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PASSIONATE ABOUT DESIGNING

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INTRODUCTION

Creativity (e.g. Atkinson 2000; Beghetto 2005; Fritz 1998; Lewis 1999 Robinson 1999;), critical thinking (e.g. Browne 2000; Stables 2012; Terenzi, Springer, Pascarella and Nora, 1995), responsibility and self-directedness (Virtanen, Leponiemi and Rasinen, 2012) have all been recognized by many writers as important human qualities required to meet the challenges of our technologically advanced society both now and in the future. In 2012 Virtanen suggested that self-directed and process-orientated citizens were more likely to be able to cope with a rapidly changing world, and even back in 1996 Wu, Custer and Dyrenfurth extolled the need for pupils to develop high order thinking and problem solving skills to meet the demands of the 21st Century. Enabling pupils in schools to develop and enhance such human qualities so that they can play a positive and active role in society should be the aim of all teachers.

In well designed, well taught Design and Technology (D&T) lessons opportunities for the development of such attributes abound (Atkinson 2000; Atkinson and Sandwith 2012; Benson 2012; Stricker,), particularly during the activity of designing which has been a fundamental element of D&T within the UK since the 1970's. Stables (2012), in discussing what she termed 'designerly-wellbeing', supported the authors' long-held beliefs that attributes such as passion, curiosity, enthusiasm, risk taking, competence and confidence could all be developed through the activity of designing. However, research clearly indicates that many teachers: lack confidence in their D&T ability (Bailey 2012); lack a real understanding of the complex nature of the activity involved (Atkinson 2009, 2011(a); Miller 2012); and are unable to support pupils effectively throughout the process (Atkinson 2009, 2011(a); Bailey 2012; Benson 2009). If this is the case, and the authors believe it to be so, then pupils are missing the opportunity to develop and enhance the all-important human qualities indicated above.

The links between creativity, intrinsic motivation and passion have been well researched (e.g. Amabile 1997; Leonard and Swap 1999; Polanyi 1966). Goleman et al. (1992) speak of creativity and intrinsic motivation as the urge to do something for the sheer pleasure of doing it rather than for a prize, and refer to passion's importance in the mix as, *the element that really cooks the creative stew is passion* (p. 30). If one accepts the importance of the relationship between passion and designing, then it follows that pupils need to be encouraged to be passionate about the activity. For this to happen teachers need to be passionate too if they are to develop the level of enthusiasm in their pupils that will sustain them through the exciting but sometimes arduous and difficult processes required to achieve outcomes of which they and their teachers can be proud. However if, as explained above, teachers do not understand the activity they are unlikely to be passionate about it.

The intention of this research project concerning a design and make task carried out by students training to become D&T teachers was to try to identify some of the factors that enabled some students to be passionate about designing whilst others from similar backgrounds and expectations, given the same brief, and in the same learning situation, do not reach this level of enthusiasm.

An initial cohort of forty-nine D&T students studying on an Initial Teacher Training (ITT) programme was identified for data collection purposes. After some preliminary data analysis a non-probability purposive sample of ten students was chosen from the original sample to complete an attitude scale and be interviewed about their design-and-make activity carried out during a thirteen-week Product Development (PD) module. Quantitative and qualitative analysis of the data collected allowed tentative conclusions to be drawn with the intention of informing and improving the way D&T ITT students could be taught, to design, and about designing, with the additional important aim of improving the students' teaching of that activity once they became D&T teachers.

BACKGROUND TO THE STUDY

Designing

Outside of an educational context the primary purpose of designing is the development of quality outcomes in various forms. Tovey asserts that the purpose of design education in a University environment is to provide students with the capability *to function as designers in the professional world* (Tovey 2012, p. 5). However, the reasons for the inclusion of designing and making within the school curriculum and therefore the reason for training teachers to teach design within D&T was originally the recognition that *the capability to investigate, design, make and appraise is as important as the acquisition of knowledge* (DfE 1989, p. 1) and the acknowledgement that D&T was an area of the curriculum which could develop such capability. In 2004 Miliband (then a junior Minister in the government's Department of Education and Skills) wrote that *designing is the combination of, and movement between, thought and action and an*

aspect of D&T that helps to make it distinctive in the curriculum (DfES 2004, p. 4). These statements continue to provide a sound educational reason for designing being part of every child's education, whilst within the D&T curriculum itself designing continues to play a vital role. Without it the subject, as we know it in England today could not exist. Designing and making using critical and creative thinking whilst developing skills in the use of a variety of processes and materials are still considered fundamental aspects of D&T in our schools today and as pointed out in the introduction the development and enhancement of important human qualities required to meet the challenges of a technologically advanced society can be delivered through, design activities taught in the D&T classroom.

Unfortunately, taught poorly design activity has been shown to taint the view that many pupils have of the subject (Atkinson 2000) and regrettably there has been considerable evidence from the Office for Standards in Education (OFSTED) (OFSTED 1998; 2000) and others (e.g. Toft 2007) who suggested that too often designing in schools has not been taught as well as it could be. Therefore it is important that those learning to become teachers of D&T must understand (Atkinson 2009; Miller 2012) and preferably be passionate about the activities involved.

Passion

Csikszentmihalyi (1990, p. 4.) defined passion as *the state in which people are so involved in an activity that nothing else seems to matter, the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it.* Passion is an emotion that can be externally observed, or a feeling that is internally observed. It is a biologically determined process that may be conscious or subconscious and one that can be induced by external events and circumstances. Although passion can have negative connotations, it is the positive power of passion that is the focus of this research.

Much has been written about the links between the joy of discovery and intellectual passion (e.g. Fridjda 2000; Polayni 1958) and the importance of passion linked to *stretching ones mind to its limits in a voluntary effort to accomplish something difficult and worthwhile* (Csikszentmihalyi 1990, p. 3). Goleman et al. (1992) speak of creativity and intrinsic motivation as the urge to do something for the sheer pleasure of doing it rather than for a prize, and refer to passion's importance in the mix as *the element that really cooks the creative stew is passion* (p. 30). The direct links between passion and creativity as the *intense drive to break through to something new* (Belitz and Lundstrom 1998, p. 57), the belief that *without passion we soon lose interest in a difficult task* (Leonard and Swap 1999, p. 78) and the idea that *passion is the energy that comes from bringing more of you into what you do* (Rosengren 2004) are all pertinent thoughts in understanding why the researchers in this study believe that being passionate about the activity of designing is an important issue.

Creativity

The critical importance of the elusive topic of creativity has been at the top of the agenda for educators, politicians and psychologists for many years. Although psychological definitions of creativity have varied, when writing in 2000 Atkinson suggested that there was on the whole common agreement on what creativity involved (Atkinson 2000). Using a quotation from the polemic work of Osche's she explained that creativity concerned *bringing something into being that is original (new, unusual, novel, unexpected) and also valuable (useful, good, adaptive, appropriate)* (Ochse 1990, p. 2). Amabile in 1997 added another factor to this definition suggesting that a creative task must be *heutistic rather than algorithmic* (Amabile 1997, p. 35). This combination of definition remains true today although in a school setting the meaning of 'original' is generally taken to indicate 'original to the pupil involved', rather than, as would be expected of a genius, something that has never been in existence before.

Recent support for those areas of the curriculum where the essential skills associated with creativity, critical thinking, responsibility and self-directedness can be developed (Stables 2012), and the right for subjects promoting these skills to remain a part of every child's education (Higgins 2012) has been welcomed as the authors believe that the raison d'être for their importance at the start of the 21st century remains unchanged.

Thankfully the D&T research community at large has continued to believe in the importance of these life skills and has relentlessly researched how to support teachers in understanding and successfully implementing creative activity in the classroom (e.g. Atkinson 2000, 2007, 2009; Hope 2012; Lawler et al. 2012; McLellan and Nicholl 2008; Rogers and Fasciato 2005).

Research has also identified various essential factors required for creativity to flourish, for example: pupil ownership and control of their ideas (Atkinson 1997, 2000; Benson and Lunt 2011; Hamilton 2007; Jeffrey and Wood 2003); the relevance of the tasks (Benson and Lunt 2011); the space and time to carry out the task (Benson and Lunt 2011); pupil interaction with others (Benson and Lunt 2011; Trebell 2007); pupil ability to take risks (Fasciato and Rogers 2005;

Hamilton 2007; Musta'amal et al. 2009); pupil ability to reflect (Musta'amal et al. 2009); the requirement of freedom to be creative, for it has been suggested that even pupils' perception of a lack of freedom undermines creativity (McLellan and Nicholl 2008).

Many writers have identified internal and external factors that, to a greater or lesser extent, affect creativity, and in turn affect passion and enthusiasm in a learning situation. In the context of the research reported in this article it is the place that passion plays in this mix that was examined. Much evidence (e.g. Amabile 1997; Leonard and Swap 1999; Polanyi 1966) has supported the relationship that exists between passion, performance and the attributes that a learner brings with them. These variables can include: a learners' general ability, intrinsic motivation, personal goal orientation, creative ability, ways of thinking and working, knowledge base, past learning experiences and the attributes of the task itself: its contextual location, its structure, its likely demands upon the learner (Atkinson 1997). Added to this, as many of the learners in this research project were mature students, were the multifaceted outside commitments such as families, mortgages and part-time jobs.

> *Family commitment was a big one. Always has been. I have 3 young children. My family outlook is children. My kids' education is priority, and also me providing for them. It is a fine balance between my kids, prosperity and life, and coping with Uni work. So did it affect my decision making? I work late at home at night because of homework and spellings – we go through the usual kids' education at home. By the time my kids went to bed at 9 then it was a really hard balance. But I would not change it for the world. I am lucky to be where I am now.* (Student T)

To identify which factor caused, affected or prevented passion in a specific learner is a difficult task and one that would require a more detailed research project than the time available for this small scale study, however the researchers believed that an in-depth semi-structured interview with a selected sample of students who had just completed a major piece of design project work might help them develop a better understanding of some of the factors involved and so enable them to improve their teaching of design activity in the future.

RESEARCH DESIGN

The Student Design Projects briefs

Design literacy inputs covering important aspects of designing had been given to all the students during a previous design module. These inputs were re-visited during the design task used in this research project to overcome any remaining misconceptions. Individuality rather than conformity was emphasized although it was explained that certain key elements needed to be evident at an appropriate place in each personal creative journey if students were to be effective designers of functional products. In terms of the design briefs set, each student was given two briefs to choose between. This meant that there were twelve briefs in total as two briefs pertinent to each combination of the four specialisms that the students had chosen to study were required (see below for an explanation of the specialisms). All briefs had successfully been used for a number of years and past iterations of the projects and student feedback had indicated that they were similar in terms of both challenge and opportunity.

The Sample

The size of the sample is problematic for the small-scale researcher with a conflict between validity and manageability (Robson 1993). The researchers were all too aware that a sample needed to be as large as possible and yet in order that the study could be resourced, particularly in terms of time, once some initial data analysis was complete with the original sample of forty-nine, a small sample of ten students was selected from the original cohort for further data collection purposes. The researchers used three criteria in order to identify appropriate students for the sub-sample.

The Sampling Criteria

1. Marks awarded: Only students who had been successful in terms of the mark they were awarded for their design-and-make activity in the PD Module were considered for the sub-sample. It was felt that by doing so the data collected would not be clouded with extra variables such as students who were not motivated in general or students who did not have enough skills required to achieve high marks in the PD module.

2. The two D&T specialisms studied: Each member of the cohort studied two out the four subject areas associated with D&T and offered by the university. Those being: Materials Technology (MT), Textile Technology (TT), Food Technology (FT) and Electronic Communication Technology (ECT). Each student chose a design brief that required both specialisms to be evident in their design activity and solution. The proportion of students studying each specialism in the sample of ten matched the proportion of students studying each specialism in the

total sample.

3. Level of Passion shown: The final criterion used to identify the sub-sample was the level of passion that had been shown by the students during their PD module. As the two researchers had taught all the students in their subject studies modules throughout the academic year and in particular during the PD module they believed that they could categorize each student as belonging to one of the following three groups:
    1. Passionate Group (P Group): Those who were extremely passionate about their project. This was evidenced in: the project itself; the processes that they had used; how they had dealt with the ups-and-downs associated with project work; how they had spoken about their activity throughout the module.
    2. Competent Group (C Group): Those who were competent designers and makers but had not appeared passionate about designing during their project.
    3. Lacking Design Flair and Confidence Group (L Group): Those who had succeeded in terms of marks awarded but who lacked design flair and confidence in their project work and in the way that they were able to speak about their activity.

Both researchers carried out this categorization of the total sample. There was a high level of agreement as to which category each student belonged to. Only students about whom there had been complete agreement were then used when the final sample of ten students was selected using the three criteria matrix (see Table I).

TABLE I
The matrix indicating the specialism and achievement of each member of the subsample
split by Levels of Passion

P Group (n = 12)		C Group (n = 12)		L Group (n = 25)	
Student	Specialism & Mark	Student	Specialism & Mark	Student	Specialism & Mark
Student Z	TT/MT 88%	Student W	ECT/MT 79%	Student S	TT/MT 70%
Student Y	MT/TT 80%	Student V	MT/FT 76%	Student R	MT/FT 68%
Student X	TT/FT 77%	Student U	FT/TT 74%	Student Q	FT/TT 62%
		Student T	MT/FT 72%		

INSTRUMENTATION AND ANALYSIS METHODS

The following materials and research instruments were used in the data analysis:
1. The cross-moderated marks awarded for the PD Module were used in order to analyse the relationship between marks awarded and levels of passion.
2. Attitudinal Scale: The ten students completed an attitudinal scale to check whether the chosen students did represent the levels of passion to which they had been allocated. The design of the scale was based on research and experience of designing such scales in the past (Atkinson 1997, 2000, 2003, 2007, 2011(b)). The scale used twenty-six statements about how positive students believed they were in various life-situations and during the product development module. A two-dimensional grid classification was designed for student replies. This was based on the Likert system (Likert 1932). The students were asked to tick one of four boxes which indicated how much they agreed or disagreed with the statements. The scale was given to the student immediately before they were interviewed and took approximately four minutes to complete.
3. Interview data: A semi-structured interview was then carried out with members of the sample separately in order to tease out further the attitudes of the students to designing and making their solution in the PD Module. Questions concerned the following: the type of processes used; what had caused them to become interested, frustrated or disillusioned; what type of thinking they had used; the problems and constraints they had encountered; whether they had coped or thrived; and whether they had found the activity rewarding; and a final question concerning where passion would be found in their project. An interview schedule of the questions to be asked and the order for delivery was designed, discussed and modified by the two researchers in order that the same understanding of the questions was established. This enabled consistency to be achieved even though the two researchers carried out the interviews separately. The interviews were recorded and then transcribed using voice recognition software (Dragon Dictate).

The students were not informed about the exact nature of the scale or the interview before hand. However, they were told that the researchers were interested in hearing how they had each approached the PD module, which they had completed at the end of the previous academic year.

Analysis of the transcribed interview data was carried out based on a qualitative data analysis approach. In this study the ten source files (the transcribed interview data) were scanned for particular ideas and concepts that were pertinent to the study. In the first instance sections of all the interview data were tagged with codes that encapsulated those concepts

(Miles & Huberman, 1994). Both researchers carried out this stage together in order that there was agreement as to the interpretation of an aspect of the interview conversation and agreement could be reached over the ensuing code. As the coding progressed the researchers were able to refine and condense the number of codes used. These chunks of information were then further analysed and clustered to form five themes in an attempt to revel what the data was indicating about factors, which could cause, affect or prevent passion in a specific learner. These themes were: Student attributes and student thoughts about creativity; design processes adopted; resource implications; support systems. It was recognized that although it was important to dissect the data in a meaningful manner it was also vital to keep the relationship between the parts intact (Miles & Huberman, 1994). By using the 'filter-and-sort-by-cases' capability of HyperRESEARCH software the researchers were able to analyse and report on individual members of the sample and by using the 'filter-and-sort-by-code' the researchers were able to select sub-sets of code references assigned to each theme, and so analyse and report on just those themes or upon the complex relationship between them.

RESULTS

Results from the cohort of 49 students

The relationship between achievement and level of passion

TABLE II
The relationship between Level of Passion and achievement for the total sample (n=49)

Level of Passion	Mean marks
P Group	74.42%
C Group	65.09%
L Group	56.04%

The results in Table II indicated a positive relationship between levels of passion and levels of achievement in the total sample.

Results for the sub-sample of ten students

The briefs chosen

From the twelve projects that the students could choose between only five were chosen by the sub-group of ten students. As already stated the briefs had all been used for several years and were similar in terms of both challenge and opportunity. The breakdown of student choice of brief indicated that there was no significant difference between the projects chosen by those in each of the three 'Level of Passion' Groups. Brief 1 was chosen by a student from each of the three groups, Briefs 2, 3 and 4 were each chosen by one student, in two out of the three groups, and Brief 5 was chosen by only one student from C Group (see Table III).

TABLE III
The relationship between the briefs chosen and the three Level of Passion Groups (n=10)

Briefs	P Group	C Group	L Group
Brief 1	1	1	1
Brief 2	1	1	0
Brief 3	0	1	1
Brief 4	1	0	1
Brief 5	0	1	0

In terms of the ten students' thoughts about the briefs they had chosen, seven students from across all the groups specifically mentioned that they had been happy with their choice of brief, indicating that they had found the contexts interesting. Although the other three students did not make specific comments about being happy with their brief, inference from other things they said suggested that they were. Half the total sample stated that they could identify with the brief they chose immediately, four because they were able to interpret the brief using their interests and hobbies and one because it meant he could design something he knew was wanted by a family member.

Although all three members of P group were amongst those who specifically stated that they were happy with their choice of brief it is interesting to note that for two out of the three this did not happen immediately. Student X believed that she was initially constrained by the two briefs she had to choose between, as she was not particularly interested in either. However she went on to say that this changed as soon as she began her research, when as she explained that she

"became almost obsessive" about one of them and knew that that was the one to choose. Student Y stated that:

> Initially, the project was something I just had to complete. But then overall I really enjoyed it and was glad that I chose the puppet theatre brief... It inspired me.

All students in C Group were happy with their project choice and only Student R from L Group stated that he would have preferred less choice as he found it difficult to decide between the two briefs. He was one of the students who based his project on family's interests. He explained that once he had made that decision he was happy with his choice as he could visualize the direction he was going.

In concluding this section the comparability between the challenge offered in the five briefs chosen by the sample and the analysis of the interview data would suggest that the briefs themselves and the support provided for students when they chose their briefs did not influence whether a student was passionate about designing their project or not.

The relationship between achievement and level of passion

TABLE IV
The relationship between achievement and Levels of Passion of the sub-sample *(n=10)*

Level of Passion	Mean marks
P Group	81.67%
C Group	75.25%
L Group	66.67%

As explained earlier as well as the level of passion one of the other criteria that the researchers used to select the sub-sample was that they had been successful in their projects. However as can be seen from Table IV there still remained a positive relationship between levels of passion and levels of achievement. Supporting the belief of the researchers and others (Belitz and Lundstrom 1998; Csikszentmihalyi 1991; Leonard and Swap 1999) that passion is an important factor in successful creative activity, as quoted earlier *the element that really cooks the creative stew is passion* (Goleman et al. 1992, p. 30).

Results from the Attitude Scale

The attitude scale was pre-coded by the researchers. A sliding scale of score corresponding to a student's level of agreement or disagreement with each statement was recorded. The highest score was given to students who indicated strong agreement with the statement, whilst the lowest score was given to students who strongly disagreed with the statement. This enabled calculations of the mean score for each statement, each student and therefore each 'level of passion' group. In order to test the ability of the statements in the attitude scale to discriminate between a positive and negative attitude, each item (i.e. statement) in the scale was subjected to a measurement of its discriminative power (DP), that being its ability to discriminate between the responses of the upper quartile (25%) of respondents and the responses of the lower quartile using the overall mean attitude score for each member of the sample to establish a rank order (Robson, 1993). Items with the highest DP indices were used for scoring overall attitudes.

The results from the attitude scale confirmed the researchers' allocation of each student in the sub-sample to a specific 'level of passion' group. P Group, those passionate about their project achieved the highest mean score for attitude and L Group, those who lacked design flair and confidence in their project work, gained the lowest mean score for attitude (see Table V).

TABLE V
The relationship between Levels of Passion and mean attitude scores of the sub-sample *(n = 10)*

Level of Passion	Mean Attitude Score (max score 4; min score 1)
P Group	3.154
C Group	3.105
L Group	2.679

In twenty-four out of the twenty-six statements the mean scores for each of the three groups indicated that P Group achieved higher mean scores than L Group. The two statements in which the least passionate students achieved the highest rather than lowest mean score were *I have drive in most of the things I do* and *I find it easy to be purposeful*. This would support the researchers' belief that the chosen sample in L Group were indeed motivated to succeed in general and

that even though they lacked 'passion' and designerly flair they were able to persevere and achieve outcomes that more than adequately met the assessment criteria for the module.

It was also interesting to note that C Group, had higher mean scores than the L Group students in reply to a number of the statements. However once again these concerned general motivation rather than being design specific. For example: being happy and not pessimistic, being stubborn and persistent. C Group also achieved the highest mean score for the statement regarding not feeling the need to seek approval before making decisions. However the researchers would not necessarily see this as a positive attribute. For they believed that a willingness to share incomplete or untested thoughts and ideas with others indicated a certain level of design confidence, which was evidenced in the work and attitude of those considered passionate about designing. P Group achieved the highest mean attitude scores for the following statements: being optimistic, non-conformist, single minded, intuitive when dealing with new situations, happy to set their own standards and values, enjoying most challenges, persevering against all odds when confronted with problems, displaying creative spontaneity and being proud of their outcome in the PD Module.

Results from the interviews with the ten students
As already explained the interview data was coded. The coded data were then organized into clusters relating to five pertinent themes in an attempt to make sense of the data and draw conclusions as to the factors that enabled some students to be passionate about designing whilst others from similar backgrounds and expectations, given the same brief, and in the same learning situation, do not reach this level of enthusiasm.

Theme 1: Student Attributes
The literature indicated that various attributes could affect levels of passion in a specific learner (e.g. Goleman et al., 1992) and therefore the cluster of data concerning attributes were analysed to see if there were any differences between the three 'Level of Passion' groups identified in this study (Groups P, C, and L), and if so what had caused those differences? One of the attributes highlighted in the literature was motivation (e.g. Amabile 1997; Leonard and Swap 1999; Polanyi 1966). The word 'motivation' was not used by any of the students during the interviews however it was believed that other terms such as, 'rewarding' and 'excited by' did infer levels of motivation. In reply to the question *Did you find the activity rewarding?* all students answered in a positive manner. However, there were considerable differences in what followed that affirmation, depending upon which 'Level of Passion' group the student belonged to. The three students in P Group all spoke very positively about both the process and the product outcome as being rewarding. The four students from C Group pointed to the learning and making aspects rather than the activity leading to the outcome, as being rewarding and motivating. The three students in L Group were also willing to agree that the activity had been rewarding. However, none of them described in any detail, or with any enthusiasm, aspects that they had found rewarding. Student R suggested that his satisfaction with his project had '...*ebbed and flowed*' and implied that this was because he feared failure as he had only made things in the past and had '...*never had to design in this way before coming onto the* [degree] *programme*'.

Also believed to infer levels of motivation was the students' use of the words 'excited by'. Although the interviewers did not use these words, everyone in P Group used them to describe their projects and/or their design activity on several occasions, whereas no one in L Group used words that indicated that they were 'excited' by their project, at any time during their interviews.

In terms of other attitudes that could be seen to have a positive or negative affect upon the students' activity and provide an indication of what had caused them, P group spoke about the need for resourcefulness and perseverance when things did not go as they had anticipated. C Group, supported the researchers' belief that they were all successful because they were motivated to succeed in all that they undertook even though they had not been classified by the researchers as passionate about designing. They each referred to a determination to succeed and even if frustrated they explained that they were not deterred or put off from completing the task. No one in L Group referred to being, determined, resourceful or having perseverance. In fact the data suggested the opposite. L Group students were quick to apportion the blame for their lack of progress or success on external factors and indicated that they felt they should not have to take responsibility for finding ways to overcome problems on their own. This feeling of being 'on their own' will be returned to when the theme concerning design processes adopted is discussed.

Another pertinent positive attribute highlighted during the interviews by members of P Group and not by those in the other two groups was the need to be flexible. They commented on several occasions on 'being happy to change direction' if something did not seem to be developing as they anticipated. In contrast students in L Group saw any changes as problematic. Student R referred to '...*wasting valuable time*' and all three students in this group inferred that they expected tutors to provide them with answers, rather than giving them more to think about by suggesting other areas they might investigate. In the role as teacher there can be a temptation to provide answers for a student who is seen to be struggling. However in a design situation this has been shown to be unhelpful and de-motivating (Atkinson, 1997;

2011). Another person's solution tends to transfer ownership of the idea away from the individual designing so that they no longer feel the need to take responsibility for its success, and will apportion the blame for any future failures on others rather than themselves.

In terms of being confident, students in P Group talked about being determined that all problems must be solved; how the project had developed their confidence; how they had enjoyed leaping into the unknown; and how they had thrived within the constraints that their design activity had imposed upon them. Whereas those in L Group all indicated a lack of confidence in their ability to cope with the unknown.

> *I doubted myself, doubted the things that I could achieve. ...I would restrict myself and think I don't know, well would it work I don't know.* (Student S)

> *I felt I was kind of in the wilderness, I didn't have a direction to go in.* (Student R)

> *If you feel you have not the right information you are not confident* (Student Q).

One student from C Group and one from L Group referred specifically to being pessimistic and how this had not helped them to make progress when they were struggling with some aspect of their design project. Seven students in total mentioned becoming frustrated, disillusioned or disheartened at some time during the design project. These frustrations will be discussed in the relevant section where the cluster of data that caused that to be the case is reported. Only three students, two students from P Group, and one student from C Group believed that they never had such feelings while they were designing.

Having analysed the difference in attitudes exhibited by the passionate students in P Group compared to the attitudes displayed by students in C and L Group it would seem that an important factor is that passionate students believe that they have the capability to design their way out of a problem, whereas less passionate students do not have the confidence to believe that they can do that.

The evidence concerning student attributes also indicated that passionate students were very motivated throughout their design projects. They used language that was full of positives, they indicated that they were on the whole happy within themselves and relished challenging, unknown situations, whereas the students who were not passionate about their design activity tended to have a 'glass-half empty' and 'can't do' attitude towards their activity that placed a barrier, a resistance, preventing them from overcoming their fear of the project they were carrying out.

Theme 2: Creativity
The second cluster of data concerned creativity. Being creative has been shown to be important if new innovative ideas are to be developed while designing (e.g. Tovey, 2012). Creativity's importance was discussed in detail with all the students during the design literacy inputs, as were various strategies for improving creative thinking. This was considered important particularly for those for whom being creative did not come naturally. So it was not surprising that all students in P Group and C Group spoke about the importance of creative thinking and explained in the interviews how they understood the interplay that must exist between imaginative and rational thought. Students in L Group also mentioned the importance of creative thinking but when asked about their own process they indicated that rational thought must come first. They explained that they were more concerned that the outcome was practical and feasible and none of them mentioned trying to achieve unique outcomes, which all students in P Group had mentioned as a goal they wished to achieve.

In support of the literature on creativity (Reeve, 2011) four students, all those in P Group and half of those in C Group specifically mentioned 'thinking outside the box' as an important aspect of designing. Student Z explained the timing of 'thinking outside the box' as ...*both early on in the process during early idea generation and when you are trying to solve details of your chosen idea.*

On the other hand two members of C group and all members of L Group indicated that being creative was problematic for them. Student W from C Group and Student S from L Group both believed that they should have been more creative throughout the project. Student R from L Group indicated that he tended to be *quite conservative* and struggled to *release the creativity* that he believed he should be capable of. However none of them suggested how this could be achieved.

In terms of 'passion', which as explained earlier, is closely related to creativity, the researchers kept the use of this word out of their interview till the final question which was: *Where do you think we would find evidence of passion in your project?* The responses from P Group indicated that they believed that passion was evident in their product, in their folios and in the way they had spoken to their tutors and peers about their project. It was also the case that Students X and Y from the P Group used the term 'passionate' to describe their creative activity on several occasions earlier in the

interviews when no other students used this term before the prompt in the final question of the interview. In terms of C Group they provided responses that indicated a less fulsome belief that their activity indicated passion. While those in L Group were even less certain about using the term to describe their activity. In fact in reply to the question concerning where passion could be found, none of them chose to use the word 'passion' at all, rather they referred to it as 'it':

> *I think it* [passion] *is probably in the final product.* (Student R)

As can be seen from the above analysis it would appear that all students understood the important role that creativity should play during designing, whether they found being creative easy or not. Evidence both from the design activity they carried out and the interview data indicated that Students from P Group were naturally creative, Students from C Group had used the creativity strategies suggested to students during the design literacy inputs, whereas the students in L Group struggled to be creative and found the strategies discussed and experimented with, went against their natural instincts to use a scientific, rational approach. The interview data for these students implied that they were afraid to change their mode of operation. It would appear that these students required more practice with a greater number of creative strategies so that when they came to use them in their design activity they could believe in their usefulness in providing creative ideas that could then be developed into solutions that worked, rather than suggesting as Student R put it:

> *What was the point in sort of chasing dreams that couldn't possibly come to fruition? ...I always try to make it a practical thing rather than a flight of fancy.*

In the next sections the students' thoughts on: the design processes they adopted; resource implications; the support mechanisms used, will each be discussed in turn, although the important interrelationship between these themes will also be picked up in a final section. These next analyses were carried out in an attempt to identify where extra support could be given to help those students who were not as enthusiastic about designing as the researchers and others (Atkinson, 2008; 2009; Miller, 2012) believe they needed to be in order to become successful teachers of D&T in the future.

Theme 3: Design processes adopted
Leading on from, and closely linked to the role of creativity were the design processes that students choose to use in order to design their products. As already described, inputs had been given to support each students' understanding of the process and how although various aspects were required to be present in everyone's design activity the order and importance of each aspect was dictated by the individual creative journey undertaken. For some students in L Group the interviews indicated that this was a difficult concept for them to accept, they would rather have been told the steps that they must take and when they must take them.

In terms of understanding the brief, all of P Group and three out of four students in C Group spoke of the need to develop a deep understanding of the brief and be aware that it often required re-defining (Baynes, 2013) as the project progressed in order to design in a meaningful way. They also spoke about the methods that they used to achieve this understanding. It was disappointing to see that no one in L Group referred to this aspect of the process even though the importance of understanding the brief (Leblanc, 2012) had been fully discussed during the design literacy inputs.

When each student was asked whether they had adopted a designer's or a scientific method (Cross, Naughton & Walker, 1981) to achieve a solution to their brief, students in P Group all indicated that they had used a designer's method. Only one student in C Group believed that they too had used a designer's method while the rest of that group suggested that they used a scientific method. L Group was in a similar position with two out of three students in the group indicating that they had adopted a scientific method to their designing. Although evidence from her interview suggested that even she had used a more scientific than designer's method throughout her activity.

Therefore it was unsurprising that no one in C or L Groups referred to the importance of developing the aesthetic aspects of the product. This was in sharp contrast to all members of P Group who spoke at length of the importance of a balance between functionality and form and the importance of thinking outside the box to achieve something new, special or different. For example Student Y indicated:

> *I did not let the function override the design. I really tried to focus on something that hadn't been done before. Anybody can be ordinary, especially in designing. You sometimes need extraordinary things. Otherwise everything would look the same. I think there's always room for something different.* (Student Y)

Evidence from the literature supported the significance of the use of reflection throughout design activity (e.g. Baynes, 2013). Its importance had been the subject of one of the design literacy inputs earlier in the year and an aspect that was re-visited during the PD module. Comments made by all members of P Group indicated their understanding of the importance of stepping back and reflecting regularly while they designed. For example Student Y explained that it had been helpful to reflect on her discarded or partially thought through ideas even though it meant *...going backwards two*

steps to get one step further forward. Those in the other two groups did not refer to, or infer using 'reflection' at any time during their interviews suggesting that this had not been seen as an important aspect of their process.
In both P and C Groups students talked about enjoying the challenge of designing, however no one in L Group mentioned enjoying the challenge. In fact two out of the three in that group complained on several occasions about how hard their project had been, the inference of their use of the term 'hard' being that they had found the process: demanding; taxing; difficult, and not something they had enjoyed.

Other negative issues that all of L Group raised, were that they recognized that they were frustrated and disillusioned when designing. Their lack of confidence they said was due to one or more of the following: a lack of information; a lack of time to make design decisions; the fact that practicalities overshadowed the development of ideas; finding it difficult to look at the big picture; being too involved in details too early; having rushed the design process because they wanted to start making as that was the area they liked best; not being able to simplify their designs so that they could make them work as they envisaged them; and a lack of various practical skills, which they believed should have been in place before they started trying to design using those skills.

A surprising result was that all those in P Group also spoke of being frustrated with designing. However, when looking at what they were frustrated with it was apparent that these students were frustrated by some parts of the process they were required to act upon to meet the assessment criteria. Having to produce evidence of developing a specification (Students X and Y) and in another case always having to use annotation to explain their thinking (Student Y and Z). Members of L Group, on the other hand, found developing a specification to be one of the easier aspects of the process to carry out. The researchers would suggest that this was because, as previously mentioned, these students felt 'safe' when there was a set of rules to follow and developing a specification provided them with a step-by-step structure to follow and that fitted these students predominantly scientific approach to designing.

In terms of the final prototype all the students in P Group spoke about being proud and excited by the final design of their product, Student X, because she felt she had managed to portray Russian culture and the history of Russia in the cloak she had designed. The other two talked about how their products were now being used. Student Z having designed a very unusual seat that was *loved and used* by his whole family, and Student Y talked about being proud to use, within a school environment, the puppet theatre and puppets she had designed to teach about inclusivity.

Students in C Group had enjoyed the challenge the briefs had offered them and were on the whole pleased with their final prototypes. The data implied that this was because they were relieved that their final product had worked. The data also indicated that as their projects progressed they were spurred on more by a desire to make their product function satisfactorily rather than a desire to make a product that as well as functioning correctly, would be new, special, different and desirable. They talked about the changes they had had to make to their products whilst manufacturing them, although they did not mention the fact that they had all required considerable help to overcome inadequacies in their designs. Unfortunately, the consequences of this was that their designs changed in an ad hoc manner that prevented their product from being successful in harmonizing functionality and elegance even though as Student W said *...at least it worked.*

This was also the case for the students in L Group. They were each fairly pleased with their final product but admitted that they too had been forced to make changes to their design as they manufactured their prototypes. They explained that they mainly turned to the workshop technicians and peers for these solutions. Understandably, because they were not the students own solutions the changes did not necessarily take due consideration of any knock-on effect upon the overall design. Students S and Q recognized this and admitted that some aspects of their final design had disappointed them.

In concluding this section the analysis of the data concerning the design processes that the students used would suggest that once again the differences between those in P Group and those in L Group were focused on a student's lack of confidence. L Group students were challenged by the need for 'individual creative journeys' rather than having steps to follow; having to 'think outside the box' when they believed they did not have time to do so, especially as their natural inclination was to use a scientific rational method of working, and not having a clear picture of exactly how their product would work in both functional and aesthetic terms before manufacturing began.

Having analysed the differences in terms of actual process between those in Group P and Group L, it would appear that the biggest difference between students in L Group and those in P Group lay in the use of enough 3D modelling early on in the process. All students in P Group explained that they had taken onboard the advice given and understood how vital it was that their designs should be developed through 3D modelling from an early stage in the process when it was not critical if mistakes were made. As Student Z explained he was able to prove to himself what would or would not work. Through this form of modelling students in P Group developed confidence in their ideas, even if those ideas sat outside their existing knowledge base. This also enabled these students not to loose ownership of their ideas, and remain confident about the design of their final product. It would seem important that in the future the benefits of this form of

modelling should to be further emphasized to all students, particularly those who are not passionate about designing, as it is something that they already have the capability to carry out and should help them overcome their lack of confidence.

Another factor identified when analysing the data on design processes used, was how pertinent resources impinged upon the design activity of each student. These and their effect upon the students' ability to be passionate about designing will be discussed in the next cluster of data.

Theme 4: Resources
The fourth cluster of interview data concerned the resources that students believed had affected their ability to design and manufacture their product and how these had affected their levels of motivation throughout that process. In this cluster the implications of: financial resources; time available for carrying out the project; material and equipment resources; and the plethora of skills required to carry out the project, will all be discussed. The researchers were aware that they were not able to overcome the actual problems associated with certain factors such as financial resources, as that was outside their remit, however analysis of the differences in how students in the three Levels of Passion groups dealt with such problems they believed could be useful.

All students signaled that their financial status had affected their activity. For example Student S from L Group spoke about the cost of materials for her project affecting the amount of money she had to live on, and Student Q explained that:
> ...*issues like funding, paying for material meant I could not do what I wanted to do. Going home to Birmingham, travel costs, definitely did impact on it, and without those my work would have been better.*

On the other hand, although Student Y from P Group spoke about her financial problems she indicated that they would not stand in the way of her project.

> *Money was a problem – a big problem. I spent a fortune and then you get to the point when actually you think, oh you want your project to look beautiful and you get enthralled with it. And I spent a fortune on spray paints. So you kind of forgo the niceties to go and buy paint and wood and things. But I think that's what you do if you're passionate* (Student Y).

The importance of time available for the project was mentioned by eighty percent of the students. One student in P Group and several in C and L Groups explained that in order to study they had a part-time job to cover living expenses and the cost of being at university. This part-time work may have provided them with enough money to undertake their project however the students from C and L Group who had part-time jobs spoke about how that had affected the amount of time they could make available for their project. Whereas Student X in P Group explained that she just juggled her time so that she had enough time for both and did not allow the lack of time to get her down. She explained that she just had to work harder and faster.

Other aspects concerning the need for more time concerned requiring more time at certain stages of the design process. Those in P Group and C Group talked about wanting more time to push their ideas further, how designing had to be a compromise with not enough time to investigate things in great depth, and the need for time to overcome problems that they had not factored in. However, even though they would have liked more time students in P Group indicated that they recognized that they must design within the time frame allocated:

> *It would be a wonderful perfect world if we had had a year to do the project, but if that was how long we were given we would still want more.* (Student X)

At the other extreme even though project management had been the subject of one of the design literacy sessions L Group were not successful in planning their time and found themselves running out of time at various stages of the process. The process taking too long was a recurring theme from students in L Group. They implied that they had not been given long enough to complete their project. However the same design brief can be set to last for a very short or a very long length of time. In this project a generic timeline of when stages should be completed by was discussed at the start of the project, however each student was expected to work out their personal timeline and keep refining it as changes in their creative journey occurred. Observation of L Group students designing suggested that their failure to time manage their projects accurately was due in part to a lack of practice in designing. This lack of practice seemed to prevent them from being confidence in working out how long each aspect of the process would take, especially when their designing took them into new unknown situations. They found the generic timeline given to them increased the pressure as they realized on a weekly basis that they were not meeting the suggested deadlines.

Members of each Level of Passion group also talked about materials and equipment as being a constraint upon their design activity. For example, Student Z in P Group talked about not being able to bend metal tube in the form he had designed, and finding out that the properties of leather where not quite as he expected. Student V from C group explained

that the limitations of the workshop meant he had to change his design. Although in neither of the above cases did the students allow the constraint to discourage them and in fact as Student Z explained it made him even more determined to overcome the problem for himself and he did this by testing each new material and process that he required. Student X was especially proud, as Textile Technology had been a new area of D&T for her and explained that:

It was the first year I had ever touched a sewing machine. It was my personal experiences that were limited I now know tenfold what I knew. Everything I learned during that aspect of my project was completely new to me. (Student X)

As has already been discussed in several of the other themes L Group tended not to blame themselves, and in the case of material and processes this was once again the case. As Student Q explained:

I had problems during the making, the CAD machine was not working properly, I did not have control over this. It made me waste time.... I became more frustrated.

In terms of practical and design skills as a resource, students talked about the skills that they did or did not develop during the project. P Group indicated excitement about the new skills they acquired because of the direction their designs had taken them, whereas the majority of C and L Group students only talked about the negative aspect of having to learn new skills. Citing a lack of time to develop skills and how this made them unconfident and despondent about their projects. For example Student R explained

I doubted myself, doubted the things that I could achieve because I didn't know how to do everything when I needed it (Student R).

In conclusion as with the findings in the other themes the students passionate about designing took problems (in this case concerning resources) in their stride whereas L Group students were not confident enough to instigate solutions for themselves and instead allowed resource issues to add to their frustration and despondency.

Theme 5: Support Systems

The final cluster of collected data that appeared to have impinged both positively and negatively upon the students' design processes concerned support provided by family, peers and tutors.

In terms of family support several students explained that their families had been beneficial because they were interested in the product outcome; they helped to test out ideas; they gave helpful feedback; and they gave them space in terms of time to get on with their projects. For example Student Z in P Group explained:

My wife was a brick she would put the children to bed and help them with their homework when it was really my turn, just so that I could get on.

Student R also indicated that his wife had been ...*very supportive, so that I could be kept out of the loop to an extent.* However, for some students, including Student R, family members could be problematic. He explained that children could have a negative effect upon their project especially if they demanded attention when he was trying to work on his designing, and Student Y explained that being a single parent meant that she had to give time to her son and explained the conflict this caused:

Its like this massive balancing act. I feel as though I am neglecting him and I'm doing work... and so yeh, sometimes particularly when you're exhausted and you know you have to be a parent and then I have to do the work... Then sometimes you kind of resent the work, and then you resent your child and it's sort of a bit ... its hard.

In terms of support within the University students from each group spoke about how useful feedback on their ideas, particularly by their peers, had been. Students Z and Y from P Group also added that they would then tease out which was the best way forward for themselves, whereas students from L Group intimated that they were grateful to use as their own, the ideas that other students gave them. When it came to the support provided by tutors and workshop technicians, students from P Group spoke with enthusiasm about the support they had received throughout their projects. Although, all three students in P Group also talked about preferring to research and experiment for themselves and only turning to experts for advice if their experimentation had not provided the outcome they desired. Whereas the data from L Group implied that they turned very quickly to tutors and workshop technicians and expected answers to be provided and when this did not occur their despondency deepened. They believed that they should have been given more direction, they found tutors different interpretations of what was required frustrating, and they believed they were not given enough of the necessary information when they needed it. An apposing view was provided by P Group students when they talked about not wanting to be strait-jacketed with too much direction, enjoying the differing points of view of tutors and technicians and enjoying the challenge of searching and finding any new information they required rather than being given it.

In conclusion on the whole all students believed that they received positive support from family and peers. Students from P and C Groups were also complimentary about the support they had received from the university, however students in L Group were not as positive about that support. The data suggested that they could not cope with being given a range of solutions to choose between, what they wanted were 'quick-fix' answers that they could use immediately to overcome their problems and move on to the next stage of the process. Unfortunately as already explained, providing answers is not a successful strategy. However the researchers recognize from the data collected that the support mechanisms that are in place should be re-appraised for the students who are not naturally creative or passionate about the activity of designing as they do not support the students sufficiently at present.

The relationship between the themes
Comparing the data from each of the themes identified relationships between the clusters and clarified the researchers understanding of the factors that appeared to have either caused, affected or prevent students from being passionate about designing during their PD project.
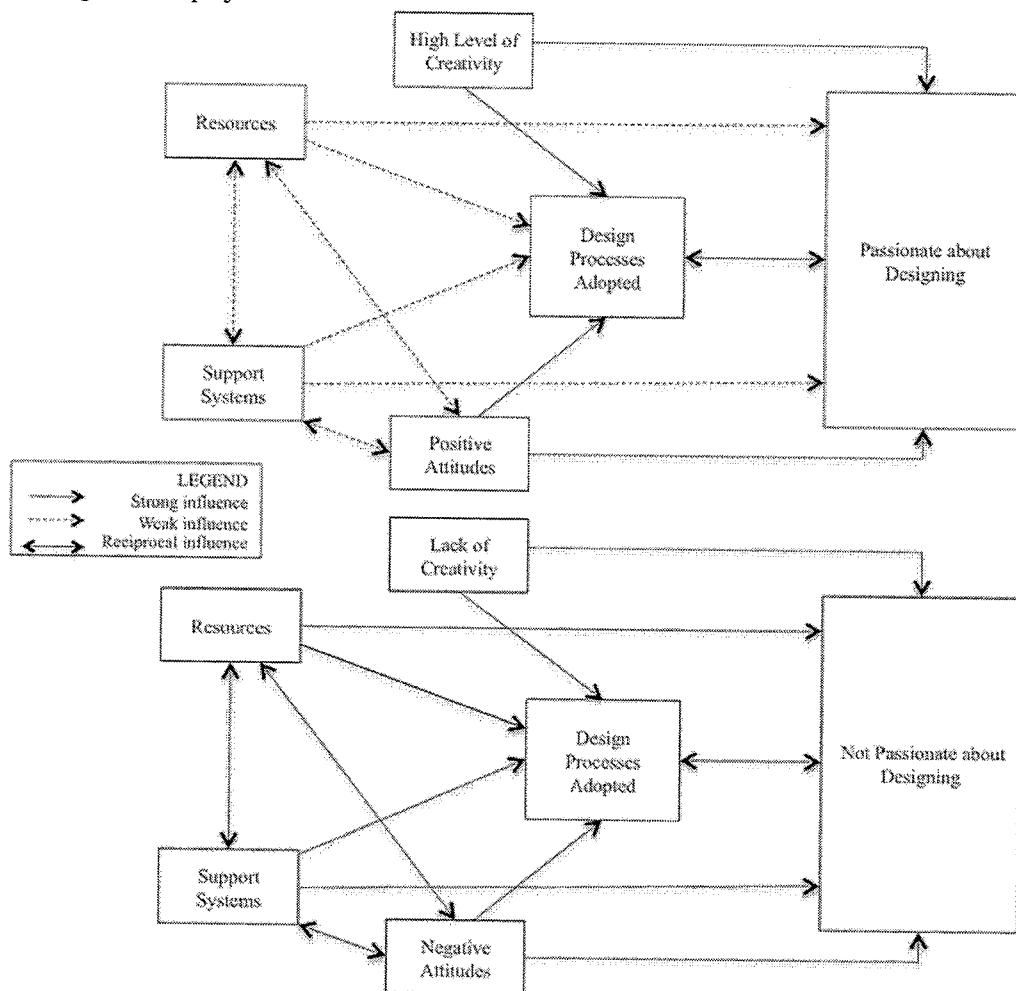

Figure 1. Causal network of themes and their interpretive relationship to each other for those passionate about designing and those not passionate about designing

The relationship between the themes concerning the group of students who were passionate about designing identified many positive factors. The data indicated that they began their projects with an underlying capability that provided them with an advantage over the students identified as not being passionate about designing; they already knew how to design. They had been successful in the past and were able to build upon that success. They were each very motivated throughout their design project. They were determined, resourceful and flexible in their thinking, and they were creative. They used language that was full of positives; they were on the whole happy within themselves, relished challenging, and unknown situations and believed that they were capable of designing their way out of any problems they encountered, mainly using their own developing expertise. They did not need to rely on others although they were happy to seek feedback to augment their thinking and expertise to learn a new challenging skill. They were able to time manage their

project to fit the time available, while working round part-time jobs and family commitments. Throughout all the challenges that the project threw at them they remained focused. Finally they produced innovative, desirable products of which they were rightfully proud.

However the analysis of data from the students who were passionate about designing did not provide obvious ways forward that could instantly be translated into strategies to help those students who were not passionate about designing. The researchers therefore turned to the combined theme data for students who were not passionate about designing in the hope that this would provide them with useful ways forward.

As expected the combination of data from the themes concerning the group of students who were not passionate about designing identified many negative factors that had affected and prevented these students from being passionate about designing. Whilst the passionate students had begun their projects being able to design this was not the case for the three students in L Group. Their previous experiences of design activity had not established good practice in terms of designing. The data for these students indicated that as soon as they began their PD projects they showed signs of lacking confidence in their ability to overcome past deficiencies. The data indicated that they tended to have a 'glass-half empty' and a 'can't do' attitude towards their activity that placed a barrier, a resistance, preventing them from conquering their fear of their lack of understanding of the processes involved and their ability to overcome their difficulties when designing in new, unknown situations. Situations where their rational thinking that had stood them in good stead in certain types of design practice in the past; were no longer enough. The data suggested that this was not helped by their inflexibility and the difficulty they had in accepting that they should use strategies that could encourage them to be more creative. They admitted that they became frustrated, disillusioned and disheartened by what they produced at each stage of the process although they continued to try hard and were determined to complete their projects. They explained that when they were stuck they believed that their only way forward was to find or be given answers that they could use. They indicated that they became frustrated when they were provided with directions to investigate, as they were unsure how to use that information. Even when they were given solutions by tutors and technicians to help them overcome insurmountable problems, they became even more de-motivated as the product no longer resembled their vision and no longer lived up to their expectations. The data indicated that in retrospect they recognized that their lack of 3D modelling had caused many of their problems both during their early design activity and in their eyes more importantly as they were trying to refine and detail their chosen idea.

In drawing conclusions about the ways forward the data from the students who were not passionate about designing did indicate some solutions. It would appear that to overcome the students poor design practice that these students needed more design activity before tackling their important PD project. This should be in the form of several short fairly structured design projects that encouraged them to: use a variety of creative strategies; produce a range of early concepts without worrying about whether they could make them or not. But most importantly these students need to be encouraged to develop ideas through 3D modelling both at an early stage and later when they are working out the fine detail of their chosen idea. These strategies should help students develop confidence in their ability to design and make decisions in unknown situations; ones in which the necessary skills will not always be in place before they begin to need them. Such projects should help to develop their understanding and confidence in the activity, and it is this confidence, which appears to be the biggest difference between those who are passionate about designing and those who are not.

CONCLUSION

The research tools used were appropriate and gave the anticipated exploratory and explanatory information. The size of the total sample was large enough to allow basic descriptive analysis to be performed. The sub-sample of ten students was, as anticipated, too small for any statistical analysis, although information gained from the interviews and analysed using a qualitative approach provided an informed picture of the relationship that existed between 'level of passion' and design activity in the cases examined. The analysis which set out to identify factors that had caused, affected or prevented certain students in this small sub-sample from being or becoming passionate about designing was assisted by clustering the data into five themes. These were: Attributes of each student; creativity; design processes adopted; resource implications; support systems. Results of the analysis of the interview data did identify ways forward that should help to overcome the factors that were seen to cause, affect or prevent students becoming passionate about designing.

The importance of informing and improving the way in which D&T ITT students are taught, to design and about designing cannot be over-emphasized. Nor should the association between a students' own design activity and their success as teachers of design within D&T in the future be ignored. For although teachers teaching design do not need to be able to design with passion any teacher wishing to motivate their pupils to design is more likely to succeed if they are passionate about designing themselves.

REFERENCES

Amabile, T. M. (1997). Motivating creativity in organizations: On doing what you love and loving what you do. *California Management Review, 40*(1), 39-58.

Atkinson, S. (1997). *Identification of some causes of demotivation amongst Key Stage 4 pupils studying design and technology.* Ph.D. thesis, Newcastle-upon-Tyne: Newcastle University.

Atkinson, S. (2000). Does the need for high levels of performance curtail the development of creativity in design and technology project work? *International Journal of Technology and Design Education, 10,* 255-281.

Atkinson, S. (2003). The relationship between learning style preference, attitude to learning, appropriate prior knowledge and achievement in the context of computer aided learning in electronics. In S. Armstrong et al. (Eds.). *Bridging Theory & Practice – European learning Styles Information network 8th Conference,* Hull: Hull University, 29-40.

Atkinson, S. (2006). An investigation into the relationship between teacher motivation and pupil motivation. *Educational Psychology, 20*(1), 45-57.

Atkinson, S. (2007). A study into attitudes of D&T teacher trainees at Sunderland University to cultural diversity and pluralism. Sunderland: Sunderland University Research Conference.

Atkinson, S. (2008). New intake – new challenges. In D. Kipperman, O. Dagan & M. J. de Vries (Eds.). *PATT20 Critical Issues in Technology Education,* Tel-Aviv : ORT Israel, 50-63.

Atkinson, S. (2009). Are design and technology teachers able to meet the challenges inherent in the theme for this conference 'D&T – A platform for success'? In E. Norman (Ed.). *Design and Technology Education: International Journal, 14*(3) 8-20.

Atkinson, S. (2011(a)). The relationship between the time spent studying subject knowledge and the attitude of trainee teachers to the subject(s) they will teach'. In D. Cheek & J. Streichler (Eds.). *The Journal of Technology Studies, 37*(1) 17-30. http://scholar.lib.vt.edu/ejournals/JOTS/v37/v37n1 Accessed 10 January 2013.

Atkinson, S., Hardy, A. & Knox, J. (2011(b)). Performance/ability differences between those trained as design and technology teachers on undergraduate (UG) and postgraduate (PG) initial teacher training (ITT) programmes. In K. Stables & C. Benson (Eds.) *PATT25/CRIPT8 Perspectives on Learning in Design & Technology Education,* London: Goldsmiths College, 24-33.

Atkinson, S., & Sandwith, A. (2012). A passion for designing. In T.Ginner, J. Hallstrom & M. Hulten (eds.), *PATT26: Technology Education in the 21ˢᵗ Century,* Stockholm: Linkoping University, 39-46.

Bailey, P. (2012). To what extent does the pedagogy adopted by trainee teachers affect children's creativity in primary design and technology activities? In T.Ginner, J. Hallstrom & M. Hulten (eds.), PATT26: Technology Education in the 21ˢᵗ Century, Stockholm: Linkoping University, 47-56.

Baynes, K. (2013). *Models of Change.* Loughborough: Loughborough Design Press

Beghetto, R. A. (2005). Does assessment kill student creativity? *The Educational Forum, 69,* 254–263

Belitz, C. & Lundstrom, M. (1998). *The Power of Flow.* New York: Three Rivers Press.

Benson, C. (2009). Working together: Primary and secondary teacher liaison. In A. Bekker (ed.), *PATT-22 2009,* Delft, Netherlands.

Benson, C. (2012). The development of quality design and technology in English primary schools: Issues and solutions. In T.Ginner, J. Hallstrom & M. Hulten (eds.), *PATT26: Technology Education in the 21ˢᵗ Century,* Stockholm: Linkoping University, 81-88.

Benson, C. & Lunt J. (2011). I'm Choosing Purple Not Pink. In K. Stables, C. Benson & M. De Vries (eds.), *PATT25/CRIPT8 Perspectives on Learning in Design & Technology Education,* London: University of London, 83-91.

Browne, M.N. (2000). The importance of critical thinking for student use of the Internet. *College Student Journal,* Sept. 1-5.

CrossN., Naughton, J. & Walker, D. (1981). Design method and scientific method. *Design Studies,* (2),4, 195-201. http://design.open.ac.uk/cross/documents/Designmethodandscience.pdf . Accessed 20 January 2013.

Czikszentmihalyi, M. (1991). *Flow: The Psychology of Optimal Experience,* New York: Harper Collins.

Department for Education and Science and the Welsh Office, (1989). *Design and Technology for Ages 5 to 16: Proposals.* London: HMSO

Department for Education and Skills (DfES). (2004). *Key Stage 3 National Sreategy: Design and Technology,* London: DfES, HMSO.

Frijda, N. H. (2000). The psychologists' point of view. In M. Lewis, & J. Haviland-Jones (eds.), *Handbook of Emotions* (2ⁿᵈ ed.), New York, The Guilford Press, 59-74.

Fritz, A. (1998). Creativity: From philosophy to practice - Keynote Address: *IDATER 98.* http://www.21learn.org/cats/testing/fritztxt.html . Accessed 10 April 2012.

Galton, M., Macbeath, J., Page, C. & Steward, S. (2002). *The Impact of Charge in Primary Teachers' Working Lives,* A report commissioned by the National Union of Teachers. London: University of Cambridge, NUT.

Goleman, D., Kaufman, P. and Ray, M. (1992). *The Creative Spirit.* New York: Penguin Books.

Hamilton, W. (2007). Constructing classroom learning environments that are interactive and authentic and aim for learner empowerment. In E. W. L. Norman & D. Spendlove (eds.), *Linking Learning: DATA Education and International Research Conference,* Wellesbourne: The Design and Technology Association, 27-36

Higgins, C. (2012). Exam reform will destroy UK's creative economy – Arts Leaders', *The Guardian Newspaper 03.11.12,* London & Manchester, 1 and 11.

Hope, G. (2012). Transformation by Design. In T.Ginner, J. Hallstrom & M. Hulten (eds.), *PATT26: Technology Education in the 21st Century,* Stockholm: Linkoping University, 223-231

Leblanc, T. (2012). Problem finding and problem solving. In S. Garner, & C. Evans, (eds.), *Design and Designing: A Critical Introduction,* London: Berg Publisher, 32-49.

Leonard, D. and Swap, W. (1999). *When Sparks Fly: Igniting Creativity in Groups,* Boston, MA: Harvard Business School Press.

HyperRESEARCH. (2010). *HyperRESEARCH Tutorials,* Randolph MA 02368-1258, ResearchWare, Inc.

Jeffrey, B. & Wood, P. (2003). *The Creative School,* London: Routledge Falmer

Lawler, T., McTaminey, A., de Brett, S. and Lord, A. (2012). Design mentoring and designerly attitudes. In T.Ginner, J. Hallstrom & M. Hulten (eds.), *PATT26: Technology Education in the 21st Century,* Stockholm: Linkoping University, 262-273.

Likert, R. (1932). A technique for the measurement of attitudes. Archives of *Psychology,* 140

Lewis, T. (1999). Research in technology education: Some areas of need. *Journal of Technology Education* 10(2), 41-56

McLellan, R. & Nicholl, B. (2008). The importance of classroom climate in fostering student creativity in design and technology lessons. In E. W. L. Norman and D. Spendlove (eds.), *Inspiring, Developing and Supporting Excellence in Design and Technology Education for All: The Design and Technology Association Research Conference,* Wellesbourne: The Design and Technology Association, 29-38.

Miller, J. (2012). *What is Wrong with D&T?* London: Royal Society of Arts. http://www.thersa.org/action-research-centre/enterprise-and-design/design/design-in-the-school-curriculum. Accessed 13 January 20013.

Musta'amal, A. H., Norman, E. & Hodgson, T. (2009). Observing creative behaviours. In E. W. L. Norman and D. Spendlove (eds.), *A Platform for Success: The Design and Technology Association Research Conference,* Wellesbourne: The Design and Technology Association, 59-68.

Ochse, R. (1990). *Before the Gates of Excellence: The Determinants of Creative Genius,* Cambridge: Cambridge University Press,.

Polanyi, M. (1958). *Personal Knowledge: Towards a Post-Critical Philosophy.* Chicago: The University of Chicago Press.

Polanyi, M. (1966). *The Tacit Dimension.* New York: Anchor Doubleday.

Reeve.E. M. (2011). Forward. In S. A. Warner & P. R. Gemmill (Eds.). *Design and Creativity in Technology & Engineering Education,* Reston: Council on Technology Teacher Education. . http://www2.tec.ilstu.edu/students/Technology_Education_Resources/Complete_Yearbook_Final.doc Accessed July 2013

Robinson, K. (ed.) (1999). *All Our Futures: Creativity, Culture and Education,* Report from National Advisory Committee on Creative and Cultural Education, London, Department for Education and Employment. http://www.creativitycultureeducation.org. Accessed 11 January 2013.

Robson, C. (1993). *Real World Research,* Oxford: Blackwell.

Rogers, M. & Fasciato, M. (2005). Can creativity be assessed? *British Educational Research Association Annual Conference,* Glamorgan: University Glamorgan. http://www.leeds.ac.uk/educol/documents/150029.htm. Accessed 11January 2013.

Rosengren, C. (2004). *The Occupational Adventure Guide: A travel guide to the career of your dreams.* [Online e-book] http://www.passioncatalyst.com/oag/. Accessed 11 January 2013.

Stricker, D. R. (2011) The many forms of creative expression, In S. A. Warner & P. R. Gemmill (Eds.). *Design and Creativity in Technology & Engineering Education,* Reston: Council on Technology Teacher Education, Chapter 3. http://www2.tec.ilstu.edu/students/Technology_Education_Resources/Complete_Yearbook_Final.doc Accessed July 2013

Stables, K. (2012). Designerly well-being: Can mainstream schooling offer a curriculum that provides a foundation for developing the lifelong design and technological capability of individuals and societies? In T.Ginner, J. Hallstrom & M. Hulten (eds.), *PATT26: Technology Education in the 21st Century,* Stockholm: Linkoping University, 425-433.

Terenzini, P.T., Springer, L., Pascarella, E.T., & Nora, A. (1995). Academic and out-of-class influences on students' intellectual orientations. *The Review of Higher Education,* 19(1), 23-44.

Tovey, M. (2012). The passport to practice'. In S. Garner, & C. Evans, (eds.), *Design and Designing: A Critical Introduction,* London: Berg Publisher, 5-19.

Trebell, D. (2007). A literature review in search of an appropriate theoretical perspective to frame a study of designerly activity in secondary design and technology. In E. W. L. Norman & D. Spendlove (eds.), *DATA International Research Conference: Linking Learning,* Loughborough: Loughborough University, 91-95.

Virtanen, S. Leponiemi, T., & Rasinen, A. (2012). Design and assessment in technology education: The 'Birdhouse Band' project. In T.Ginner, J. Hallstrom & M. Hulten (eds.), *PATT26: Technology Education in the 21st Century*, Stockholm: Linkoping University, 425-433.

Wu, T.F., Custer, R. L., & Dyrenfurth, M. J. (1996). Technological and personal problem solving styles: Is there a difference? *Journal of Technology Education* 7(2). http://scholar.lib.vt.edu/ejournals/JTE/jte-v7n2/wu.jte-v7n2.html. Accessed 11 January 2013.