Defining User Requirements and Strategies for a Multimedia Learning Environment Aimed at Enhancing Creativity in A' level Design and Technology Teaching and Learning.

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Abstract

This paper describes preliminary research into establishing strategies for designing computer-based learning material, which have the potential to enhance creativity in post-16 design and technology (D&T) A' level students. It explores meanings and perceptions of creativity from the point of view of D&T students. A series of three focus group interviews were carried out with A' level students, in which aspects of creativity within the D&T classroom were discussed. The interviews provide insights into what students need from learning expressed in their own words. These insights are envisaged to provide an empirical basis for the future design and implementation of an interactive multimedia learning environment (IMLE), aimed at enhancing students' creativity. The design and implementation of the learning environment will take place in the further stages of the wider research project, which identifying user requirements is a part of. The findings of the interviews form a list of user requirements to be used within an IMLE, concerning aspects of pedagogy and curriculum, or in terms of computer based learning, recommendations on the structuring of content and the structuring of learning interactions. Among the key findings are the need for, and importance of, collaborative work, discussing ideas and sharing perspectives, to developing and encouraging generative as well as evaluative thinking in students. The computer as a dialogue partner emerges as a valuable conceptual model within human computer interactions. The constructivist paradigm is seen as appropriate in supporting students' natural learning strategy, experiential learning and the type of task-oriented, problem solving learning environment which would best support creative thinking in D&T.

The findings discussed in this paper form the first part of a wider PhD research which explores the potential of multimedia technology and structured learning to enhancing creativity in D&T A' level students. The stages of design and implementation of the learning environment are the next step of the research which will build directly on the findings of interview data discussed in this paper.

Key Words: multimedia learning, D&T, creativity, learning environment design, pedagogy, constructivism.

Introduction

The report *All Our Futures: Creativity, Culture and Education* (NACCCE / DfEE, 1999) defines a technological challenge for creative cultural education, this is the need to educate and prepare young people to work in a rapidly changing world, which is continuously shaped by technology. The report calls for teachers to develop strategies for teaching and learning which introduce technology to students in a progressive and innovative way. These strategies should aim to encourage students to 'find new modes of creativity and deepen their understanding of the world around them' (NACCCE / DfEE, 1999:21). As a response to this challenge, this research focuses on exploring the potential of multimedia technology for enhancing students' creativity.

If using technology is to be considered as a tool for transforming methods of teaching and learning it needs to be conceived as a learning aid rather than an end in itself. This would mean establishing a strong theoretical foundation by addressing issues of pedagogy and curriculum. From an educational multimedia perspective, Boyle (2002:13) suggests that curriculum corresponds to the structuring of learning content and pedagogy to the design of user interactions. These form the two major focus areas within this paper.

In a critique of learning technology, Laurillard points out that most multimedia for learning seems to lack, in its design and conception, a pedagogy, which draws on a firm empirical basis (Laurillard, 2002:64). Accordingly, this paper describes an approach to forming a teaching strategy for a multimedia learning environment, which draws directly on empirical data of how to teach as informed by what students need from learning.

Aims

According to Laurillard (2002:69),phenomenography: gaining an insight into learning through exploring students' perceptions of the learning process, constitutes the best approach to generating a teaching strategy. This paper reports on the findings of an exploratory, phenomenographic study of D&T students' perceptions of the learning process as related to creativity. It further discusses how the findings of the study would affect the design of a learning environment, which has enhancing student creativity as its primary aim.

Literature review

The focus of research is the transition from AS to A2 in schools, as a stage of particular importance in D&T education. It is a stage where students are given an opportunity to display and apply their potential for original thought within a self-directed project, and are required to manage and take control of this process autonomously.

As the intent of research is to find ways of encouraging creative practice, literature was examined for an initial working definition of creativity. Approaches from the broader perspective of creativity in education were explored (DfEE / NACCCE, 1999; Weisberg, 1988; Hennessey, 1988; Cropley, 2001). These were further delineated by definitions of creativity specifically within the subject domain of D&T (Barlex, 2003; Kimbell, 2000; Cross, 1997; Rutland, 2000). Several aspects of students' experiences of design and creativity processes were explored. The Nuffield QCA Project's findings (Rutland, 2000) and the report *All Our Futures - Creativity, Culture and Education* (DfEE / NACCCE, 1999) were especially useful in outlining the basic areas of enquiry. These were context building, stimulus necessary for creative activity, encouraging reflective thought as described by Cross (1997), supporting risk taking, emphasised by Kimbell (2000a) and autonomy. Additional aspects of creativity identified as relevant within the wider research literature were experiential learning, collaborative work and intrinsic motivation. These were used as the basis for identifying areas of inquiry (formulated as questions) which in turn provided a framework for data gathering.

Method

A series of three focus group interviews were carried out with A' level D&T students within the Sheffield LEA. Each of the three interviews lasted one hour. The largest group consisted of ten students and the smallest of three. The questions were open ended, placing an emphasis on discussion. The interviews were video recorded in order to obtain data of the participants' non verbal communication. (Heath, C.; Hindmarsh, J., 2002). Video recording was especially useful in capturing data from questions which were either task related, or involved the analysis of visual material.

The focus group format of interviewing was adopted (Manion, L. 2000:288). In this approach, rather than focusing on a question and answer dialogue with the researcher, the emphasis is on students' interactions and the dialogue, which naturally develops amongst them. In this way students' own perspective on issues discussed is allowed to emerge, thus focusing on the students' rather than the researcher's agenda.

Data analysis and evaluation

The phenomenographic perspective which this study has adopted in data gathering and the emphasis on students' agenda in learning, suggested that one plausible approach to data analysis might be grounded theory (Glaser, 1967) in which hypotheses emerge and theory is generated from the data obtained.

The constant comparative method of grounded theory was adopted in data analysis, where 'data is coded only enough to generate, hence suggest theory' (Glaser, 1967:103). The testing of theory generated is not the purpose of this mode of data analysis. Accordingly, the purpose of the interviews was only to suggest requirements for adaptation of pedagogy and curriculum content within an IMLE, not to provide a definitive design specification. Such a specification will be gradually formed and refined as the project develops through testing and evaluating the learning material with A' level D&T students.

A qualitative data analysis tool, Atlas/ti, was used to analyse the interview data. The software is designed with the conception of aiding the generation of theory from data.

Key findings and implications for IMLE design

Following are some of the key findings, which interview data has yielded. Each finding is interpreted in terms of its implications for IMLE design.

Group work

In group work, each student brings a different perspective to the discussion. In students' own words, when discussing as a group, variations in thinking can lead to the development of creative thought. Part of the reason for thinking processes developing is having to express ideas in words. The act of speaking results in clarifying ideas. The following comment illustrates this point1:

Jane 'We had to design some way of carrying food and drink in a restaurant and we all talked about it, then we went away and designed and you could see that everyone had got ideas from what everyone else had been saying. It is a lot easier to do those designs after you've talked …'

Feedback from other students is unique – the informal style in which the discussion occurs predisposes students to share ideas in an honest way, which has valuable potential for learning:

Craig 'You can always go to your mates for aesthetic reasons because you are into the same kind of stuff - so if you make a clock that looks like it is from 1930s and say 'what do you think to this?' they'd go 'well it's pretty ugly actually'- so you are going to get an honest answer off your friends. It's not like going up to a complete stranger and they try to be polite to you - you go to your friends for honest answers.'

There is a strong implication that a multimedia learning experience, which aims to support creativity, would benefit students most if it is designed as a collaborative learning environment, involving several learners. The computer's main role should be that of a facilitator of dialogue among students. This idea of collaborative work as a learning strategy is supported by Kant and Wittgenstein's social constructivism theory: the notion that all meaning, knowledge and truth are essentially a social construction (Howe, 2000:19).

Experiential learning and problem solving
Experiential learning: using one's previous knowledge and experiences in trying to understand concepts and solve problems encourages generative thought. Within task related questions in the interviews students displayed the ability to construct complex ideas on the basis of previous knowledge and experience. The following example illustrates this point:

Question Where did the designer get their inspiration from?
Brian The human body
Craig Speaks for itself, there can't be anything comfier than sitting down on something that's sitting down.
Mark Inspiration comes from somebody who slouches on a couch, people rarely sit upright in a sofa. If you want to relax you tend to slouch down, stretch your legs forward, which is what this has got, head tilts back slightly…

The students' analysis of the chair's functionality was based on previous experiences of observing how people sit in chairs. In these terms, the kind of knowledge, which students constructed, was based not on knowledge explicitly taught or memorised but on everyday life experience. A further factor which needs to be considered is that knowledge construction is more likely to emerge in the interaction of the life experiences, which several students bring into a discussion, as is the case with the example above. Once again, it is in discussion that ideas are born. The dialogue, which develops among students, serves the purpose of triggering 'local memory searches', i.e past experiences, which Weisberg is referring to in describing the process of creative problem solving (Weisberg, 1988:153). This indicates that experiential learning is a form of knowledge construction, which helps creative thought to develop and characteristically occurs in the course of discussion.

Problem solving is what the subject of D&T requires of students and accordingly it is what D&T students adopt as a natural learning strategy (Hennessey, 1999). Across the groups interviewed, students were more motivated when working on a task towards a common goal. This was especially apparent within one task based question within the interviews, which asked students to draw the links representing the interrelations among key stages within the design process (Cresswell, 2002 : 39). Even though the question's content, the design process, may have been boring to students they actively contributed with ideas. While their motivation may have been initially extrinsic, they had to do the task because they were told to, the degree of engagement with the task was quite high which suggests intrinsic motivation. Students' body language (Heath, 2000:99) and comments on the task conveyed active participation. This raises the question: if it was not the subject matter which engaged them, what did? I would argue that the answer lies almost entirely in the way the question was posed, as a task. The rules were explained and the tools of interaction provided. In this way, the setting was not unlike a game, where students worked as a team towards the achievement of a common goal. It is therefore natural to conclude that learning material, which aims to engage D&T students in active participation needs to adopt a task oriented problem-solving format.

Experiential learning and problem solving are closely interrelated - 'all attempts to solve problems are firmly based on past experience' (Weisberg, 1988:153). The process of creative thinking as problem solving suggests a constructivist approach to generating a teaching strategy. In constructivist

IMLEs the learner actively constructs knowledge through exploring a task / solving a problem. Constructivism also supports the idea of using students' natural learning strategies, the idea of experiential learning, as a starting point on which new knowledge and understanding are gradually built (Boyle, 1997:49 ; Laurillard, 2002:67).

Autonomy

Research literature has established autonomy as a necessary condition for creativity (Barlex, 2003 ; Hennessey, 1988 : 32). Interview data indicates that learning to generate their own lines of enquiry and to identify design problems can promote autonomy in students. Finding a topic to design for seems to be one of the most problematic stages of the design process:

Question	Which stage (of the design process) would you say is the hardest?
Craig	'Specification. It's all right if you are being given a specification but with this project we are totally on our own. We have to write our own brief. You've been waiting since Year 7 for your own project and then you are totally blank, you can't think of anything to do. It's quite hard to think of something to do but you have to also make it with a difference... You have to think of products that you can change for the better and it's sometimes really hard.'

Interview data analysis has shown that generating lines of enquiry can be interpreted as a condition for creativity. Students' comments indicated that whenever the student has been unable to create a line of enquiry for themselves the teacher did this for them, and lack of autonomy was the inevitable result.

This issue has strong implications for the content to focus on within an IMLE. To enable students to create their own lines of enquiry, the emphasis should be on content which is context-rich. Examples could be eco design, user needs and wants, ergonomics etc., which explicitly deal with design issues in context. A further implication is the need to diminish the teacher's role as someone who suggests lines of enquiry. This will be substituted by the computer in a more passive role of guidance provider to the benefit of making the learner more active in their thinking. The notion of the computer as a facilitator rather than an instructor of learning, is a characteristic factor of constructivist theory (Doolittle, 1999:13). The computer will be seen as a 'dialogue partner', which directs thought without restricting it. This conceptual model of interaction is described by Preece as 'conversing' (2002:44).

Stimulus

The use of media in education is often conceived as providing stimuli. One such example is Alessi and Trollip's definition of simulations as intrinsically motivating (http://www.csu.edu.au/division/celt/edtech/multimedia/mmintro.htm). Interview data has shown that stimuli work best when accompanied by guidance, possibly in the form of open-ended questions. Such questions would encourage the student to reflect on their experience. The following is an example of how a small amount of visual stimulus, a picture shown to the student - triggered reflexive thought:

Question	Where did the designer get their inspiration from?
Carl	It is a lot more about form and being aesthetically pleasing - I mean you can just get a mug and put flowers in it if you wanted to and you can still call it a vase. But here the design is concentrated a lot more on how it looks and how he or she (the designer) thinks the consumer desires in a way.

While there was a minimal amount of input from me, it proved crucial to getting the student to think.

These findings further define the role of the computer as a dialogue partner and as encouraging reflection. Unless reflective thinking is actuated through dialogue, exposure to stimuli is of limited use. An IMLE has the advantage of being able to bring these two features: stimuli and guided dialogue, together, within a holistic learning experience. This leads to the conclusion that the role of the computer should be one of a source of stimuli, as well as a facilitator of conversation.

Existing products

Students indicated existing products as a major form of inspiration for their work. This is not unusual or even contrary to creative practice. Existing products can be a starting point for creativity as long as the process of looking at them is defined by an attitude of constant modification (Weisberg, 1988). This process can involve questioning, hence exploring a problem further. On the contrary, students look at existing products as a straightforward 'source of inspiration', on which minor modifications are usually made in order to turn it into a 'new' idea:

Question	Which (source of inspiration) do you think is more valuable? Which do you find easier to work with?
Tom	'Books 2... when you are doing something for inspiration if it's your

own inspiration then you have to do it from scratch. If you take it from a book you're already half way there. So basically you're just copying.'

It is unlikely that such an attitude would yield original thinking, because the students' approach is one of acceptance rather than of constantly questioning what they see. The implication for pedagogy is to start from the context, in this case existing products, and move towards abstraction, how the concepts within the product can be used outside the particular example. This approach has been described by Laurillard in her theory of teaching as 'mediated learning': 'Teaching as mediating learning involves constructing the environments which afford not only learning of the world, but also learning of descriptions of the world.' (Laurillard, 2002:22). In this case, looking at existing products is learning of the world. Reflecting on the concepts and issues behind a product is learning of descriptions of the world.

Conclusions and future work
To summarise, the interview data highlighted:

- the need for discussion and idea exchange among students;
- a task-oriented, problem solving approach to structuring learning material;
- constructivist psychology as a suitable starting point for generating a teaching strategy;
- the need to address autonomy by focusing IMLE content on design issues in context;
- the need for stimulus and guidance to work together in order to ensure students' learning;
- the need for an attitude of constant modification to existing products.

The research has uncovered tensions in identifying a theoretical perspective. The interview data has further highlighted these tensions. In attempting to form a teaching strategy which draws on empirical data it appears that phenomenography and constructivism are both valid approaches. In exploring students' perceptions and experiences, phenomenography offers a sound approach to empirical data which can be applied within IMLE design. However constructivism emerges from the interviews as the theory that best supports students' natural learning patterns. Each of these offers a different approach to pedagogy. Phenomenography sees the computer as an instructor that 'moulds' the experience of the learner (Laurillard, 2002:70). While it is possible to have such an approach in teaching Newton's Law for example, to 'mould' students' thinking would be contrary to creative

practices where autonomy and freedom of thought are valuable. In this way, constructivism seems to offer a better solution in seeing the learner as actively constructing knowledge and favouring experiential learning and problem solving over instruction. However, interview data has also emphasised the need for guidance. Howe and Berv (2000:32) suggest the answer lies in "mixing ostensibly constructivist and non-constructivist teaching techniques as appropriate." The implication for generating a teaching strategy is to develop a hybrid approach to theory, one that recognises the need for instruction but is not too prescriptive in its method as to inhibit independent, original thought.

The purpose of the interviews was to generate initial theory of what IMLE design should involve. Accordingly, the next step in this research will be to design and test the practical as well as the theoretical dimensions of an IMLE through iterative cycles of development and evaluation. The broad constructivist paradigm initially adopted, will need to be refined and adjusted to meet the requirements for an environment which affords learning and creativity.

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