AC 2009-1259: TOWARD A DESIGN TAXONOMY AS A PARADIGM IN DESIGN PEDAGOGICS

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Toward a design taxonomy as a paradigm in design pedagogies.

Abstract

Design is one of the most complex activities students encounter during their post primary education (high school). However because of its complexity it is not wholly recognised and accredited. This results in ad hoc approaches to design activity. These ad hoc approaches are thus stifling students’ cognitive development in achieving higher order cognition necessary for design activities. The activity of design involves the ability to gain knowledge, understand knowledge, apply it, analyse it, link it, and evaluate it, to improve the world around us. The output of design activity is artefacts or systems, which all vary in degrees of creativity due to ones ability to identify and progress through a design issue. Pre-designed or pre-solved projects may hinder the development of students’ thinking process and thinking skills from the aspect of developing creativity. However, during design activity the application of a range of skills is vital and necessary. Thus in the context of pedagogical approaches, the development of a design taxonomy for design activities is desirable.

In the context of this research project, the qualitative observations and informal interviews findings have provided evidence that thinking skills are necessary for the promotion and development of design activity. The two test groups; control and experimental, displayed negative and positive results respectively, in terms of thinking skills due to the lack or presence, of a strategic approach to design activity. As a result of a design taxonomy approach, students and teachers became more aware of the skills and structure necessary for designing. This paper sets out to report the methodology for building awareness and relevance of students’ design cognition and ability. This is achieved through application of a ‘design taxonomy’ with reference to the principles and practices of design activity through a design skill-set portfolio and viewpoints in reference to the process of design activity towards the completion of a design project.

Introduction

According to the former United States Secretary for Education Richard Riley the top ten jobs that will be in demand in 2010 did not exist in 2004[1]. Students are currently preparing for jobs that do not exist yet, using technologies that have not yet been invented, in order to solve problems that are not evident as problems yet. The amount of information is doubling every two years. It is predicted that by 2010 information will double every 72 hours. A shift needs to occur in the current post primary education from knowledge acquisition, lower cognition, to knowledge application, higher cognition, “knowing when and how to use that knowledge”[2]. Applying knowledge correctly is a critical factor of design activity, especially when vast sources of information are readily available. Another obstacle is that “most current approaches to curriculum, instruction, and assessment are based on theories and models that have not kept pace with modern knowledge of how people learn”[3]. The concern is in terms of helping students develop skills and guidance to develop a personal and self exploring style, appropriate to the principles, practice and process of design activity.
Design literacy.

Traditionally Ireland is not seen as a design literate nation. It is predominantly known as a musical and literary profound nation. However, nowadays design can be made applicable to such a vast range of areas that its meaning too has become vast and difficult to simplify. In the context of this research ‘design’ refers to design activity in Second Level education in Ireland. ‘Design’ is not a stand-alone subject in Irish second level education. The subject matter of any subject in second level education is broad. However in the case of design, the subject matter is greater due to its multidisciplinary nature. Design is a major element in the practical subjects Technology, Material Technology (Metal), Material Technology (Wood) and Technical graphics.

In many ways we are all designers; from planning our day to what we want our living room to look like. Design could be seen as making changes. According to Mark A. Runco “teachers are responsible for many of the experiences which can dramatically influence the creative expression” [4]. A design taxonomy attempts to aid teachers’ influence on students design ability and creativity and overcome the issue where “students did not always put their design knowledge into practice” [2] by establishing the subject matter, skills-set and activities necessary for successful design activity.

Ad hoc approaches to design activity.

Design is a multifaceted general objective activity, which involves open-ended problem-solving to remedy a fault, to bring something new, and represent creativity or originality. Design is an activity in which there are numerous correct possible answers. The multiple possibilities in design activity however, is not explored with students either being given the design solution for manufacture or the dominance of first idea. “Design is more a mental process than a written one” (4th year student; 15 years old) is a good description of the pedagogical approach to design required in the Irish education system. However there is a great ambiguity surrounding the thought process for designing, described by Nigel Cross as ‘designerly ways of thinking’ [5]. The present practice is generally assessment based and does not require evidence of the ‘internal-thoughts’ by students in arriving at their end product. (Table 1) These internal thoughts are the back-bone to the ‘secret’ design practice of professional designers, which need to be externalized into a design taxonomy or arrangement for teachers and students.

Table 1: Sample grading for design activity. (Technology syllabus, Ireland)
In 1976, Ken Baynes commented that the central concept regarding design creates a lot of confusion for many teachers in design education \cite{6}. This confusion is still evident in aspects of the present Irish second level education system. This issue is also highlighted by Ai Girl Tan, that “not all teachers including those who are expected to develop creative potentials of learners possess a comprehensive view of creativity” or design \cite{4}. Another issue concerning design education is the background or profession the practice is derived from. This can lead to different views and practices regarding the meaning of design. However, for successful design activity in a second level education context establishing a design taxonomy is desirable. A design taxonomy consists of a ‘skill-set’, which aims to aid and develop students designerly ways of thinking through the progression through various ‘Viewpoints’ in solving a design issue.

**Input to obtain a creative output.**

According to research carried out by Marc deVries, student’s normally associate design with an output rather than the process to achieve the output \cite{7}. The present design practice is generally assessment based, which does not require evidence of the ‘internal-thoughts’ by students in arriving at an end product. Stephanie Atkinson observed similar constraints caused by “examinations in particular (which) are tending to inhibit the creative development of all but a few of the pupils”\cite{8}. This dominance of output rather than process is stifling the development of students design ability in the Irish education system.

Design is posing problems for novice designers in many areas. Petroski discovered a similar difficulty occurring with engineering design where “design has been a notoriously problematic aspect of the engineering curriculum”\cite{9}. Design is a subject which requires the ability to solve problems or issues by the communication of their ideas. The main obstacle expressed, by both educators and students of design education, is the influences on design ability and creativity\cite{10}. For this study the main influences being applied include:

- Activities prior to task engagement.
- Opportunity to engage in wild thought.
- Stimuli present in immediate environment.

The application for the purpose of input to obtain a creative output is through the medium of random inputs similar to Edward De Bono’s tasks for developing creativity\cite{11}. However for the purpose of this study the influences applied are in the context of the design skill-set.

**The process of design activity.**

Design has many different domains which creates complexity. Design is predominantly practiced in the Irish education system using a linear design process (Figure 1). The correct practice for a design process, as Fiell noted “is not linear; it is rather a complex activity similar to a game’s strategy but strangely it is a game where the rules are continuously changing and that is what makes it so fascinating and mysterious”\cite{12}. The linear approach to design contradicts the reasoning behind why one practices design. A design process evolved primarily as a problem solving process due to a problem. Design on the other hand does not occur due to a problem but rather due to ill-defined problems\cite{13}. However, design processes being used to design in a problem solving methodology in education systems are causing difficulty as they are not “accurate descriptions of actual practice”\cite{14}. 
In the current Irish curriculum design activity is highly structured on a design process illustrated in Figure 2. From applying this design process it is recommended that one follows the logical sequence of this design process and that evidence of these stages is reflected in the students’ design folder. However, generally design is taught in a linear and assessment based approach, stifling design ability and creativity; “If one only works from within an established pattern then one tends to follow its natural line of development and is unlikely to restructure the pattern.”[16]

The present design process works to a certain extent however “many students shut down when given a list of requirements and constraints”[17] thus design ability and creativity are suppressed.

The cognitive activity involved in design activity in the professional world is an area of great ambiguity. As a result the assessment in post primary education is dominant on the end products rather than the meaningful imperative journey to achieve such a result. This is resulting in “the process that they use to solve a design problem; it’s the road that they take to arrive at their solution. If they follow the same old route, they’ll arrive at the same old place”[17]. A similar approach will be taken in the design strategy study to that of Lindström; “students intentions, and their way of interpreting the tasks as the school expects, are not just plucked out of thin air. They are included in a context that is determined by the students’ socio background, their cultural identity and values, and the school framework factors.”[19]

Designing a design taxonomy.

From a previous study carried out, it was discovered that active problem solving is the predominant practice occurring in Irish second level design education. In the traditional design
environment this practice involves the teacher administering a design brief to students, predominantly a closed brief, which consequently is followed by the students receiving a generic design solution from the teacher. This practice is due to many hindering factors such as resources and school timetabling. It has been proven that studying worked examples is less effective for developing design ability\textsuperscript{[20]}\textsuperscript{[20]}. This is due to the fact that young designers do not have sufficient skills for knowledge management\textsuperscript{[21]}\textsuperscript{[21]} as they are exiting concrete operational stages and approaching formal operations of cognitive development. Thus the design taxonomy is structured as a workbook-style ‘skill-set’ portfolio and ‘Viewpoints’ (Figure 3). The skill-set portfolio acts as a discovery and development tool, capturing the development of the student as they progress through the design ‘skill-set’ portfolio. The portfolio allows students to record their progress and also as a reference for future activities such as the ‘Viewpoints’. The design skill-set portfolio also provides students with constructive critical feedback from self, their peers and their teacher. On completion of the skill-set portfolio students will holistically apply the skill-set to a design issue through the ‘Viewpoints’. ‘Viewpoints’ offer a structured process to solving a design issue through the recurring progression of key areas which include framing the issue (intent), brainstorming, directing design and proprietary feature.

**Skill-set.**

The design skill-set portfolio deals with the principles and practices which are necessary skills for design activity. This skill set was formed from the amalgamation of research, capstone projects, third level institutions such as the Bauhaus practice and training\textsuperscript{[22, 23]}\textsuperscript{[22, 23]}, theorists such as Richard Kimbell\textsuperscript{[24]}\textsuperscript{[24]} or Henry Petroski\textsuperscript{[25, 26]}\textsuperscript{[25, 26]}, workshops such as Dyson and interviewing professional designers. This skill-set includes (Figure 4):

- Issue to discover: *knowledge*.
- Doodle to design: *communication*.
- Shape product to person: *form*.
- Working to purpose: *function*.
- Model to make: *realisation*.

Each of these skills includes evaluation:

- Improvements to changes: *evaluation*.

Figure 3: Design taxonomy key components; skill-set and viewpoints.
Knowledge: This skill deals with the relevant knowledge in relation to the design activity. As a designer knowledge is a vital tool, helping them identify, understand, develop and evaluate the issue of concern. As students will not have this vast knowledge base they should access the relevant and required knowledge from the sources around them; teacher, peers, professionals, media, internet, books etc. How one uses the information is what is important.

Communication: We all have ideas in our minds. Representing these ideas helps one to further understand and develop their spatial reasoning and ideas. Many skills such as various modes of communication, fractation and reversal are used to develop and restructure ideas and concepts.

Form: The goal is to develop a student’s sensitivity to form; to create it, analyse it and understand it based in this formal theory of spatial relationships. Form theory describes form in terms of character, balance, dominance and position. Through form theory the student is learning to see. Visual sensitivity is the fundamental core strength of a designer. Form essentially deals with 3-D products. Therefore all 3-D projects should be designed in 3-D, you cannot develop and good 3-D design on paper.

Function: There can be many different ways of doing things. The comparison between designs is what matters. For example, pick out some particular function and show how this was handled by different designers (students). The important aspect at the initial stages of designing is not to criticise and to challenge ‘why’, thus open up new ideas.

Realisation: Students will not be making as it requires a different skill-set. However realisation represents a vital aspect of design. For example an activity similar to fractation, though in reverse, solutions are given in the form of case study projects and students must determine the original problem; this is not analysis but restructuring.

Development of the design skill-set and assessment of the necessary skills relevant to design expertise should result in an increase in student design performance over the course of study.
This design taxonomy is a “simple intervention in which students are asked to process metacognitively or to explain material to oneself have been found effective in improving problem-solving and, in particular, transfer to new problems”[20].

**Layout, presentation and structure of design skill-set.**

**Layout and presentation:** The design skill-set portfolio is presented in a highly visual form with a section for each skill (Figure 5). Within each section a skill is introduced through the necessary background information which aids to nurture the development and understanding of this skill. This is followed by developmental tasks which build up students design and creative ability with reference to the relevant skill. In the developmental tasks the students have space to note (sketch or write) their solutions to each task.

The order of implementing the various design skills is not hierarchical. The skill-sets represent the principles and practices for successful design activity.

![Figure 5: Design discovery portfolio sample page.](image)

**Structure:** The portfolio is divided into the five key skill-sets. The progressive discovery of each individual skill is similar to the hierarchical order of Blooms’ taxonomy [27] (Figure 6). A sample of the progressive or hierarchical nature in discovering each skill-set includes:

- Lower order: Pairing / Association / Connection / Linking.
- Lower – Higher order: Improvement / Growth / Productivity / Addition.
- Higher order: Story / Invention / Problem solving.
Design process to design ‘Viewpoints’.

Once the design skill-sets are understood and practiced students may progress to the processing of these skills to design issue through the ‘Viewpoints’. The approach or process for design activity will be structured in relation to key three ‘Viewpoints’:

- Framing the problem / issue.
- Direct design.
- Proprietary feature.

Each Viewpoint is necessary for design progression. The Viewpoints should be carried out in logical progression however not linear as each viewpoint is associated and inter-reliant, Figure 7. The Viewpoints all involve a range of strategies to ensure optimum design practice. Table 2 outlines the main activities for each ‘Viewpoint’.

Figure 6: Bloom’s Taxonomy of Learning.

Figure 7: Inter-reliant Viewpoints 1, 2, 3.
Table 2: Viewpoint strategies.

<table>
<thead>
<tr>
<th>Viewpoint</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewpoint 1 (V1): <em>Framing the problem/issue: intent</em></td>
<td><img src="Image" alt="Diagram" /></td>
</tr>
<tr>
<td>Students independently carry out:</td>
<td></td>
</tr>
<tr>
<td>▪ Sketch / notes initial thoughts.</td>
<td></td>
</tr>
<tr>
<td>▪ Relate to what is already out there.</td>
<td></td>
</tr>
<tr>
<td>▪ (Self assess) Impinge / aid on your current thoughts.</td>
<td></td>
</tr>
<tr>
<td>Groups work together:</td>
<td></td>
</tr>
<tr>
<td>▪ View each others initial thoughts.</td>
<td></td>
</tr>
<tr>
<td>▪ Provide positive views.</td>
<td></td>
</tr>
</tbody>
</table>

| Viewpoint 2 (V2): *Direct design* | ![Diagram](Image) |
| Groups working together: | |
| ▪ Assign ‘manager’ for brainstorming session. | |
| ▪ Refinement: Groups (six pupils) produce brainstorming poster in relation to key aspects of design situation. | |
| Individually students clarify all the information to date: | |
| ▪ Modify to fit the client requirements if necessary. | |
**Methodology.**

**Background.**

The methodology for this study, which commenced in January 2009, involved two test groups; control and experimental. The control groups acted as exemplars for the current design practice occurring in Irish post primary education. The experimental groups were exposed to the design taxonomy intervention comprising of the ‘design skill-set’ for the principles and practices and the design ‘Viewpoints’ for process of design. The study occurred in fourteen diverse second level school types; secondary, community, comprehensive and vocational. All participants were exposed to two similar standard design projects selected from a compilation of past Junior Certificate design project briefs. These were selected as the findings from this study can be compared to Chief Reports by the State (Ireland) Exam Commissioner. Control and experimental student participants completed two design projects, pre and post exposure to either the design pedagogy or the design taxonomy. From the two projects a factor of experience was determined.

**Participants.**

The participants include teachers and students of Irish second level junior cycle education. The participants are currently partaking in a subject of the Technologies; Materials Technology (Wood), Material Technology (Metal), Technical graphics or Technology. Table 3 outlines the statistical information for the student and teacher cohorts.
Table 3: Participant breakdown.

<table>
<thead>
<tr>
<th>Initial participant sampling</th>
<th>Teacher cohort</th>
<th>Student cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>6</td>
<td>125</td>
</tr>
<tr>
<td>Experimental group</td>
<td>6</td>
<td>175</td>
</tr>
<tr>
<td>Mean age</td>
<td>-</td>
<td>13.35</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>-</td>
<td>0.656</td>
</tr>
<tr>
<td>Gender distribution (m : f)</td>
<td>11 : 1</td>
<td>4 : 1</td>
</tr>
</tbody>
</table>

The teacher cohort.

The second level teachers, the implementers of the study, are the governing participants. The control or experimental groups were determined by:

- Teacher interview. The teacher interview determined the teacher’s opinions, values, beliefs and understanding of design activity.
- School type.
- School socio-economic background.
- Teacher training college.

The various school types each have their own structures and ethos which consequently affects the status of design in the practical subject. For example in a vocational school design education would have more recognition as a subject element than in a secondary school which has a more academic focus. However the institution of teacher training can also have an influencing effect on the pedagogical approach used by the teacher. For example, Thomond College, a college of technology education, would have a good approach and awareness to design education; however, this practice minimally existed in the University of Limerick prior to 2004 (Both colleges are now amalgamated). As a result of this limitation in teacher training many teachers have not fully embraced design activity in schools throughout Ireland. This difference will be evident from the control group. However due to the highly structured approach of the strategy for the experimental groups the influence of the teacher training should be less influential on the student activity. The teachers chosen for the experimental groups displayed more understanding and progressive views for design education.

The function of the control teacher groups was to implement normal classroom activities associated with design principles, practices and processes. The experimental cohorts implemented a strategic approach through a proposed design taxonomy; skill-set and viewpoints.

The student cohort.

For the final evaluation of test data the control and experimental groups consist of six and eight groups respectively. Within each group there were approximately twenty-five pupils. Each group represented one of school types; comprehensive, community, vocational and secondary. As the students are from different school types a range of socio-economic backgrounds were also evident.

The student groups were from second year of their Junior Certificate cycle. This second year group was chosen for many reasons:

- More maturity and knowledge than first year students.
Many first year programmes run the optional subjects, which design education are categorised under, which pupils receive approximately six weeks exposure of the subject. This could create both disruption and apathetic participation during the study.

Third year students are in an exam year and this could create additional pressure due to both academic studies and practical project completion.

Streaming of students into higher level and ordinary level would not be dictated at this stage.

The function of the control student participants is to act as a sample group for the current post primary students, demonstrating design activities in their normal classroom environment under their teacher’s guidance. The design outcomes by the control group will be used in a comparison study with the experimental group. The experimental student group will be exposed to the proposed design taxonomy; skill-set and viewpoints through pre-designed and pre-planned activities which aspire to aid and develop students design ability. The primary function of the experimental groups is to demonstrate outcomes (training), in relation to design activity, consequent to exposure of the design taxonomy.

**Design and structure of Research tools.**

The primary aim of this study is to evaluate a proposed design taxonomy in terms of its training towards design activity. The aim is not to ‘teach’ design but to develop an arrangement which will promote students’ motivation and ability in generating alternative ways of looking at something and creating something.

Figure 8 details the procedural approach to the design study between the control and experimental cohorts. Table 4 categorises the various research tools implemented between the control and experimental participants.

![Design study flowchart](attachment:image.png)

Figure 8: Design study flowchart.
Table 4: Participant research instruments.

<table>
<thead>
<tr>
<th>Research instruments</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher interview</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Design Attitude survey</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Index of Learning styles</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Design project one</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Strategy intervention</td>
<td>×</td>
<td>✓</td>
</tr>
<tr>
<td>Normal design practice</td>
<td>✓</td>
<td>×</td>
</tr>
<tr>
<td>Design project two</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Post interviews</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

1. **Teacher interview.**

For the study a range of suitable representative teachers had to be selected. Initially a range of teachers from the post-primary schools database were selected. Once these teachers agreed to participate in the study they were informally interviewed. The purpose of the interview was to determine the teacher’s views, values, understanding and pedagogical approaches to design activities within the second level education environment. From this interview the teachers were grouped into experimental and control groups depending on their preference.

2. **Design attitude survey.**

This survey was developed by Marc de Vries in co-operation with Virginia Tech – Technology Education and Eindhoven University, The Netherlands\(^{[28]}\). It serves the purpose of evaluating participants (students) value of design activity in the technologies and the value of their own ability in the field of design. This survey was administered by hard copy to each student by their class teacher. Each question was read aloud by the class teacher to ensure no ambiguities existed in grammatical or understanding of the phrased questions. Administering the survey electronically was not possible due to timetabling issues/restrictions in IT rooms in schools. The following instructions were given to candidates before commencing:

- Answer each question.
- If you are uncertain about a certain answer chose the response as close to your response as possible.

3. **Index of Learning styles survey.**

The purpose of the *Index of learning styles* (ILS) survey was to determine students preferred way to learn. The preferential styles of learning then became part of the design strategy for the intervention. The ILS, devised by Felder-Silverman, as an instrument to determine the preferential learning styles of students was used, which have been proven in reliability and validity\(^{[29]}\).

The ILS survey consisting of 44-binary answer single response questions was administered to students by hard copy by their class teacher. Each question was read aloud by the class teacher to ensure no ambiguities existed in grammatical or understanding of the phrased questions. The following instructions were given to candidates before commencing:

- Answer each question.
- If both answers appear to suit chose the response which appeals more than the other.
4. **Design project one (DP1)**

The purpose of DP1 was to determine participants’ cognitive skills and style when designing independently. All participants undertook DP1 in their usual classroom environment without the instruction from the class teacher. DP1 was also compared to the design ability of students in ‘Design Project Two’ after exposure to the design taxonomy skill-set for the experimental cohorts or design subject matter for the control cohorts. All participants were given guidelines, which also aided the teacher’s position solely as a knowledge source rather than an instructor:

- Use your own approach to solve the design issue.
- To the best of your ability demonstrate all your ideas/thoughts, through doodling, sketching, drawing, illustrations, colour, writing, or models.
- You must produce three or more initial design ideas.
- To the best of your ability you must select and represent a final idea.

**Design project one: Design brief.**

*A playschool requires a toy suitable for young children. The movement of the toy should result in some form of secondary motion. Design a toy suitable for this purpose.*

5. **Design taxonomy intervention. (Experimental)**

The design taxonomy investigated the factor of experience of design and creativity development of experimental participants by implementing an active and visual design skill-set discovery portfolio. The skill-set strategy intervention, composed in a workbook format, divided into the five main design skills. The design skill-set is designed using many of Edward de Bono’s concepts such as lateral thinking to improve students design ability and creativity within the Technologies (woodwork, metalwork, technology, technical graphics) through various cognitive tasks using “random inputs”\(^\text{[11]}\) (Figure 9) as the inspiring medium.\(^\text{[11, 16]}\)

Some developmental tasks include:

- Various views.
- Collection.
- Like with like.
- Removing values.
- Made easy.
- Crisis cracks.
- Inventing sport/hobby.
- Snap connection.
- Thoughts to ideas.

![Figure 9: Sample Random inputs.](image-url)
As a result the design skill-set discovery portfolio sets out to build students awareness and confidence to the key skills necessary for designing and also various approaches for designerly ways of thinking. On completing the skill-set portfolio students will apply the approaches and skills encountered to a ‘Viewpoints’ process to design (Table 2).

6. Design pedagogy. (Control)

After DP1 students are exposed to design subject matter as per the curriculum. This stage of the study is not an assessment of the teachers approach to teaching design, but how pupils will approach Design Project two after exposure to design in their normal classroom environment. Also, provided it is normal practice, any material or information pupils are exposed to should be recorded by the pupil for use in DP2 in the pupil notebooks provided.

7. Design project two (DP2).

The purpose of this project was to determine participants’ cognitive skills, between DP1 and DP2 post exposure to design skill-set (experimental) or design subject matter as per the curriculum (control). During DP2 the participants, Control and Experimental, were exposed to different design practices and processes;

- **Experimental cohorts:** Complete DP2 using design taxonomy; skills-set and viewpoints.
- **Control cohorts:** design subject matter from the subject curriculum.

**Design project two: Design brief.**

*It is difficult to read information from a sheet lying on a horizontal surface when using a computer. Design an artifact to support A4 size sheet of paper. The artifact should be adjustable for the angle of reading and it should be portable.*

8. End of study interviews.

Informal semi-structured interviews were administered with randomly selected individual students and teachers from both the control and experimental groups. This served the purpose of gaining the perspective of students and teachers in relation to the tasks undertaken. Each interview was audio recorded for transcription purposes, thus permission was sought from each interviewee prior to the interview. Each interview commenced with an outline of the primary purpose of the group and the tasks administered to this group.

**Discussion**

The assessment of design cognition highlights the necessary skills for successful design activity. From qualitative observation of this study it was “demonstrated that students are not aware of their own design processes” [30]. From observing students’ designing for DP1 there was “very little discussion about process and very little process apparent” [30]. Also many students’ designs were very symbolic, i.e. trucks, airplanes etc. Pupils also tended to become fixated on their first design idea or had difficulty thinking of more than one design idea. One student commented “what is the point in coming up with more design ideas, my first one is the best one”.
In relation to the qualitative observations and informal interviews of students and teachers at the end of DP2 there is a vast proportion of ‘control’ students who feel ‘thinking up design ideas’ is the greatest hindrance during design activity. Many experimental students felt that the design taxonomy aided their design activity in the context of design thinking.

Many would agree that people learn better when they can build on what they already understand. Students have an excellent basic knowledge and a great understanding of daily artefacts such as an umbrella or a book. The design taxonomy appeals to experimental student’s current understanding of design activity for the promotion of “designerly ways of thinking”[5].

Further analysis of impending data will be carried out using SPSS tests. A sample of the analysis will include:
- *T-tests* to determine the difference between the two different conditions for DP1 and DP2.
- *T-test* to determine the difference in thinking ability for the two test groups, control and experimental.
- *ANOVA* to determine the difference between school types / training colleges.

**Conclusion**

The research methodology was designed to evaluate the consequence of implementing a strategic approach, through a design taxonomy, to design activity both in terms of pedagogic and learning. This was achieved through:
- Investigating the teacher training institutions approach to design activities.
- Obtaining the value system in the current design education.
- The factor of experience of the key design ‘skill-set’ and ‘Viewpoints’ was demonstrated by pupils during design activity for DP2 in comparison to independent design activity in DP1.
- A comparison study also occurred in terms of the control group participants and experimental groups design activity for DP1 and DP2.
- The overall impact of the strategy intervention and design activity was further investigated and evaluated through informal interviews of sample participants.

The expected results will show a positive impact for design activity based on the implementation of a design taxonomy. The traditional approach to design activity in the Irish second level education system is not providing students with a skill-set or approach to facilitate and develop ‘designerly ways of thinking’. The introduction of a design skill-set and viewpoint approach to design activity will allow students to broaden and externalize their design activity, as a result enhancing their design experience.

**Bibliography.**