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Students’ voices about information and communication technology in upper secondary schools

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Abstract
Purpose – The purpose of this paper is to explore upper secondary school students’ voices on how information and communication technology (ICT) could structure and support their everyday activities and time at school.
Design/methodology/approach – In all, 11 group interviews were conducted with a total of 46 students from three upper secondary schools. NVivo PRO 11 was used for a qualitative content analysis.
Findings – The results show that ICT plays a central role in the students’ schooling, not in terms of “state-of-the-art” technology, but rather as “state-of-the-actual”, by for example supporting the writing process and for peer support, digital documentation and storage.
Research limitations/implications – A relatively small number of students in three schools and three specific programmes make generalisations difficult.
Social implications – The study could lead to a better understanding of students’ expectations and use of ICT at school and in everyday life.
Originality/value – The originality of this paper is the focus on students’ voices about how the basic use and functionality of ICT could structure and support their everyday activities at school.

Keywords Teaching, Students, Upper secondary school, Use of ICT, Student voices

Introduction
Information and communication technology (ICT) is said to play a central role in several K-12 school-related activities, from school leader management and administration to teaching and learning in the classroom (Selwyn, 2011). In the ongoing digitalisation of schools, students can use their own digital devices (BYOD) (Song, 2014) in learning activities during their time at school. Research reports that in many western schools students use ICT devices such as laptops and digital tablets on a regularly basis (Jähnke et al., 2017; Håkansson Lindqvist, 2015) and that the digitalisation of education has meant that more outcome is expected from ICT in teaching and learning activities (Wastiau et al., 2013).

Digitalisation has also resulted in a number of challenges (Olofsson et al., 2017; Tondeur et al., 2016). Due to digitalisation, there is an increased pressure on schools and teachers to integrate ICT in teaching and learning activities, even though this may be at odds with their own knowledge, beliefs and doubts about their potential (Howard, 2013). Other concerns are how schools respond to a situation in which students have instant access to their own ICT devices at school (Selwyn and Bulfin, 2015) and how schools deal with students using ICT...

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for academic and non-academic purposes at school (Salomon and Ben-David Kolikant, 2016). However, a major concern in the digitalisation of schools is how to keep abreast of the ongoing technological developments and the options that new digital tools, applications, services and communities make possible (Siddiq, 2016). This paper aims to explore the digitalisation of schools from a student perspective. More specifically, the focus is on students’ voices about how ICT contributes to the structuring and support of their everyday activities and time at school.

Research on students’ use of ICT at school
The increased interest in both research and practice in students’ use of ICT at schools (Lindberg et al., 2017) can be related to the one-to-one (1:1) movement that has taken place in western schools (Håkansson Lindqvist, 2015). Here, Harper and Milman (2016) suggest that two factors in this increased interest are related to ongoing digital developments and investments in new ICT tools for teaching and learning. Further, and as pointed out by, for example, Pettersson (2017), the digitalisation of schools and the 1:1 movement have nurtured research on the question of students’ possibilities to develop their digital competence in use of various ICT tools for activities inside and outside school.

Research on digitalised schools also reports on students’ different uses of specific ICT tools for different purposes. In addition to laptops, three tools that are of interest in this paper, and that are often targeted in research on 1:1 schools, are: smartphones, which are increasingly focussed on in research and questioned as a learning tool (Liu et al., 2014); digital tablets, described as flexible and multimodal ICT tools for students’ learning (Peluso, 2012) and the learning management system (LMS), which has played an important role in school over the last 20 years (Ros et al., 2014). These three tools are accounted for below.

In research on smartphones, the results either seem to point in different directions or to be ambiguous. For example, Philip and Garcia (2015) indicate that the use of smartphones in school has a positive impact on students’ learning. Beland and Murphy (2016) show that the banning of smartphones in schools in four English cities has positively affected students’ examination results at the end of nine-years of compulsory schooling. Students attending schools in which smartphones are banned experience higher academic results after the ban than before it, with the lowest achieving students improving the most. However, Ott et al. (2017) argue that rather than prohibiting mobile phones, pedagogical integration in support of learning should be at the heart of any discussion between teachers, students and parents.

In research it has been claimed that the use of digital tablets prepares students for life and work in the twenty-first century (Clarke et al., 2013) and that tablets have positive impact on students’ motivation for learning (Ciampa, 2014) and the development of oral, written and graphical communication (Bagdasarov et al., 2017). On the more challenging side, students’ misuse of tablets at home and at school (Blikstad-Balas and Davies, 2017) can also be mentioned. In this context, Ditzler et al. (2016) conclude that “How the teachers used the device was indicative of how the students would use it. For example, in one math class the teacher only used the device to upload and view homework assignments, and the students in the class did the same” (p. 185).

Ros et al. (2014) claim that LMS facilitates communication and collaboration, for example, between teachers and parents or between students. Similarly, Yildirim et al. (2014) put forth that LMS can support collaboration both inside and outside school, be customised by users and be used via smartphone apps. However, Cerezo et al. (2016) point out that the use of “LMS requires more effort by the student when deciding what, how, and how much to learn; how much time to invest; when to abandon and change learning strategies; when to increase effort; and so on” (p. 42). In turn, Garcia-Petralvo and Alier Forment (2014) argue that it is important for institutional LMS to co-exist with, be compatible with and enrich all the other ICT tools that are used by students in the learning context.
Acknowledging the research reported above, this paper attempts to answer the question formulated by Selwyn (2010): “What is the use of technology in educational settings actually like?” (p. 70). Selwyn specifically emphasises that research should be encouraged to focus more on “state-of-the-actual” rather than “state-of-the-art” technology. One example of such a focus can be found in Bulfin et al. (2016) and their study of the various ways in which Australian secondary school students use ICT. They highlight that even if schools respond optimistically to the ongoing digitalisation, they “continue to regulate student behaviour, not least in terms of what students are expected to do, and when and where they are expected to do it” (p. 240). These same scholars further distinguish between the notions of “school as a location/setting for digital technology use” (p. 2) and “school as a purpose for digital use” (p. 2). The former refers to how the use of technology is facilitated by institutional infrastructures, school rules and regulations, whereas the latter refers to how ICT is used for “the logistics of managing one’s studies or using technology to engage in learning” (p. 2). Bulfin and colleagues also report that due to various infrastructures and regulations, only certain types of ICT are used and that information retrieval (e.g. Google) and content creation (e.g. Word) are the commonest in-school ICT activities. The latter is in line with Mangen (2016), who argues that writing is now mainly performed using digital technology, rather than a pen and paper. Clarke and Svanaes (2012) report that an increased use of digital writing in school can contribute to greater student motivation and that, “For those who struggle with their handwriting, which can be a problem across different disabilities, typing notes and messages is often easier and less time consuming than writing by hand” (p. 60).

**Purpose and research questions**

The purpose of this paper is to explore upper secondary school students’ voices about ICT and how it can be used to structure and support their everyday learning activities and time at school. Based on research indicated above, the paper addresses two research questions:

**RQ1.** What do the students use ICT for in their daily practices?

**RQ2.** Which support structures regulate the students’ use of ICT?

**Methodology**

This study is part of a four-year research project exploring how ICT is used in upper secondary schools in Sweden. The three schools included in the study have been recognised for their advanced use of ICT. Two of the schools are campus-based (A and B), whereas the third (C) has a mixture of on-site and distance teaching. When the data was collected in November 2015, schools A and B had just introduced a new LMS system.

The data consist of semi-structured focus group interviews. A total of 11 group interviews with 46 students from the first and third year were carried out, during which a moderator used open-ended or specific questions to facilitate and deepen the conversation. In six of the groups, the students followed theoretical programmes such as the Technology Programme (TE) or the Natural Science Programme (NA), and in five of the groups the vocational Electricity and Energy Programme (EE) was followed. There were between three and six students in each group and the interviews lasted between 30 and 60 minutes. The interviews were transcribed verbatim prior to being analysed.

The content analysis using NVivo (Pro 11) included meaning condensation (Kvale, 2008) and consisted of several steps. The first step of meaning condensation resulted in 22 broad categories of the complete set of data. In the next step, these text-based categories were transferred to a Word document consisting of 242 pages. The document was read several times in order to: identify whether some of the categories were too broad or outside the scope of the study and could therefore be removed and determine whether some categories were
similar in focus and content and could instead be grouped together in one category. This process resulted in 17 categories in a 64-page Word document. In the fourth step, the document was repeatedly read in order to further condense the meaning of the data. This resulted in 12 categories in a 15-page Word document. The two main themes and six sub-themes presented below were constructed from these 12 categories. In each theme, certain aspects emerged in the analysis that was qualitatively separate from other aspects. This implied that a number of students shared the same view of how ICT was used. Exactly how many students shared the same view is of less importance (Altheide and Johnson, 2011), in that views reflect qualities, rather than frequencies.

Results
In this section the results are presented in a thematic and qualitative manner. The students’ quotes are marked to show to which school they belong (A, B or C) and the year of study (1 or 3). For instance (B1) means a student from school B in year 1.

Theme 1: how and when should ICT be used at school?
This first main theme is concerned with how the students’ address aspects of their use of ICT related to time, space and specific ICT tools in their learning activities. Four sub-themes are part of theme 1.

Sub-theme 1: variations in the students’ use of ICT. There were some variations in the students’ voices about the frequency of use of ICT. For example, one group of students attending a theoretical programme at school C, described ICT as being used intensively on a daily basis: “If you don’t bring the laptop you won’t be able to do anything because you won’t get tasks on paper” (C1). In contrast, a group of students in a vocational programme (B3) estimated the time of ICT use to between three and four hours per week. However, the majority of the students in the 11 groups said that they used ICT at school at least four out of five days a week. According to the students, the use of ICT was either decided on by the subject teacher or themselves. However, some students stressed that their teachers ought to decide when to use ICT: “…you actually have to trust the teacher’s judgement. I mean they were also students once” (B1). Several students were confused about when ICT could or could not be used at school and experienced the way their teachers talked about ICT as paradoxical: “…well I [the teacher] am rather old-fashioned so I want you to take notes using pen and paper[…] but they [the teachers] anyway always tell us to bring the laptop as often as possible” (B1).

Sub-theme 2: ICT – making storage and text production easier. The students at all three schools said that ICT supported the ongoing documentation of their school work: “[…] you have all your stuff in one place, you can search for things. Everything is so easy. I especially appreciate the easiness” (B3), or “[I] can create folders [in Google Drive] and know for sure where they are” (C1). The students also said that the laptop helped them to take structured notes: “[Y]our notes aren’t a mess even if you are stressed. If you’re stressed and take notes using pen and paper you can’t always read what you’ve written” (B1). Some students pointed out that the laptop enabled them to move text sections around easily and reformulate sentences in their documents and that digital written texts were of a higher quality and could be completed in less time than they would be with pen and paper: “[I] mean, we can write so much faster on the computer. Basically our fingers fly over the keyboard” (A1) and “[I] often change a lot in the [text] structure. You can’t [using pen and paper] move a section in the same way, which means that you need to think in a different way than you’re used to. That takes a lot of time” (A3). Another aspect of how ICT supported students’ communicative work was: “[…] when giving oral presentations it’s much easier to have your notes in your smartphone” (B3). Some students said that teachers
should only use digital assignments, both with regard to digital editing and for physical comfort: “[…] writing 27 pages make your hand ache a lot” (C1).

**Sub-theme 3: peer support through ICT.** Several of the groups revealed an understanding of ICT as a functional tool for peer support in school-related activities and in particular mentioned Dropbox, Facetime, Google Drive, Snapchat and Facebook – but not the local LMS. Peer support ranged from sharing information about subject-related assignments, to providing each other with peer review comments on writing assignments. The tools used were mostly those provided by their schools. It can be noted that regarding parallel ICT tools, the students referred to power, in the sense that they, not the teachers, could decide who should have access and which information should be posted “[If we invite the teachers so they can see and read, it often only includes the presentation. First you write down everything [in Google Drive] so that your classmates can take part in a discussion, and after that we do the presentation” (A3).

One of the groups described a Facebook page that was reserved for members of their class. This page was used to share information to support their school work “[…] when you are ill and at home there is always the possibility to post a question [on Facebook] about for example whether we have received any homework or whether I’ve forgotten something to do with school. That’s really great!” (B1). Another peer support activity was students sending text messages to support a classmate who was either ill at home or in the same classroom, but who did not know how to solve an assignment. Another example was mentioned by a student at school C, who by using the smartphone received support from her father geographically located elsewhere in Sweden: “[I] text a mathematical problem for him to solve. He then texts the solution to me and calls me to explain what he did [how he solved the problem] and how he got that answer” (C1).

**Sub-theme 4: in-school use of smartphones.** In many of the groups, the discussions during the interviews revolved around not being allowed to use smartphones in class: “[The teachers think that you use it [the smartphone] for checking out social media […] you should show [the teacher] what you are searching for” (A3). According to the students, the teachers found it difficult to judge whether smartphones should be used for learning purposes or not: “[It is easier for them [the teachers] to check whether the laptop is being used than the smartphone” (B3). Several of the students saw the use of smartphones in the classroom as a potential distraction and a disturbing element. The importance of student responsibility was expressed in several of the groups: “[I] feel that if you pick up the smartphone you’ll risk missing the lecture, but that’s your own fault. It’s your problem. You have to take more responsibility” (B1). One group posed the rhetorical question: “[…] perhaps they [the smartphones] could be part of the teaching, so you can focus on the right things?” (C1).

Despite voices about smartphones being regarded as a distraction and students seldom being asked by their teachers to actively use them for learning purposes, there were some exceptions: “[Name of the teacher] lets us use it [the smartphone] as a dictionary, for listening to music, for checking out things we want to know more about or understanding in order to make learning easier” (A1). Some students also described the advantages of using smartphones in class: “Maybe you have a test that day or something needs to be handed in. If you have taken a photo and by accident display it [the photo] on the smartphone, you just think ‘now I remember’ [we have a test today]” (B1). Other advantages were that smartphones could be used as calculators and for speed Googling to avoid starting up the laptop. The smartphone was also easier to carry than a laptop. Another argument for in-school use of the smartphone was: “[If I want to check something here and now it’s very convenient. It’s great for retrieving information” (C3).

Regarding the usability of technologies like the laptop, tablet and smartphone, the students seemed to prefer laptops to smartphones and tablets: “Personally I think that the laptop is far better than the smartphone. It has a much more powerful hardware which
makes things so much faster and it’s also easier to write on it [the laptop]. The space for writing is very small on a smartphone” (A1). In fact, tablets were only mentioned in passing in two of the groups and then in terms of them being used in the students’ homes for leisure.

Theme 2: regulatory aspects in the students’ use of ICT
The second main theme concerns students’ talk about how the support structures in school make some activities possible but hinder others. From a student point of view, the regulatory aspects both enable and challenge in their everyday life at school. Two sub-themes are part of theme 2.

Sub-theme 1: user-contracts and technical support. A student laptop user-contract had to be signed at all three schools. According to the students, the school leaders, teachers and IT technicians had the right to control the students’ laptops if there was any suspicion of irresponsible behaviour. Several students regarded the contracts as reasonable: “[I] can’t say that this is wrong. It’s a school laptop and should be used for that purpose and not for a lot of other things” (A1). However, many students also expressed uncertainty about the regulations in terms or whether they were used in practice, or were simply a rhetorical trick: “[I] think they are pretty cool about this [downloading], but yes it might prevent students from doing it if the school first issues a warning and if it happens again take the laptop away” (A1). Despite this, it was apparent that the students did not want their laptops to be impounded, mainly because they were important for their school work and confiscation would adversely affect their studies. It can further be noted that some students also wanted to use their school laptops for private means, so that both school and non-school-related material was on one single digital device: “[A] lot of people do that. Using it [the laptop] both as a private and work computer is common in many workplaces” (A1).

Different voices about the in-school ICT support were present in all the groups. Overall, the students seemed to be relatively pleased with the support they received. However, one frequently mentioned aspect was the limited opening hours of the ICT support centres, which potentially conflicted with students’ lesson times. Further, the turnaround time for the repair of a laptop by the local ICT support centre could range from one day to two or three weeks. At school C, the students were concerned that “only having one IT technician at the school is vulnerable” (C1). Other students at school C said that the internet connection was not always stable and that they had experienced problems with lessons not running smoothly as a result: “[…] it was on a Monday. All the students are in school that day, sitting with their laptops. It [the connection] didn’t work, there were too many of us [connected to the internet at the same time]” (C3). Students at this school were also grateful that the maths teacher made sure that the ICT infrastructure worked well for the distance-based lessons: “[…] even though he has his own class [of students], he always pops in to make sure that everything’s OK” (C3).

It can also be noted that the students at all three schools seldom talked about support in terms of more structured introductions of digital software, such as Microsoft® Office or the local LMS, although there were some exceptions. At school C, students said that in year 1 they were introduced to “Class Live [a synchronous ICT tool] and taught how to use Fronter [the local LMS] and LMS for online communicative purposes when studying at a distance”.

Sub-theme 2: the LMS – the good and the bad. Students’ voices about the local LMS were concerned with both possibilities and hindrances in relation to the teachers’ and their own use of the system. Many students said that most teachers used the local LMS to some extent and that a mobile app for the LMS would probably result in more active use. The teachers’ use of LMS was mainly related to activities such as distributing and collecting assignments, posting student grades and disseminating information and learning materials.

According to the students, many teachers were dissatisfied with the design and functionality of LMS: “[I] haven’t met a single teacher who actually likes it [the local LMS]” (B1). The limited use of LMS by the teachers was related to the age of the individual, their
own interest in using LMS, or their low levels of digital competence: “[T]oo often you hear expressions like ‘I’m not confident in using ICT, I can’t use it’. They [the teachers] have to learn, that’s the reason why it’s like it is when it comes to the present use of XXX [LMS at school B]. There are lots of possible functions in the system, but we only use one of them because that’s the only specific function they [the teachers] know how to use” (B3).

In many of the groups the students seemed to be dependent on their teachers’ consistent use of the LMS. If this was not consistent, the students could miss school assignments and as a result fall behind in their school work. For example, a student in school C said that: “[…] if we’re out on a training camp, we’re not physically able to go and see the teacher” (C1). The teachers’ use of LMS also seemed to reflect how frequently the students logged into LMS: “[…] if you know that work is to be done or has been uploaded [to the LMS] you log in. You don’t log in on the off chance to check for new information” (A1). Many of the students related an inconsistent use to the implementation of a new LMS system: “[I]t [XXX, the former LMS] was easier to use than YYY [the current LMS] and above all our teachers knew that system really well. Now the teachers hardly know how to use YYY, it has become more difficult to access the things you need. In my experience, since we switched learning platform things have got worse” (B3).

The students at all three schools mainly used LMS to submit assignments and download new tasks. However, the LMS was also regarded as an important hub for supporting and structuring their school work: “[I]t’s so much easier. You don’t need to keep track of a lot of paper […] you can access [the LMS] at home. If you are ill you can still do your [school] work” (A1).

A new LMS system had recently been introduced at two of the schools and there were different voices among the students about this. On the positive side, the students regarded some of the teachers as supportive and able to demonstrate the basics of the new system, such as how to report sick leave and absence from school. However, according to several students, texting a classmate and asking her or him to tell the teacher was the easiest way of reporting. Many students regarded the new LMS as user-unfriendly, that it contained unnecessary levels: “[…] just to submit work to the teacher you have like click ten times. It would’ve been so much easier to choose from a dropdown list or search [in the LMS] […] it takes like ten minutes [to send a message in the LMS]” (B1), or was outdated: “[T]he LMS is not up-to-date enough. It [the LMS] expects that we log into the system using our laptops. It would’ve been much smarter to use an app” (A1).

Discussion
When it comes to what the students use ICT for in their daily practices (RQ1), it would seem that ICT is used more or less on a daily basis and that students are expected to bring their laptops with them to class, even though some of the teachers never actually make use of them in their teaching. Ambivalent signals like these could help to generate opportunities for a more structured and efficient use of ICT at school. It could also be argued that if students always brought their laptops to class, teachers would have richer opportunities to use them to re-plan, improvise or capture teachable moments.

Students indicate that ICT is used for ongoing digital documentation and regard both Google Drive and the laptop hard drive as easily accessible containers for storage and for searching for material in order to solve a school assignment (cf. Bulfin et al., 2016). Furthermore, ICT is mentioned as a tool that supports oral presentations and the taking of structured notes during lectures. Another advantage in relation to digital text production is that text processing programs such as Word seem to provide students with rich possibilities to edit, structure and re-structure their texts. In general, written assignments are of a higher quality and completed in less time than they would have been using pen and paper (cf. Clarke and Svanaes, 2012; Mangen, 2016). Furthermore, in many of the groups, different tools for peer support and the sharing of information are regarded as central, such as
Dropbox, Google Drive and Facebook (Bulfin et al., 2016). Interestingly, ICT tools and resources are not always provided by the schools, but are instead selected and used by the students. Of importance here is that the students, rather than their teachers, decide how the tools are used and who has access to the peer support communities that are established. Regarding specific ICT tools, it can be noted that besides laptops, students often talk about the in-school use of smartphones and the local LMS. Digital tablets are only briefly touched upon. With regard to smartphones, in several of the groups the students say that they are not allowed to use smartphones in class, sometimes for reasons that are not clear. Teachers are also described as being unsure about whether or not smartphones can be used for learning purposes, and that the easiest solution is to ban their use in class. The smartphone is also talked about as a distraction, but if used responsibly as a tool for learning. According to the students, the smartphone is instantly available, can help them to remember assignment deadlines and be used as a calculator. Furthermore, smartphones can be functional tools for peer support, both at school in class and outside for school-related issues. In research, the question of students’ use of smartphones has been reported as both negative (Beland and Murphy, 2016) and positive (Philip and Garcia, 2015). The findings in this study also indicate positive and negative aspects.

Turning to which support structures regulate the students’ use of ICT (RQ2), two identified issues are technical support and structural support via the schools LMS. Overall, the students in the three schools seem to be satisfied with the support and accept the need to sign a student laptop user-contract. However, given the important role that laptops appear to play in the students’ everyday lives at school, a turnaround time of up to three weeks for support if the laptop crashes, as indicated by some students, is likely to hinder their school work.

The local LMS is used by the schools as a tool to facilitate the organisation, administration and structuring of the students’ learning, but is also described by the students as being of inferior standard and sparsely used by some of the teachers. Notably, at two of the schools the LMS system had recently been replaced, which could explain why the students regarded it as under-used. However, at the same time, LMS is referred to as a highly important hub for supporting and structuring students’ schooling (cf. Yildirim et al., 2014). Students download and upload their assignments and collect information via the LMS, e.g. to find out whether a lesson has been cancelled. In many of the groups, the students talk about the importance of teachers using LMS consistently. For example, if students are unable to attend school, they can still access their assignments and thereby reduce the risk of falling behind in their school work (cf. García-Peñalvo and Alier Forment, 2014).

Limitations
One limitation is that only students from three schools and three study programmes were involved. Another limitation is that schools A and B had only just introduced a new LMS, which could mean that the focus on LMS issues was over-emphasised by the students from these schools. Further, the fact that two of the schools were campus-based (A and B) and the third (C) had a mix of campus and distance teaching may have led to biased data.

Conclusions and future research
According to the students, the schools need to be more precise and effective in the use of ICT to structure and support their everyday activities and time at upper secondary school, e.g. by using ICT for writing, documentation, storage and peer support. One conclusion is the importance of consistency in the teachers’ use of ICT, especially the LMS and clarity about when laptops can be used in class. A further conclusion is students’ appreciation of prompt ICT support and a responsible in-school use of smartphones. Another conclusion is that in order to learn more about “school as a purpose for digital use” (Bulfin et al., 2016), research on the use of ICT in K-12 schools could benefit from an increased focus on “state-of-the-actual” rather than “state-of-the-art” technology (Selwyn, 2010). Considering that, future research could, for example, continue to
investigate: students’ use of school-based ICT and ICT that they themselves choose, students’ perceptions of how ICT helps them to work better, smarter and get better grades, how different kinds of school regulations impact students’ use of smartphones, teachers’ understanding of students’ perspectives on the use of ICT for everyday activities in school.

References


Further reading

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A comprehensive rubric for instructional design in e-learning

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Abstract
Purpose – The recognition of practice in online instruction is still subject to interpretation and different approaches as a result of the rapid changes in technology and its effect on society. The purpose of this paper is to address these differences through a synthesis that can be easily accessed and consulted by educators in the field of e-learning.

Design/methodology/approach – This paper reviews different examples of rubrics and instruments in higher education to propose a more comprehensive rubric that constitutes a synthesis of how some institutions in HE approach best practice in this field.

Findings – The proposed comprehensive rubric emanating from the synthesis of different approaches supports the development, remixing, sharing and integration of online modules and courses by providing a single reference point with as wide a range as possible of potential pedagogical tools, facilities and approaches to e-learning.

Research limitations/implications – It is not within the scope of this paper to review quality assurance processes and administrative components, but to propose a rubric for course design and self-review of faculty and higher education institutions for a better alignment with what is regarded as current standard best practice.

Practical implications – Instructional designers in e-learning have a new comprehensive rubric that can consult at design stage.

Originality/value – Different approaches towards what is called “good practice” are brought together and analysed to provide a synthesis and a single source that can be consulted by practitioners in the field of e-learning.

Keywords E-learning instructional design, E-learning peer review, E-learning quality standards, E-learning self-review

Paper type Research paper

Literature review: slightly different paths for e-learning

By the year 2002, the fusion between in-class instruction and online instruction was already being recognised as a major new trend; old practices were being transferred online, and different institutions had rather different understandings of the concept of e-learning (Frydenberg, 2002; Graham et al., 2013; Young, 2002). As late as 2011, Guri-Rosenblit and Gros (2011) concluded there were “noticeable gaps” in e-learning research and definition of terminology. One of the reasons for this lack of coherence is:

The technological environment within which modern education operates is becoming increasingly complex, offering new possibilities but also giving rise to challenges. We have seen a continual evolution of technologies and how they are used since the introduction of the Internet (Conole and Alevizou, 2010, p. 9).

De Freitas and Conole (2010) observed the trend of more global, more networked and more mobile technology infrastructure and these are emerging in online pedagogy. Indeed, McLaughlin and Lee (2010) argued that this new landscape:

Calls for the active involvement of students in defining their learning goals and choosing both ICT tools and strategies for learning; it also requires recognition that user and learner generated content has a central place in a curriculum that fosters self-regulated learning (p. 38).
Learning in the digital age thus requires a re-thinking of teaching and learning and not just replicating existing practices with new technology (Beetham and Sharpe, 2013).

While in the early years of public internet the emphasis was on the technical foundations of e-learning, the pedagogical implications started shifting direction from managing the logistics of e-learning to managing the content (Govindasamy, 2002). An “interactive and constructive potential of e-learning” was being recognised, one which contrasts with the traditional sage on the stage approach of information transfer. However, it had to prove it was more than just a more convenient way to access content (Garrison and Anderson, 2011, p. 54).

The focus of course design and pedagogy has shifted from teaching to learning, with teachers also becoming learners in the process of professional development and engagement with their students. Rather than transferring the passive teacher-centred form of learning to the online domain, a constructivist approach would make the experience learner centred, where active learning and engagement takes place (Rovai, 2004). The emphasis in higher education has shifted from the delivery of instruction to the production of learning (Barr and Tagg, 1995).

Far from simply providing a more comfortable channel to access instructional content, Nagel and Kotzé (2010) found, “When students engage in online activities and take responsibility for the quality of interaction, they can have a superior learning experience” (p. 218). ICT can indeed be successfully applied to enhance the educational process, especially in making learners active participants (Tomte and Sutherland Olsen, 2014). On the other hand, the digital literacy of academic staff remains a challenge (Johnson et al., 2015), with many feeling the pressure of 24/7 online connectivity in the age of social media (Grove, 2017).

E-learning faces issues of suspicion (Casey, 2008) and quality (Jung and Latchem, 2012) when compared to traditional instruction. However, a meta-analysis by Means et al. (2013) on behalf of the US Department of Education reveals a significant increase in performance for blended learning but not for pure online learning. This confirmed earlier conclusions by Pankin et al. (2012).

In their literature review on the use of Web 2.0 technologies in HE, Conole and Alevizou (2010) observed a number of key challenges proposed when technology meets education, including the tensions around the nature of openness, and changes in the role of educators and students. HE in Europe seems to be responding positively to these rapid developments in e-learning, though the adoption of e-learning and MOOCs is gradual (Gaebel, 2015).

Empirical evidence is increasing in respect to online learning and new developments such as open educational resources (OER), mobile learning, software agents for online evaluation (Daradoumis et al., 2013), bring your own device, the flipped classroom, wearable technologies, adaptive learning technologies and the Internet of Things (Johnson et al., 2015). These have attracted the attention of researchers to an ever-higher degree in recent years. However, more research on OER and MOOCs is required (Bozkurt et al., 2015).

The NMC Horizon Report 2017 (HE Edition) refers to a medium-term trend of using digital tools to measure knowledge and skills acquisition in online learning environments, including collaboration and creativity (Adams Becker et al., 2017).

According to the Times Higher Education Teaching Survey 2017, half of academics and 68 per cent of administrators agree that students benefit from digitised content, but they evidence less enthusiasm for recording lectures and putting them online. The use of social media for instructor-student contact is still not widespread as many academics feel the pressure of constantly being in demand by students (Grove, 2017).

Crossbreeding between social network sites and e-learning is increasingly observable. Though Facebook is not a replacement for VLEs in education, the latter “could certainly
learn something from Facebook and the nature of its user created groups and networks, instant communications, alerts and like/sharing features” (Hogg, 2013, p. 35). These VLEs, such as MOODLE and Blackboard, had to introduce features similar to the increasingly popular social network sites (Ronan, 2015), while some social network sites such as LinkedIn are assuming educational roles (Hoffman, 2015). This development and the proliferation of MOOCs are some of the most interesting but controversial trends in higher education right now (Johnson et al., 2014). Early research shows that MOOCs are indeed contributing to online learning, though more empirical research is needed (Gamage et al., 2015; Glance et al., 2013).

An overview of four different rubrics

Measurement through rubrics

The measure of the success or failure of whether technology-driven education delivers the promised success can be determined through rubrics based on traditional principles, updated to cover the introduction of new technologies. In this manner, different instructional strategies can be devised to serve the different learning domains, including intellectual and cognitive strategies, attitudes, etc. (Fennisich, 2008, p. 310).

Graham et al. (2001) refer to the Seven Principles for Good Practice in Undergraduate Education published in 1987 as a popular framework for the evaluation of traditional classroom-based education, based on 50 years of research. These principles have been adapted for online education:

- Principle 1: good practice encourages student-faculty contact.
- Principle 2: good practice encourages cooperation among students.
- Principle 3: good practice encourages active learning.
- Principle 4: good practice gives prompt feedback.
- Principle 5: good practice emphasises time on task.
- Principle 6: good practice communicates high expectations.
- Principle 7: good practice respects diverse talents and ways of learning.

Established frameworks began to be adopted and adapted to e-learning. For example, the rubric provided by the Quality Online Course Initiative of the University of Illinois (2015) (www.ion.uillinois.edu/initiatives/qoci/index.asp) is based on six sections, each with specific criteria, that mirror the above-mentioned seven principles:

(1) Instructional design – Criteria: 1.1 Structure, 1.2 Learning Goals/Objectives/Outcomes, 1.3 Course Information, 1.4 Instructional Strategies, 1.5 Academic Integrity, 1.6 Use of Multimedia.

(2) Communication interaction and collaboration – Criteria: 2.1 Activities and Opportunities, 2.2 Organisation and Management, 2.3 Group Work.

(3) Student evaluation and assessment – Criteria: 3.1 Goals and Objectives, 3.2 Strategies, 3.3 Grades, 3.4 Feedback, 3.5 Management.

(4) Learner support and resources – Criteria: 4.1 Institutional/Programme Support and Resources, 4.2 Academic Support and Resources.

(5) Web design – Criteria: 5.1 Layout Design 5.2 Use of Multimedia, 5.3 Use of Images, 5.4 Links/Navigation, 5.5 Accessibility.

California State University provides a Quality Online Learning and Teaching instrument to measure the effectiveness and quality of online courses (Christie, 2014). The instrument can be used for both self-evaluation and peer evaluation. It consists of 58 objectives in ten sections:

- Section 1: course overview and introduction (eight objectives).
- Section 2: assessment of student learning (six objectives).
- Section 3: instructional materials and resources (six objectives).
- Section 4: students interaction and community (course design) (seven objectives).
- Section 5: facilitation and instruction (course delivery) (eight objectives).
- Section 6: technology for teaching and learning (five objectives).
- Section 7: learner support and resources (four objectives).
- Section 8: accessibility and universal design (seven objectives).
- Section 9: course summary and wrap-up (three objectives).
- Section 10: mobile design readiness (optional) (four objectives).

The University of Malta (2015) provides Minimum Standards for Study Units in the VLE with a shortlist of suggested elements that must be provided in face-to-face courses complemented by online study units (blended mode) to meet minimum standards. This “advisory” is provided by the IT Services at the University of Malta rather than a unit responsible for academic quality assurance or pedagogy. Indeed, quite significantly, these guidelines do not make any reference to pedagogy for e-learning.

The following are the elements listed in the advisory by the University of Malta (www.um.edu.mt/vle/staff/minimumstandards): study unit description, tutor profile on VLE, class announcements (provided by default in the VLE), general Q&A forum, communication statement (tutor-student communication protocol), course readings, other learning resources, and assessment outline (exemplars and use of anti-plagiarism software).

QualityMatters™ is a commercial product that provides course design rubrics for different levels in the education domain. One of them is specific to higher education and provides eight general standards that “work together to ensure students achieve desired learning outcomes” in online and blended learning (QualityMatters™, 2014, para 5). A score of 85 per cent qualifies a course to receive a QM certification for quality in course design.

The standards of QualityMatters™ (2014) are: course overview and introduction, learning objectives (competencies), assessment and measurement, instructional material, learner activities and learner interaction, course technology, learner support, accessibility and usability.

A synthesis of the rubrics to formulate the new comprehensive rubric

Synthesising a comprehensive rubric

The rubrics referenced in this document all have common criteria that cover the most basic elements that an online course should satisfy if it aspires to provide effective teaching and learning. These common standards are (in no particular order): instructional design, web design and technical access, communication between tutor/s and students, interactivity and community building, instructional resources with possible multimedia use, instructional support, assessment, and evaluation of the instruction with learner feedback (see Table I).
The four institutions under analysis all cover most – if not all – the criteria derived from the synthesis of their rubrics.

In terms of ratings, the California State University (2013) and QualityMatters™ (2014) provide their own rating scales. The former allows the adopter of the rubric to assign the same weighting range to all criteria (one to three points) according to the extent to which it is met or not, while the latter sets specific number of points (one, two or three) to be awarded to any individual standard when it is met (no points for partial or non-fulfilment). The QualityMatters™ rubric assigns the most points (three out of a maximum of three) to the statement of the learning objectives/competencies, assessment, the quality of instructional resources, tutor-learner interaction, learner support, and the ease of use of the technical platform where the virtual learning environment resides.
The comprehensive rubric

The synthesis of the four rubrics just referenced has produced the following comprehensive rubric that covers all the aspects mentioned by the four institutions. This comprehensive rubric is not a collation of the four rubrics but a synthesis of the separate approaches that—in the author’s view—reflects the context of e-learning as explained at the beginning of this paper. This rubric has not been tested in lab setting or a real-life scenario.

There are ten main standards, each containing specific standards. Ten main standards and specific standards are as follows:

1. Instructional design – an analysis of the learning needs and the use of appropriate strategies and methods to meet them:
   - Structure of learning.
   - Learning aims and objectives – what the instructor needs to achieve with the learning process.
   - Learning outcomes – what learners need to achieve to have successfully completed the learning process.
   - Instructional strategies and methods.

2. Course opening – welcoming learners:
   - Accessibility – the instructor gives clear instructions on how to access all elements of the online learning environment.
   - Role – the instructor gives clear information about his professional role in the learning environment.
   - Description – a course description with pre-requisites (if any), clear learning outcomes and what is expected of the learners is provided.
   - Behaviour – the learners are made aware of regulations, policies and ethics that govern the course.
   - Integrity – the instructor is aware of the academic integrity needed to facilitate learning.
   - Technical competences – the learners are made aware of the technical competences needed to successfully reach the learning outcomes.
   - Ownership – the instructor gives learners the opportunity to share their own learning goals.

3. Assessment of learning – determining what the learner has learnt and subsequent accreditation:
   - Goals and objectives – the learners are aware of what is expected of them when they are assessed.
   - Strategies – clear, well-defined and measurable assessment of learning outcomes suited to the level of the learners.
   - Grading – grades are given in a fair and transparent manner through appropriate assessment instruments sanctioned by the institution.
   - Feedback – both instructor and learners are given the opportunity to provide feedback related to grading.
   - Management – learners have access to their grades and feedback at all times so that they can track their learning progress.
(4) Interaction and community – the exchanges between instructor and learners that build a community that supports teaching and learning:

- Fostering – the instructor welcomes learners and gives them the opportunity to communicate and create an online environment that fosters peer learning and engagement.
- Management – community building is supported by clear instructions, rules and regulations. While the instructor facilitates engagement, learners are invested with the ownership of community building.
- Peer learning – group work and other activities that foster peer learning are encouraged and structured not only to fulfil the learning outcomes, but also to present learners with an opportunity to learn skills and competences that go beyond such outcomes, e.g., digital literacy.

(5) Instructional resources for teaching and learning:

- Provision – learning materials are either provided by the instructor or the learners are given enough time to procure such resources. The difference between compulsory and optional resources is to be made clear.
- Application – the instructor clearly explains how the resources are going to be applied and utilised.
- Entitlement – the instructor makes sure that the resources indicated to fulfil the learning outcomes are open and accessible by all the learners without unwarranted technical, financial or administrative barriers. The use of OER should be encouraged.
- Variety – learning resources are varied in terms of the multimedia content and multi-modal delivery channels to cater for the different learning preferences of learners.
- Openness – the instructor should give learners the opportunity to suggest their own resources for adoption in the course.
- Academic integrity – the instructor promotes best practice in the use of third party resources, including anti-plagiarism practices and sound academic research/writing practices. The use and/or adherence to the creative commons licensing framework is encouraged.

(6) Learner support – learners enabled to achieve their maximum potential:

- Instructional support – the instructor explains his/her role in the process.
- Academic support – learners know how to obtain such services as mentoring, advice and other skills that support them in achieving the learning outcomes.
- Technical support – learners know how to obtain technical support to overcome potential issues in accessing the learning area and achieving the learning outcomes.
- Administrative support – learners know how to obtain administrative support to overcome potential issues in accessing the learning area and achieving the learning outcomes.

(7) Technology design – technology is at the service of teaching and learning:

- Support – all the utilised technologies and resources support the achievement of the aims and objectives of the instructor and the learning outcomes for learners.
Centricity – all technologies and resources used support a learner-centric rather than an instructor-centric educational approach. The learners must be in control and technology must assist them in achieving the learning outcomes.

Openness – the technical infrastructure used to deliver the teaching and learning is procured and implemented according to open standards and formats that maximise the value for money and the range of options to fulfil the learning outcomes and the academic needs of faculty and learners.

Authentication – authentication at different levels (device, software, virtual learning environment, specific course/learning area) should provide access to a safe and secure teaching and learning environment with the minimum number of steps possible to access the learning areas.

Access – the virtual learning environment/learning area is device/platform agnostic as much as possible, thus accessible over different software platforms, browsers and computing devices. The instructor provides alternative resources if any of these are not easily accessible for technical reasons related to special needs of learners.

Interface – the user interface and navigation in the learning area is simple enough to be conducive to teaching and learning without the need to possess advanced ICT skills and competences.

Investment – the technical requirements of the instructional resources and the virtual learning environment/learning space do not require learners to make any significant new investment in hardware, software and online services to be able to access and use these resources to fulfil the learning outcomes.

Management – learners are aware of the rules, regulations and policies at institutional and at learning community level that govern the use of the technological infrastructure supporting e-learning.

Course evaluation – feedback to improve teaching and learning:

- Entitlement – instructors should give learners the opportunity to provide feedback on the whole learning experience. On the other hand, instructors should also be able to provide their feedback within their organisation.

Course closing:

- Assessment – learners should have access to their grades and the course material after the closure of the course (depending on the institution’s access policies). The final grades should be provided within a reasonable timeframe after the closure of the course.
- Resolution – all pending issues between the instructor and the learners are resolved.
- Archiving – the instructor makes sure the course/learning area resources, texts, communication, etc., are backed-up or archived (in line with the institution's access policies) in a safe and secure way.

Instructional design cycle:

- Academic review – the instructor and the organisation review the course description, the experience gathered, and the evaluation given.
- Technical review – the instructor, with the relevant technical unit in the organisation, reviews the performance of the technical infrastructure used to deliver teaching and learning.
• Administrative review – the instructor, with the relevant administrative unit/s in the organisation, reviews the administrative processes supporting the delivery of teaching and learning.

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Recommended actions in support of instructional design for e-learning in higher education

The following recommendations are compiled from the literature review and the development of the comprehensive rubric:

(1) Teaching and learning should dictate the technological implementation of supporting tools and facilities, not the other way round.

(2) An educational institution wishing to provide e-learning opportunities needs a clear vision and a strategy sustaining e-learning from an academic, technological and administrative point of view.

(3) The use of e-learning pedagogies should be promoted as an official part of the professional work of academics, with tangible incentives and rewards that can take different forms, including professional recognition, financial and material rewards.

(4) An educational institution wishing to implement e-learning needs to invest in academic training and support, in technical support and a sound technical infrastructure, and in administrative support.

(5) An educational institution should take time in getting to know the views and needs of its faculty and students.

(6) A VLE should not be utilised as a simple online repository of content or for document management.

(7) E-learning should attempt to benefit from the affordances provided by technology as guided by the digital pedagogies and experience with e-learning, especially providing students with an element of control over the pace, time and path of study. Otherwise, it simply serves as an extension of traditional teaching practices.

(8) Student-instructor and student-student interaction, collaboration and work through the VLE (community building).

(9) A VLE alone does not provide a complete range of tools to facilitate online learning; therefore, complementary tools such as social media should be sought.

(10) E-learning, with MOOCs for example, is an opportunity to explore micro-credentialing and accreditation of online learning.

Discussion

The analysis of the rubrics has confirmed the myriad of possibilities provided by technology when applied to teaching and learning. Indeed, the resulting comprehensive rubric is rather long, and its components may indeed contribute to the welcome conclusion of the long-standing debate on whether e-learning is as rigorous and effective as traditional face-to-face environments (Casey, 2008; Jung and Latchem, 2012). Such a rubric will surely support faculty in the ever-increasing implementation of e-learning (Gaebel, 2015).
The active involvement of students in the learning process, rendered possible by technology, is well catered for in the comprehensive rubric. The early emphasis of technology in e-learning has given way to more credence in the pedagogical benefits (Garrison and Anderson, 2011; McLoughlin and Lee, 2010; Rovai, 2004).

The lack of common definitions of e-learning and its constituents is notable in the chosen rubrics, but there is nevertheless a common approach: empowering the educator to empower the student in an online environment that promotes learning.

Digital literacy of faculty and time pressures remains a challenge and even though technology is available, the application of the elements listed in the comprehensive rubric requires a level of digital competence from instructors (Conole and Alevizou, 2010; Grove, 2017; Johnson et al., 2015).

MOOCS, OER, BOYD, social elements, artificial intelligence, augmented and virtual reality are acquiring more space and attention in education, and the comprehensive rubric must take into consideration these new instructional approaches and updated digital pedagogies (De Freitas and Conole, 2010).

The tensions created by the implementation of technology in HE, especially the changing role of educators and students brought by more social, more ubiquitous and more open learning spaces, will surely bring to light any gaps between the planned and the actual implementation of e-learning. It is up to the educator, as a professional, to mind these gaps and bridge them.

Limits of scope
It is not within the scope of this paper to review quality assurance processes and administrative components, but to propose a rubric for course design and self-review of faculty and HE institutions for a better alignment with what is regarded as current standard best practice.

Suggestions for further research
The proposed comprehensive rubric does not provide a scale for assigning points when applied, thus giving a weighting to the elements of the rubric perceived as more important than others. There are other rubrics on e-learning by reputable HE institutions that could be included in the analysis. The litmus test for the rubric is its application in real-life situations. This is an excellent opportunity for follow-up research analysing the outcomes of its application.

References


Further reading

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Enhancing student engagement through simulation in programming sessions

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Abstract
Purpose – The purpose of this paper is to explore the use of a simulator for teaching programming to foster student engagement and meaningful learning.

Design/methodology/approach – An exploratory mixed-method research approach was adopted in a classroom-based environment at a UK university. A rich account of student engagement dimensions (behavioural, affective/emotional, and cognitive) was captured through descriptive and inferential statistical analysis. This was triangulated through reflective and in-depth validation of open-ended questions.

Findings – Results show higher behavioural and emotional engagement in simulator-based sessions, but relatively low cognitive engagement when compared with traditional programming sessions. A strong interweaving relationship between these three dimensions is evident in both the traditional and simulator approaches. Therefore, a balanced distribution of the dimensions is recommended for effective planning and delivery of programming sessions.

Research limitations/implications – Student engagement is multidimensional as it includes various internal and external/ecological factors. This study did not consider external factors, such as family and societal influence; it focused on the classroom-based environment.

Originality/value – This study critically examined the use of simulation as a means to foster student engagement in programming sessions. Findings suggest that a balanced activities within the three engagement dimensions can facilitate meaningful learning.

Keywords Programming, Student engagement, Classroom environment, Engagement dimensions (behavioural, emotional and cognitive), Meaningful learning, Simulator

Paper type Research paper

Introduction
Typically, computer programming is associated with science and engineering disciplines, such as mathematics, physics and psychology (QAA, 2016). However, researchers and practitioners discuss various skills of art, such as creativity and critical thinking, as requirements for becoming an effective programmer (Bergin et al., 2005). Conventionally, programming is considered a difficult subject to teach (Jenkins, 2002). This may be because it draws on a wide range of disciplinary skills; whatever the reason this is likely to impact of student engagement. Research shows that disengagement is not exclusive to programming though, as students across the board experience a lack of engagement which often manifests itself in boredom and alienation (Mann and Robinson, 2009; Mann, 2001). In the programming context, disengagement results into high dropout rates (Bennedsen and Caspersen, 2007).

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Learning and teaching of programming modules in higher education involve a unique nature of subject-matter and learning procedures. Teaching programming requires a skill orientation through which students can build capacity to “select, reflect, evaluate, justify, communicate and be innovative in their problem solving” (QAA, 2016, p. 12). Researchers, such as Kujansuu and Tapio (2004), emphasise student engagement and meaningful learning in achieving programming-related knowledge and skills. Meaningful learning is a catalyst for student engagement and quality education (Willingham et al., 2002). In general, the literature on student engagement and programming is not extensive. This particular area of technology-mediated learning environment needs to be better explored because technology itself can accelerate or hinder student engagement and meaningful learning (Perini, 2016).

The use of a simulator for disciplinary teaching and learning is not uncommon, particularly in the context of higher education. Examples include the use of Operation and Supply Mini Simulator to mimic graphical calculator in supply chain course (Yahaya et al., 2017); Patient Simulator for paramedic evaluation (Wyatt et al., 2015); and TeachLivE simulator for pedagogical skills enhancement of faculty members (Dieker et al., 2014; Chini et al., 2016). Predominantly, research on the use of simulator in programming is limited to the design of tool and students’ comprehension of the taught concepts, particularly in areas of computer architecture and assembly languages (Topaloglu and Gürdal, 2010; Nova et al., 2013). Until now, the relationship between student engagement and meaningful learning in the teaching of programming has been unexplored.

This research investigates the implications of a simulator in learning and teaching of programming topics with a specific focus on student engagement and disciplinary pedagogies. The context of the study was a second-year programming course in a new UK university in the south of England.

Definitions

Student engagement

The term student engagement has varied meanings and definitions in educational research including within curricular and extracurricular fields (Lawson and Lawson, 2013). Within the curriculum it relates to student participation and performance in learning activities (Darling-Hammond, 2010; Eccles and Wang, 2012). Broadly speaking, student engagement involves students’ participation, effort and resources (Krause, 2005). This particular study focuses on students’ engagement from three dimensions, namely behavioural, emotional and cognitive in classroom environment.

The importance of student engagement in learning is indisputable (Trowler and Trowler, 2010). Students only learn when they are involved (Astin, 2012). Therefore, in a formal educational setting the engagement of students indicates the overall quality of learning and teaching (Kuh, 2009). Particularly, in a higher education context, this relates to student achievements and competences (Kahu, 2013). Research demonstrates that engagement contributes to student persistence and satisfaction in their learning journey (Pascarella and Terenzini, 2005).

Student engagement is multidimensional (Fredricks et al., 2005). It can be seen as something internal, from the perspective of affective and cognitive phenomena (Appleton et al., 2008). It can also be seen as something in the ecology of the learning environment though the influence of planned curriculum, interactions with peers, family and society (Gibbs, 2010; Lawson and Lawson, 2013).

Nature of engagement in meaningful learning

Student engagement in the curriculum involves gaining knowledge by building on prior learning, observing teacher actions, responding to questions and solving problems
Meaningful learning involves cognitive processes, such as critical thinking, active discussion and problem solving (Mayer, 2002). In this process, students get opportunities to plan, reflect and share knowledge.

In a classroom situation, student engagement is a dynamic process involving students’ personal acts of attention or motivation and their interactions with teachers and peers (Lawson and Lawson, 2013). More precisely, there are three major dimensions of engagement for meaningful learning in classroom environment. These dimensions, namely behavioural, emotional and cognitive, along with associated factors, are elaborately discussed by Fredricks and McColskey (2012), but briefly explained here.

First, behavioural engagement refers to students’ attention to class activities and attempts to participate. These can also be negative when students pretend to be attentive, or they come into a class unprepared, resulting in failure to achieve meaningful learning.

Second, students’ self-belief, personal motivation and peer support for learning indicate their emotional engagement in a classroom environment. The relationship of students with teachers and peers are two important indicators that can help develop this kind of emotional or affective engagement.

Finally, students’ cognitive engagement includes planning and strategies for learning, self-regulation, and meta-cognitive processes such as recognising value of engagement.

Student engagement in programming sessions

Surprisingly, learning to become an effective programmer requires a substantial level of imagination and creativity. Research shows that creativity is fostered by pedagogical approaches, the physical environment and resources, the relationship between teachers and students and other factors both within and beyond the classroom (Davies et al., 2013). There is a link between students’ motivation, engagement and creativity (Craft et al., 2008); this reinforces the argument that higher engagement is necessary for becoming an effective programmer.

The study

Inside the black box: simulation as a pedagogic tool

Web Development is a programming module that incorporates client and server-side technologies. Students on this module were expected to gain practical knowledge and skills on the development of server-side database-driven applications using a programming language, Hypertext Preprocessor (PHP). Additional learning outcomes were “enhanced awareness and capacity to tackle common security issues in server-side Web applications”. The module entailed pre-requisite knowledge and applied basic Web technologies skills such as Cascade Style Sheet (CSS), HyperText Markup Language (HTML) and programming fundamentals including sequence, selection and loop. In addition, students were required to have a working knowledge of basic language syntaxes and semantics.

Topics varying from client-server architecture, server-side scripting, data format and web services were taught in this module over eight two-hour sessions. Four sessions were taught using an in-house simulator developed by the module leader. This simulator mimics coding processing and compiler activities visually, with error notation of code syntaxes and guidance of programming steps. Similar to any PHP editor, this simulator was equipped with programming editor functionality that allows code writing and processing. Others features include an action menu, error checking and code lining. Conversely, traditional teaching methods were used in the remaining four sessions for topics, such as SQL injection and cross-site scripting, Web data formats, and Web services.

In this study, the simulator sessions facilitated sequential visual representations of the processor activities both at front and back-end. For example, in the sessions “communication with database”, the simulator visually presented how data transforms
from the client page to the database at the back-end, which is not the case in traditional teaching approaches. In addition, the steps of data transformation, formats and metadata within and outside the database were presented upon running the code for data input, retrieval and output. These activities and processes are hidden in traditional sessions when such queries are fired within a PHP code. Thus, code writers are unaware of back-end activities in dealing with such instances. In both traditional and simulation-based sessions there were simple classroom instructions and demonstrational approaches of technical know-how, after which the students were tasked with similar activities on the taught concepts as common in any learning and teaching setting.

**Problem statement and the research questions**

Engaging with learning processes and environments is vital for students to become skilled in programming. However, students may be confronted with different challenges in terms of creativity and imagination. Student behaviours strongly influence their problem solving, reflective practices and feedback exchange (Perkins et al., 1986). Additionally, there are challenges related to learning styles, learning speed and motivation (Jenkins, 2002). By acknowledging these challenges, the following baseline information about student engagement was explored in a unique programming module. The study investigated the following two research questions:

**RQ1.** To what extent are the dimensions of student engagement in traditional and simulator-based programming sessions comparable?

**RQ2.** To what extent does a simulator impact on programming pedagogy?

The novelty of the learning and teaching of this module is the integration of a simulator which is a virtual machine that imitates real-world actions and processes. In this instance, the tool imitated the steps and procedural processes of program events with guidance on the completion of relevant program.

**Methodology**

This is a case study of an innovative intervention in one UK university where classroom environment related to student engagement was explored. It followed a mixed-method approach allowing data triangulation from a validated self-report survey inspired from Fredricks and McColskey (2012) and the novel approach based on Brookfield’s (1995) Critical Incident Questionnaire (CIQ).

Case study methods are a recognised way of illuminating educational phenomena which cannot be fully explained by relevant theories (Eisenhardt, 1989). The approach is particularly helpful to study “how” and “why” aspects of actions and experiences (Yin, 1994). The self-report survey is a useful measure to explore student engagement, especially the emotional and cognitive dimensions which are not visually observable. This method elicits in-depth subjective perceptions of research participants more effectively than traditional indicators, such as class attendance records and task completion rates (Fredricks and McColskey, 2012). Similarly, the CIQ is a widely accepted set of open-ended questions which can collect “vivid happenings”, especially student experiences at critical moments in their learning (Brookfield, 1995, p. 114). Furthermore, it helps identify engagement and associated reasons through student reflections and feedback (Hedberg, 2009).

Data captured from four traditional and four simulator-based sessions were compared to explore student engagement in the classroom environment. Survey data and the CIQ provided quantitative and qualitative data respectively. Several benefits were ensured with these two data types including a greater convergent validation or triangulation (Fielding, 2012); gaining richer perspectives and arguments in relation to relevant theories and practices (Johnson et al., 2007); and being able to draw comprehensive conclusions (Teddlie and Tashakkori, 2009).
Survey

A synchronous audience voting response system was used in each of the eight sessions to administer an 18-item survey questionnaire. A PowerPoint document was prepared where each slide contained an item-statement with corresponding response options. The statements appeared on screen consecutively, providing sufficient time for responding. Students voted anonymously using individual clicker devices. Although the numbers of participants varied in simulator-based ($n=32$) and traditional ($n=21$) sessions, the data sets showed a normal distribution, as seen in Figure 1. Therefore, the data sets are independently reliable and broadly comparable.

The questionnaire used in the study (see Table I) is a simplified version of the 11 engagement subscales discussed by Fredricks and McColskey (2012). The statements address behavioural, emotional and cognitive phenomena of student engagement in classroom environments.

Statement response options included student perceptions and self-assessment in a five-point Likert scale (Likert, 1932). The data were processed using statistical software, SPSS. In order to reduce response bias, negative statements were included (see items 3 and 9) and reverse coding was applied accordingly. The internal consistency or the coefficient of reliability of the survey

![Figure 1. Normal distribution of data sets](image)

<table>
<thead>
<tr>
<th>Behavioural</th>
<th>1. I actively participated in the lesson</th>
<th>2. I was more attentive in this lesson compared to other lessons that did not use a simulator</th>
<th>3. There was no opportunity to work with classmates</th>
<th>4. I was able to link my learning with own experiences</th>
<th>5. This lesson motivates me to share my ideas with others</th>
<th>6. I asked questions about the simulator tool for clarification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affective/Emotional</td>
<td>7. Using a simulator made the lesson fun</td>
<td>8. The simulator tool has motivated me to participate in the given tasks</td>
<td>9. The lesson did not have any clear learning goal</td>
<td>10. I feel the lesson is useful for my future profession</td>
<td>11. There was clarification when I had doubts</td>
<td>12. I would recommend today’s session to my friends</td>
</tr>
<tr>
<td>Cognitive</td>
<td>13. The session provided me with challenging tasks</td>
<td>14. I knew what I was supposed to learn</td>
<td>15. I learned things that might be useful in the practical world</td>
<td>16. The learning I have gained is valuable</td>
<td>17. I was able to link my learning with other lessons</td>
<td>18. After attending the session, I feel I now understand the concept of today’s topic better</td>
</tr>
</tbody>
</table>

Table I. Survey questionnaire items
questions was measured by Cronbach’s α test which confirmed a strong internal consistency and high reliability of the survey questions (Cronbach, 1951; George and Mallery, 2003). Table II shows the α scores of the sections.

CIQ
In addition to the self-report survey, a paper-based questionnaire adapted from Brookfield’s CIQ was administered in the sessions:

- When did you feel most engaged in today’s session?
- When did you feel most distanced in today’s session?
- What action of your teacher/classmates did you find most affirming and helpful?
- What action of your teacher/students in the lesson did you find most puzzling or confusing?
- What element/activity of the lesson surprised you the most (e.g. something that someone did in the lesson, your own reactions, or anything else that occurs to you)?

The CIQ allowed students to reflect on personally engaging moments and events in the sessions. It helped identify associated factors, such as learning environment, actions of teachers and peers and their impacts on meaningful learning. As the students responded immediately, the data were specific and authentic. Students found completing the CIQ easy to do, demonstrating that it was accessible and intuitive. The CIQ data were in written format and were processed using NVIVO software. To reduce bias, data processing was carried out by the researcher not associated with the Web Development module design and facilitation processes (Sandelowski, 1993). Furthermore, the corresponding relationship between the CIQ and survey data set enhanced reliability of the responses (Morse et al., 2002).

Findings
The self-report survey data revealed the levels of targeted students’ behavioural, emotional and cognitive engagement; the CIQ data provided rich explanation and clarification through specific examples. The data sets individually and together revealed a reciprocal relationship among the three dimensions of engagement confirming the importance of enhancing student engagement leading to practical recommendations.

Survey results
The calculated mean scores of responses are presented for simulator and traditional sessions in Tables III-V. Comparative scores are interpreted in four ascending categories, namely “low” (1 to 1.99), “average” (2 to 2.99), “modest” (3 to 3.99) and “high” (4 to 5). Additionally, survey items are paraphrased for easier readability (full questionnaire in Table I).

The mean scores related to the behavioural dimension of engagement were generally higher in the simulator sessions (see Table III). Findings show higher attention and active participation in the simulator sessions. Students felt the sessions were more connected with their personal experiences and involved improved opportunities to work and exchange
ideas with peers. Contrarily, data about asking questions (Item 6, Table III) show that students asked fewer questions compared to the traditional sessions.

Similar to the mean scores of behavioural engagement, the scores of emotional engagement were also generally higher in simulator sessions (see Table IV). However, there was a slightly lower score in the case of motivation to attempt tasks (Item 8) in the same sessions. This means that the students found the simulator sessions more interesting when they were aware of their learning goals and received required clarification to avoid confusion. As a result, they preferred to recommend the simulator sessions to their peers. Yet, the students considered themselves a little less challenged to actively participate in the given tasks of the simulator sessions.

Contrary to the mean scores of behavioural and emotional engagement, the scores of cognitive engagement were generally lower in the simulator sessions except for students having better understanding of concepts (Item 18, Table V). The lower scores suggest two possible reasons; on one hand, students may have found the simulator sessions engrossed and engaging, such that taught concepts became simpler (because students could see and make sense of the back-end processes) as they could not relate those to real-life situations.

### Enhancing student engagement

#### Table III.
Mean scores of behavioural engagement

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Statements</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Simulator-based ($n = 32$)</td>
<td>Traditional ($n = 21$)</td>
</tr>
<tr>
<td>1</td>
<td>Active participation</td>
<td>3.38</td>
<td>1.338</td>
</tr>
<tr>
<td>2</td>
<td>Attention in session</td>
<td>3.03</td>
<td>1.150</td>
</tr>
<tr>
<td>3</td>
<td>Collaboration with peers</td>
<td>2.97</td>
<td>1.307</td>
</tr>
<tr>
<td>4</td>
<td>Linking learning with experience</td>
<td>4.00</td>
<td>1.344</td>
</tr>
<tr>
<td>5</td>
<td>Opportunity to share ideas</td>
<td>3.13</td>
<td>1.238</td>
</tr>
<tr>
<td>6</td>
<td>Questioning for clarification</td>
<td>2.84</td>
<td>1.370</td>
</tr>
</tbody>
</table>

#### Table IV.
Mean scores of emotional engagement

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Statements</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Simulator-based ($n = 32$)</td>
<td>Traditional ($n = 21$)</td>
</tr>
<tr>
<td>7</td>
<td>Fun of session</td>
<td>3.38</td>
<td>1.264</td>
</tr>
<tr>
<td>8</td>
<td>Motivation to attempt tasks</td>
<td>3.41</td>
<td>1.292</td>
</tr>
<tr>
<td>9</td>
<td>Clarity of learning goals</td>
<td>3.50</td>
<td>1.368</td>
</tr>
<tr>
<td>10</td>
<td>Session useful in future profession</td>
<td>4.00</td>
<td>1.107</td>
</tr>
<tr>
<td>11</td>
<td>Clarification when in doubts</td>
<td>3.72</td>
<td>1.085</td>
</tr>
<tr>
<td>12</td>
<td>Recommend sessions to peers</td>
<td>3.31</td>
<td>1.306</td>
</tr>
</tbody>
</table>

#### Table V.
Mean scores of cognitive engagement

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Statements</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Simulator-based ($n = 32$)</td>
<td>Traditional ($n = 21$)</td>
</tr>
<tr>
<td>13</td>
<td>Provision of challenging tasks</td>
<td>3.00</td>
<td>1.295</td>
</tr>
<tr>
<td>14</td>
<td>Knowing what to learn</td>
<td>3.59</td>
<td>1.388</td>
</tr>
<tr>
<td>15</td>
<td>Learning useful in practical world</td>
<td>3.28</td>
<td>1.486</td>
</tr>
<tr>
<td>16</td>
<td>Gained learning is valuable</td>
<td>3.72</td>
<td>1.143</td>
</tr>
<tr>
<td>17</td>
<td>Linking learning with other sessions</td>
<td>3.50</td>
<td>1.591</td>
</tr>
<tr>
<td>18</td>
<td>Taught concepts better understood</td>
<td>3.94</td>
<td>1.216</td>
</tr>
</tbody>
</table>
believing such situations are more complex. On the other hand, the simulator could have simplified learning processes to such a degree that students understood the taught concepts, and thus found the given tasks less demanding.

Apart from comparing the mean scores, the linear relationship among the behavioural, emotional and cognitive dimensions was also explored using the Pearson correlation coefficient test or bivariate correlation measurement (see Figure 2). The five cut-off points: 
- 0.1: weak,
- 0.3: modest,
- 0.5: moderate,
- 0.8: strong,
- 0.8: very strong were applied in this regard (Muijs, 2011).

The findings show a very strong interweaving relationship between the three dimensions of engagement in both the simulator-based and traditional sessions (see Figure 2). Whereas in the simulator sessions the behavioural-emotional and behavioural-cognitive relationships became stronger, the relationship between emotional-cognitive engagement was less strong. A possible reason for less strong emotional-cognitive engagement in the simulator sessions could be as a result of perceived less challenging tasks. This may be further strengthened by the self-report questionnaire responses for Item 13 where respondents found the tasks cognitively less challenging in the simulator sessions. Considering the teaching delivery of both types of sessions were similar, the findings about lower level challenge may indicate students found taught concepts with the aid of a simulator easier to understand. This assumption is further intensified by Item 15 of the survey where participants had a better understanding of concepts as against the traditional sessions.

**CIQ results**

The CIQ is theme based and thus analysed in five distinctive areas of student engagement. In the description, the words a few, some and most are used to present about one-fourth, half and three-fourth of the total research participants, respectively.

**Most engaging moments.** There were several highly engaging moments for the students in simulator sessions. For example, most of the students thought they were highly engaged when there was an opportunity to work practically, such as while creating CSS pages, coding HTML, creating a website and solving tasks of the given worksheet. Some students also found a number of teacher activities engaging, such as while the teacher explained and demonstrated the simulator, and taught procedures for uploading their work on the server. On the other hand, in traditional programming sessions, the students thought the cross-site scripting demonstration, question-answer phase and the introduction of new topics were the most engaging moments.

**Least engaging moments.** Most of the students mentioned that the beginning of the simulator sessions were the least engaging moments for them. Some students were confused about HTML basics. A small proportion of students found themselves engaged while the...
teacher was lecturing, particularly while introducing a new content. There was also a delay at some points, such as while distributing passwords and at the time of uploading work to the server. Some students struggled to synthesise the information given at the beginning of the sessions. A few students felt that the physical aspects of the classroom, such as room temperature and seating arrangements, made them disengage. In the traditional sessions some students mentioned that there were too many tasks and, in many cases, they struggled to understand complicated concepts. Some students disengaged during object-oriented PHP. Others disengaged when working on advanced tasks.

**Most helpful activity.** Several tasks helped the students to be actively engaged in the simulator sessions. One of the most helpful activities include tutor’s monitoring of the student work, recapping of previous sessions, student response checking and offering assistance when the students requested it. Some students found the on-screen instructions and question-answer sessions helpful. Some found individual tasks with worksheets and discussion with classmates helpful. In the traditional sessions, the students found that the answering of questions by the teacher was very helpful. Some students mentioned the detailed explanation of a process, such as the steps of adding a hyperlink, and also the use of real-life examples as highly supportive. Besides, one-to-one support and the tutor’s commentary during a demonstration were also helpful for the students.

**Most confusing activity.** A majority of the students did not find any confusing activity, either on the part of the tutors or students, in the simulator sessions. Some, however, mentioned that the functioning complexity of the tool and delayed response of the tool editor were confusing while linking two files. A few respondents expressed the need for more direction and guidelines by the tutor before and during the work. Others indicated that their confusion arose because they had not prepared adequately for the session. In the traditional sessions, some felt that there was less teaching and more tasks for them to undertake. In some cases the students had to cover certain tasks very quickly and, while responding to the tutor’s questions, there were sometimes conflicting answers from their fellow peers. Occasional switching between platforms designed to orient with real-life professional scenario was confusing for some of the students. For example, moving from Neptune to Edward2 servers and Filezilla application required the use of multiple passwords.

**Most surprising event.** For most, the demonstration of the simulator, uploading the work on server and the HTML activity were surprising. They were also surprised by the need to integrate and build on learning from the previous year. Some students were astonished as they found the teacher doing less teaching. A few students were amazed with the voting system using clickers which was used to conduct the survey in the sessions. Remarkably, some students reported that they were surprised how easily they were able to pick up PHP concept by using a simulator. On the other hand, some students thought there was nothing surprising in the traditional programming sessions. A few students thought that the documentation of lectures by keeping notes of the explanation of code in the traditional classes was astonishing for them.

**Key learning**

This study has deepened understanding and provided explanation about the behavioural, emotional and cognitive dimensions of student engagement in programming subjects (Fredricks et al., 2005). Comparative analysis of the data indicates that the simulator sessions were more interesting, collaborative and focused on learning goals, bringing about enhanced attention and participation of students. However, the simulator sessions were not cognitively challenging to students which poses questions about whether these sessions were so effective that students mastered complex tasks easily; or not challenging enough because they gave too much information away. Challenge aside, the strong correlation
between dimensions suggests that if the engagement elements of any dimension change, there is a possibility that the other dimensions will be affected proportionately. It is therefore important to include quality learning activities which can effectively contribute to students’ behavioural, emotional and cognitive engagement in a balanced manner.

**Enhancing student engagement using a simulator**

Student engagement is strongly linked to meaningful learning in programming (Kujansuu and Tapio, 2004; Willingham et al., 2002). The findings here indicate that students appear to be engaged in meaningful learning through their engagement and participation in simulator-based sessions. The use of a simulator created a dynamic learning environment that facilitated shared understanding of programming concepts through fun-based and easy to grasp learning activities. However, more questioning opportunity and cognitively challenging tasks for students might enhance student motivation and thus meaningful learning. Besides, the numbers of respondents were relatively small, so in case of an increased number, these relationships may vary, even any of the dimensions may become more or less influential on student learning.

**Value of teaching-learning actions**

Teachers and educational resources play an important role in engaging students in learning processes (Davies et al., 2013; Mayer, 2002). This study has explored specific actions of teachers and students both in simulator-based and traditional sessions. These actions provide pointers to meaningful learning and engagement.

First, simulator sessions proved helpful in linking learning contents, personalising student learning and improving engagement. Students expected to share and collaborate in these sessions and asked fewer questions for clarification. The simulator sessions show the value of inquiry-based and collaborative approaches to teaching. A weakness of the simulator sessions seems to be low levels of cognitive challenge, but this may be because the simulator increased student understanding. Nonetheless, it has been identified that more challenging tasks would further enhance engagement. This aligns with theories about setting high expectations (Craft et al., 2008; Lawson and Lawson, 2013).

Second, simulator sessions were more engaging as there was a connection with relevant professions and industry. Students are engaged when they know the usability of their learning in practical life. In the process, the students need to discuss relevant issues and see an association of the content with other topics and subjects.

Third, the learning environment of simulator sessions was less intimidating and more dialogic. These features along with reflections and inquiry of students foster student engagement (Perkins et al., 1986). Besides, they are highly engaged when the teacher ensures clarity of learning points, and introduces more reflection through meta-cognitive approaches like the CIQ.

**Limitations and future study**

The focus of this research is to explore the impacts of a simulator on student engagement in programming sessions within the classroom environment. Therefore, the findings do not elucidate how and to what extent non-classroom-based variables, such as cultural backgrounds and social powers, influenced student learning. Eventually, based on a comparative investigation to teaching and learning activities of the simulator-based and traditional programming sessions, several behavioural, emotional and cognitive changes were identified. These findings appear as a starting point for the exploration of suitable pedagogical designs for meaningful learning of programming concepts. In this regard, it would be essential in future work to measure quality levels of learning gains and difficulties.
faced by students in the two approaches of programming sessions. Additionally, a large scale longitudinal study involving more students may reinforce or challenge the findings of this study with new perspectives and guidelines.

**Conclusion**

This study provides evidence that the use of a simulator in programming sessions can improve student engagement for meaningful learning. Varied dimensions of engagement include behavioural, emotional and cognitive aspects, which need to be addressed in session planning and implementation. As these dimensions are interrelated, teachers should be aware of these different dimensions in creating meaningful learning. The level of engagement in simulator-based tasks need to be carefully calibrated as this study show higher engagement but potential lower level of challenge. Therefore, tutors should understand a balance of the three engagement dimensions is imperative and ensure that teaching and learning-related drawbacks are tackled by employing suitable teaching-learning activities.

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Abstract

Purpose – The purpose of this paper is to examine how chatbots can be used to address two key struggles that students face in first year – a sense of being disconnected from the instructor, and information overload. The authors propose that chatbots can be a useful tool for helping students navigate the volumes of information that confront them as they begin attending university, while at the same time feeling somewhat personally connected with the instructor. This is achieved without increasing instructor time commitment, and perhaps reducing it in large classes. The paper reveals the results of applying this tool in a large first year class and proposes improvements for future iterations.

Design/methodology/approach – A tool was designed and implemented and tested against research insights.

Findings – Chatbots are an effective means to reduce student transition challenges.

Research limitations/implications – Technology which feels social and personal as well as functioning on a tool that students use will make the student feel more connected to the course and the instructor.

Practical implications – Tools aiding transition should be easy to use and allow customizable information access.

Originality/value – Chatbots are an unexplored tool. They have the benefit of addressing information overload as well as making the student feel socially connected without increasing instructor workload.

Keywords Social media, Transition, Technology, Information overload, Education, Instant messaging

Paper type Case study

Introduction

A significant amount of research has explored two key components that this paper brings together: students transitioning into first year university, and the use of information technology in education.

A great deal of literature has examined the difficulties that students face when starting university. What has been shown is that quite often the challenges faced stem not from a lack of academic preparedness but from several other factors. Among those most frequently cited are a sense of being disconnected from other students and from the instructor and the difficulties of navigating a new environment with new expectations and structure (Jones et al., 2009). Related to this but not directly examined is the significant volume of information to sort through, absorb, and act upon. A review of the information management literature reveals that high quantities of information may have unintended negative effects such as confusing and frustrating the recipient, leading to information anxiety and diminished performance (Eppler and Mengis, 2004).

Technology has been proposed as a possible tool which can be harnessed to deal with the above issues. In particular, it has been examined as a tool to connect with and assist students both socially and academically (Rau et al., 2008). The research shows that tools such as e-mail, text-messaging/short-messaging systems (SMS) and instant messaging (IM) can be effective for sharing information with students, answering their questions, and helping them feel connected to the instructor (Rau et al., 2008; Lauricella and Kay, 2013). Their benefits from a student perspective are the potential for a quick response, convenience, ease-of-use and a sense of greater connection with the instructor. However, the problems associated with IM are that it can be frustrating for the student if the instructor is not online and the student sometimes perceives it as breaching privacy boundaries. For the instructor, it demands greater availability and greater time spent responding to individuals.

The author gratefully acknowledges the contribution of Leanne Hagarty in designing the survey and providing some of the papers which motivated this paper.
A recent technology innovation that extends IM is the chatbot. This is an automated response system that has some limited artificial intelligence capabilities and appears as a contact on the IM system. Its benefit is that the student can navigate through frequently encountered questions using an intuitive, conversation-like approach and locate information as it is needed, when it is needed. The chatbot can also send reminders or be used as a mass communication tool by the instructor to send messages. The fact that it resides on the student’s mobile phone makes it convenient and at the same time, may give the student the sense of being a little less disconnected from the professor, while at the same time not too close.

This paper examines the literature on student transition, information overload and the use of chatbots to address the challenges from the intersection of these two issues. It is important to do so because student retention is a challenge that all universities confront and we are constantly seeking tools and approaches which can make student transition and therefore student retention more successful. This generation views and uses information and communication technology in vastly different ways compared to its parents. This creates the opportunity for new educational solutions to old educational problems.

The paper describes the findings from the use of a rudimentary chatbot in a large first year class. It concludes by identifying areas of improvement for future iterations of the tool, as well as other applications.

Literature review

Student transition

A significant amount of research has engaged in understanding the challenges of student transition into first year university because the majority of student departure occurs during this time (Jones et al., 2009). The movement from a prescriptive, structured high school system to the independence of a university system makes students feel disoriented and they often struggle to motivate themselves (Harley et al., 2007; Briggs et al., 2012). They must also adjust to increased academic demands and altered teaching arrangements (Jones et al., 2009). Although information is one of five important aspects of successful transition, they often experience information overload on arrival (Briggs et al., 2012). Finally, they feel disconnected socially from peers and instructors which also serve to reduce motivation and help-seeking behavior (Harley et al., 2007).

Successful transition is therefore more likely to occur when the student can be an autonomous learner, access and absorb the needed information, and feel socially connected to instructors and peers (Briggs et al., 2012). Supportive university systems can enable socialization and adaptation (Briggs et al., 2012), whereas systems of information giving enable student access to information needed to make good decisions (Briggs et al., 2012). However, providing administrative information sessions and documentation in class and through online systems is not sufficient (Harley et al., 2007). Information overload can lead to feeling of demotivation, frustration, and anxiety and students must feel comfortable seeking help (Eppler and Mengis, 2004; Er et al., 2015).

Er et al. (2015) examined college students’ online help-seeking behavior and found that students may avoid seeking help in order to uphold a positive social image; they want to avoid being viewed as appearing incompetent. They also suggest that students are more likely to seek help if they are able to do so with anonymous identities and that instructor support in help-seeking is both useful and non-threatening.

With respect to the social aspect of transition, social presence is consistently associated with student motivation and is also believed to influence motivation (Rau et al., 2008). Social presence is created by the intimacy and immediacy of interactions (Rau et al., 2008). Similarly, a sense of connection with the instructor, i.e. frequency and quality of contact, is a significant predictor of student persistence in the face of challenges (Tinto, 2002 cited in Jones et al., 2009).
Scholars have examined the use of text-messaging (SMS) to support transition to university. They demonstrated that the use of SMS has the potential to enhance support provided to students, facilitate the development of productive relationships for those who would otherwise be socially isolated and provide valuable assistance (Harley et al., 2007). Because students receive text messages in a device they consider personal – their mobile telephones – this mode of communication was a way of blurring the distinction between the academic and social aspects of university life and strengthening relationships between staff and students (Harley et al., 2007).

At the same time, there are concerns that we want to develop independent learners and ensure that they are not dependent on support structures, and that instructors are not over-burdened (Jones et al., 2009). From an instructor’s perspective, as the number of students increases it becomes more difficult to connect with students individually regardless of the mechanism. In addition, it is not reasonable to expect that instructors would be continuously available to students even if the technology allows it.

Scholars have noted that it would be a missed opportunity if universities did not consider tools such as SMS and IM to support first year students given that these communication tools are “where students live” (Harley et al., 2007). Our paper accepts this proposition and examines a new tool – the chatbot – and the role that it can play in supporting student transitioning while addressing some of the concerns associated with SMS and IM.

**Technology in education**

Communication technology such as text messaging, e-mail, and instant-messaging have all been examined both as educational tools and for their impact on student-instructor bonding. In all cases, it has demonstrated value in enhancing the experience and performance of the student. Lauricella and Kay (2013) examined how higher education students use text and IM for academic purposes with peers and instructors and found that students regularly used it for academic purposes with peers but did not use it as frequently with their instructors (Lauricella and Kay, 2013). E-mail, on the other hand, was rarely used for peer-to-peer communication and students did not report feeling positively about or bonded to the instructor when this technology was used (Lauricella and Kay, 2013). Those that did use IM to communicate with the instructor noted that it was more convenient than e-mail since they always have their mobile phones in-hand and appreciated that it allowed them to get in touch with him/her and get quick answers (Lauricella and Kay, 2013).

A study by Jones et al. (2009) showed that over 70 percent of students were interested in using their phones to receive deadline reminders and over 60 percent were interested in receiving questions from their tutors. Approximately, 40 percent indicated that they would appreciate being able to use their phones to find out information and keeping touch with tutors or asking questions. Students viewed the reminders and announcements of administrative changes that arrived in their phones were an effective aid to time management (Jones et al., 2009).

Scholars have consistently shown that SMS is a personal way to reach students and let them know that they should look at materials available online (Rau et al., 2008).

In terms of information overload, research showed that using SMS to communicate with the instructor did not increase student pressure; when students received a message they felt that they were being cared for and felt bonded strongly with the instructor and classroom activities. They were motivated to pay attention to information in their e-mail or online when directed to do so in this way (Rau et al., 2008). Scholars propose that text messaging reminders of when assignments are due can help first year students adjust to academic life (Lauricella and Kay, 2013) by helping them manage their new and substantially increased workload. With respect to asking for assistance, students feel more comfortable doing so when using technology because of reduced social cues (Rau et al., 2008).
With respect to social bonding, informal communication is very effective in social bonding and social learning; adoption of informal interaction into education improves student-instructor relationships, promotes student motivation and reduces student pressure (Rau et al., 2008).

Messages are arriving to the student’s mobile phone (an object perceived as “personal space”) (Lauricella and Kay, 2013). Furthermore, IM and SMS are viewed as less formal means of communication and more personal (Rau et al., 2008). As a result, when the instructor communicates with the student using SMS, some students feel that it made the instructor feel more approachable and friendly (Lauricella and Kay, 2013) and the distance between the two is shortened resulting in a better relationship and higher student motivation (Rau et al., 2008).

On the other hand, some students resented when SMS or IM were used to communicate with faculty because they considered their mobile phones a personal technology and disliked faculty entering into their personal space (Lauricella and Kay, 2013). Students also noted the frustration and limitation of not being able to reach the professor if he was not online and that sometimes they simply did not want to appear visible to their instructor (Kay and Lauricella, 2015).

To our knowledge, the role that chatbots can play in addressing some of the above concerns has not been examined. Chatbots reside in IM platforms and can assist with simple questions with basic artificial intelligence as well as providing a more intuitive navigation for finding information. They therefore offer that the possibility of assisting with a student’s information needs while, perhaps, feeling somewhat personal by virtue of being accessible through mobile phones.

Information overload

Scholars summarizing prior work on information overload point out that there no universally accepted definition. It can mean having more information than one can assimilate or can mean being burdened with a large supply of unsolicited information, some of which may not be relevant (Edmunds and Morris, 2000; Eppler and Mengis, 2004). Basically, overload occurs when supply exceeds processing capability (Eppler and Mengis, 2004).

Information overload is seriously affecting the ability of people to do their jobs and impinging on relationships and quality of life (Edmunds and Morris, 2000).

Research has demonstrated that the quality of decision or reasoning has an inverted-u relationship with the amount of information (Eppler and Mengis, 2004). Beyond a certain point, the information is no longer integrated into the decision process, decision accuracy declines and the individual becomes confused and has difficulty recalling prior information or using it effectively (Edmunds and Morris, 2000; Eppler and Mengis, 2004).

Emotionally and psychologically, overload is usually associated with loss of control over situation and feelings of being overwhelmed (Bawden and Robinson, 2009). Psycho-emotional reactions of stress, anxiety and low motivation may also occur, as well as greater tolerance of error, sense of loss of control or a false sense of security (Eppler and Mengis, 2004).

Information overload is caused by a combination of factors including the information (quantity, quality, frequency, etc.), recipient and technology among other reasons (Eppler and Mengis, 2004). Overload has been exacerbated by the rapid advance of communication technology, which allows it to be shared in multiple forms and through a variety of channels, and the fact that our classical methods of handling it may be inadequate for electronic forms (Edmunds and Morris, 2000; Bawden and Robinson, 2009).

Overload can be reduced if it is delivered in the most convenient way and format and intelligent information management systems are used which foster and easier prioritization of information, in particular systems that reduce a large set of options to a manageable size; simplify functionalities and design of products, use artificial intelligent search systems.
Eppler and Mengis, 2004). Structuring it is key to making it more manageable and more valuable (Edmunds and Morris, 2000). Solutions to information overload revolve around the principle of taking control of one’s information environment (Bawden and Robinson, 2009).

At the same time, some propose that push technology can be useful by reducing the need to search for information or the risk that he is not aware of it. Push technology works by pushing notices of pre-selected information to the user, thereby alerting him (Edmunds and Morris, 2000). However, this system is ineffective if the user does not want information pushed to him or if too much information is pushed to him (Edmunds and Morris, 2000).

The intersection of the above three streams of research motivates this paper and the creation of a chatbot for a large first year class. The design of the chatbot will be described below, as well as the results of a survey of students who used it. The paper concludes by summarizing the insights obtained and directions for future iterations of the technology.

**BU111 bot implementation**

Chatbots are automated IM accounts that are programmed with chat-based logic. They appear in your IM contacts as any friend would and are accessed in the same way.

Chatbots have become popular due to two important trends: billions of people worldwide now use IM apps, and the app model of executing activities is problematic because you have to download and learn a new app for each activity you want to perform or you have to access a website. Chatbots offer the potential to provide support without requiring the individual to wander around an app or website, or learn how to use a new interface. For example, a chatbot could ask your criteria and suggest relevant things to look at. Bots represent a unique opportunity because many smartphone users find themselves in a state of app overload. They have too many apps that do too many things and are often hesitant to download new ones, no matter how great they might seem. Bots solve this problem by providing access to new experiences and services from within a familiar and comfortable space: a chat app.

Furthermore, the conversational interface which is used to help the user navigate through content or find desired content is very similar to a conversation one might have with another person, and is easier than hunting and clicking on a website.

In designing the chatbot for our course, there were several points raised by scholars, in addition to the observations described above, that informed its creation and design:

1. Humans interact with media in inherently social ways (Veletsianos and Miller, 2007);
2. An information retrieval system should be designed so as to reduce the risk of failure by the user and thereby increase his self-efficacy (Wilson, 1999); and
3. Although there is an abundance of information available, it is often difficult to obtain useful, relevant information when it is needed (Edmunds and Morris, 2000).

We were therefore focused on developing a tool that would make information retrieval easy and convenient by enabling it to occur through mobile phones. Furthermore, by using a chat interface, the hope was that the search for information would be more intuitive and less frustrating. Finally, by injecting a little humor into its interface it was hoped that the chatbot would feel “friendlier.”

Figures 1 and 2 illustrate the BU111 Bot in a user’s phone. When the user first connects with the chatbot, he sees the Main Menu options shown in Figure 1. The student can choose among Assignments, Help, and other options that are likely to be the key areas of information he might be interested in. The second illustration shows both the conversational response and the options which appear if the user selects “Assignments” from the Main Menu. If the student selects a link which is attached to a document, the document will open in the user’s phone.

The chatbot assists the student with organization with three important features: the Weekly Tasks allows the student to look up what is required in any particular week of
Using chatbots to aid transition

Figure 1. List of main menu and assignment menu options

Figure 2. Elements of humor, “personality” and assistance
the term; the student can opt to receive notifications once per week reminding him of what is required that week; and the instructor can send out “blasts” reminding and sharing information with students. To ensure that the students still developed some independence over time, the automatic weekly notifications changed over the semester from explicit tasks to “check your course outline” to “what should you be doing right now?”

The “blast” feature available to the instructor allowed her to send notifications, reminders and words of encouragement to anyone who was using the BU111 Bot. From time to time, this feature was used simply to send jokes, particularly during times when the instructor knew students would be feeling very stressed.

Figure 2(a) and (b) shows some small personality elements that were in the bot. If a command was entered which the chatbot could not understand, then the message, “What you talkin’ bout, Willis” appears. This is a well-known expression from a popular television series in North America. The “Tips and Tricks” option shown in Figure 2(a) is a collection of advice that was gathered from upper year students on how to survive the course, first year, and university in general. Each time a student selects this option he receives two random tips out of the collection. Notice that the conversational style of the chatbot is casual rather than formal, “Sure thing! How can I help you?” (Figure 2(b)).

The Help categories illustrated in Figure 2(b) provide the students with some non-academic information. The “I’m Bored” option connects the students with student clubs and the athletic complex.

The BU111 Bot operated on the Kik messaging platform. It was created by two students of the business program. It was implemented in a large first year business class teaching roughly 1,900 students. The format of the class is two 1.5 hour 300-student lectures per week. In addition to lectures, students were required to attend weekly labs and prepare specific assignments and activities for the labs prior to attending. Course requirements are two exams, one online assignment, one individual case analysis write-up requiring extensive research, one large group project requiring the identification and validation of a new venture opportunity, as well as two group presentations (one case presentation and one presentation based on the new venture project).

Findings
A voluntary survey was conducted of the students who chose to use the chatbot. Approximately, 1,700 first year students registered with the chatbot and 315 responded to the survey, providing an acceptable response rate of 18.5 percent. Students were asked to answer the questions and consider the impact of the chatbot in comparison to their other classes where no chatbot was used. It was also possible to view usage through a dashboard that is built in with the chatbot.

Using the dashboard it was possible to see that Weekly Tasks was the most frequently used feature, followed by Assignments. Approximately 1,700 and 1,500 students used each feature frequently at the beginning of the term. Use declined over the course the term which was expected given that the assignment instructions were also available on a course website. The survey results validate this information, indicating that many students used the Weekly Tasks feature throughout the term (see Table I).

With respect to student transition, the chatbot appears to have been valuable both directly and indirectly.

Tables I and II show the features that were most valuable and most often used. Not surprisingly, Assignments, Weekly Tasks and Notifications were most frequently selected. The Assignments and Weekly Tasks features allowed students to look up the assignment requirements for each of their assignments, while the Weekly Tasks listed the requirements for their lab preparation each week. It should be noted that this information was always
readily available on the course website and on the course outline. This suggests that the convenience of accessing the information on their phones as well as being able to find it more easily than searching through a website was of value to the students.

In terms of helping students meet course requirements, Tables III and IV show that over 60 percent of students felt that the chatbot at least somewhat helped them meet lab preparation and course assignment requirements. Given that the chatbot only provided access to information on what should be prepared, it would be safe to assume that the students were reflecting the ability to easily find the information they needed and ensure that they had all information needed.

Please indicate how often you used the listed chatbot features

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Never</th>
<th>A few times over the semester</th>
<th>Weekly</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllabus</td>
<td>101</td>
<td>200</td>
<td>13</td>
<td>314</td>
</tr>
<tr>
<td>Assignments</td>
<td>62</td>
<td>205</td>
<td>47</td>
<td>314</td>
</tr>
<tr>
<td>Weekly Tasks</td>
<td>53</td>
<td>181</td>
<td>78</td>
<td>312</td>
</tr>
<tr>
<td>Lab</td>
<td>134</td>
<td>140</td>
<td>39</td>
<td>313</td>
</tr>
<tr>
<td>Class</td>
<td>184</td>
<td>108</td>
<td>20</td>
<td>312</td>
</tr>
<tr>
<td>Tips and Tricks</td>
<td>150</td>
<td>147</td>
<td>17</td>
<td>314</td>
</tr>
<tr>
<td>Help</td>
<td>183</td>
<td>117</td>
<td>14</td>
<td>314</td>
</tr>
<tr>
<td>Notifications</td>
<td>86</td>
<td>141</td>
<td>87</td>
<td>314</td>
</tr>
<tr>
<td>Other, i.e., formation of a group chat</td>
<td>227</td>
<td>66</td>
<td>17</td>
<td>310</td>
</tr>
</tbody>
</table>

Table I. Chatbot feature use

Which three features of the chatbot were the most valuable to you?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syllabus</td>
<td>95</td>
</tr>
<tr>
<td>Assignments</td>
<td>189</td>
</tr>
<tr>
<td>Weekly Tasks</td>
<td>235</td>
</tr>
<tr>
<td>Lab</td>
<td>81</td>
</tr>
<tr>
<td>Class</td>
<td>15</td>
</tr>
<tr>
<td>Tips and Tricks</td>
<td>65</td>
</tr>
<tr>
<td>Help</td>
<td>28</td>
</tr>
<tr>
<td>Notifications</td>
<td>139</td>
</tr>
<tr>
<td>Other, i.e., formation of a group chat</td>
<td>9</td>
</tr>
</tbody>
</table>

Table II. Chatbot feature value

Did use of the chatbot assist you in meeting the lab preparation requirements?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>34.3</td>
<td>106</td>
</tr>
<tr>
<td>No</td>
<td>38.2</td>
<td>118</td>
</tr>
<tr>
<td>Somewhat</td>
<td>27.5</td>
<td>85</td>
</tr>
</tbody>
</table>

Table III. Assistance in meeting lab preparation requirements

Did use of the chatbot assist you in meeting the course assignment requirements?

<table>
<thead>
<tr>
<th>Answer options</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>43.6</td>
<td>134</td>
</tr>
<tr>
<td>No</td>
<td>30.6</td>
<td>94</td>
</tr>
<tr>
<td>Somewhat</td>
<td>25.7</td>
<td>79</td>
</tr>
</tbody>
</table>

Table IV. Assistance in meeting assignment requirements
The Notifications feature allowed students to opt to receive push messages on Sundays that reminded them of Weekly Tasks that were due in the upcoming week. The notifications evolved over the course of the term in order to encourage them to become autonomous rather than relying on others – at the beginning of the term the notifications provided a detailed list of what should be completed. Within a few weeks, the notifications reminded students to look at their course outlines for what was required and at the end of the term, they were simply messages to the effect of, “shouldn’t you be doing something to prepare for BU111?”

Tables V and VI show that over 50 percent of students found the chatbot at least somewhat aided them with time management. More importantly, approximately 84 percent of students indicated that the notifications at least somewhat prompted them to work on course requirements and in Table VII we see that 18 percent of students perceived the notifications as “something I must attend to.” Furthermore, as shown in Table VII, 46.7 percent were relieved to be reminded, suggesting that the tool helped alleviate some of the stress of managing academic demands. Survey comments further confirmed that students appreciated the push notifications however, some expressed frustration at the fact that they became more vague over the term and they wanted them to be more specific and prescriptive as they had been at the beginning of the term. It is fair to conclude that these students were resisting taking ownership of their learning and reinforces the concern that technology and support structures must be used judiciously so that students learn to self-organize to ensure their success (Briggs et al., 2012; Jones et al., 2009).

The most interesting insights related to social connection are shown in Tables VIII and IX. Despite the fact that the chatbot is not human, approximately 65 percent of students indicated that the chatbot at least somewhat made the course feel more personal than other courses (Table VIII). In Table VII, we see that 13 percent of students felt cared for when they received notifications. Students taking the survey often commented on characteristics associated with

<table>
<thead>
<tr>
<th>Did Notifications and reminders prompt you to work on course requirements?</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>45.2</td>
<td>131</td>
</tr>
<tr>
<td>No</td>
<td>16.2</td>
<td>47</td>
</tr>
<tr>
<td>Somewhat</td>
<td>38.6</td>
<td>112</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Did the chatbot aid your time management?</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>22.7</td>
<td>70</td>
</tr>
<tr>
<td>No</td>
<td>47.7</td>
<td>147</td>
</tr>
<tr>
<td>Somewhat</td>
<td>29.5</td>
<td>91</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If you used the Notifications feature, how did it make you feel when you received it (select all that apply)</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>relieved to be reminded</td>
<td>46.7</td>
<td>129</td>
</tr>
<tr>
<td>this is something I must attend to</td>
<td>18.1</td>
<td>50</td>
</tr>
<tr>
<td>they care about me</td>
<td>13.0</td>
<td>36</td>
</tr>
<tr>
<td>they are watching me</td>
<td>6.2</td>
<td>17</td>
</tr>
<tr>
<td>I can plan my own time</td>
<td>15.9</td>
<td>44</td>
</tr>
</tbody>
</table>
humans, “Liked the motherly feel it had” and “Liked the sass.” Many students made statements such as “made the professor more relatable.”

In general, the chatbot appears to have been a useful transition tool as shown in Tables X and XI. Just under 50 percent of students indicated that the chatbot at least somewhat increased their level of motivation in the course and approximately 69 percent indicated that it at least somewhat assisted them with the transition and adaptation to university. Although survey in this round of research did not gather data on challenges for students, anecdotal data suggest that the use of Kik as a platform created a substantial resistance to adoption. Students did not want to add an app to their phones that they were unlikely to use beyond BU111. Furthermore, the limited artificial intelligence capabilities of the chatbot limited the ease and speed with which the bot could provide answers to frequently occurring questions or the ability to use natural language to access answers or content that was often accessed.

From the instructor’s perspective, the challenges associated with use were the fact that it was not easy to create/program the chatbot. To do so generally requires knowledge of a programming language such as Python. Creating a chatbot also requires a substantial amount of time to design the structure of the bot, identify the kinds of content which should be provided and how this should be most efficiently provided. Furthermore, once created it is challenging to

### Table VIII. Social perception of bot

<table>
<thead>
<tr>
<th>Did use of the chatbot make the course feel more social and/or personal than other courses that did not use a chatbot?</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>38.6</td>
<td>120</td>
</tr>
<tr>
<td>No</td>
<td>34.4</td>
<td>107</td>
</tr>
<tr>
<td>Somewhat</td>
<td>27.0</td>
<td>84</td>
</tr>
</tbody>
</table>

### Table IX. Willingness to ask questions

<table>
<thead>
<tr>
<th>Did you ask questions to the chatbot that you might not have asked your professor or TA?</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>28.2</td>
<td>88</td>
</tr>
<tr>
<td>No</td>
<td>71.8</td>
<td>224</td>
</tr>
</tbody>
</table>

### Table X. Chatbot as a transition aid

<table>
<thead>
<tr>
<th>In comparison to other courses, did you feel that the provision of a chatbot assisted you with the transition and adaptation to University academic expectations in BU111?</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>28.9</td>
<td>89</td>
</tr>
<tr>
<td>No</td>
<td>30.2</td>
<td>93</td>
</tr>
<tr>
<td>Somewhat</td>
<td>40.9</td>
<td>126</td>
</tr>
</tbody>
</table>

### Table XI. Motivational impact

<table>
<thead>
<tr>
<th>Did use of the chatbot increase your level of motivation in this course more than other courses that did not use a chatbot?</th>
<th>Response %</th>
<th>Response count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>19.9</td>
<td>61</td>
</tr>
<tr>
<td>No</td>
<td>51.5</td>
<td>158</td>
</tr>
<tr>
<td>Somewhat</td>
<td>28.7</td>
<td>88</td>
</tr>
</tbody>
</table>
make adjustments as further programming was needed. Finding such expertise is not easy and not inexpensive. As courses change each term the bot would require adjustments to its programming which would mean an ongoing commitment of time and money.

Conclusions and future iterations
Mobile telephones are prolific and students and their phones are inseparable. The existing findings related to technology in the classroom suggest that they may represent an opportunity to both make students comfortable in their new environments socially and help them manage its complexity so that they can transition into university more easily. The use of the chatbot represents an opportunity to assist students by providing information that can be quickly and easily found, as well as make them feel a little more comfortable and connected with the instructor. Importantly, both of these objectives are achieved without increasing the demands on the instructor. Indeed, the instructors of BU111 found that the student e-mails they received asking questions caused by information overload or an inability to find information declined significantly.

Cautions from the findings suggest that a balance must also be achieved between enabling transition and building dependence. It was interesting to note that although this was a tool that was not available in any other course, some students still resented that they were not receiving weekly detailed reminders of their work rather than appreciating that some form of prompt was being provided. At some points, students must learn to problem solve and search for information without an automated assistant or someone close by who has all of the answers. Future research identifying the most appropriate time and method for “weening” students off of ready-made assistance and become self-reliant students is an important first step to becoming self-reliant young adults.

Furthermore, additional research is needed not only on mechanisms for handling information overload but also the development of intuition and search- and problem-solving skills. Although the bot assisted students with dealing with information overload by making it easy to find course information, research into how to best use technology to develop search skills is needed. An additional question that now arises from the potential solutions that technology can provide is whether these solutions simply aid transition or if they create a dependence and create disincentives or even a hindrance to the student’s ability to develop coping mechanisms. Do they encourage students to persist and succeed by helping them cope with the trivialities of search or do they undermine their ability to cope when the tool is not available? Finally, future research will more specifically explore the extent to which the chatbot aids transition rather than simply making life a little easier for the transitioning student. Do mechanisms that aid students in finding needed answers and provide them with a perception of social connections actually aid in retention? A comparison of students who used the chatbot against those who did not will be included to better understand the impact of the tool.

Future iterations of the chatbot will incorporate insights gained from this version. In reviewing the comments, some students liked the jokes and individual notifications and wanted more while others did not. As indicated in Table VII, approximately 16 percent of students reacted to the notifications with “I can plan my own time.” This reinforces the notion of individual information preferences and that “overload” is a very individual thing. Future iterations of the chatbot will allow students to subscribe and unsubscribe to receive notifications as well as jokes and individual review questions so that their individual information and communication preferences are more likely to be satisfied.

In addition, the chatbot will be developed for Facebook Messenger. Most students already have Messenger and it is a cross-platform product (runs on both mobile telephone and computer/tablet), whereas Kik has fewer subscribers and it only works on mobile telephones.

We will also be experimenting with making the chatbot “friendlier” by incorporating photos and images. Images are more aesthetically pleasing than text alone, but we believe
that visuals of faces and humor increase the “friendliness” of the product and, it is hoped, increases social bonding further.

Finally, we plan to harness more of its potential as an educational tool by pushing weekly or bi-weekly “food for thought” or review questions so that students are at least thinking about the material between lectures. At least one of the instructors also plans to use it to hold virtual office hours. Students often indicate that they are uncomfortable coming to the professor’s office and find it intimidating. It is hoped that in allowing students to ask questions during a designated hour (so that the burden to the instructor is not increased), using social media will encourage more students to ask for assistance or at least feel that the instructor is in general more approachable.

With the increasing flexibility and artificial intelligence of technology, we have at our disposal tools that could be used to educate as well as enable the support of student transition if used judiciously and appropriately. Rather than lamenting the proliferation of smart devices, we should continue to seek ways to use them to make our students and ourselves smarter.

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Teachers’ pedagogical reasoning and reframing of practice in digital contexts

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Abstract

Purpose – The purpose of this paper is to advance the understanding of teachers’ reframing of practice in digital contexts by analysing teachers’ pedagogical reasoning processes as they explore ways of using information and communication technologies (ICT) to create added pedagogical value.

Design/methodology/approach – A design-based research (DBR) approach is employed, in which the on-site researcher collaborates with eight teachers of English as a foreign language in four Swedish schools over a period of two years. Multiple data sources are included for thematic coding and analysis. The technological pedagogical content knowledge (TPACK) framework is used as a conceptual construct in the analysis.

Findings – The findings show that teachers’ pedagogical reasoning is a complex and multidimensional process and is closely integrated with teachers’ reframing of practice. Common characteristics in the teachers’ reframing of practice are identified. The results highlight the reciprocal relationship between developments in teachers’ pedagogical reasoning and TPACK development and the need for a distinction between general and specific, theoretical and practical TPACK.

Research limitations/implications – An increased focus on TPACK research on teachers’ pedagogical reasoning is required. DBR is a relevant approach for this.

Practical implications – The pedagogical uses of ICT identified as adding value could benefit teachers in other contexts.

Originality/value – Rich data from multiple design contexts are collected and analysed over time through DBR. The paper contributes new knowledge about the process of pedagogical reasoning and its relation to teachers’ reframing of practice. The paper also contributes to TPACK theory development.

Keywords ICT, Design-based research, TPACK, Added pedagogical value, Pedagogical reasoning, Reframing

Paper type Research paper

Introduction

In Sweden, as in most other European countries, information and communication technologies (ICT) have been increasingly introduced in schools. One trend is the introduction of so-called one-to-one schools, where every student is equipped with a computer. Hopes have been expressed that ICT could be used to create added pedagogical value by supporting teaching and learning in new and improved ways. However, as previous research has shown, introducing ICT into classrooms does not necessarily mean the creation of added value (OECD, 2015; Wastiau et al., 2013). Vrasidas (2015) argues that for this to happen, teachers would need to reframe their practices and develop what Koehler et al. (2014) refer to as technological pedagogical content knowledge (TPACK). However, due to the complexity and reciprocity of teacher knowledge and teacher practice, further research is needed in order to better understand...
and support teachers’ reframing of practice in digital contexts (Olofsson et al., 2015; Voogt et al., 2013).

The research reported on here is part of a longitudinal design-based research (DBR) project, in which the researchers worked with eight upper secondary school teachers of English as a foreign language (EFL) in four one-to-one schools. Relatively few studies have examined teachers’ pedagogical reasoning and the meaning of TPACK for specific subject domains (Voogt et al., 2013). A DBR approach can provide a rich account of teachers’ design considerations and pedagogical choices over a sustained period of time (Bannan et al., 2016). A central idea in this DBR project is to explore ways of using ICT to create added pedagogical value in EFL education, i.e. using ICT to support learning in ways that would not be possible without it. Shulman’s (1987) model of pedagogical reasoning has therefore been used to discern and analyse different dimensions of teachers’ ICT-supported practice.

The purpose of this study is to contribute to the understanding of teachers’ reframing of practice in digital contexts by analysing their pedagogical reasoning on how to integrate ICT to create added value in relation to the design of a representational repertoire (e.g. multimodal examples and demonstrations), the design of learning activities and the evaluation of their educational design and assessment of students’ knowledge representations (e.g. texts, recorded speech or other digital multimodal representations of student performance in relation to the learning outcomes). The paper presents an analysis of how teachers’ pedagogical reasoning is formulated, manifested and developed during the DBR project. The TPACK framework (Koehler et al., 2014) is used as a conceptual construct to analyse and discuss different aspects of teacher knowledge in relation to this reasoning.

Teachers’ reframing of practice
An important part of teachers’ reframing of practice involves understanding and discovering the potential affordances of digital technologies (e.g. smartphones, wikis, etc.) and considering how they could be used in relation to different aspects of their practice (Holmberg, 2014; Norman 2013). Shulman (1987) identifies different aspects of teacher practice and refers to them as “the processes of pedagogical reasoning and action”. The “separation” of reasoning and action should not be (mis)understood as a separation of theory and practice, but as an analytical and semantic division of a multidimensional process. Schön (1983) refers to this process as an ongoing “reflective conversation with situations”, in which teachers reflect on their actions and understandings in an integrated multidimensional and multifaceted process. In this paper, the term “pedagogical reasoning” is used to describe the integrated processes, in which teachers apply and reflect on different aspects of their professional knowledge and practice.

Shulman (1987) describes the unique knowledge that differentiates teachers from content experts as pedagogical content knowledge (PCK). Koehler et al. (2014) argue that the increasingly important role of ICT in teachers’ practices warrants a discussion about teacher knowledge using a conceptual construct that incorporates technological knowledge (TK) and its relation to pedagogical knowledge (PK), content knowledge (CK) and PCK. They have extended Shulman’s categorisation of teacher knowledge and describe this “new” amalgamation as TPACK. The TPACK framework also includes technological content knowledge (TCK) and technological pedagogical knowledge (TPK), i.e. knowledge about the reciprocal relationship between technology and content and technology and pedagogy. The TPACK framework has become a commonly used conceptual framework in research into teachers’ knowledge about using ICT to create added pedagogical value (Harris et al., 2017). It has also proved to be an intuitive concept when communicated and discussed in collaborations between researchers and teachers (Voogt et al., 2013).
However, in their review of the TPACK literature, Voogt et al. (2013) conclude that defining teacher knowledge is not enough and that studies of teachers’ pedagogical reasoning (i.e. teachers’ use and development of knowledge in practice) are needed to better understand their decisions about the use of technology. It is in this pedagogical reasoning that teachers’ knowledge, skills, judgements, analyses, decision-making processes and so on are manifested and can be studied. The process of reasoning also includes aspects of making sense of past, present and future situations and understandings, thus influencing present and future decision making (Weick, 1995). The process of pedagogical reasoning is a central part of the process of teachers’ reframing of teaching, teaching practices, possibilities with ICT, etc. Similarly, the use of ICT affects all aspects of the pedagogical reasoning process (Smart, 2016). Analysing teachers’ pedagogical reasoning is one way of furthering understanding about their decisions to use technology and their reframing of practice (Harris et al., 2017). DBR is increasingly acknowledged as an advantageous approach for such efforts (Albion et al., 2015). Although DBR often focuses on the designed intervention (e.g. designed artefacts, tools used, etc.), the close and extended collaboration between researchers and teachers in situated design contexts provides unique opportunities to study teachers’ design thinking and action and reflection-in and reflection-on those actions (Plomp and Nieveen, 2013; Schön 1983).

**Methodology**

This study was conducted as part of a DBR project, where the on-site researcher collaborated with eight upper secondary school teachers of EFL in four different one-to-one schools in Sweden over a period of two years. The teachers (six women and two men) had between 6-12 years of English teaching experience. They described themselves as positive about the potential of ICT for pedagogical purposes and as somewhat more digitally competent than the average colleague. The study focused on the teachers’ pedagogical reasoning in relation to educational design in a total of 18 different classes in four theoretical and two vocational study programmes, and in classes from years one, two and three.

The on-site researcher’s primary role was to explore the teachers’ intentions for and *de facto* use of ICT and to gain a basic understanding of their pedagogical reasoning. The teachers’ pedagogical reasoning was stimulated by the researcher’s questions about their educational design intentions and practices. Similarly, the teachers’ questions to the researcher were recognised as an aspect of and a stimulus for their own pedagogical reasoning processes. The teachers’ design questions, ideas, experiences and enacted educational designs were interpreted by the researcher and discussed with the teachers in relation to theories of learning and available technologies.

Thus, during the project, the on-site researcher and the individual teachers participated in a collaborative ongoing reflective conversation with and about their design situations. In these design conversations, both parties suggested ways of using ICT to create added value, although the final decision on implementation was taken by the teachers themselves. If a teacher expressed the need for hands-on “technical assistance”, the researcher provided this as far as was possible and acted as a tutor until the teacher felt comfortable in his/her own use of the technology.

**Data collection and data analysis**

As teachers’ pedagogical reasoning about how to use ICT to create added value in educational designs is in focus, the data collection for this study was limited to periods of planning, introducing and evaluating the designs. The allocated time for the designs was six to eight weeks, with 150-180 minutes of lesson time each week. Sometimes, individual teachers’ scheduling, workload, periods of mandatory national
testing or pre-planned educational activities necessitated a hiatus in the collaboration. In-between the physical meetings, Skype meetings with screen sharing lasting approximately 5-15 minutes were held when needed, mainly in relation to the use of tools or minor design decisions. These Skype meetings were not recorded, but documented as field notes. Evernote (evernote.com) was used as a reflective text and image-based tool.

The data consisted of: 23 hours of transcribed design conversations, the teachers’ practical enactments of their design intentions (i.e. their educational designs), 35 written reflective log entries that the teachers shared with the researcher in Evernote, eight hours of transcribed focus-group interviews with students in groups of four to six (in order to further understand how designs as enactments of teachers’ pedagogical reasoning were experienced by students), and the researcher’s field notes.

The inclusion of multiple data sources was considered important for the trustworthiness of the analysis (Lincoln and Guba, 1985). Re-listening to design conversations and focus-group interviews in close proximity to their recordings supported the formulation of expanded descriptive and reflective field notes as an initial part of the analysis. Also, listening again to the recordings while reading the transcripts facilitated the detection of nuances that had not been captured in plain text, e.g. intonations or hesitations which can indicate levels of understanding or reframing. Using field notes, transcripts and recordings in parallel in an extended process of thematic coding and analysis (Ayres, 2008) helped to avoid de-contextualisation through coding (Flick, 2014, p 26.). Parts of the individual and focus-group interviews relating to educational design served as member checks and as complements to the coding process. A preliminary coding frame was constructed based on the Shulman’s model of pedagogical reasoning. The data were coded with the aid of the Nvivo software (version 11), which facilitated coding in relation to multimodal design elements as part of the teachers’ educational designs, e.g. the inclusion of an individual blog as a tool for metacognitive reflection. The teachers were classified as case nodes in Nvivo and data sources were classified according to time, which allowed queries to be made that helped to visualise the relationships between the coded data and different teachers over time. Abductive inferences about teachers’ pedagogical reasoning during the study and how this was described, enacted in practice and/or experienced by students could thus be made in consecutive rounds of thematic coding, where the codes became progressively less descriptive and more analytical (Ayres, 2008). The TPACK framework was used as a conceptual construct in both the analysis and the presentation of the results.

**Results**

In this section, the results of the study are presented under three separate headings referring to the teachers’ pedagogical reasoning about the use of ICT for added pedagogical value in EFL: the design of a representational repertoire, the design of learning activities and the evaluation of educational designs and assessments of students’ knowledge representations. Three interconnected aspects of the teachers’ pedagogical reasoning emerge from the analysis of the data and are illustrated under each of these headings. These aspects relate to: the most common uses of ICT and the perceived added value of these uses, teachers’ intentions for vs their actual use of ICT, and reasons for any discrepancies between intentions and use with regard to TPACK. In combination, these aspects contribute to a more complete understanding of the development of the teachers’ pedagogical reasoning during the DBR project and how they frame and reframe their teaching practices in digital contexts.
Pedagogical reasoning in designs of representational repertoires

In Shulman’s (1987) pedagogical reasoning and action model, he discusses the need for teachers to find ways of transforming their understanding of the content, to “scrutinise” the teaching material to decide whether it is “fit to be taught” and if it is not, to decide how it could be “made more suitable for teaching” (p. 16). He refers to this process as transformation.

The internet as a source of authentic and relevant teaching materials

Today, the amount of teaching material available on, e.g., the internet is practically unlimited. In this study, none of the eight teachers made use of a course textbook or any other kind of pre-ordered course material, but instead used ICT to find web-based content and create their own teaching materials. The teachers admitted that finding and creating teaching materials took time, yet it was necessary because it allowed them to use and create material that, in their words, was “more authentic” and illustrated a “real life use of English” (in contrast to material constructed specifically for school use). It was also considered important to use material that was up-to-date and considered relevant by the students. This striving for authenticity and relevancy was manifested in the choice of up-to-date sport-related multimodal news content for reading and discussion in a class, in which the majority of the students were athletes. The teachers also found it important to work with topics and explanatory examples that they themselves found interesting.

The teaching materials mainly consisted of:

1. Multimodal content illustrating a real-life use of English in the form of written texts, videos and podcasts freely available on the internet. These were mainly used as examples to model the intended learning outcomes.

2. Explanatory and “already transformed” multimodal content. This content was produced by:
   - official educational stakeholders like the British Broadcasting Corporation;
   - EFL or ESL (English as a second language) teachers from around the world; and
   - native English speakers.

3. Explanatory texts (sometimes scanned from books) or multimedia presentations (mainly PowerPoint) that the teachers had either received from colleagues or created themselves. At two of the schools, the teachers had used their learning management system (LMS) to create folders and share different kinds of teaching materials.

It could be argued that the teachers’ decisions to sometimes use teaching materials created by others meant that they accepted other people’s interpretations and transformations. Not using a textbook also meant the lack of a publisher “guaranteeing” the quality of the teaching material. In general, the teachers in this study demonstrated a highly developed CK and PCK. For example, their oral and written English was excellent and they understood which aspects of the learning content were problematic for learners (e.g. certain grammatical constructions, nuances in oral speech, etc.). However, in less favourable circumstances, the wealth of online teaching materials of varying quality could be considered a potential problem if teachers simply “accepted” someone else’s transformations.

Multimodal transformation and annotation of digital content

The teachers considered that authentic educational material was easy to find, but expressed that they often wished they knew how to “choose certain parts (of this content)”, “comment
on it”, “build on it” and “save it for use in other contexts”. Moreover, they also found it difficult to include external material in the school’s LMS in a “logical way” without having to resort to less satisfactory solutions, such as word documents with long lists of links. The results showed that the teachers had the necessary curricular knowledge and CK to identify teaching materials with explanatory value and/or value as models for the intended learning outcomes. It could also be argued that they had the general theoretical TCK to envision the value of this functionality of ICT. However, at the beginning of the project design conversations revealed that they lacked the specific practical TK to curate, edit and annotate, i.e. digitally transform, this material to suit their own and their students’ needs. Towards the end of the DBR project, learning this in collaboration with the on-site researcher was mentioned as one of the benefits of being involved in the project.

The fact that the teachers did not know about or had not used annotation tools such as screeencasting services could be interpreted as “a lack of TK”, or them not being “technologically competent”. However, based on the on-site researcher’s experience and the teachers’ own statements, they could all be considered somewhat more ICT competent than their average school colleague. Three of the teachers even had special roles as someone to whom their colleagues could turn for help with ICT-related issues. Moreover, when the on-site researcher introduced the teachers to a web-based screeencasting tool for editing and annotation (Screencast-O-Matic), they immediately saw its potential as a teaching tool. Shortly after this, six of the eight teachers wrote about or showed the on-site researcher how they had learned to use screeencasting for annotation or lecturing purposes. This illustrated that TK as “knowledge about traditional and new technologies that can be integrated into curriculum” (Koehler et al., 2014, p. 102) was a rather blunt theoretical concept. In this study, the six teachers who quickly learned to create screeencasts proved that they had the necessary knowledge and skills to use the required technology once they had been introduced to the ideas of annotation and screeencasting. In other words, their general theoretical TK enabled them to understand the benefits of a certain digital tool and to quickly develop the necessary specific practical TK to use the tool to add pedagogical value to their representational repertoire.

Pedagogical reasoning in the design of learning activities

The teachers’ work in designing a representational repertoire to help students’ learning was intimately connected to ideas about how students could use these representations in different learning activities. For example, at the beginning of the DBR project, one teacher used two speeches by Angelina Jolie and Leonardo DiCaprio that were available on YouTube as examples of powerful speeches and illustrations of argumentation and speaking techniques. This was done in the classroom by the teacher fast-forwarding, pausing and commenting “live”. After being introduced to editing and annotation tools by the on-site researcher, the teacher used a web-based tool (TubeChop) to select illustrative parts of these speeches and make a screeencast to record and comment on their specific qualities and the techniques used by Jolie and DiCaprio. The screeencast was made available to the students as a link in the LMS, so that they could watch it whenever and wherever they wanted. Thus, these tools helped the teacher to add value to his/her representational repertoire. However, the teacher also realised that finding, selecting and commenting on other good (or bad) argumentative speeches was a fruitful way for students to understand the qualities of speeches and the techniques used to deliver them. The teacher therefore designed a learning activity, in which the students were asked to find argumentative speeches and to choose and comment on their illustrative parts. The students thus created digital knowledge representations to illustrate their understanding of what characterised a good argumentative speech and what needed to be learned to deliver it. In other words, the teacher asked the students to use ICT to transform and convey their understanding of
the content, just as the teacher had done. Here, the development of the teacher’s TK in relation to content representation allowed him/her to express specific practical TCK. At the same time, the teacher’s existing PCK also helped him/her to see the pedagogical potential of the technology in a learning activity. By realising this potential, the teacher could also be said to express specific practical TPK and TPACK.

**Documentation and sharing of knowledge representations for collaborative learning**

During the initial design conversations, all the teachers, albeit to varying degrees, said that they thought that ICT could be used to create added value that would help them to support collaborative learning to a greater extent. However, they also expressed that for various reasons they had not explored these potentials (Holmberg, 2017). One of the reasons for this was that the teachers lacked functionality to support collaborative learning in the LMS used by three of the schools: “I can see their texts, and that’s good, but the mass of knowledge that they (the students) have is seldom shared between them”. The teachers also did not have specific practical knowledge about the alterative tools that allowed their students to engage in collaborative creation and dialogue.

There were other kinds of technology-related questions that they did not know the answers to: “Well it’s just […] how do you record, practically speaking? Could everyone use their phone or iPad? How would they […] how do you share it so that I can see it, and a number of students, but not everyone?” Some of the teachers also felt that they had to be able to support students if they asked them to use their own hardware to video record themselves or each other. Here, the teachers did not have sufficient specific practical TK to realise their intentions for increased collaborative teaching and learning. However, they did have the general theoretical TK to envision uses of ICT that could support the collaborative learning of a specific content and thus, arguably, general theoretical TPACK.

In dialogue with the on-site researcher, several free web-based services with built in social and collaborative functionality were introduced, explained and gradually adopted by the teachers and students (e.g. Wikispaces, Evernote, Blogger, Padlet, YouTube, and Diigo). Thus, the students’ use of ICT to create and document knowledge representations and share these for peer modelling and peer discussion became an increasingly common type of learning activity in the teachers’ educational designs during the research project. For example, the students’ digital knowledge representations of their views of what characterised a good argumentative speech were shared for peer modelling and discussions using Google Docs. Again, the teachers’ existing general theoretical TK helped them to quickly develop the necessary specific practical TK, which in turn enabled them to realise their intentions and display specific practical TPACK.

**Authentic tasks and learning activities**

Student-created digital knowledge representations were also increasingly used for “authentic audiences”, such as other students in the school, parents, or the entire world. The possibility of using ICT to make learning activities as authentic as possible was mentioned as an important added pedagogical value by all the teachers. Two major reasons for this became evident in the research material. First, creating for and presenting to an audience outside the classroom was seen as a way to: “force the students to get their act together”. Knowing that there was a “real” deadline and/or that a “real” audience would be listening to the podcast or watching the video was an incentive for the students to perform well.

Second, the teachers also expressed that the creation of digital artefacts for use in “the real world” meant that the actual learning process became more authentic, in that the students had to use digital tools and a language that was not adapted for classroom use: “[…] because then you don’t get the […] do I have to write a complete sentence or does it have to be […] there is a context that can provide answers to those questions”. The teachers’
insights related to TCK, i.e. an understanding that Swedish school English and native English differed and that the use of ICT could illustrate this. However, these insights also related to TPK, i.e. how ICT could be used as a pedagogical tool to motivate students by allowing them to participate in authentic contexts. The teachers’ creation of educational designs incorporating such added value could be described as signs of TPACK. The importance of situating a learning task in the context of future use is supported by previous research on ICT-supported authentic learning (Herrington et al., 2014).

Stimulation and support of metacognitive reflection

Another area in which ICT was envisioned as creating added pedagogical value related to the support of student metacognition. Six of the eight teachers envisioned using ICT to document thinking and reflections on this as a potential pedagogical added value. Four of the teachers stated that they had considered using, or had used, the built in functionality in their LMS or word documents for this purpose, but that the difficulty of commenting on and sharing students’ reflections made such use unsatisfactory. Thus, a majority of the teachers showed signs of theoretical general TK/TPK in relation to ICT-supported metacognitive reflection, but did not have specific practical knowledge and experience in this area.

The possibility of using blogs was mentioned during the ensuing design conversations. The teachers either had not considered this as a possibility, or had voiced concerns about how to “keep track of all and new” (b)log entries and how to “comment on them”. The on-site researcher demonstrated how notifications about new blog entries could be received and how blogs could be commented on. Moreover, the researcher illustrated the possibility of students reflecting through or on multimodal content such as audio/video recordings and screencasts. The conversation thus revolved around TK and TPK-related questions. However, the on-site researcher also asked why and how the teachers wanted their students to reflect on their thinking and learning. Hence, the teachers’ role in relation to student metacognition and the expressed need to comment on the students’ reflections was problematised, where the focus was on pedagogy.

As part of this collaborative pedagogical reasoning, i.e. discussing, trying out and evaluating the benefits of different ICT and other strategies to support student metacognition, five of the teachers incorporated the support of student metacognition into their educational designs. Four of them chose tools with a blog or “blog like” functionality to do this (Blogger, Evernote and Padlet). Having previously developed their TK (and having made sure that the students also had the necessary TK) to document, annotate and share multimodal knowledge representations, these were now used to support students’ reflections on their learning outcomes and learning strategies. A very visible added value of this was connected to students’ oral performances. As these could now be documented and annotated, it meant that students (and teachers) had something tangible to reflect on and relate to (Caldwell and Heaton, 2016).

One of the teachers decided to use the LMS instead. Although s/he was aware of its limitations, s/he did not want the students to: “have to learn [how to use] a new tool, where to find it and its password”. This illustrates how teachers have to take not only their own, but also their students’ TK into account and whether or not it allows ICT to be used in a way that creates added pedagogical value. That students are not a homogenous group as far as digital literacy is concerned, this became evident in this study (Anderson, 2016). Regardless of which ICT was used (e.g. blogs or LMS), the teachers found ways of enabling students to discuss and reflect on their learning with their peers and to use their own and/or their peers’ knowledge representations as practical examples in these discussions. Thus, during the DBR project, the teachers developed a practice in which ICT was used to support students’ individual and collaborative metacognitive reflection in relation to the learning goals, the study process and the knowledge representations produced.
Pedagogical reasoning in evaluations of educational design and assessments of students’ knowledge representations

Shulman (1987) discusses teachers’ constant checking of students’ understanding as an important and integrated part of teachers’ pedagogical reasoning. However, during the initial design conversations with the teachers they all, to varying degrees, expressed that they spent more time than they had envisaged on administering tests. One teacher even went so far as to say: “we don’t teach anymore, we just collect products for assessment”.

Automated feedback

In relation to this, a number of the teachers mentioned the use of ICT for automated feedback as a potential added value. Some of the teachers used web-based services to create flashcards and word tests with automated feedback. However, analyses of the designs and design conversations show that they recognised that the potential added value of this use was limited to students’ learning of factual knowledge, e.g. words and spellings.

Prior to the national tests in English that Swedish students take as part of their English studies, one of the teachers asked the on-site researcher for help in creating a standalone material that could be used to practise reading and listening skills and provide automated feedback or material for self-correction. This teacher knew that s/he would have to work individually with some students to help them to prepare for the test, but wanted the rest of the class to be able to do this on their own. A web-based service called Blendspace was used by the on-site researcher in collaboration with the teacher to curate and aggregate freely available resources with varying levels of difficulty from the web to build two “Blendspaces”, where students could practise their reading or listening skills. These resources were shared with three other teachers in the project whose classes would also be taking the national tests that term. When questioned about the potential value of these Blendspaces, the teachers were very positive (also on behalf of their students). The statistics available in Blendspace showed that each Blendspace had approximately 350 views before the national tests by the student group consisting of approximately 100 students (four classes). The teachers used two lessons for voluntary work with the Blendspaces, which were only available to students with access to their unique links.

However, despite the perceived usefulness of such ICT, only one of the teachers used Blendspace as a recurring part of his/her practice. The reasons why the other teachers did not start or continue to use Blendspace were a perceived lack of time and/or TK to create a Blendspace and a fear of losing control of the assessment process when using material created by others. The only teacher who continued to use Blendspace as part of his/her practice was the one who had watched and helped the researcher to create a Blendspace. This teacher knew how to incorporate content created by others and comment on it, thus tailoring it to the needs of a class. In other words, this teacher had developed specific theoretical and practical TK, which arguably allowed her/him to perceive affordances that the others did not (Norman, 2013, p. 18-19).

Student, peer and teacher assessments in relation to knowledge representations

In relation to the assessment of students’ knowledge representations, using ICT to support self-assessment and peer assessment (as part of the self-reflection/metacognition described under the previous heading) was increasingly mentioned as an added value during the project. Students used their computers and phones to create, document and share multimodal knowledge representations (e.g. texts, discussions, speeches). The teachers also used their newly developed knowledge of screencasting to formatively annotate and assess
students’ documented multimodal knowledge representations. The ability to do this in direct relation to a student’s knowledge representation and use their voices to convey the nuances in this process were mentioned as adding pedagogical value.

Conclusion and discussion
This study explores how eight teachers over a period of two years applied and reflected on different aspects of their professional knowledge and practice in their efforts to use ICT to create added pedagogical value. The findings show how a reframing of the teaching/learning process and teacher practice is enacted and elaborated through the teachers’ pedagogical reasoning. The complexity and reciprocity of the teachers’ pedagogical reasoning is illustrated by the fact that the most common uses and/or identified added values of ICT (e.g. to support learning through authentic tasks and practice, support of collaboration with different actors, assessment and reflection in relation to documented multimodal knowledge representations) were all elaborated, reconceptualised and/or discovered during a reciprocal process of pedagogical reasoning and TPACK development.

The findings illustrate how teachers’ pedagogical reasoning, as a process of discovering, evaluating, taking advantage of and/or creating added pedagogical value with ICT, is intrinsically linked to a continuous development and active reframing of teachers’ TPACK, i.e. what Olofson et al. (2016) refer to as TPACKing. Moreover, the findings illustrate that TPACK as a theoretical construct for discussing the theoretical and practical aspects of teacher knowledge development does not necessarily distinguish between teachers knowing about ICT and knowing how to use it. In this paper, the teacher knowledge and skills that are necessary for pedagogical ICT use are described and discussed in terms of theoretical or practical, general or specific. For example, at the beginning of this project the teachers expressed different kinds of added pedagogical value that they believed could (theoretically) be created through an informed use of ICT. The teachers also often had a general idea about how this could be done, such as using ICT to choose certain “parts” of web-based material, to support collaborative learning and to create multimodal knowledge representations for formative teacher/peer/self-assessment and metacognitive reflection. However, even though they all worked in one-to-one schools, many of their ideas had not been put into practice. Thus, in a sense they could be said to show signs of theoretical and general, but not practical and specific TK, TCK, TPK or TPACK. Nevertheless, having a theoretical and general understanding of a certain use of ICT meant that a quick demonstration or description by the on-site researcher helped them to develop the practical and specific knowledge and skills to use ICT as per their intentions. This practical and specific use of ICT led to new general ideas, or to a specification of existing theoretical ideas and insights about how it could be used to create other types of added pedagogical value, i.e. teachers’ practical use of ICT led to a reframing of teachers’ general and/or specific theoretical TPACK.

Only teachers who know how, i.e. have the necessary practical and specific knowledge and abilities, are able to use ICT in line with their pedagogical intentions. In the light of this, the fact that previous research on and development of teacher TPACK has primarily focused on “measuring” this through self-assessments, mainly in terms of general TPACK knowledge, is not optimal (Willmark, in press; Voogt et al., 2013). This study shows that teachers’ pedagogical reasoning can be viewed as a continuous process of iterative reflective professional conversations with design situations, where ICT is used for added pedagogical value and the “necessary” specific practical TPACK is manifested and elaborated on in situ. Based on these findings, there can be no expected use of ICT (Vrasidas, 2015) or the measurement of (a situated and continuously evolving) TPACK as an attainable goal. Instead, further research is needed to better understand teachers’ pedagogical reasoning.
and how best to support teachers in the process of pedagogical reasoning and TPACK development.

The findings in this study demonstrate how a reframing of the teaching/learning process and teacher practice is enacted and elaborated through the teachers' pedagogical reasoning. Some identifiable common characteristics of this reframing are that:

- Collaboration is no longer envisioned as and/or limited to text-based peer assessment, but widened to include different modalities, e.g. through YouTube videos and audio podcasts.
- Documenting, annotating and reflecting in relation to multimodal knowledge representations become central parts of the teaching learning process.
- There is an increased focus on designing for the exchange of and interaction in relation to students’ documented knowledge representations as expressions of knowledge.
- Teachers (and students) to a lesser extent view knowledge representations as artefacts to be graded and “forgotten” and more as visualisations of knowledge that can be used to support further understanding, teaching and learning in a process of individual and collaborative sense-making.
- ICT is increasingly used to support learning in authentic contexts, i.e. on the web with people and tasks from “outside” the classroom, and with collaborative technologies like wikis and blogs.
- Students are increasingly viewed as being responsible for their own learning and able to act as independent learners without constant commentary or “assessment”, for example in relation to metacognitive reflection.

This reframing of the teaching learning process is both a sign of and a prerequisite for a changed “culture”, in which students feel more comfortable commenting on each other’s performances, given that this is now perceived as helpful rather than judgemental. However, the notion of school as a place where products are produced for assessment is still apparent amongst students. This is visible in student comments like: “I didn’t understand the blogging part, [the teacher] didn’t even correct it”.

It is also worth noting that the teachers’ reframing of practice (and the parallel development of TPACK) often led to the design of learning activities involving students as users of ICT and in ways that required more of them in terms of digital literacy and TK. Thus, this reframing of practice was also dependent on a reframing of students’ practices. This is yet another indication of how multifaceted the process of changing pedagogical practices is, and that taking advantage of the potential of ICT is something that has to be continuously worked on in situated contexts by teachers and students. This study strengthens the argument that DBR, with its focus on teacher-researcher collaborations in situated pedagogical reasoning, can advance the understanding of teachers’ reframing of practice and support the process of unveiling and generating added pedagogical value through the use of ICT.

References


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