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Software literacy and student learning in the tertiary environment: PowerPoint and beyond

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Abstract

In this paper, we explore the relationship between student success in acquiring software literacy and students' broader engagement and understanding of knowledge across different disciplines. We report on the first phase of a project that examines software literacies associated with Microsoft PowerPoint as a common software package encountered and used by most students at tertiary level. Student data was collected through an online survey and focus-group interviews. One hundred and seventy-nine first-year Engineering and Media Studies students from a New Zealand university responded to the survey. A majority of students considered themselves to be confident and comfortable in engaging with new technologies, had access to mobile-based technologies or laptops, and relied on this hardware and related software for electronic forms of communication and information access in their university courses. On the whole, students expressed a preference for informal strategies (including trial and error) when learning about PowerPoint, expected it to be used in their university coursework, and could identify its related affordances and constraints, and how those affected their learning. Despite their familiarity with PowerPoint, students fell short in their ability to critique the ways the software shaped their understanding of disciplinary knowledge. Implications are discussed in terms of university teaching, including the nature of support services.

Keywords: ICT; software literacy; PowerPoint; presentation software; teaching and learning; university students

Introduction

Software is not neutral. It comes with social and cultural assumptions that afford particular actions while constraining others. Software is designed for particular purposes and embeds particular values in its affordances such that particular ways of thinking and acting are more likely than others. This perspective underpins the conceptualisation of our research project, which explores how tertiary students develop the understanding and skills they need in order to use software as forms of software literacy.

In this paper, we first describe key ideas from the field of software studies which underpin the motivation of our study—we then focus on themes emerging from the literature on lecturer and student adoption of a specific software package—Microsoft PowerPoint (PPT)—which is commonly used in tertiary settings. This is followed by a description of our research that focuses on how first-year undergraduate students from two different disciplines encounter and engage with PPT in a New Zealand tertiary institution. We then report on the initial findings emerging from our study. The paper ends with a discussion of what the findings might mean for the teaching and learning of disciplines in which software is a focus—including the nature of relevant support service provision in tertiary teaching and learning contexts.

Emerging ideas from software studies

Software studies, a comparatively new field of enquiry championed by Manovich and others (Fuller, 2008; Johnson, 1997; Manovich, 2013), propose that 'software', which encompasses many forms of computer programming, is the dominant cultural technology of our time. A core premise of software studies is the need to recognise the role of software in shaping the nature of our institutions and our everyday lives, and for software users to develop a more critical awareness of how software operates to both 'empower and discipline' us (Kitchin & Dodge, 2011, pp. 10–11).

Empirical research into how software is understood, interpreted, and 'performed' by individuals and groups within a tertiary education context where software is taught and learned is only just emerging. Concepts such as computer literacy, information literacy, digital literacy, digital information literacy (and related terms) that differentiate between distinct literacies relevant to specific digital technologies have been well discussed. However, these concepts do not go far enough—they do not focus on lecturer and student critique of particular software in terms of its affordances and constraints, and how these affordances and constraints shape the way knowledge within a discipline is presented and communicated to affect student learning. For example, a key study led recently by the New Zealand Ministry of Education identified digital information literacy as students' ability to access and evaluate electronic information in order to critically manipulate and use such information for their learning purposes in recognition of the broader social and cultural contexts within which the information is situated (Hegarty et al., 2010). The authors of the study provided a progression for the development of digital literacy skills, but they did not examine the nature of student critique and decision making about which tools might best serve their purpose. Developing the ability to critique is an essential characteristic of a 21st-century learner (Gilbert, 2005).

From our observation and experience, we hypothesise that, although useful, such characterisation of digital information literacy does not go far enough in identifying, describing, and supporting the ways students learn how to use software. Students might not realise, the full implications of the affordances and constraints offered through particular software. To date, no studies that we know of raise the role of student understanding of how software and its affordances influence knowledge generation and critique. Many studies have been conducted on information literacy and on ways of mastering software (Underwood, 2009) but the role of software itself tends to be

taken for granted and has not been questioned. Software studies is only emerging as a field of study (Fuller, 2008; Hawk, Rieder, & Oviedo, 2008).

For the purposes of pursuing our interest in this area we have defined the notion of software literacy as understanding, applying, problem solving, and critiquing software in pursuit of particular learning and professional goals. It relies on a combination of general competency with software and technologies, and the ability to undertake more independent (even informal) learning of discipline-specific programmes as and when required (Hight, Khoo, Cowie, & Torrens, 2013). Our notion of software literacy is grounded in a practice-based schema which aims to distinguish a novice user from an expert user by proposing a progressive transition from novice to expert-like understanding, capabilities, and qualities (Jones, 2008; Livingstone, et al., 2014). We view software literacy as encompassing three specific levels of capabilities:

1. A basic functional skill level that allows the use of a particular application to complete a specific set of tasks
2. An ability to independently problem-solve when using an application for familiar tasks (including the ability to identify and activate resources to help resolve any difficulties)
3. The ability to critique the application, recognise its strengths and weaknesses, and apply a similar analysis to software designed for similar purposes (users at this level can make an informed selection from software applications and are empowered when learning new software)

Most people develop proficiency with common software packages informally, as part of everyday engagement (Bulfin & Koutsogiannis, 2012; Hague & Logan, 2009). Informal learning practices have been shown to increase learners' sense of agency and, subsequently, to have the potential to make learning a richer and more fulfilling experience (Furlong & Davies, 2012). To begin to understand software literacy and how it develops, our initial investigations of software literacy focused on MS PowerPoint (PPT). This application is not consistently a focus for instruction, but is widely used in lectures across the disciplines in tertiary settings.

PowerPoint and tertiary teaching

PowerPoint was initially designed as a corporate presentation tool. This corporate use contrasts with the current view that teaching and learning is best understood as a social practice supported by interaction and dialogue rather than simply presenting information to students. As such, a teacher is both limited and supported by the design decisions embedded in this software (Adams, 2006). Research indicates a wide understanding of the key affordances of PPT in teaching to:

- link to external (including multimedia) sources
- employ interactive dynamic features such as branches, hidden slides, and action buttons
- retain keyboard control of presentations so users can respond to the audience while presenting (Cyphert, 2007)
- display ideas in a hierarchical, albeit linear, manner (Adams, 2006).

However, concerns have also been raised over:

- the way PPT encourages a fragmentation of information and knowledge, and how this may negatively affect student literacy and thinking (Craig & Amernic, 2006; Tufte, 2006)
- limits to the amount of content that can be conveyed per slide, reducing the analytical quality of the information and evidence presented (Cooper, 2009; Tufte, 2006)

- the homogenising effect of bullet points, and their distortion of any hierarchical or critical conceptual relationships between ideas (Tufte, 2006; Vallance & Towndrow, 2007)
- the tendency towards pre-planned monologues rather than dialogue, leading to teacher-centred pedagogy that results in audience/student passivity (Kinchin, Chadha, & Kokotailo, 2008; Pros, Tarrida, Martin, & Amores, 2013)
- a reinforcement of student perceptions that they can perform well in exams by studying only the PPT slides, and drops in student attendance in lectures when PPT handouts are available online (Gier & Kreiner, 2009).

There is clear evidence that when lecturers fail to employ interactive and student-centred strategies when using PPT, student learning outcomes reveal no significant difference between students who are taught with PPT and those taught without PPT (Can, Karaca, Akyel, & Demirci, 2012; Pros et al., 2013). On the other hand, more active and student-centred learning in PPT-supported lectures has been shown to be beneficial. For example, Gier and Kreiner (2009) demonstrated that using content-based questions (where educators pose questions in the PPT slides several times throughout a lesson) leads to substantially higher quiz scores and exam marks. Their work highlights the value of integrating more active teaching and learning techniques in PPT-based lectures. Alongside this evidence, an emerging body of literature gives credence to the notion of teachers actively performing and communicating ideas by using body language and gestures (Alibali & Nathan, 2012). For example, Pozzer-Ardenghi and Roth (2007) explored evidence of science teachers performing in the classroom, arguing that teachers need to convey the concepts they teach by drawing on multiple and different forms of resources such as talk, non-verbal body language (gestures, body movement, facial expression) and material resources to facilitate students making sense of science ideas in lectures. These findings fit with the assertion by Endicott (as cited by Cyphert, 2007) that presentations do not need to be determined by the tools used. They are informed by the clarity of a story, the passion in the presenter's voice, and the importance of the subject to the audience.

PowerPoint and tertiary student learning

Our analysis of recent research in the area of PowerPoint and tertiary student learning suggests that students' perspectives on PPT show a lack of software literacy (in the terms we have outlined). Students perceive PPT to be a helpful cognitive tool with electronic files and slide printouts useful for review, and assume the content embedded in slides to be the most important (Adams, 2006). Despite students being certain that they were more accomplished learners with PPT, their performance on tests did not necessarily change when lecturers used the software (Susskind, 2004). Engineering students in O'Dwyer's (2008) study suggested PPT-based lectures were more interesting and provided greater support for their learning, although they recommended a combination of PPT and whiteboard use. Rosenthal et al. (2003) found students responded positively to the multimedia affordances in PPT. Similarly, Craig and Amernic (2006) report that students like to learn with PPT and believe that such presentations are amusing, improve clarity, and reinforce subject matter. In contrast, Armitage (2009) found students could struggle to know whether to focus their attention on the slide content, the lecturer's words, or their own notes. Students expressed concern about the pacing of slide presentations, the density of slide content, and the lack of natural breaks in PPT-based lectures.

Research context

This section examines how students become aware of and develop software literacy understanding and skills about PPT. It reports on the initial findings from our 2-year research project (2013–2014) in a tertiary institution in New Zealand. The study, which is funded by the

New Zealand Teaching and Learning Research Initiative (TLRI) (Khoo, Hight, Torrens, & Cowie, 2013), aims to unpack student assumptions, experience, and critique about software.

A qualitative interpretive methodology was adopted to frame the collection and analysis of the data collected in the study (Maykut & Morehouse, 1994). Two very diverse disciplines of study—Engineering and Media Studies—were selected for study. First-year undergraduate courses in both disciplines are characterised by high enrolments of students (180 and 104 students respectively) with diverse backgrounds, but the courses differ in terms of disciplinary foci and professional pathways. Data was collected through an online student survey (179 respondents) and student focus groups (36 participants). The project received human ethical approval and all participants were voluntary. Analysis of the data was underpinned by sociocultural theory, which directed attention to interactions between people, the tools they use to achieve particular purposes, and the settings in which the interactions occur (Cole & Engëstrom, 1993; Wertsch, 1998). The survey data was analysed to understand the overall broad patterns of the students' general access to technologies, the ways students acquired PPT skills, what they see as its strengths and limitations, and their approaches and follow-up work in relation to PPT lectures and notes. The focus-group interviews were transcribed and read carefully several times before the common key ideas from each transcript were coded into themes. The thematic analysis of the interview data involved inductive reasoning (Braun & Clarke, 2006) in which specific interesting observations and ideas are identified and then developed into general patterns or themes (Patton, 2002). Such inductive reasoning is consistent with qualitative interpretive methodologies and sociocultural perspectives that emphasise the value of participants' social realities and the way a tool's affordances can mediate how learners think, speak, and act. Analyses of both data sources were further integrated to develop overall key themes emerging from each case study (Merriam, 2001).

Findings

In this section, we report first on key findings in relation to students' general competence with technologies and software, and then on their assumptions, experience, and views of PPT.

Students' general orientation to and competence with technologies

When asked about their general views towards adopting new technologies, 16% of the students reported they loved new technologies and considered they would be amongst the first to experiment with them, 30% liked new technologies and would use them before most people do, 42% would use new technologies when most people they know do and, finally, 10% of students considered themselves to usually be late adopters of new technologies (see Figure 1). Only 2% of students were sceptical of new technologies and resisted using them unless they had to. These results illustrate that just under half (46%) of the students considered themselves to be early or quite early adopters of new technologies, with another 42% using new technologies as they became mainstream. This suggests that a majority of students were both confident and comfortable when experimenting with new technologies.

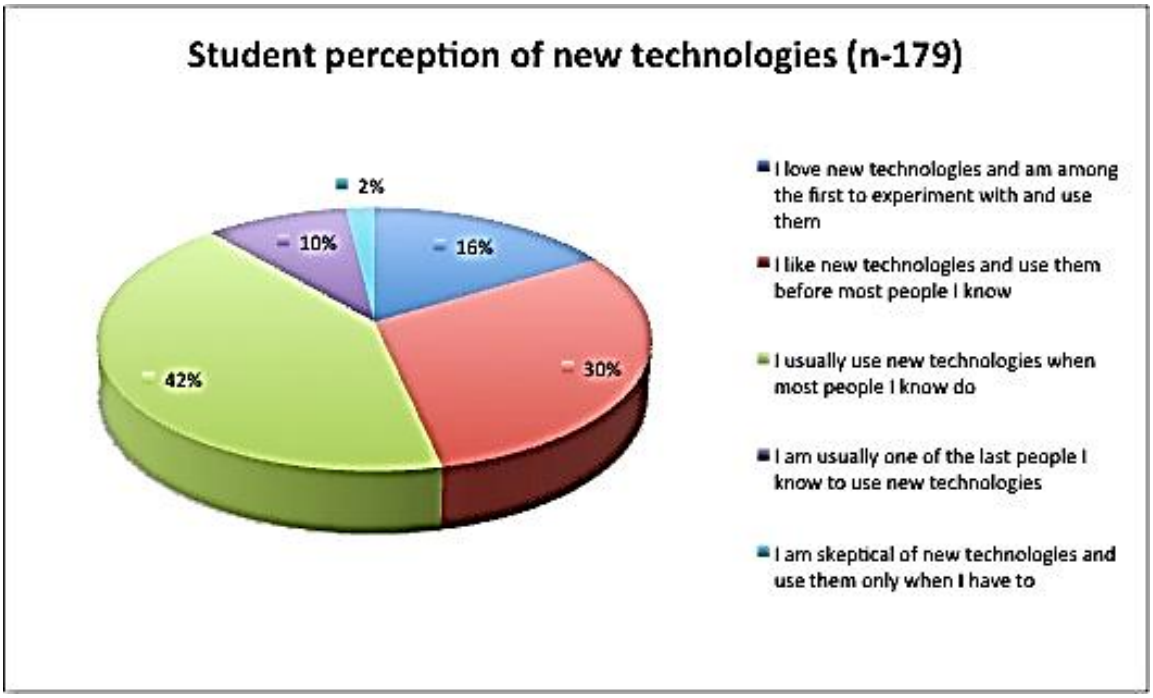

Figure 1 Student views towards adopting new technologies

Next, when asked to report on the technologies to which they had exclusive access for learning, students indicated that the top five technologies were internet-enabled laptop (120 students, 75%), followed by smartphone with internet connection and photo-capture capability (106 students, 68%), laptop without internet connection (90 students, 62%), mobile phone without internet connection (non-smartphone) (67 students, 46%) and, finally, a desktop computer with internet connection (33 students, 22%). Additional qualitative responses in the survey highlighted student access to tablet technologies, e-books, Kindles, and iPod Touches.

In addition to access to general technologies, students reported that the software they used daily was email (124 students, 77%), internet search engines (121 students, 75%), text messaging (103 students, 64%), social networking sites such as Facebook and Bebo (84 students, 52%), and video-sharing websites such as YouTube (67 students, 41%).[1] Finally, when asked to indicate their competence with a range of commonly used software, students reported that the top five types of software they could use and extend to a range of tasks (implying they were comfortable and had expert-like abilities and confidence to use these types of software) were web browsers (69%, 112 students), email (57%, 93 students), word processing (56%, 90 students), digital music service (44%, 71 students), and presentation software (30%, 48 students).

The findings confirmed that students were generally confident in their engagement with technologies and software. Most students had access to mobile-based technologies or laptops, and reported being competent with software that relates to online forms of communication and information searching (web browser and email categories) or, particularly, those applications and platforms they had to use to accomplish their academic coursework.

[1] Only the top five types of software are reported.

Student assumptions, experience and view of PowerPoint

Student survey responses revealed that 41% considered they had the basic skills needed for PPT use, 19% thought they could troubleshoot problems while using PPT, and 30% thought they could apply PPT functions to a wide range of tasks (see Figure 2). Only 7% considered they would need some help with most tasks, and 4% of students had never used presentation software. In terms of our theorised development of software literacy, those with basic skills could be considered to be at the first level, those who could troubleshoot were at the mid-level, and those who saw wider applications were approaching the third and highest level. These student responses confirm a basic assumption of our research, which is that the ubiquity of PPT means it is both widely known and used with various levels of expertise amongst the tertiary student population we sampled.

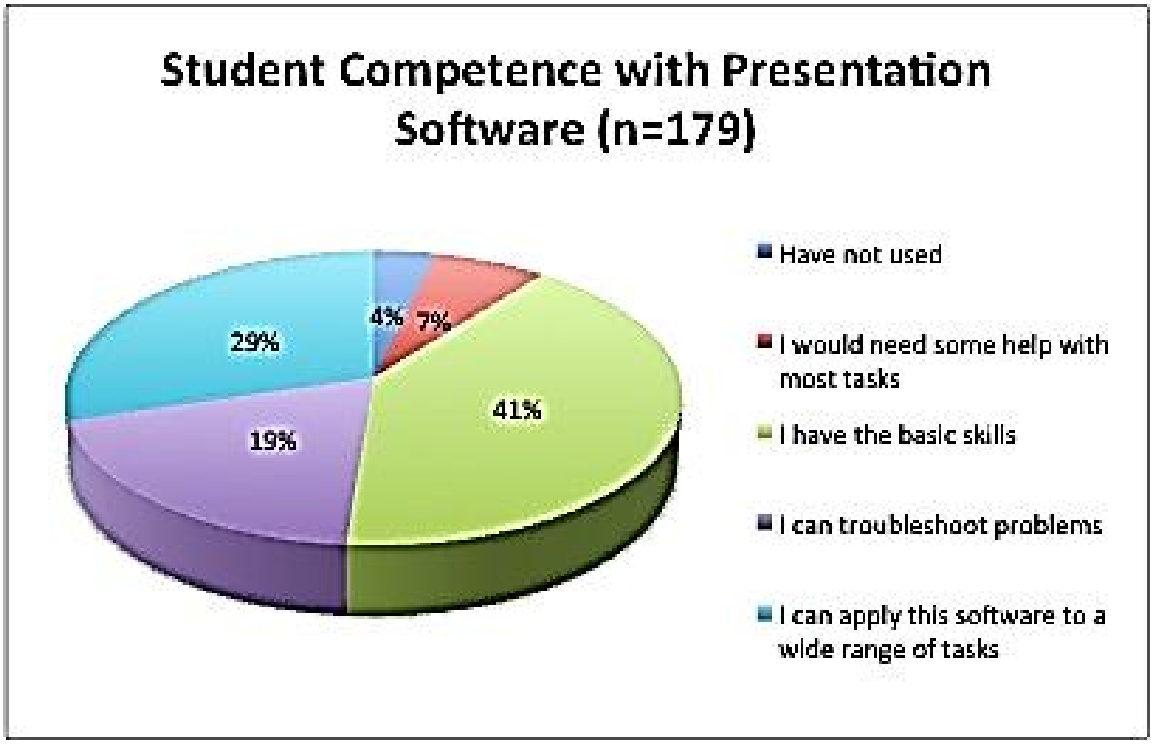

Figure 2 Student-reported competence with using PowerPoint

We were particularly interested in how students learned how to use PPT. Anecdotal evidence had suggested such applications are rarely a focus for direct instruction. We provided students with a list of strategies and asked them to indicate which they had used to learn how to use PowerPoint, and the extent to which these strategies had been useful to them in their learning. The strategies on the list were commonly adopted by users learning about new software—such as attending a course or workshop; reading a paper-based manual or step-by-step instruction booklet; going online or referring to the internet for step-by step instructions or video tutorials (e.g., on YouTube); watching someone use the software (face to face); discovering through trial-and-error or practice; joining an internet forum (e.g., a discussion forum to ask other users for help); asking a friend or peer; and, finally, asking a knowledgeable person, teacher, or expert.

Students reported drawing mostly from informal learning resources when acquiring basic skills to use PPT (i.e., the first level in our software literacy scheme). When asked to identify “useful”, “very useful”, and “extremely useful” strategies for learning, trial and error and asking an expert emerged as the preferred options (both were selected by 87% of students), followed by asking a friend (85%), or watching someone use the application (82%). Interestingly, these strategies (as

with the trend in the reported overall strategies data) constitute the more informal ways of learning about new software compared with more formal strategies such as attending a workshop to learn about PPT (42%), or reading a paper manual (33%). The focus-group interviews complemented these survey findings in that students reported a preference for strategies such as trial and error or discovery, and accessing YouTube video tutorials and Google to watch or ask about specific questions about PPT functionality. Sample student quotes related to these findings were:

> I didn't learn PPT [because I'm homeschooled] so basically I just clicked around and just figured it out.[2]

> I did a lot of online tutorial as well. If there was something that I saw that I wanted to create, I just Google search tutorial for such and such, then I do a tutorial and work through it and learn that way. Some of them are youtube …. Its got tutorials on how to use or create different elements. If there is something I want to do, I learn how to do it.

> Same with PPT, you know—you can go on Google and say how to do a proper Power Point, and there's heaps of information out there…

Common across these main reported strategies is the idea that students take the initiative and agency when learning about PPT. Given our earlier findings, it comes as no surprise that a majority of students reported being confident and comfortable to engage and experiment with new technologies. This naturally translated into students drawing from informal learning strategies and taking a more active role in learning basic software skills.

PowerPoint's affordances and constraints for presenters and audience

When asked their views on the opportunities that PPT affords for presenters, students identified that the software allowed the embedding of multimedia resources in a presentation (88%) and built-in templates helped to structure and organise ideas (86%). They suggested that information can easily be condensed into slides (81%). Three supporting student comments elaborate on these ideas:

> You can make neat presentations for a number of different tasks whether for a speech or formal gathering or alternatively, take advantage of it when it is used during a lecture. It is more appealing than text on paper and the ability to add in different media such as film clips makes it more entertaining.

> It organises topics in a concise manner to show which ones have the most priority helping to convey information in the best possible way.

> You can break up information and present it in an organised way that can combine image.

Students highlighted that, from an audience's perspective, using bullet points in a PPT presentation allows audience members to pay attention to key points (87%). Most students thought that PPT supports guided note-taking (83%) and the provision of more focused lecture presentations (78%). Focus-group interviewees explained these ideas as follows: PPT bullet points provide a reference point which can be expanded on, slides are visually easy to follow and save writing time, embedded multimedia resources can be an appealing and meaningful prompt for learning; presentations are easily customisable; and all material is self-contained within a PPT file—making it easy to access and revisit. Three representative student quotes illustrate these ideas:

[2] All student comments are reproduced as written in the responses to the survey.

> [PPT is] Useful as it shows bullet points of info worth noting down in a lecture.
>
> It's [PPT bullet points] quite helpful during lectures as it stops the lecturer going off topic and makes note taking easier.
>
> [PPT] Can clearly convey relevant information. Can easily be shared and accessed. Is not too flashy as to distract from relevant information. World standard.

The survey included items based on the limitations of PPT derived from the literature. These included: the brevity of information on each slide (68%), PPT files not containing enough detail for students to understand a lecture (65%) and a tendency for presenters to move too quickly through presentations (63%). The focus-group data also highlighted frustrations with PPT layout or templates used repetitively; PPT used as a 'fixed script' for a lecture; text-laden slides presented too quickly for their content to be processed; and inappropriate visuals. Four representative student quotes expand on these ideas:

> [Slides in PPT don't] make good notes, not detailed enough and sometimes can be disjointed in lectures.
>
> Also lack of a bigger picture sometimes, as they [slides in PPT] just flow from one idea to the next, without acknowledgment of any form of a hierarchy or directory.
>
> Too many word on slides makes it hard to read or take in. [A lecturer] … can flick through too fast, harder to take notes
>
> "Death by powerpoint" EVERYONE uses it, and it's very similar. Not 3D or exciting. Microsoft is capable of more like the "metro" design. They should remake PPT to be exciting.

Student assumptions and experience with PowerPoint-based lectures

When asked about their assumptions and the role of PPT notes in their learning, students in the focus-group interviews reported that they expected their lecturer to use PPT notes and to make these handouts available to them. Having access to the PPT notes reassures students that they are not missing out on their learning of coursework. They also perceive their lecturers to be wasting time if they are writing on the board instead of giving PPT lectures. Three different student quotes unpacked these themes:

> …say in your first year all your subjects are PPT, and in your second year there's one subject that does partial PPTs and then the rest doesn't [use PPT] you might not take the stuff that's written up on the board [per se] or just said aloud seriously, you might not take notes and you might forget about it and it may be important stuff that is simply not put on that PPT slide.
>
> The PPT slides are the best point of reference for what you're doing…As much as you need the talking, you need the PPT slides. Especially putting them up on Moodle, that's my first point of study is looking at what was going on and then finding out more if I didn't understand it.
>
> You take a look at bullet point [on the PPT slides in the lectures], we don't have to write down because we can get it in Moodle. I write down what [the lecturer] says and then it gives you a really good starting point so if you don't entirely understand you have something to move forward on. For me that's really helpful.

Very few students discussed how PPT shaped their disciplinary knowledge, but four focus-group participants alluded to this possibility by explaining that learning through PPT lecture notes is

like learning via 'factoids', and complained of a wider decomposing of information. This was encapsulated in the following representative student quote:

> In PPT, you see a lot of factoids put on the screen rather than actual information. One of the things I noticed the other students were saying that they liked the bullet points. Society as a whole seemed to be heading towards factoid based learning rather than actual learning…But from what I have seen the flip side to that is that people only look at the bullet points and not pushing their own researching it further, looking into it deeper. Because there is not enough information in the bullet points to know everything you need to know about that point. Its really really helpful as a starting point but its not even close enough.

This quote conveyed a common student (mis)assumption that the PPT bullet points in (and on their own) adequately reflect the extent of the knowledge presented in a lecture. Some students believe that little work is needed to extend them further.

Student use of PowerPoint notes for revision, and strategies for extending their notes

A majority of students reported using PPT notes when revising for their course (77%), while another 56% of these students reported doing extra study to add to their PPT notes so they could better understand the lecture content. These students supplemented the PPTs by making their own notes (61%), attending the lecture lab or tutorials (61%), or reading the course textbook (60%). A representative student quote alluded to these ideas:

> It's also good to learn from a PPT slide because you can […] once again if the lectures slides are up you can have the lecture slides, you can have the notes on what they're saying…you can write what you're hearing as well, so then everything's all together, in one document, done. Then you can just go back to that one document instead of flicking through several pages of your books then getting the lecture slides

Student perceptions of lecturer practices in PowerPoint-supported lectures

When asked their views on lecturers' best practices when using PPT in lectures, students raised key ideas which included: lecturer ability to combine their PPT lectures with practical demonstrations to help students make real-life connections in their learning; ensuring slide layouts are simple and clear; structuring information and ideas into meaningful chunks and sequential order; using additional and creative resources to supplement bullet points (video, audio, images, photographs, diagrams); and using non-verbal cues and gestures to cue ideas, images, and bullet points. Three student quotes illustrate these ideas:

> One of my lecturers also when she's talking about something, she'll have an exercise and then on PPT she can just type in and write up the stuff she's doing and show us how she's doing it as well.

> The combination of it all sort of works together. There was good flow, it was quite easy to read. It seemed nicely laid out. Good use of font.

> It [lecturer body language, gestures, voice tone/pitch]…definitely helps you connect the information to what you can see that it's important but at the same time if you're using something like [Panopto] where it's just the screen, the intonation of the voice is really important, in some ways more than the gestures to fit with the Power Point.

On the other hand, students reported lecturers' worst practices for PPT use to be: visual pollution; reading from or talking through slides without engaging students; having inappropriately sized text which is difficult to read; and skipping through slides so quickly that students are unable to follow the ideas. Four different representative student quotes point to these findings:

> …big impact font and default word art that detracts from the point completely because it's just so colourful and stupid.
>
> Reading the slides [won't be] much of a help if the lecturer wasn't talking [and explaining] at the same time. So you can't just put the slides on and read it.
>
> And the slides are there, and we did do a couple of equations and there is a lot of information in there, but that's information overload. Like, you can't take all that in, it's just too much.
>
> Some people mustn't [have] looked at what they are presenting on a big screen because some things if you are sitting at the back of the class you can't read on the screen.

Student judgements concerning lecturer use of PPT in lectures allude to the need for lecturers to be cognisant of the way they design their slides to convey ideas (presentation of ideas) and the way they talk about and expand on those ideas in the slides (performing to unpack ideas) to teach and communicate their disciplinary knowledge. In general, these findings indicate that students think they have a good level of experience and expertise with PPT use—such that they are in a position to judge lecturers' practices in PPT-supported lecturers. That is, they can make assumptions about which slide design and presentation techniques are considered to be the most appropriate practices for teaching and learning in tertiary settings.

Discussion and conclusion

Student tertiary learning experiences are clearly embedded within software infrastructures, platforms and applications. Because they have easy access to hardware, students can draw on this software to meet their learning needs. Students were generally confident and comfortable in engaging with new technologies, and reported being confident and competent in undertaking more active and independent (even informal) actions when learning new software (including MS PPT). Others have found similar evidence of student agency and independent learning through informal approaches facilitated by digital technologies and social media (Furlong & Davies, 2012).

The ideas raised in the literature indicate that lecturers and students are generally aware of PPT, have the basic skills to use the application, and are able to troubleshoot and refine their practice over time to serve teaching and learning goals. These findings confirm the existence of the first two levels of our software literacy framework. However, despite an awareness of the affordances of PPT, it appears users still lack the ability to critique software or to give considered thought to how it shapes and communicates disciplinary knowledge (the third level of our framework). Students in our study reported a range of expertise in using PPT and could identify key affordances and constraints relevant to their learning. They passed judgement on teacher practices that were useful (or not) in PPT-based lectures, and highlighted the need for teachers to consider and draw from a range of appropriate presentation techniques such as the need for structure in PPT slides and the value of multimodal resources. They also identified performance techniques (such as the way lecturers talk, gesture, and move) as helping them to focus on, and make meaningful connections between, the information on the PPT slides and important ideas within a discipline. Such practices have been identified as useful in previous research (Pozzer-Ardenghi & Roth, 2007). Overall, the findings thus far highlight student understanding and experience at the first two levels of our software literacy framework—students consider they have the basic skills and are able to troubleshoot and suggest solutions to problematic situations.

Additionally, the students in our study generally expected that PPT would be used in their lectures and that they would have access to PPT handouts—echoing findings from other studies (Clark, 2008). Just over half of students purported to make the effort to extend on their PPT handouts. As in Gier and Kreiner (2009), there was common student (mis)assumption that

studying solely from the PPT handouts would suffice. There was a lack of awareness and understanding of how commonly available software (such as PPT) shapes and constrains the way disciplinary knowledge is presented and communicated. This worrying observation confirms a relative lack of student critique at the third level of our software literacy framework.

Implications

We now propose some implications for practice as a result of our findings.

Firstly, if students are operating with relatively uncritical understanding of software (including PPT), lecturers need to be aware of this and work to challenge their students through their teaching practice. Lecturers themselves therefore need to be more critically literate about software, and should consider more carefully how they use software to communicate disciplinary knowledge. There are clear benefits to be derived from moving beyond default affordances of PPT (bullet points, linear lecture structures, ambiguous hierarchy of concepts and so on), and paying close attention to both the presentation and performance of PPT slides by, for example, augmenting slide content with discussion, prompts for interaction, and reinforcing a hierarchy of key concepts. These findings can inform tertiary staff development sessions so that the lecturer's attention can be directed to the role played by software such as PPT in shaping and framing what and how they teach, and how their students learn.

Secondly, there is a case to be made for students to be encouraged to move beyond a reliance on PPT content for study, and to consider the role it plays in shaping the ways disciplinary knowledge is communicated and performed in tertiary learning contexts. We consider software literacy at the third level to be fundamental to effective participation in an increasingly software-saturated culture and society. Consequently, we favour a more formal acknowledgement of (and focus on) lecturer and student software literacy by tertiary institutions.

The second phase of our project will focus on teaching and learning contexts with disciplinary-specific software learning in Media Studies (e.g., Adobe Photoshop, Final Cut Pro), and Engineering (SolidWorks) to explore the effect of more direct instruction on student software literacy development and disciplinary understanding.

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