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DIGITAL DESIGN COMMUNICATION: MEASURING LEARNER TECHNOLOGICAL PROWESS AND SELF-EFFICACY IN PROBLEM RESOLUTION

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Abstract

Currently the Bachelor of Design is the generic degree offered to the four disciplines of Architecture, Landscape Architecture, Industrial Design and Interior Design within the School of Design at the Queensland University of Technology. Regardless of discipline, Digital Communication is a core unit taken by the 600 first year students entering the Bachelor of Design degree. Within the design disciplines the communication of the designer's intentions is achieved primarily through the use of graphic images, with written information being considered as supportive or secondary. As such, Digital Communication attempts to educate learners in the fundamentals of this graphic design communication, using a generic digital or software tool. Past iterations of the unit have not acknowledged the subtle difference in design communication of the different design disciplines involved, and has used a single generic software tool. Following a review of the unit in 2008, it was decided that a single generic software tool was no longer entirely sufficient. This decision was based on the recognition that there was an increasing emergence of discipline specific digital tools, and an expressed student desire and apparent aptitude to learn these discipline specific tools. As a result the unit was restructured in 2009 to offer both discipline specific and generic software instruction, if elected by the student.

This paper, apart from offering the general context and pedagogy of the existing and restructured units, will more importantly offer research data that validates the changes made to the unit. Most significant of this new data is the results of surveys that authenticate actual student aptitude versus desire in learning discipline specific tools. This is done through an exposure of student self efficacy in problem resolution and technological prowess - generally and specifically within the unit. More traditional means of validation is also presented that includes the results of the generic university-wide Learning Experience Survey of the unit, as well as a comparison between the assessment results of the restructured unit versus the previous year.

Keywords **–** Design communication, Self-efficacy, Digital communication, Learner perception

1. INTRODUCTION

Within the design disciplines, communication is taught and mentored at numerous levels. For the purpose of this paper the 'design disciplines' being referenced to are Architecture, Landscape Architecture, Interior and Industrial Design. In addition, this paper's 'communication focus' is constrained within the design process, a process of communication that happens primarily between the designers and the client; it does not include the communication that happens when an artefact is documented for final construction or fabrication. Furthermore, it is essential to distinguish between information and communication: Information is knowledge about facts and events, while Communication is the transfer of information between people that can be subjective, expressive and aesthetic. [1]

The first and obvious level of design communication is verbal. Design verbalisation has distinct subtleties and curiosities; the teaching of which is achieved primarily through mentoring within the studio environment and exposure to design literature. Design students are required to gradually adopt a design vocabulary as they progress with their education, in order to fully and appropriately communicate their design intentions and proposals. The second level of communication for designers is visual. It would be an understatement to contend that the expression of design intent would be impossible without the use of visual methods. Visual design communication is taught and mentored to design students from two perspectives. The first of these is the individual ability to express design proposals conceptually using proportioned freehand drawings or sketches. The second is the construction of mainly orthogonal scaled visual media using technologies like the traditional Drawing Board and increasingly the Personal Computer (PC) and Computer Aided Design and Draughting (CADD or simply CAD).

Freehand drawings could be argued as somewhat unrestrained by visual design conventions, while technically produced visual media is largely constrained. In other words: freehand drawing can be seen as expressing 'visual thinking' in the process of resolution of the design problem; while orthogonal communication becomes mainly evident at the conclusion or final result of the design process, and is largely achieved using technical means like CAD. This is not to argue that freehand cannot be orthogonal and *vice-versa*. What is fundamentally different between the two is the intended audience of this visual communication. Freehand drawings can be argued as an individual or smaller peer group communication means, while orthogonal and technically produced can be presented as communication intended for a wider, less initiated audience. As such, Digital Communication (DEB201) is at one level a unit that attempts to indoctrinate learners into the fundamentals of visual communication of design intent, both as a process and as the ultimate result. A major cause of communications failure within design teams is the misinterpretation of freehand sketches. [2] As a result, on another level, DEB201 also acknowledges that the interpretation and transformation of expressive, imprecise freehand drawings to orthogonal resultant is problematic, particularly when it involves human-computer interaction and wider team environments.

In addition to visual communication skills, DEB201 also attempts to instil in students a means to achieve this communication using digital means or tools. This could be argued as involving a third language of visual communication. Hollnagel and Woods argue that one primary precondition in addressing the question of humans and technological artefacts working together is the existence of a common language. [3] This language, it is argued must allow practically no ambiguity in interpretation by a wider group of people, it must be applicable for general explanation purposes as well as specific purposes like analysis and evaluation. Furthermore it must also describe important functional characteristics in addition to mere technical descriptions. It can be argued that orthogonal design drawings like plan, section and elevation in conjunction with their technical drawing conventions like line-weight and hatch patterns is such a well developed representational language. This well developed language that had evolved over countless centuries has however been disrupted by the Digital Revolution through the transformation of the technical means of production - the manual drawing board being replaced by CAD. Developed in the early 1980's, CAD renames Line-weight as Layer and Print as Plot, and from the perspective of an Architect the notion of Rhythm becomes Array and to Elevate is now referred to as an Extrusion. Arguably this renaming of discipline specific terms is an attempt to appease all the design disciplines and the engineers with a single CAD package. At the start of the 1990's CAD became globally pervasive in all the design disciplines, and as a result Queensland University of Technology (QUT) introduces the teaching of this 'digital technologies' skill.

Technology by its very nature is constantly evolving. In response to the development of the Virtual Prototype (VP) concept in the 1990's, there was a subsequent emergence of discipline specific software that steadily displaced conventional CAD. (For additional information see [4]) One of the numerous advantages of these newer software packages is arguably the replacement of the earlier CAD injected language with accepted discipline specific terminology. In 2009, DEB201 once again changed in response to the increasing prevalence and wider acceptance of the VP within the design disciplines.

This constant change in technology means that design students and professionals need to develop self confidence in their ability to use technology to express design intent and to communicate with their peers. One way of viewing this is to use the concept of self-efficacy. The theoretical framework for self-efficacy was developed by Bandura [5] [6]. Multon, Brown and Lent [7] state that self-efficacy influences "choice of behavioural activities, effort expenditure, persistence in the face of obstacles, and task performance". Given the problematic nature of design communication, coupled with the use of technology, students' efficacy in their abilities to communicate their designs could be increased or decreased when the requirement to use technology is included. Additionally, Bandura posited that self-efficacy should be explored in the context in which the behaviour or skill is expected to be expressed. He advocated the use of surveys specifically designed to provide information on the needed or required behaviour.

Since there are no published studies containing reliable surveys measuring design self-efficacy or technological literacy, the priority for this paper was to begin the development of such a specific survey. As such, this study is an exploration of the development of this specific survey, as well as an investigation of students' beliefs in their design skills using technology.

2. BACKGROUND

2.1 Previous Units

Digital technologies were initially taught within QUT's School of Design since the mid 1990's as two elective subjects or units; namely 'Fundamentals of Virtual Environment' and 'Introduction to Three Dimensional (3D) Modelling'. In response to student feedback and an Australian Institute of Architects (AIA) Accreditation Panels' recommendation to make the use of digital tools a mandatory skill for design students, in 2006 DEB201 was introduced as a core subject. DEB201 essentially collapsed the content of the previous two elective units into one mandatory unit.

'Fundamentals of Virtual Environment' introduced students to the use of interactive 3D models, from the perspective of a design tools rather than as a presentation tool. A range of 3D modelling software was used to create a 3D model of a particular object. Once the 3D model was complete, Virtual Reality Modelling Language (VRML) was then used to script different interactions like real-time navigation within the model. This 3D approach allowed participants to dynamically interact, test and ultimately refine their design proposals.

Digital design data creation can be differentiated into two methods. The first of which is to initially draw the project using two dimensional (2D) representations in the form of plans, sections and elevations and to later use this 2D data to generate a 3D model which can be used for presentation. The second approach, pioneered by Graphisoft's Archicad software in the mid-1980's, is to create the data directly in 3D and then to use the software to extract the 2D data from the 3D model. 'Introduction to 3D Modelling' taught both of the above approaches.

3. DIGITAL COMMUNICATION

DEB201 is a core unit delivered to all first-year students in the four design disciplines of Architecture, Landscape Architecture and Industrial and Interior Design, within the School of Design at QUT. DEB201 introduces students to the foundational aspects of digital design communication, placing generic design in context and focusing on the multidisciplinary nature of the design process. DEB201 is an approach to the theory and practise of digital media, exploring the translation from manual to digital media in design communication and presentation.

By the completion of DEB201 students should be able to demonstrate the following discipline specific capabilities at a beginner level:

- Understanding the application of communication theories to digital communication.
- Understanding the application of digital technologies for design development.
- Awareness of the use of digital technologies for design evaluation and communication.
- Be confident in the use of digital technologies for small group design development.

3.1 Existing Delivery Mode

The delivery for DEB201 comprised an initial one hour lecture followed by a two hour tutorial session in the computer laboratories, every week for the duration of the 13 week semester. The teaching of DEB201 was project based with the student assessment divided into two assignments (Fig 1 and 2). For the first assignment students worked individually on an exiting design of their choice. In this first assignment students learnt how to generate design communication that they could share with their colleagues and peers. The second assignment started with a group exercise where students initially learnt how to collaborate by sharing 3D objects that they had created individually. Students were then given the task to individually produce the kind of documentation necessary to communicate their design intent to a non-expert individual like a client.

In an attempt to address the challenge of mixing students from a variety of design disciplines, Autodesk's VIZ software was chosen as the generic digital for use in DEB201. VIZ provided the practical functionality to easily model primitive shapes such as cubes, spheres and cylinders, which were easily modified, and subsequently combined into a range of complex shapes. By using VIZ students could also represent any object without having any formal technical knowledge of how it was constructed. For example: a box could be used to represent a wall, a table top, a garden bench or even a building.

The student's responses to DEB201, as measured in the Learning Experience Survey (LEX), showed that this prior approach was largely very successful. There were however a number of comments from students who thought that they were being taught software that was not the most relevant to their chosen profession.

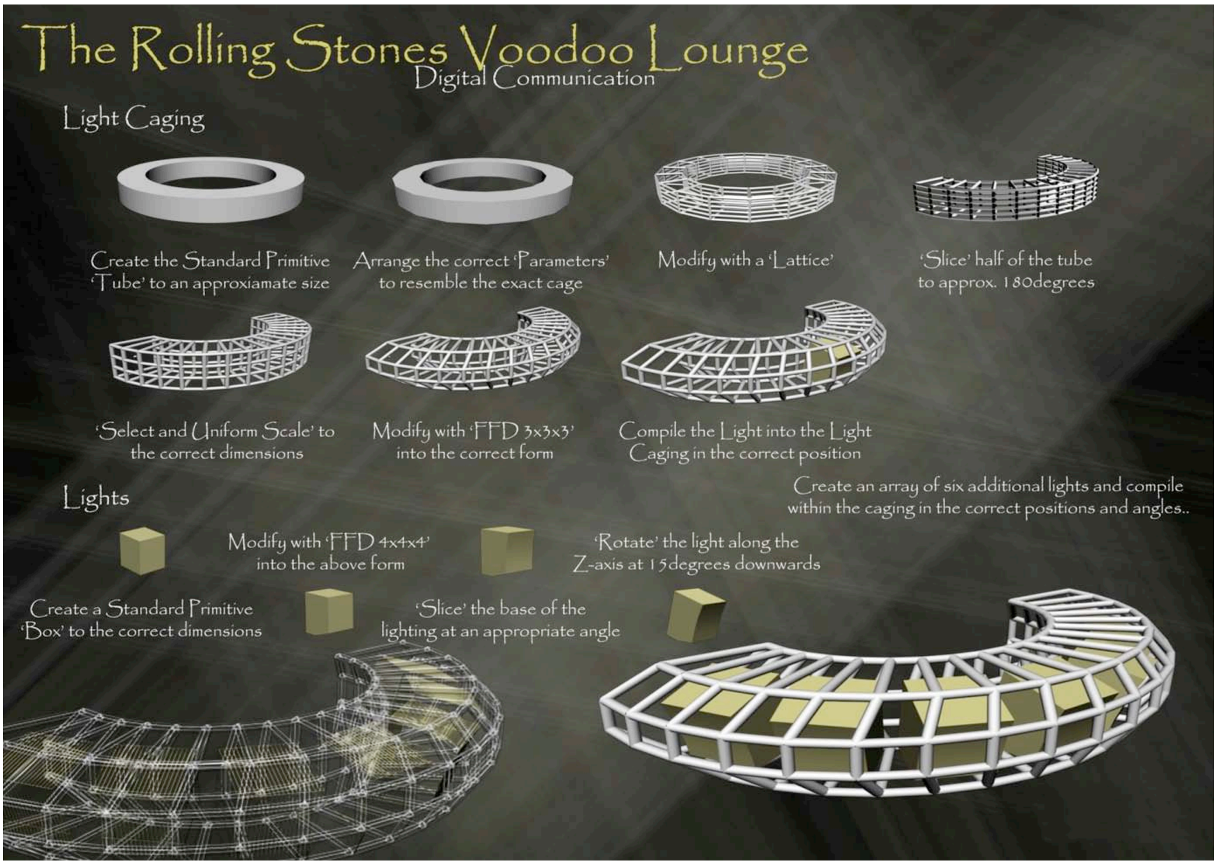

Figure 1: An example of student work submitted for the first assignment in 2008. As with Fig. 3 below, the primary focus is on the creation of 3D objects (using 3D content creation software) and communication of the objects or intent (using Layout and Publication software). The intended audience is principally technically initiated peers' like fellow designers.

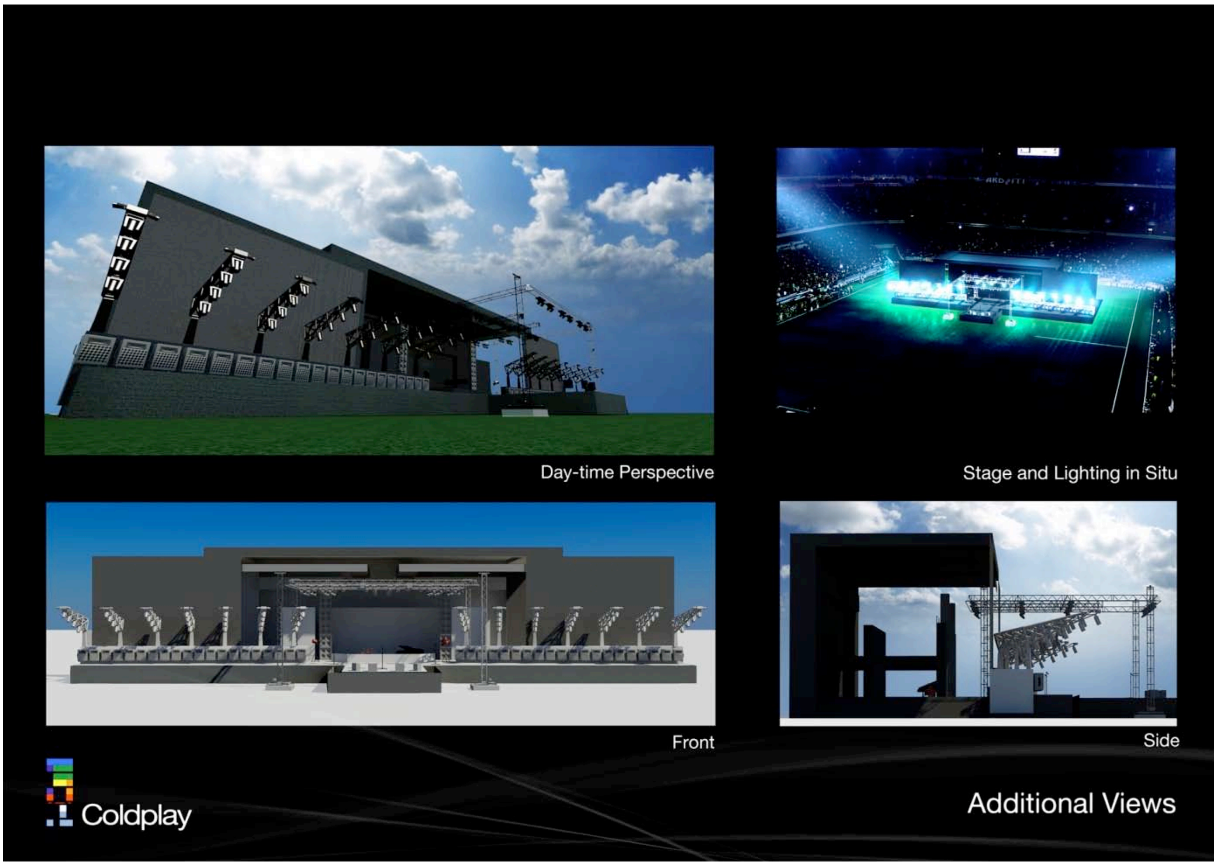

Figure 2: An example of student work submitted for the second assignment in 2008. As with Fig. 4 below, the focus is partially the refinement of the 3D objects (using 3D content creation software) into context. While primarily, the focus is the ultimate communication of the design intent (using Layout and Publication software). The intended audience is principally laypersons like the client

3.2 Restructured Delivery Mode

In response to student's feedback, the emergence of the VP model and in an attempt to offer more options to students, DEB201 was restructured in 2009 to incorporate numerous, rather than a single, software tools. The delivery of the restructured DEB201 was largely unchanged from the previous year in that it still comprised a one hour lecture followed by two hour tutorial. In the restructured unit, students had a dual advantage in that Lectures were made available as both live and virtual sessions. Students could attend both the live lecture and later at their convenience review it by watching the recording, or alternatively students could only watch the video recording and not attend the live lecture.

The most significant change to DEB201 was that students could now elect which tutorial class they wished to attend based on their discipline or software preference. Additionally, they could then also choose a project that was either generic or discipline specific.

A total number of 22 classes were made available and organised under the following labels:

- Nine classes were labelled as 'Generic'. Of these nine classes seven used Autodesk's Max Design with the remaining two using the open-source software Blender.
- Seven classes were labelled as 'Interior and Architecture'. Of these seven, two used Graphisoft's Archicad software, three used Autodesk's Revit software and the remaining two used Google's Sketch-up software.
- Three classes were labelled as 'Game and Industrial Design'. All of these classes used Autodesk's Max Design.
- Three classes were labelled as 'Landscape'. All of these classes used both Max Design and AutoCAD.

For the first assignment (Fig.3), students were required to digitally re-produce a hand drawn 3D representation of an 'object' of their choice, but constrained, by having to have relevance to their specific discipline. For instance students in Architecture modelled buildings, Landscape students did garden designs, Interior Designers modelled furniture and Industrial Design students produced 3D models of products.

As part of the first assignment, each student was required to document his/her object and make the documentation available to all the other students by publishing it on a Wiki page. This initial exercise led to the second assignment (Fig.4), in which students were required to produce a complete context that included their own 'object' and other students' 'objects' like land, buildings and furniture. During this second exercise, students not only learnt how to visually communicate and digitally present their design intentions to other students, they also learnt how to technically combine their digital work by converting all the 'electronic versions' of their work into a common file format.

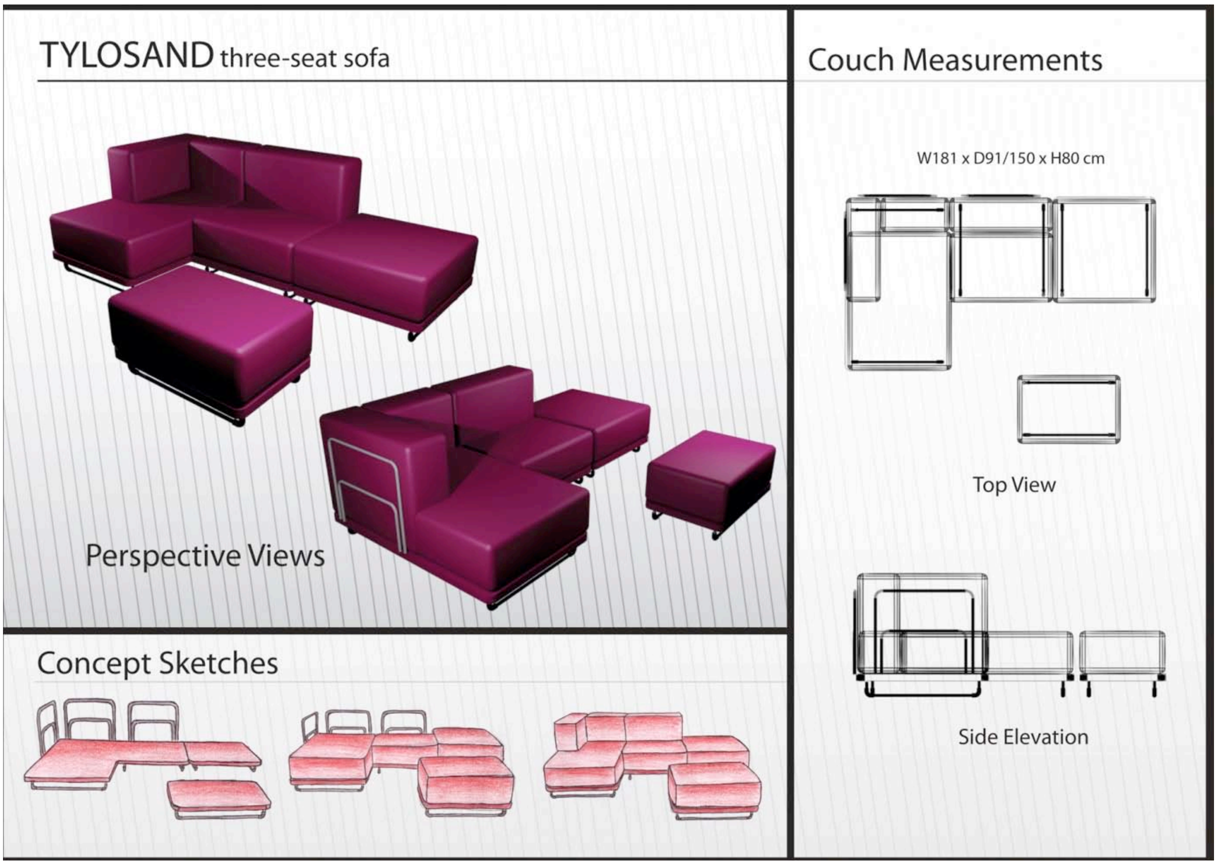

Figure 3: An example of student work submitted for the first assignment in 2009.

Figure 4: An example of student work submitted for the second assignment in 2009.

4. LEARNING EXPERIENCE SURVEY (LEX)

LEX is the university wide student evaluation of all units, teaching, and learning at QUT. Introduced in September 1, 2007, LEX provides the feedback that is essential for the continuing improvement of Teaching and Learning. In LEX, students are invited to participate during weeks 10-12 of the 13 week semester. At this stage of the semester, students in DEB201 would have completed 70% of the cumulative assessment for DEB201.

The LEX survey results provide not only data on the teaching and learning experiences of students, but also other relevant information such as communication, unit materials, online activities and unit satisfaction. In addition to certain numerical type responses, students are also asked questions that solicit their written opinions on aspects like “What were the best aspects of this unit?” and “What aspects of the unit are most in need of improvement and why?” Student responses to these two questions are included in the discussion below.

LEX’s numeric responses are on a 1 to 5 scale, with 1 indicating a very poor student satisfaction through to 5 indicating a very high student satisfaction. The LEX results for DEB201 in 2009 registered a unit response averaging between 3.3 and 3.6 in the areas of ‘Skills and Knowledge’, ‘Relevance’, ‘Organisation and Structure’, ‘Learning Feedback’, and ‘Unit Satisfaction’. When compared to the previous year, 2009’s feedback recorded an increase in the areas of ‘Relevance’ and ‘Learning Feedback’, while the ‘Organisation and Structure’ of the unit registered a slight decrease of 0.1.

4.1 Unit Satisfaction:

The LEX section on ‘Unit Satisfaction’ is still more comprehensive and includes the following ten numerical sub-categories for student evaluation: ‘Assessment Workload’, ‘Assessment Level of Difficulty’, Assessment Relevance to Topic’, ‘Lecture Presentation’, ‘Tutorials’, ‘Computer Labs’, ‘Unit Materials’, ‘Unit Website’, ‘Unit Online Activities’ and ‘Textbooks’.

There was an increase in ‘Unit Satisfaction’ in seven categories in this restructured unit compared to the previous year. The teaching component of the unit shows a remarkable increase in the level of satisfaction with the ‘Lecture Presentation’ increasing from 59.6% in the previous year to 71.8%, with ‘Tutorials’ up from 64.9% to 67.5%. This is consistent with a majority of students’ written comments on lectures such as: *“Good variety of lecture topics”;”Stef is very passionate in his teaching and organises interesting lectures”;”The lectures were always interesting and provided insights into to where the digital world may be headed”,* A similar result is seen in students’ comments on the ‘Tutorials’, such as: “*The best aspect of this unit was our small tutorials as we all got a chance to have one on one help with our tutors ..”, “I was highly motivated because of how well the tutorials and lectures were run”, “I appreciated that we were given tutorial time to work on our assessment. This worked very well, as questions could then be asked in relation to my particular assignment”.*

The students satisfaction on ‘Assessment”, increased from 71.1% in the previous year to 84.6% and their satisfaction on ‘Assessment Workload’ increased to 86.5% when compared to 80.7% in the previous year. Their satisfaction in the ‘Level of Difficulty’ decreased from 73.7% to 70.9%. The students’ comments on assessment were positive and included: *“Assessment tested a wide range of skills”, “The assessment taught me how to use the programmes well”* and *“The workload and assignments were appropriate and relevant”.*

On the topic, ‘Computer Labs’ the level of satisfaction increased from 51.8% in the previous year to 61.5% in 2009. For example, the students commented: “*The computer lab sessions were great to ask questions and get feedback and help on our assignment”, “The classes in the computer labs were very helpful”.* However, a few students were not happy when *“students from other classes in the labs at the same time”,* (on rare occasions?).

There was a decrease in the level of satisfaction in the ‘Online Activities’, and ‘Unit Website’. The students’ comments’ ranged from “*I was unhappy with the QUT Blackboard site as it if difficult to navigate around and takes a long time to load”* to positive observations such as, *“The website was always updated with new information and this is very helpful way of assisting students in achieving the best grades.*

To the question on “What were the best aspects of this unit and why?

This question received not only the maximum number of responses, but, also very encouraging comments: *“It is a real world relevant. Opened up ideas for presenting work to clients and for other subjects’ assessment”; “A good way to start getting into design software. Unit was very well organized and podcast lectures were great, always up on time”; “Learning the various concepts related to digital communication as well as its quirks. The podcasts were good and the lectures were at a great time of day.” “Everything I learnt was new. For me this was the most enjoyable part, learning and developing skills in an area I had always been interested in”;”it was wonderful to learn new skills in a computer program I had never used before. This subject is fun”; “The tutorials were excellent, I learned a lot from Ben and wish I had more classes with him. The lectures were also excellent; they described what was required and what was expected and the use of different programs to achieve different results. The ability to download the podcasts for reviewing, I wish all my units had that facility*.”

To the question on “What aspects of the unit are most in need of improvement and why?”

Some students were not happy that the lectures started too early, at 8 a.m.; a time-table that clashed with their disciple specific units; and the inability to sign up for tutorials they preferred because they had reached their capacity. There were requests to make tutorials *“course or major specific”; “a separate brief for each design discipline”; “any student with experience in any modelling programme has a significant advantage. Is there any way to change this?”*

4.2 Overall Assessment Results

There was a slight increase in the number of students enrolling in DEB021 in 2009 (481) when compared to the previous year (471). The total number of students (Fig.5) who successfully completed DEB201 in 2009 (391) increased slightly when compared to the previous year (388). However, there was a marked difference in the number of high achievers amongst the students who completed DEB201 in 2009 when compared to the previous year. For example, the percentage of students achieving a higher distinction (85% - 100%) increased from 0.9% in the previous year to 3.4% in 2009. Similarly, those achieving a distinction (84% - 75%) increased from 11.9% in 2008 to 20.9% in 2009; and those achieving a credit pass (65% -74%) increased from 27.8% in 2008 to 32.3% in 2009. The remainder of the students who successfully completed DEB201 received a pass grade (50% - 64%) and their percentage changed from 43.1% in the previous year to 32.1% in 2009. The percentage of students who failed DEB201 decreased 13.8% in the previous year to 12.3% in 2009.

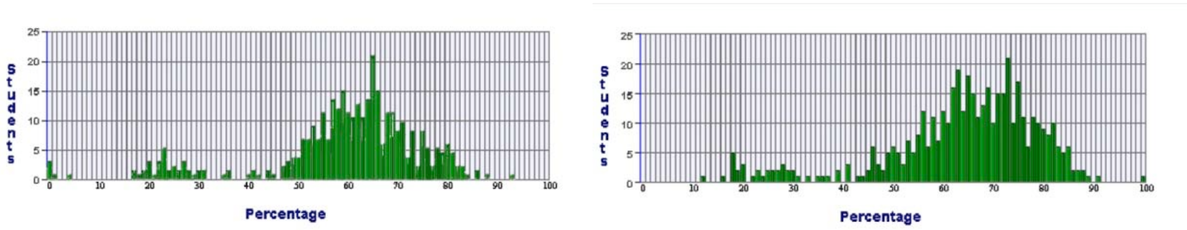

Figure 5: Graphs illustrating overall student performance in 2008 (left) when compared to 2009 (right).

5. STATISTICAL ANALYSIS OF CONTENT SPECIFIC SURVEY

In addition to the LEX and the overall assessment results for DEB201, the authors have additionally conducted a content specific survey. This survey, which measured student prior use of discipline specific software, general ability to solve problems, and confidence in using technology (both from the perspective of '3D Content Creation' and 'Layout and Publication' software) used Bandura's methodology [8]. '3D Content Creation' are those software packages used to actually model the student's 'object', while 'Layout and Publication' are those softwares used to present the final design intent. The results of this survey have been statistically analysed using Statistical Package for the Social Sciences (SPSS).

5.1 Student responses

The results of the statistical analysis indicate that most students had no prior exposure to either '3D Content Creation' or 'Layout and Publication' software (58.9% said "no" and 41.1% said "yes"). Specifically, with regards to the '3D Content Creation' software 67.9% had not used this software before and 79.8% had not used the 'Layout and Publication' software. A minority had used more than one software package of each type (13.7% for '3D Content Creation' and 7.2% for 'Layout and Publication' software). For '3D Content Creation' software, the most commonly used packages were Autodesk AutoCAD and Revit, while Adobe Photoshop was the most common for the 'Layout and Publication' software. These results are tabulated in Fig. 6 below.

3D Content Creation software	Yes	No
Autodesk AutoCAD	26 (15.5%)	142 (85.5%)
Autodesk Revit	21 (12.5%)	147 (87.5%)
Autodesk 3D Studio Max	9 (5.4%)	159 (94.6%)
Google Sketchup	8 (95.2%)	160 (94.8%)
Graphisoft Archicad	7 (4.2%)	161 (95.8%)
Autodesk Inventor	3 (1.8%)	165 (98.8%)
Nemetschek VectorWorks	3 (1.8%)	165 (98.2%)
Autodesk Max9	2 (1.2%)	166 (98.8%)
Siemens SolidEdge	2 (1.2%)	166 (98.8%)
Bentley Microstation	1 (0.6%)	167 (99.4%)
Autodesk Maya	1 (0.6%)	167 (99.4%)
Parametrics Prodesktop	1 (0.6%)	167 (99.4%)
Layout and Publication software	**Yes**	**No**
Adobe Photoshop	28 (16.7%)	140 (83.3%)
CorelDraw	13 (7.7%)	155 (92.3%)
Adobe Illustrator	3 (1.8%)	165 (98.2%)
Adobe InDesign	2 (1.2%)	166 (98.8%)
Adobe Fireworks	1 (0.6%)	167 (99.4%)
CorelPaint	1 (0.6%)	167 (99.4%)

Figure 6: Table indicating student prior use of either '3D Content Creation' or 'Layout and Publication' software.

From the survey, students' self-efficacy rating (confidence in their ability to use technology to achieve and communicate certain goals) was extracted and converted into a rating of between 1 and 20. Scores from 1 to 10 indicated that students did not have confidence in their ability to complete certain tasks, whereas scores from 11 to 20 indicated that students were confident in their ability to achieve certain tasks. 11-14 indicated relatively low self-efficacy, 15-17 indicated moderate self-efficacy and 18-20 indicated high self-efficacy.

Students indicated that they generally had moderate self-efficacy in their ability to complete more general tasks using the ‘3D Content Creation’ software. (Mean = 15.22, Standard Deviation (SD) = 2.01) and ‘Layout and Publication’ software (Mean = 15.69, SD = 2.22). The self-efficacy surveys targeting technological literacy showed a similar pattern (Mean = 15.42, SD = 2.85 respectively for ‘3D Content Creation’ and Mean = 14.99, SD = 3.57 for ‘Layout and Publication’. There was however more variability in students’ responses to this portion of the survey.

Survey type	**Mean**	**Standard deviation**	**Minimum**	**Maximum**
‘3D Content Creation’ self-efficacy	15.22	2.01	8.36	19.18
‘Layout and Publication’ self-efficacy	15.69	2.22	6.91	19.82
‘3D Content Creation’ technological literacy	15.42	2.85	6.80	20
‘Layout and Publication’ technological literacy	14.99	3.57	4.00	20

Figure 7: Table indicating student self-efficacy and technological literacy in the use of ‘3D Content Creation’ or ‘Layout and Publication’ software.

Total results for all scales used in the survey were analysed using Pearson’s correlations. Bivariate correlations were performed on the general and revised self-efficacy scales, the total technological literacy results from ‘3D Content Creation’ and ‘Layout and Publication’ items.

This indicated that, as expected, there was a high degree of correlation between students self-efficacy measured using the general and revised self-efficacy scales ($r=.471$, $p < .01$). r^2 was 22.18%. ($r=$ Pearson’s correlation, $p=$statistical significance level, and r^2 is the amount of variance accounted for in one measure by the other measure.)

There was a moderate correlation between the more general ‘3D Content Creation’ software use and ‘Layout and Publication’ software use ($r=.182$, $p<.05$). There was also a correlation between the general self-efficacy scale and the ‘Layout and Publication’ self-efficacy measure. ($r=.2$, $p<.05$). There were moderate correlations between ‘3D Content Creation’ software use and ‘3D Content Creation’ technological literacy ($r=.209$, $p<.05$) and general self-efficacy and ‘3D Content Creation’ technological literacy ($r=.227$, $p<.05$). There was also a significant correlation between ‘3D Content Creation’ technological literacy and ‘Layout and Publication’ technological literacy ($r=.31$, $p< .01$). $r^2 = 9.6\%$. The correlation between ‘3D Content Creation’ and ‘Layout and Publication’ technological literacy was significant ($r=.293$, $p<.05$).

6. DISCUSSION

This study adopted the strategy advocated by Bandura’s [8] advice to construct measures of self-efficacy that are context specific. The design of the survey was therefore targeted to the completion of discipline specific design tasks, using the specific software applications available to students in DEB201.

Most students had moderate to high levels of self-efficacy in terms of their beliefs that they could achieve certain design and communication processes using technology in DEB201. This finding however needs to be expanded in a subsequent study with outcomes from a purely design studio.

The correlations between ‘3D Content Creation’ and ‘Layout and Publication’ technological literacy indicate that these tasks may also represent discrete parts of a wider design process. That is, they may be indicative of students’ generalised self-efficacy concerning their ability to communicate their design intentions using technology. The results of the data analysis reveal that there is a low to moderate degree of correlation between ‘3D Content Creation’ and ‘Layout and Publication’ self-efficacy. One interpretation of this is that these skills are in fact highly inter-related and are sub-skills of the wider design process or design communication. However, an alternative explanation might be that as these skills are taught together, students’ self-efficacy beliefs related to the two skills become correlated as per Bandura [8]. At this stage of the research project, it is not possible to specify this with any degree of certainty and additional research should seek to clarify whether these skills are in fact discrete parts of the wider design process. The influence of prior knowledge of the software packages, and how this relates to self-efficacy and student learning outcomes, also needs to be clarified. Since some students believe that those with prior software knowledge had an advantage, this may influence their own beliefs in their ability to communicate design intent; as they internally compare themselves to someone with prior software experience.

Improvements to the current version of the survey can be suggested based on the preliminary data analysis. Future versions of the survey could be shortened; for example, both the general and revised self-efficacy measures could probably be omitted. Having gathered data on students' previous software experience, we are now in a position to streamline the survey by providing students with the list of software they can then select from. This is likely to improve data accuracy as students will have the options listed rather than having to recall them from memory.

The pedagogical implications of this survey, while only very preliminary, are arguably extensive. If students have confidence in their ability to carry out design tasks using technology, then they are more likely to persist in their efforts to do so. They are also more likely to attempt to master the technology to achieve their design intentions, even if their confidence in their ability is overly optimistic. If as we believe it is crucial for a designer to be fluent in both methods of communicating (freehand and technical), then this needs to be identified. This is done so that appropriate instructional strategies can address the apparent gap and begin to increase students' self efficacy beliefs. Supposedly then students could develop the motivation to persist with either medium for communicating design concepts. Appropriate instructional tasks could focus on developing early confidence in design communication using technology.

7. CONCLUSION

The primary intention of this paper was to validate the restructuring of DEB201 in 2009. From the overall assessment results, it is apparent that a higher percentage of students have preformed at a significantly improved level. Additionally, those students failing DEB201 decreased, albeit by a marginal amount. Further, the LEX results indicate that student satisfaction with DEB201 increased significantly, when compared to the previous year. While the content specific survey has indicated that a moderate to high degree of student self-efficacy has contributed significantly to the success of the restructured DEB201.

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