The growing necessity for graphical competency

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Abstract

This paper aims to explore the value of graphical competency within contemporary technology education and society. In an attempt to establish the key perspectives on the contemporary merit of achieving competencies associated with graphical education, a review of the literature from both national and international sources was undertaken.

Graphical education in Ireland, in the context of technology education, has its roots in vocational education. The traditional subject focused on developing knowledge and competencies primarily associated with craft based outcomes (Seery, Lynch, & Dunbar, 2010). This philosophy has shifted focus in recent times in reaction to the ever-changing needs of our global society. However, as McLaren (2008) discusses the recent changes in curriculum across many countries, as having left many educators questioning the role of communication graphics in today's educational milieu. With the availability of resources such as digital media and CAD systems in industry, many have questioned whether graphical education is a redundant subject area (McLaren, 2008).

Therefore, an analysis of the role of graphical competency in a broader technological context is required. Plane geometry, knowledge of projection systems, standards and conventions are core skills that were associated with an early conception of graphical education. Today however, a broader skills set is envisaged to comprise contemporary graphical capability within technological education. Elements of graphical education, such as spatial ability, are core cognitive aptitudes that have been identified as vital to many vocational fields (Steinhauer, 2011) most notably, but not exclusively, the technology and engineering subjects. However, they are also vital in everyday tasks such as communicating ideas and finding one's way in an environment (Hegarty, Richardson, Montello, Lovelace, & Subbiah, 2002). Graphical education also lends itself to the development of further cognitive complexities such as modelling and ideation. As Baynes (2010) discusses, graphical competencies are directly related to practice and understanding in design.

Considering the visual nature of society, the requirement for graphical competencies becomes more urgent. Technology education offers a suitable arena for the development of these competencies and more specifically graphical education where the associated skills are taught explicitly.

Introduction

The principle goal of this paper is to examine the role of graphical education within a contemporary view of technology education. This research is concerned with investigating the purpose and value of graphical education and it is envisaged that the research presented in this paper will contribute to this investigation. Graphical education equips students with a number of core competencies, some of which will be discussed in this paper. Key perspectives on the importance of visual skills, as part of a broad skill set, are presented in the first section. The paper discusses the importance of visual literacy in contemporary society and within education. The paper addresses some of the contemporary views of graphical education within modern technological curricula.

The Visual Culture

Much of the available literature on modern visual literacy refers to the current culture of society as the visual culture (Duncum, 2001) or the digital media culture (Jonson, 2002). Regardless of the specific name there is no doubt that society, in general, has become more dependent on visuals to negotiate meaning in contemporary environments (Elkins, 2008). Mirzoeff (1999) distinguishes between two phases of human culture, modern which refers to the past and post-modern which refers to the present but reiterates that a concrete dividing line cannot be drawn between the two. He also highlights that it is in the postmodern era where the visual culture has become dominant over modern cultures (Ibid).

This shift that society has taken is evidence of a greatly altered environment where words and text alone are no longer the dominant mode of communication (Felten, 2008). As Duncum (1999) discusses, within contemporary society there is now a new amalgamation of technologies, economic relations and social formations where the pictorial plays the central role. Debord (1977) describes society as that of the 'spectacle' and discusses in depth the dominance of consumerism which is influenced predominantly by the visual. Authors such as, Lash and Urry (1994), claim that to look at the latest products that are available is to witness the seductiveness and power of the visual. Heywood and Sandywell (2012) claim that Debord's original allegory of the 'Society of the Spectacle' is no longer adequate and we should now consider the 'Universe of the Spectacle' as every branch of knowledge and contemporary social systems now rely on the creation of visual meaning.

Visual media is becoming the norm for communication in all facets of contemporary technological society (Bertoline, 1998). As outlined by Mirzoeff (1999), in everyday living, the internet and the television are the dominant modes of communication and there is always a visual message being described. With the ease of manipulation of visual media today, a renewed focus on visual skills is required and questions the role of education in equipping individuals to participate effectively in the visual culture.

Visual Literacy

The role of the visual within postmodern culture and the need for a renewed focus on visual skills are becoming more apparent. This section of the paper attempts to address some of the skills required to participate effectively in this contemporary visual culture. Brumberger (2011) provides an overview of a number of attempts to define visual literacy which are not all completely in agreement. Although there is disagreement as to an encompassing definition of visual literacy, most theories share common concepts (Avgerinou, 2011). A general definition as Bleed (2005 p.5) describes it as the ability to 'understand and produce visual images'. Mirzoeff (1999) highlights that as the visual culture moves forward the skills required to participate in it change, this may be a factor that has prevented the establishment of a universal definition. Given the visual nature of modern society, visual literacy becomes even more necessary as part of a post-modern curriculum both in professional and everyday contexts.

The enGuage report (cited by Bleed 2005, p.7) lists visual literacy as one of the key skills for the future, which will 'advance thinking, decision making, communications and learning'. With the power of modern advertising, which relies heavily on the image, there is a need for citizens to become 'critical viewers' through the study of the visual (Mirzoeff, 1999). Stafford (2008) presents an urgent need to focus on visual studies within modern school curricula. One of the main reasons, as she discusses, to have an enhanced awareness of one's own visual strengths is due to the power of modern technology in completing some of the more basic neural connections of the mind:

> While growing neurons continuously establish transient connections with one another in a random fashion, these connections rapidly unravel unless some outside influx causes them to be utilized, amplified and thus stabilized
>
> (Stafford 2008, p.45)

These neural connections are essential during the learning process and with the access to visual technology that is available today such as computer aided design (CAD), animations and simulations, some may not be occurring to an extent that existed prior to the technological era. Onians, Anderson, and Berg (2012) describe in detail how an informed approach to studying the visual can be adapted from the field of neuroscience. Again, they discuss the critical links made by neurons during tasks and highlight that modern imaging can now graphically display dendrites being formed on the neurons during a task. These dendrites are generally formed as a part of experience, which today is predominantly visual (Bertoline, 1998). Eisner (2002) uses the example of a map as a visual tool which helps an individual to navigate an environment and reiterates that this is a powerful graphical tool that displays relationships in space. Therefore, if we have the ability to interpret and utilise such a tool, through the development of spatial abilities and visualisation skills, it allows us to 'understand a particular environment and our place in it' (ibid p. 11). Having a stronger awareness of one's own visual abilities can enhance performance in a number of contemporary settings.

Avgerinou and Ericson (1997) conducted an extensive review of literature in search for a definition of visual literacy and the associated educational benefits. Some of the benefits they cited were increased in all kinds of verbal skills, improved self-expression, increase in student motivation, catering for a wide variety of learning styles, improved image of self, confidence and independence (Ibid p.289). This work was further consolidated by the production of a framework, containing the core elements of visual literacy, which stemmed from the literature review (Avgerinou, 2011). This framework is illustrated in figure 1.

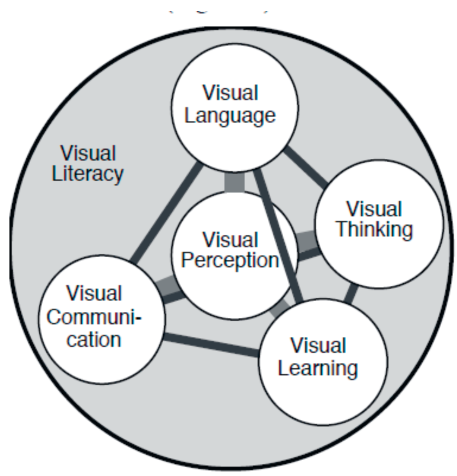

Figure 1: Components of Visual Literacy (Avgerinou 2011)

The Role of Graphical Education within Technological Curricula

Focusing on Irish education, graphical education began with its roots in two different areas; Art and Technical education. The focus of this paper is concerned with technical aspects of education and will therefore focus on graphical education where the skills taught were associated primarily with manufacturing based outcomes (Seery et al., 2010). Plane geometry, knowledge of projection systems, standards and conventions are core skills that were associated with an early conception of graphical education, and were primarily concerned with the effective communication of craft based outcomes (Seery et al., 2010) . While these skills may be still critical components of graphical competency, a broader conception is envisaged to comprise contemporary graphical capability within technological education.

Graphical education aims to address the development of a unique set of skills in students and encourage them to become 'problem definers and creative problem solvers' (NCCA, 2007). The philosophy of graphical education programmes varies slightly depending on the cultural context but a number of core areas associated with graphical education are commonly identified in the majority of the literature. These include problem solving abilities (NCCA, 2007) , creativity (Eisner, 2002), spatial cognition (Sorby & Gorska, 1998), geometrical knowledge (Olkun, 2003), drafting skills (McLaren, 2008), sketching abilities (Lane, Seery, & Gordon, 2009), visualisation , and ideation and modelling skills (Baynes, 2010)

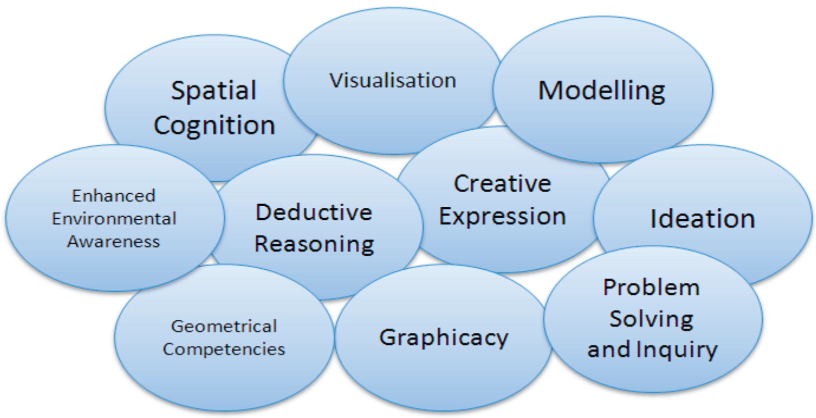

Figure 2: Some core aptitudes associated with graphical education

Figure 2 highlights some of the core competencies associated with a contemporary view of graphical education. Elements such as graphicacy which has been defined as means of visual communication (Danos & Norman, 2010) are critical within an contemporary technology curriculum. Communication by visual means has already been described as a critical element of modern culture earlier in the paper and is vital within technology education where students are often tasked with elaborating on and communicating design ideas. As Danos and Norman (2010) discuss, it is an area with great potential and can break through the conventional language barriers.

Elements of graphical education, such as spatial ability and visualisation, are core cognitive aptitudes that have been identified as vital to many career fields (Steinhauer, 2011) most notably, but not exclusively, the technology and engineering subjects. These skills, which are core elements of graphical education, are also essential for broader tasks such as finding one's way or place in an environment (Hegarty et al. 2002, Eisner 2002). The ability to visualise possible solutions to problems or issues is an essential skill within problem solving which is one of the core aptitudes technology education aims to address (NCCA 2007). Previous research by Sorby and Gorska (1998) and Sorby (2009) have shown that developing skills in sketching and drafting have significant positive effects on students spatial abilities and hence learning to use CAD.

Focusing on geometrical competencies within graphical education also facilitates the development of spatial abilities (Olkun, 2003). The development of geometrical knowledge and the ability to apply it to solving problems offers a significant basis for the development of advanced reasoning skills (Velichova, 2002). In the context of graphical education, geometry is a valuable analytical tool for solving problems of an abstract nature.

Modern graphical education promotes modelling and ideation which are core 'sense-making' activities (Kimbell, 2004). Modelling allows an individual to refine their cognitive process through various mediums and communicate aspects of the imagination which are not easily communicated through language or text (Baynes, 2010). Baynes (2009) illustrates the interchange between the mind and physical representation through modelling (see figure 3) which is critical for representing cognition in physical form. This interchange between internal and external modes of personal discourse is a very important skill refining a design or solution to an abstract problem. Lane and Seery (2011) has brought this concept even further in relation to supporting cognitive processing.

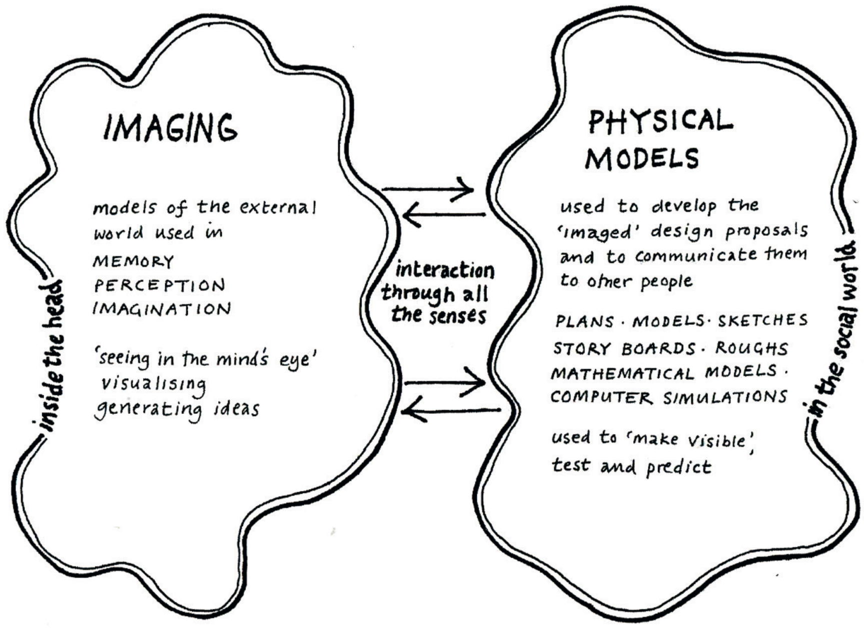

Figure 3: Diagram of interchange between imaging and modelling (Baynes 2009b)

Mechanical drafting of solutions still holds a place in the curriculum and as Field (2004) discusses, knowledge of technical drafting develops thinking in three dimensions and communication in two dimensional media. McLaren (2008) explores the value of teaching mechanical drawing in contemporary curricula and through an extensive analysis of literature establishes it as a universal graphical language which aids cognition and makes innovative problem solving explicit. Therefore, despite the dominance of CAD and digital media in most design contexts, tool independent graphical education still holds an essential role in developing robust competency.

Blurring the Subject Boundaries

Graphical education has been shown to develop a number of core competencies normally associated with design and engineering professions. This section attempts to explore the use of graphical competencies in broader educational contexts. Bedward, Wiebe, Madden, Minogue, and Carter (2009) explore the development of graphical literacy as a means of enhancing inquiry and problem solving skills in science education. The focus of their work linked elements of science, engineering and technology with a universal graphics tool during the problem solving process. The research provided robust evidence of the power of graphical representation in constructing meaning (Bedward et al., 2009) and has strong links to Baynes (2009a, 2009b, 2010) and Lane & Seery (2011) concept of refining cognitive processes through modelling although applied to a different context.

Sherwin (2008) provides a strong case for teaching visual literacy skills to law students discussing that the image when used in legal proceedings can often portray significant meaning not readily interpreted from linguistic mediums. Previous research by Danos and Norman (2010) has shown that visual skills are not just applicable to those subjects that explicitly teach it but to a wide range of different fields. The role of the visual has emerged as an urgent research topic according to Mitchell (2008) who explains that it is essential in all fields from human psychology and social behaviour to the structure of knowledge itself.

Petty (2009) provides an extensive review of the use of graphical tools in general teaching strategies which have been shown to produce an effect size (impact on student learning) of between 1.2 and 1.3. One of the primary reasons one should employ graphical representations of concepts is that it promotes whole brain learning and caters for a wide variety of learning styles (Petty 2009). Avgerinou and Ericson (1997) provide a brief overview of the pervasiveness of the visual across much of education generally which highlights the need for enhanced graphical competencies across all fields.

> In the middle years, we employ schemata and diagrams to simplify processes and procedures, e.g. The rain cycle. In secondary education, pupils are required to engage with an increasing range of visually presented information, e.g. conventional signs and maps. In chemistry, great reliance is placed upon the pupils' ability to understand three-dimensional molecular structures.
>
> (Avgerinou and Ericson 1997, p.289)

Conclusion

This paper considers some of the relevant viewpoints on the visual nature of modern culture. Graphical education has been discussed in relation to the role it has to play in developing a broad contemporary skill set. Expressing and constructing meaning through graphical means are methods that all young children engage with prior to formal schooling (Eisner 2002, Anning 1997). However as Eisner (2002) discusses, these skills are often overlooked in favour of more traditional elements of literacy during formal schooling. Felten (2008) states that the dominance of traditional literacy has ended and we have entered a new era of the visual. This is not to say that this paper advocates the discontinuance of traditional literacy but to place emphasis on a new concept of literacy that treats the visual as a core element including visualisation and visual thinking skills.

Visual thinking and expression are core elements of constructing meaning in a wide variety of learning contexts. Modelling and ideation, which are forms of visual expression, have been shown to be powerful problem solving and sense making tools (Baynes 2009a, 2009b, 2010, Anning 1997, Eisner 2002, Kimbell 2004). Graphical education promotes the development of these skills and more including, but not limited to, spatial cognition, analytical geometrical knowledge, which aims to develop deductive reasoning, and communication skills. Innovative thinkers and creative problem solvers are the types of graduates required in our multi-faceted, ever changing society (Robinson, 2001). With the role that visual communication plays in this modern society, providing students with the necessary graphical tools and the ability to put them in to action through graphical education can only enhance these desired qualities.

Graphical education is no longer rooted in a set of traditional values with a vocational focus. It has developed from a subject, which focused on the production of accurate mechanical drawings, to one which embraces a conceptual outlook. In order to develop these traits effectively, an enhanced vision of graphical capability must be established for future education. Lowther, Bassoppo-Moyo, and Morrison (1997) addressed a similar agenda when discussing the introduction of computers to education and stressed the need for educators to progress from literate to competent. In terms of graphical education, it is envisaged that this would mean moving from simply being able to use these graphical tools to constructing appropriate pedagogical resources and strategies to enhance the learning of them in the classroom. In other words, it means moving from being graphically literate to graphically capable.

Previous research by Brumberger (2011) has shown that simply being emerged in the visual culture of society does not guarantee the necessary cognitive skills required to become critical visual thinkers. The principle goal must be to establish a set of transferable cognitive skills that range across many subject boundaries and better equip the student with the necessary visual skills to participate effectively in post-modern technological culture. This brings into question the purpose of graphical education. Is it a subject that is purely concerned with representation or is it the arena to develop these enhanced cognitive aptitudes for transferable purposes? Education is the environment where these skills can be developed as a set of multi-modal literacies and capabilities. More specifically graphical education provides an opportunity to focus effectively and explicitly on transferable, life –long skill, especially within technology education.

If these graphical skills are to be facilitated through an educational milieu, further research must be undertaken to establish a framework of graphical capability. Does becoming a graphically capable entail simply mastering the core graphical competencies such as spatial cognition, ideation skills etc.? Alternatively, does it entail further development such as enhanced awareness of one's own metacognitive abilities in a graphical context? The research discussed in this paper supports the use of graphics as broader sense making tools and allows an individual to externalise their cognitive processes. This paper provides an initial rationale for developing graphical skills in contemporary education and establishes the basis for future research in the area of graphical capability.

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