resulted in me just slopping color on the page - **Student 131**	
Transfer	Not enough time to do it right and accurately. Casting the shadow though was very hard to do - **Student 104** Difficult to complete the task in the given time but probably worked better because I was under pressure - **Student 115**	
Enlightenment	Good exercise. I got better as it went on. Helps you to remember things better - **Student 102** I thought this activity was more of a memory test than a sketching exercise. The reason I gave it a four was because it was mainly like the leaving certificate trying to remember and regurgitate and sketching was only second fiddle - **Student 131**	
Journey	I feel that it brings out pupils creative side and it allows people to use their imagination a lot more and express themselves **- Student 10** There was more time wasted thinking of what to do than on what we actually drew - **Student 108**	

Discussion

As a result of analyzing the literature associated with freehand sketching and the findings of a number of preliminary studies, the model of drawing and sketching activities (Figure 1) was proposed. This new model was implemented and its effectiveness evaluated during the research study described in this paper.

Prior to discussing the measured effectiveness of the model it is important to understand the significance of its design. The model progresses from left to right where the perception based

"drawing" activities on the left are controlled and reflective in nature. In contrast, the conceptual *"sketching"* activities on the right are automatic and reflexive.

The strength of the model lies in its potential to promote student's progression across the three stages of development through perceived, memorized and conceptualized activities. The perception based activities build students *"graphical libraries"* (Storer, 2008) as they are constantly able to refresh vivid perceptual snapshots while composing their drawings (Fish, 1990). The memory focused activities in the center of the model develop student's ability to access their *"graphical libraries"* through *"visual mental imagery"* (Borst, 2008) and to communicate these through sketching. The final conceptually focused phase of the model promotes students ability to manipulate and synthesize their "graphical libraries" through tasks which are imaginative and reflexive in nature.

This research presents empirical evidence that illustrates the transition from perception to memory and imagination with varying degrees of certainty. Performance in the observationally focused activities was consistent while considerably more variation was seen once the transition to the more cognitively challenging conceptual based activities occurred. This can be seen in Figure 3 where both the researcher scores for the perception based activities (Recognition through to Auxiliary Enquiry) were generally higher than the subsequent memory and conceptually focused activities. This was a significant finding and suggests that perception based exercises with the visual scaffolds are both effective and critical for developing fundamental drawing skills.

The findings which described the students learning experiences while completing the model of activities validate the importance of the three stages of progression and the different cognitive focus for each. It was found that participants were generally positive about their entire learning experience and valued the educational significance of what they were doing. This was supported by the mean value scores provided by all students at the end of each activity (Figure 3) in addition to their qualitative feedback comments (a selection of which was presented in Table 2). In addition to being generally positive it was evident that the participants generally tended to be self-reflective and critical of their performance at the end of each activity.

A separate measure was used to establish the magnitude of improvement (if any) of the participants sketching skills. While this is not the focus of this paper it is worthwhile noting that participants who were found to have had little or no improvement were generally positive during the early perception based activities but they became less positive during the memory and conceptual focused activities. This was also supported in their lower mean value ratings for the activities.

In terms of second level education, this finding should encourage teachers to stimulate pupil's levels of motivation prior to and during sketching activities. It is important that teachers encourage pupils to evaluate their sketches and performance and to realize what they did well and what they need to improve upon. If this level of self-reflection and analysis is encouraged, it will help students to realize the steps involved in learning sketching skill.

In conclusion, the educational significance of the model of activities must not be underestimated. It promotes the development of a complex cognitive and psychomotor skill from a controlled and reflective process to a process which is automatic and reflexive (Satpute, 2006). The ability to freehand sketch is critical in assisting visual thinking and the complex cognitive processes

underpinning it. It has significant importance across multiple disciplines such as science, technology, engineering and mathematics where the *"visualizing instinct"* plays a critical role in supporting the *"language instinct"* (Fish, 1990) in problem solving and the externalization of visual cognitive processes.

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