USING VIRTUAL TOOLS TO SUPPORT COLLABORATIVE LEARNING IN DESIGN EDUCATION

By

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ABSTRACT

An increasingly popular topic of discussion relating to higher education learning methodology is online learning, particularly online collaborative learning (Resta and Laferrière, 2007). With the emergence of 'Web 2.0' there are currently a multitude of CSCW (Computer-Supported Cooperative Work) tools available which facilitate such work strategies. There is however dispute surrounding the effectiveness of such methods and the level of adoption by the student population. One particular field in which group working and group based projects feature extensively is the design industry. It could be expected therefore that undergraduate design students in particular, being considered 'digital natives', would be utilising the available online collaborative work tools to their full potential. Whilst it is safe to assume that some level of online collaborative working takes place within the course of these assignments it is currently unclear to what extent these tools are utilised or what forms these tools take. Through the evaluation of data obtained from undergraduate design students at Loughborough University on the level of uptake of online collaborative work tools within the context of group projects and assignments, the aim of this paper is to provide suggestions for possible ways to improve the adoption of online collaborative work tools within undergraduate design education.

Keywords: Collaboration, Virtual Tools, Undergraduate, Group Assignment, Design Education.

INTRODUCTION

An increasingly popular topic of discussion relating to higher education learning methodology is online learning, particularly online collaborative learning (Resta and Laferrière, 2007). With the emergence of 'Web 2.0' there are currently a multitude of CSCW (Computer-Supported Cooperative Work) tools available which facilitate such work strategies, ranging from free to access Wiki's to paid software solutions. There is however dispute surrounding the effectiveness of such methods and the level of adoption by the student population.

One particular field in which group working and group based projects feature extensively is the design industry. With professional designers working with individuals from varying fields and backgrounds, as well as increasingly working globally, this industry is likely to be at the forefront of online collaborative working. It could be expected therefore that undergraduate design students in particular, being considered 'digital natives', would be utilising the available online collaborative work tools to their full potential. Whilst it is safe to assume that some level of online collaborative working takes place within the course of these assignments, it is currently unclear to what extent these tools are utilised or what forms these tools take. There is currently little research available into the adoption of these collaborative work tools by student populations, with only a very small portion of this research focussing specifically on design orientated tasks.

The nature of the work conducted however brings with it's own requirements for potential tools being used, either to facilitate or improve on traditional methods of working. Hilliges (2007) suggests that "important parts of our professional and personal life still depend on co-located collaboration and face-to-face communication, with all the nuances of facial expression and body language, and the immediacy of verbal communication." If this is the case

then it may suggest a disparity between the expected uptake of work tools and the actual uptake of online collaborative working methods by undergraduates on design based courses.

The aim of this paper is to provide suggestions for possible ways to improve the adoption of online collaborative work tools within undergraduate design education. This has been achieved through the evaluation of data obtained from undergraduate design students at Loughborough University on the level of uptake of online collaborative work tools within the context of group projects and assignments, as well as exploring students' reasons behind the adoption or, indeed, avoidance of specific technologies.

1. Web 2.0 and Online Collaborative Work Tools

There has been a lot written on the impact and development of Web 2.0 tools, as well as online collaborative work tools as a whole, with specific focus paid to the educational potential of these tools. In the past it was argued that there was a social-technical gap, a divide between the social requirements of provided tools and their technological feasibility (Ackerman, 2000). However since the emergence of Web 2.0 the lines between social engagement and technological interaction have been blurred.

The term Web 2.0 was first used in 2004 to describe the development of the internet as a social tool, encouraging and facilitating online collaboration and sharing. Murugesan (2007) suggests Web 2.0 harnesses the web in a more interactive and collaborative manner. Characterised by the emergence of social tools, such as Facebook, Twitter and Wikis amongst others Web 2.0 allows "the exchange of thoughts via the web without restrictions of time or place" (Chu and Kennedy, 2011). This technological potential combined with the widespread integration of online presence into everyday life has made access to various means of online collaboration easier than ever before.

With these new technologies CSCW (Computer-Supported Cooperative Work) tools have also developed in their complexity, with tools, such as Google Docs offering free to use, synchronous collaborative document editing, and websites such as Mural.ly offering a "flexible content format that aggregates media and files, ideal for group ideation and visual sharing" (Michael Carney, 2013). Both of these are examples of an ever growing number of online tools in which users are able to collaboratively work on shared documents in online workspaces in real time. This synchronous communication and sharing of files and knowledge has been fundamental in creating improved technologies for CSCW. In a study into Designing for Collaborative Creative Problem Solving, (Hilliges, 2007) the belief that for collaborative creative problem solving tools to be successful they would require 'Immediacy of Communication and Interaction' is addressed. This is contrasted however by the findings of Hara, Bonk, and Angeli (2000) who suggest that through using online discussion forums it allows users "more time to reflect on course content and make in-depth cognitive and social contributions", which would suggest a more asynchronous approach to collaborative working to be more beneficial.

With these technological improvements however, there still appears to be a disconnect between the technology and the users' uptake. Whilst there is a substantial amount of research into the uptake of specific tools such as wikis (Bold, 2006; Witney and Smallbone, 2011) there is little in the way of research into reasoning behind software choices. Whilst on face value it may seem like common sense to suggest that within current undergraduate activities the use of technologies is widespread, this study however will aim to identify if this is in fact the case, and explore and analyse user's motivations behind choice of platforms used, if any.

Another area which has previously been documented is the inclusion of Web 2.0 tools into current learning practises. The majority of existing literature on the subject focuses on the means of implementing Web 2.0 tools into existing classroom learning (Barnett, 2006; Graham, Tripp, Seawright, and Joeckel, 2007; Hoekstra, 2008), with some studies focussing on how Web 2.0 tools can be utilised outside of the classroom (Vaughan et al., 2011). These papers tend to focus on the inclusion of collaborative learning tools and methods accessible by both staff and students for observational benefits. Vaughan et al., suggest that to improve the use of Web 2.0 tools outside of the classroom faculty should focus on directing the use of the

tools through specific course structure. By designing 'problem-based' learning activities which require the use of Web 2.0 features to encourage collaboration, Vaughan et al., propose that this will encourage students to use the tools outside of the classroom and will enable guided use of the tools for improved results. Vaughan et al., do however suggest that these systems should demonstrate the use of Web 2.0 tools to guide the students' use. This system of use through requirement is likely a factor contributing to the potential uptake of Web 2.0 tools amongst undergraduate design students. The likelihood is that use of online collaborative work tools will have been instigated by either the requirement or suggestion of faculty members and therefore when studying students' uptake it is important to consider the course background of students involved. It would be beneficial when researching the uptake of such tools to involve a student sample from various Universities or Institutions.

When exploring current literature on the subject of online technology uptake, whether within the context of design study or otherwise, it is important to pay attention to the publication date. The speed of technological development and the relatively recent emergence of Web 2.0 have expanded the ways in which users are able to interact through technologies and therefore sources conducted before this period may be less valid in their findings. The research conducted in the course of this study aims to provide specific, discipline relevant exploration, following in a similar vein to the study conducted by Margaryan, Littlejohn, and Vojt (2011) who explored the utilisation of digital tools amongst students in the age bracket described as 'digital natives'. The work conducted by Margaryan et al., differs from the research within this study however as it addressed individual use, as well as social technology uses outside of learning activities.

2. Collaboration within the Context of Design

Within the outlines of this study, it is important to identify the specific needs of the user base in question, design undergraduates. The nature of the work conducted within design disciplines, and the prevalence of group assignments (Gleeson, 1996) would suggest a high percentage uptake of online collaborative work tools within design students. There has been significant research done into the successes and failures of online learning techniques by students within various disciplines including Social Work and Engineering Students, and post-graduate trainee teachers (Wang, 2012). There appears however, to be little in the way of research conducted into the adoption of these tools and techniques by students studying design based courses.

This study focuses on students studying design based degrees as it is likely that there will be specific requirements of collaborative tools due to the nature of the work conducted. In a study titled Designing for Collaborative Creative Problem Solving (Hilliges, 2007) the focus is placed on the requirements of specific techniques within the creative process, such as brainstorming, when creating a collaborative design environment. Hilliges also raises the importance of visual awareness within group working, as documented by Dourish and Bellotti (1992). Hilliges suggests that "important parts of our professional and personal life still depend on co-located collaboration and face-to-face communication, with all the nuances of facial expression and body language, and the immediacy of verbal communication." Research from Diehl and Storebe (1987) however suggests that in a brainstorming environment it is in fact Electronic Brainstorming Systems which prove to be the most efficient. Reasons for this being attributed to the reduction in 'production blocking', a phrase used to describe the act of an individual inhibiting other participants during group activity, as well as the increase in anonymity, removing the apprehension which may be associated with presentation of ideas or thoughts in a group environment. For an online tool to be successful it is expected that the tool should be able to either sufficiently replicate the benefits of working in-person, or alternatively offer additional benefits which are not achievable through in-person working. The difficulty in achieving the first of these goals is replicating the intricacy involved in the communication involved within design working.

One such intricacy is the use of gestures Tang (1989). Tang suggests that the use of gestures is important to the success of collaborative working in design. Whether gesturing to specific areas within the shared workspace or gesturing to

individuals present, the use of gestures is an important means of expressing intention. This use of gesturing as an expression of intent or as a means of moving attention is difficult to replicate through online platforms. Tools such as video streaming or webcam communication only allow a limited engagement with the users' environment as the user can only gesture towards his/her screen (Tang, 1989). Cross and Cross (1995) report on the role of teamwork and social interactions within the design process. They discuss the importance when working within teams of having 'roles and relationships within the team, relative to each other', these include hierarchal roles as well as skillset derived roles. They also discuss the practise of initiating activity within group working. Cross and Cross suggest that when working in-person 'activities may be initiated tacitly rather than there being a formal decision to undertake the activity'. This ability to coordinate work without the need for formal initiation differs from online working which often requires there to be a structured work plan so as to ensure group members are aware of what they are required to do, and also so that individuals are aware of what others are doing.

A number of studies have been conducted into the potential for creating specific online collaborative work tools for designers, and touch on some of the topics raised in this study, however they focus primarily on the specific technological aspects of the tools being proposed. Su et al., (2010) report on the requirements for producing a "Web 2.0-based collaborative annotation system for enhancing knowledge sharing in collaborative learning environments". In this report Su et al., reference certain software design requirements to best facilitate the creation of an online collaborative tool allowing users to add personal or shared annotations to documents. Whilst the limitations of existing tools are touched on and the requirements of the target user are highlighted the main focus is on features of the software such as the system architecture. Equally reports such as 'Observations from supplementing the traditional design process via Internet-based collaboration tools' (Niadmarthi, Allen, and Sriram, 2001) focus more heavily on the successes and failures of the devised approaches, rather than the users' overall perceptions of the use of online collaborative tools.

Whilst discussing collaborative working methods in the context of design or otherwise it is important to define 'collaboration'. Misanchuk and Anderson (2001) make an important differentiation between collaboration and cooperation in terms of group working. Misanchuk and Anderson describe cooperative working stating "A machine metaphor can illustrate cooperation in the classroom: different parts of the machine perform different functions and goals, but work together towards a similar end," collaborative working on the other hand is described as "In the case of collaboration, the group members work toward a common goal, one that carries a mutual investment". This differentiation is important when exploring the adoption of online collaborative work tools by design students as it reflects the varied nature of the work being completed in design based group assignments.

3. Research Methodology

A mixed method approach was decided upon as being the most appropriate means of conducting research into the habits of design undergraduates when it comes to the use of online collaborative work tools. The research method implemented utilised a questionnaire survey supplemented by in depth interviews based on the findings of the initial survey. This methodology was chosen as it allowed for a quantitative approach to the research, offering the ability to gain a broad, if limited view of the habits of the demographic, followed by a qualitative research element allowing for a more detailed exploration into the complexities of the participants' choices.

3.1 Quantitative Online Survey

The main objectives of the online questionnaire survey were:

- To evaluate the uptake of online collaborative work tools by design undergraduates.
- To explore the specific online collaborative work tools used by design undergraduates.
- To evaluate the user requirements of online collaborative work tools amongst design undergraduates.
- To evaluate the perceived setbacks of online collaborative work tools by design undergraduates.

The online survey was made available to design students in undergraduate study or who had graduated within twelve months prior to the release of the survey. Participants were required to provide details of their course of study as well as their current year of study as of the time of completing the survey so as to allow differentiation between the different demographics. The same survey was made available to participants from all demographics so as to allow for comparison of results upon the completion of data collection.

The design of the survey was produced around a set of key questions which allowed for a broad quantitative understanding of the use of online collaborative work tools amongst design undergraduates and so as to fulfil the main objectives of the research as listed previously. The questions were designed to provide clear data on:

- The use of online collaborative work tools.
- The specific tools used.
- The factors affecting the decision to use online collaborative work tools.
- The factors affecting the choice of online collaborative work tools used.
- Whether the use of online collaborative work tools could replace in-person group working.

The survey was piloted with five final year design students to establish suitability of length, coherence, and practicality of data obtained. Based on the feedback received from the pilot study two of the 10 questions were re-worded for improved clarity as were the means of answering two of the questions, changing from a ranking system to a 7 point itemised rating scale where a response of 1 corresponded to "Of no importance" and 7 corresponded to "Of most importance". Where relevant, comment boxes were provided to allow participants to add additional options or to add further information. The final question was an open ended question related to specific times when online collaborative work tools were not suitable or where group work was required to be completed in-person. The reasoning behind the answers to this question acted as the basis for the interview based research.

The finalised survey was administered online using Survey Monkey (surveymonkey.com) to students within Loughborough Design School. The survey was distributed via the 'Loughborough Design School Students' and 'LDS Finalists' Facebook groups and was completed by 45 individuals. All 45 results were completed suitably for analysis.

All participants were made aware of the use of the results and that all results would remain anonymous. Participants were informed that their completion of the survey granted permission for the results to be used in the findings and data analysis sections of this report. Participants were invited to provide additional contact details to volunteer for participation in the further interview based research.

Due to the optional nature of the survey and the selected distribution channels the sample size taken is only a small representation of a much larger student base. Potentially more importantly the sample was taken only from students studying at Loughborough University. This may have influenced the results due to specific teaching methods or course requirements within Loughborough University design modules, therefore only providing a representative insight into the entire design undergraduate demographic.

3.2 Qualitative Interviews

To supplement the online survey results further research was carried out in the form of interviews conducted with participants who volunteered their continued input during the online survey. A total of 10 participants volunteered for further communication. Each interview was conducted one-on-one with the participant and lasted approximately 20 minutes. All participants were required to read a participant information document and sign a consent form agreeing to the communication as long as they were happy to do so.

The aim of the qualitative research stage was to answer the question 'Why do undergraduate design students choose to use online collaborative work tools?' A semi-structured interview approach was used to allow for further explanation if necessary, as well as to allow the alteration of the interview order to best suit the responses given by the participant (Barbour, 2008).

All participants were initially asked to comment on their answers to the final question in the online survey "In your

experience of group projects undertaken were there instances where work was conducted in person? If yes please state the nature of the work and reasons for working in-person." The base questions for the interview were compiled around the results of the initial survey. The interview questions aimed to explore contradictions found within the results of the survey as well as provide additional opinion and insights into student's perceptions of online collaborative work tools allowing for comparisons to be made with the existing literature on the subject.

4. Findings

4.1 Quantitative Online Survey

To begin the survey questionnaire participants were asked to provide some brief background information, including their course of study, and year of study. Tables 1 and 2 outline the demographic profile of the participants. As shown in Table 1, students studying in design courses at Loughborough University have the option to complete a year in industry which would be considered their third year of study, however those who chose not to complete the year in industry would also be considered third year students, however they would be finalists, it was therefore necessary to differentiate between the two.

Whilst the questionnaire was distributed through means which would be accessible to students completing years in industry there were no participants from this category. It was also expected that the number of graduates who completed the survey would be significantly less due to the likelihood of reduced use of the distribution channels. As the spread amongst the other demographics was relatively even the data was considered to still provide a useful sample of the broader demographic of Loughborough Undergraduate Design Students. Two participants failed to provide their course details.

Year of Study	Number	Percentage
First	12	26.6
Second	13	28.2
Third (Placement)	-	-
Finalist	17	37.7
2013 Graduate	3	6.6
Total	45	100

Table 1. Distribution of Participants by Year Group

Course of Study	Number	Percentage
Product Design Technology	12	26.6
Industrial Design Technology	31	68.8
Total	43	95.4

Table 2. Distribution of Participants by Course

As would be expected from students attending similar courses at the same University, all participants (n=45, 100%) indicated that they had participated in group oriented projects during the course of their undergraduate studies. Whilst an expected outcome this does however confirm the previously identified requirement of design students to actively utilise group working methods.

Participants were next asked to indicate whether during the course of these projects any online collaborative work tools were used. Of 45 participants who had previously indicated that they had participated in group oriented projects only one participant indicated that they had not used any form of online collaborative work tools meaning (n=44, 97.8%) had utilised online work tools during their group project involvement.

In this case, however it can be assumed that the single participant had either misunderstood the question or incorrectly answered as they have continued on to provide information on their use of specific online collaborative work tools and their experiences. If this is considered the case then all participants (n=45, 100%) indicated that they have utilised online work tools during their undergraduate studies.

As a follow up question participants were asked to indicate which online collaborative work tools they have used. A selection of twelve collaborative tools ranging from broad functionality social media sites to very specific technical sites were listed along with a comment box for additional answers.

The vast majority of participants indicated that they had used Facebook within their group work (n=44, 97.78%), file sharing tool Dropbox, (n=28, 62.22%) and collaborative text and data document creator and reader Google Docs (n=24, 53.33%). Smaller numbers of participants indicated the use of video and telecommunication tool Skype (n=8, 17.78%), image sharing and organising site Pinterest (n=6, 13.33%), collaborative presentation production tool Prezi

(n=4, 8.89%), Blogging site Tumblr, (n=2, 4.45%) and finally note taking and organisation tool Evernote (n=2, 4.45%).

The next section of the questionnaire focussed on the factors which influenced the participants when choosing to use online collaborative work tools, either consciously or subconsciously, as well as the factors which influenced their choice of tool to use within the project (see Table 3).

These questions utilised a 7 point itemised rating scale to obtain participant preference towards various factors which may influence their decision. Table 4 summarises the data obtained from asking participants to indicate the level of importance they felt a set of factors had on their choosing to use online collaborative work tools.

Online Tool	Responses	
	(%)	Number (n)
Facebook (Groups, chat, etc.)	97.78	44
Dropbox Folders	62.22	28
Google Docs	53.33	24
Skype	17.78	8
Tumblr	4.44	2
Evernote	4.44	2
Bubbl	0	0
Scribblar	0	0
Basecamp	0	0
Mural.ly	0	0
GrabCAD Workbench	0	0
Fusion 360	0	0
Other (Given answers)		
Pinterest	13.33	6
Prezi	8.89	4

Table 3. Distribution of Selections of Online Tools Used

The responses to this question were relatively mixed, however the preference towards flexibility of the work tool (eg, the tool providing the ability to communicate at the participant's convenience) was apparent with slightly under 50% of participants considering this factor to be of 'Most importance' when choosing to use online collaborative work tools. It is also clear to see that the reduced pressure of face to face interaction factors lowly in the participant's decision, averaging only 2.69 suggesting it is nearing being of 'No importance' to the decision to use online collaborative work tools.

Continuing in obtaining data relating to the participants reasoning for decisions relating to their use of online collaborative work tools participants were next asked to again rate the importance of a set of factors using a 1 to 7 scale. This time the factors related to the participant's reasons for choosing the specific online collaborative work tools to be used within a project.

Table 5 summarises the data collected. The data obtained again showed a fairly mixed spread, trending towards most factors being considered of relatively high importance to the decision of which tool(s) to use. What immediately stands out from this set of data is the comparatively, very low importance of the tool being able to provide a means of face-to-face communication. Averaging to only 2.4 on

	1 No importance	2	3	4	5	6	7 Most importance	Total	Average Rating
Flexibility-Ability to communicate at your convenience	0%	0%	0%	4.44%	13.33%	33.33%	48.89%	45	6.27
	0	0	0	2	15	15	22		
Ability to track user input (written Record of individual participation)	0%	17.78%	11.11%	11.11%	22.22%	24.44%	13.33%	45	4.64
	0	8	5	5	10	11	6		
Reduced pressure of face to face interaction	17.78%	31.11%	26.67%	13.33%	11.11%	0%	0%	45	2.69
	8	14	12	6	5	0	0		
Add structure to workflow-Ability to organise and coordinate work being done	0%	8.89%	6.67%	8.89%	22.22%	37.78%	15.56%	45	5.20
	0	4	3	4	10	17	7		
Need for features provided by online work tools	2.22%	8.89%	11.11%	11.11%	15.56%	22.22%	28.89%	45	5.11
	1	4	5	5	7	10	13		

Table 4. Distribution of Ratings According to 'Importance' of Various Rationales

	1 No importance	2	3	4	5	6	7 Most importance	Total	Average Rating
Familiarity With the tool	2.21%	0%	2.22%	2.22%	13.33%	46.67%	33.33%	45	5.98
	1	0	1	1	6	21	15		
Software availability-For example does the software require membership to use?	0%	0%	0%	2.22%	24.44%	35.55%	37.78%	45	6.09
	0	0	0	1	11	16	17		
Immediacy (such as instant messaging facilities)	4.44%	2.22%	8.89%	20%	17.78%	33.33%	13.33%	45	4.98
	2	1	4	9	8	15	6		
Face-to-face communication Such as webcam facilities	26.67%	42.22%	15.56%	4.44%	2.22%	8.89%	0%	45	2.40
	12	19	7	2	1	4	0		
Toolset-Does the software include all the tools required to complete a task or will other tools be used as well.	0%	4.44%	26.67%	22.22%	20%	20%	6.67%	45	4.44
	1	2	12	10	9	9	3		
Ease of use	0%	0%	0%	4.44%	6.67%	55.56%	33.33%	45	6.18
	0	0	0	2	3	25	15		
File sharing capabilities	0%	0%	0%	4.55%	6.82%	31.82%	56.82%	44	6.41
	0	0	0	2	3	14	25		
Synchronous working capabilities (more than one person working on a document at once)	6.67%	15.56%	11.11%	20%	13.33%	26.67%	6.67%	45	4.24
	3	7	5	9	6	12	3		

Table 5. Distribution of Ratings According to 'Importance' of Various Rationale

the rating scale this places it little above 'Of no importance' suggesting that the need for face to face communication is not required for the successful practise of group working or is merely undesirable for such tasks.

The final section of the survey utilised a quantitative lead question followed by a qualitative follow on question relating to the participants experiences of conducting work in-person with members of their groups within these projects, in particular the participant's perception of the necessity of working in-person.

Only 2 (n=2, 4.44%) of the participants indicated that within their experience of working with groups during the course of their study they had not conducted any of the work in person with their groups. Both of these participants were finalist students which would suggest that they have gone the full length of their undergraduate studies without participating in any in-person group activities.

The follow-on question for participants who indicated that they had conducted work in person asked for comments on their reasons for doing so. The opened ended nature resulted in varied quality and forms of answers. In general individual participant's responses revolved around a key 2-3 factors which they felt necessitated working in-person. For ease of evaluation keywords were established in replies to aid in categorising responses, for example, one participant's response read "Working in person normally gets things done faster when deadlines are looming. We were always advised to meet up with our groups so sometimes did it just to make sure we were all working". In this response the phrases "gets things done faster", "were always advised to meet up", and "did it just to make sure we were all working", were pulled out as key phrases and categorised as 'speed', 'requirement' and 'reassurance' respectively. Across the full range answers there were 8 predominantly recurring themes of response, these included:

- Fluidity of working in-person
- Working in-person for organisational purposes
- Ease of working in-person
- Speed of working in-person
- Reassurance of group activities
- The need for specific tools or methods
- Convenience of meeting to conduct in-person working
- The 'face-to-face' impact on working

Of these the most common replies were the speed of working in-person, with 14 participants (31.1%) citing features relating to the speed of in-person productivity as a necessity, the need for tools or methods which the participant felt weren't available through online means, with 13 participants (28.8%) and organisational benefits of working in-person followed with 10 replies (22.2%).

In addition to these 'primary' responses there were a selection of responses given by a small number (1 or 2) of participants, these included failures when using collaborative work tools leading to in-person working, course requirements for in-person meetings and online tools having not particularly been considered.

One importance of working with groups in-person which was frequently mentioned by participants (n=7, 15.5%) was the broad benefit of 'face-to-face' interaction. This term was repeatedly used however the benefits of face-to-face interaction were rarely defined. One participant's response read "Face to face meetings are easier for allowing people to judge reactions and share ideas", giving the most clarity to their perception of the benefits of face-to-face communication.

4.2 Interview Responses

Of the 45 participants who completed the initial survey section of the research 6 provided their details, volunteering for further communication. These 6 participants were contacted and interviewed focussing on their responses to the initial survey.

The interviews were based around a pre-designed set of questions; however this was not strictly adhered to, allowing some flexibility within the communication. The focus of the majority of the interviews moved towards exploring and understanding any contradictions within the participant's survey answers. As a starting point participants were reminded of their answers to the final question from the survey, about the need for in-person working, and were asked to elaborate on the answer they had given. Of the 6 interview participants 4 had cited face to face interaction as being one of the main requirements of meeting in person. Participants were asked to try and define what they believed the benefits were of in-person face to face communication over online alternatives, such as the use of Skype or Webcam facilities built into various online work tools (eg. Facebook chat webcam facilities). One participant, (Interview Participant 2) described the ability to adapt to the reactions of their colleagues when face to face, stating "When you're talking to somebody in person you can tell if they understand what you're saying, and you can sort of get an idea for if they're engaged. Online it's harder to judge things like body language I suppose". All participants cited a natural preference towards communicating in person, but when questioned about online alternatives few were able to explain why the online tools fell short of face-to-face communication.

When discussing their reasoning behind choosing which online collaborative work tools to use participants again cited familiarity with the tool and ease of use as two of the most important factors, suggesting also that online collaborative tools are predominantly used for file sharing and brief communication rather than for completing the work itself. Tools, such as Facebook and Dropbox were explained as being the primary tools used as they are already integrated into the majority of student's lives. Because of this it is considered less 'effort' to adapt these tools for work purposes than it would be to begin utilising a new tool even though it may have advantageous functionality.

Participants generally commented that they would not be adverse to utilising more online tools if they felt they would be beneficial to the projects, particularly in terms of digitizing processes which are currently conducted using traditional means. Participants suggested that the use of tools such as Dropbox and Pinterest have made file sharing

much easier and had it not been for lack of awareness of tools such as Mural.ly they would have considered using them in the past.

5. Discussion

5.1 Undergraduate Design Students' Uptake of Online Collaborative Work Tools

At surface level, the results obtained through the online survey support the assumption that design students would demonstrate a high level of adoption of online collaborative work tools. The feedback from the questionnaire survey in particular comprehensively demonstrated that undergraduate design students at Loughborough University are utilising online work tools during their group projects in one form or another. The 100% affirmation in the survey proved this, as did the participants' indications of tools used. There are however extended findings which suggest that the initial quantitative data doesn't tell the whole story. Limited use of selected tools and limited variation in tool selection suggest that rather than online collaborative working students more accurately undertake online cooperative working. The differentiation between the two is discussed in greater detail in the upcoming sections.

5.2 Low Variation of Tools Used

Immediately apparent was the small number of tools indicated by participants as having been used. Participants indicated 3 primary tools which were used, with Facebook, Dropbox, and Google Docs accounting for the vast majority of selections (n=96 81.4%) and Facebook being selected by all but one participant. With the variety of tools available, ranging from very specific task oriented tools to very broad multi feature tools it could be expected that the range utilised would be greater, particularly given the nature of the work being completed. As previously established within the literature review, group working methods such as brainstorming feature heavily in the creative process (Hilliges, 2007), this is supported by the sentiments of the participants, both within their provided reasons for utilising in-person group working within the survey as well as in the one to one interviews. Tools such as Scribblar facilitate such working on an online, collaborative platform; however no participant indicated that they had used any such tools.

One potential reason for the lack of uptake of a more extensive range of tools is that students are simply unaware of their availability. Participants expressed familiarity with the tools as one of the most important factors impacting their selection of tools to use. This is supported by the findings for the three most commonly used tools, Facebook in particular. Tools such as these are routinely used by students and are therefore already a part of the students' daily activities. If the participant has limited or no previous experience with the tools and is not directly advised to use alternative tools for completing the work it is unlikely that they would seek to find a tool to replace in-person methods with which they are already familiar. Participants expressed that had they been aware of tools such as Mural.ly there is a high chance they would have trialled the tools within their group working however this is purely speculative.

Tying in with the factor of awareness of tools, another factor influencing tool selection which rated highly amongst participants was the availability of the software or tool. Tools which require additional sign-ups or registration, especially tools which require membership and payment are much less likely to be utilised within undergraduate projects. For what is likely to be a short to mid length (2-6 month) project it is extremely unlikely that students would invest financially in a tool which may only be used once per year. What makes factor relevant for this study is that this is potentially more relevant to the student demographic rather than the design demographic as it is more likely that within industry these membership prices will prove to be less impactful.

When looking at the breakdown of tools used, by year group second year students made 44 selections of tools between 13 participants, averaging 3.4 tools used per participant. Finalist students on the other hand averaged 2.5 tools used per student, as shown in Table 6. This result may have been influenced by a minority of participants having used notably more or less tools than others, interestingly however 5 of 6 instances of participants indicating the use of Pinterest came from second year students as did both of the instances of Tumblr use. These potential increases may suggest a differing attitude towards the use of online tools between year groups or may

Online Tool	Responses by Year Group								Total
	First		Second		Final		Graduate (2013)		
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)
Facebook (Groups, chat)	11	91.6	13	100	17	100	3	100	44
Dropbox Folders	3	25	9	69.23	14	82.35	2	66.67	28
Google Docs	7	58.3	8	61.54	7	41.18	2	66.67	24
Skype	1	8.3	5	38.46	2	11.76	-	-	8
Tumblr	-	-	2	15.38	-	-	-	-	2
Evernote	-	-	1	7.69	1	5.88	-	-	2
Bubbl	-	-	-	-	-	-	-	-	-
Scribblar	-	-	-	-	-	-	-	-	-
Basecamp	-	-	-	-	-	-	-	-	-
Mural.ly	-	-	-	-	-	-	-	-	-
GrabCAD Workbench	-	-	-	-	-	-	-	-	-
Fusion 360	-	-	-	-	-	-	-	-	-
Other (Given answers)									
Pinterest	-	-	5	38.46	1	5.88	-	-	6
Prezi	3	25	1	7.69	-	-	-	-	4

Table 6. Distribution of Selection of Online Tools used by Year Group

indicate a change in the advice given by lecturers between year groups. The first year results do not support this speculation, however this may be due to fewer experiences of group working or a more limited scope for tool use within first year modules when compared with second year group oriented projects.

When looking at the top selected tools used the depth in which students utilise these tools appear extremely limited. One common trend amongst the three most commonly used tools is the ability to share files, as was referenced in the survey stage of the research as being a primary factor in the selection of online tools. Aside from file sharing capabilities the other advantageous feature which these tools offer students appears to be the asynchronous nature in which they are used. The ability to communicate and share content as and when best fits the user adds convenience to group working where it may otherwise prove difficult to arrange opportunities to work synchronously.

Participants acknowledged that there were tools available which would facilitate working on tasks which are currently conducted in person, however their perceptions of the usefulness of these tools were mixed. Participants appreciated that the ability to carry out tasks such as brainstorming without the requirement of arranging group meetings and travelling to and from said meetings sounded beneficial, however they felt that using these tools would likely be unnecessary given their situation, wherein likely that all group members would to be able to arrange an in-person meeting with little difficulty and complete the task in one go.

5.3 Contradictory Findings

Within the findings were a number of contradictions between the factors students indicated to be of importance to them when selecting which tools to use and their reasons for working in-person. One of the main contradictions involved synchronous and asynchronous work styles. Participants had scored face to face features and synchronous working particularly lowly (2.4 and 4.2 out of 7, respectively) when asked to rate factors which would influence their decision over which tools to use, however when asked for their opinions on the benefits of working in-person participants frequently cited the speed and ease of working face to face, and the convenience of group working with group members present. Further exploration into participants' opinions on this contradiction revealed that the current perception of online collaborative work tools is that whilst they provide a means of synchronously working on shared documents, which wouldn't otherwise be possible or convenient through traditional online systems, they are not suitable as a replacement for working in-person. Rather, these tools provide support for in-person group working. It is apparent that students feel that the immediacy provided by working in-person was difficult to reproduce online due to the complexity and immediacy of communication involved, this rationale supports Tang's observations relating to the importance of the use of gestures within collaborative group working (Tang, 1989).

There also appears to be a division between students' attitudes towards working in-person and working using online tools. Students commented on the need for in-person group working to complete certain tasks such as brainstorming even with online collaborative tools available to facilitate such working. The primary reason given for this lack of uptake of online tools for such tasks is

the fluidity of working in-person. Being able to adapt to what is being said and judge reactions is something which students feel currently doesn't translate well to an online platform, even with face to face features such as Webcam tools.

5.4 Nature of the Use of Tools

Whilst it has been identified that undergraduate design students are utilising online tools within group projects the range of tools used and the ways in which they are used are extremely limited. As has been briefly mentioned previously when discussing the range of tools used, online tools are primarily being used as support tools for tasks such as file sharing and basic project organisation. The use of tools in this way is similar to the differentiation made by Misanchuk and Anderson (2001) between collaboration and cooperation in terms of group working. "A machine metaphor can illustrate cooperation in the classroom: different parts of the machine perform different functions and goals, but work together towards a similar end", (Misanchuk and Anderson, 2001) mirrors the students approach to online work tools, using tools such as Facebook to coordinate individual work efforts towards the group's final goal of completing the work. With this differentiation between collaborative and cooperative working it could be said that students are barely utilising true collaborative tools at all within their studies and are more accurately adapting tools for cooperative working purposes.

Instead students prefer to conduct the majority of collaborative working, including tasks, such as brainstorming, concept evaluation, and design development in-person. It is difficult to precisely identify the reasoning behind the preference for in-person communication. Within the interview responses participants made reference to a number of reasons working in-person is preferable. These reasons included the ability to read individual's body language and gestures, the immediacy of communication, the failures of technology such as 'lag' and internet difficulties and the ability to complete tasks directly amongst others. There was no definitive or unanimous reason given as to why in-person working is preferable, there was however a tacit agreement amongst participants that in-person working was preferable.

Certainly in the case of this study, it became apparent that one of the primary reasons for the preference towards working in-person was the ability to do so. All participants in the interview stage made reference to the 'convenience' of working in-person. Participants explained that whilst all group members were in the same building at the same time, be it for lectures or otherwise it was not difficult to coordinate meetings. This ability to work in-person with group members is likely to have influenced how the participants had used online tools. If the participants hadn't had the ability to work in-person it is likely that there would be greatly differing results in terms of both tools used and the way in which the tools are used. A potential avenue for further research would be into the adoption and use of online collaborative work tools with participants who were unable to coordinate meetings in-person. This would better explore how participants utilised online collaborative work tools and would likely yield more varied results showing a greater use of online collaborative work tools.

Conclusion

Having identified the tools used by undergraduate design students and evaluated their reasons for these choices and their perceived benefits of using online collaborative work tools it has become apparent that whilst online tools are used by almost all design students it would be difficult to classify the tools used as true collaborative work tools, or to classify their use as true collaborative working.

It appears that students' use of online tools is predominantly for supporting collaborative working which still takes place in face to face meetings. The primary role of online tools within design students' studies appears to be work organisation. Online tools are used to coordinate the sharing of files and to communicate with group members asynchronously with greater ease than using email systems. While there are signs of some integration of more complex uses of tools such as the use of Skype and synchronous work tools such as Google Docs the uptake has been limited.

One of the factors which has influenced the findings of this report is the location of participants, particularly their close proximity to colleagues with whom they have conducted

group working. This has meant that participants involved in this research have all stated that when required it has not been of any particular difficulty to arrange meetings in-person with their group members. It is likely that this has reduced the requirement for online collaborative work tools as participants perceive working in-person to be as good as, if not preferable to working online using collaborative tools.

The uptake of true collaborative online work tools could potentially increase amongst undergraduate design students, however for this to happen it is likely to require a level of instigation from faculty at the students' institution. With tools available which feature vast ranges of features and functionality the level to which they are being overlooked is surprising. With encouragement it is likely that students would become accustomed to, and benefit from, the use of online methods of working utilising collaborative tools, however these tools are likely to remain a supplement to traditional face to face working rather than becoming a full replacement unless this becomes a necessity. Further research into the use of such tools within design populations spread across greater distances is likely to yield very different results. Whilst the uptake of these tools was found to be limited within the results student attitudes towards the potential of such tools was positive with students indicating that had there been the requirement to use such tools they would have felt confident and comfortable in doing so.

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