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Digital transformation in German higher education: student and teacher perceptions and usage of digital media

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Abstract

Digitalization in Higher Education (HE) institutions is an issue that concerns many educational stakeholders. ICT skills are becoming increasingly relevant in every context, especially in the workplace, therefore one of the prime objectives for universities has become preparing future professionals to be able to deal with problems and search for solutions, including digital competence as a vital skill set. Different policies, initiatives and strategies are currently being proposed in Germany, addressing educational technology innovations in HE. The University of Oldenburg is presented as an example, in an endeavour to gain an understanding of what is being proposed and what is actually happening in teaching and learning in German university classrooms. Two datasets were examined regarding the use and perceptions of students ($n = 200$) and teachers ($n = 381$) on the use of digital tools. Findings reveal that both teachers and students use a limited number of digital technology for predominantly assimilative tasks, with the Learning Management System being perceived as the most useful tool. In order to support the broader use of educational technology for teaching and learning purposes, strategies for HE institutions are suggested.

Keywords: Higher education, University professors, University students, Germany, Educational technology, Student perceptions, Teacher perceptions, Digital media usage, Digitalization

Introduction

With the number of 'wicked challenges' growing around the world, the need for university graduates to possess a range of collaborative and interdisciplinary skills is ever increasing (Oliver & Jorre de St Jorre, 2018). Recognition of the importance of ICT skills and digitalization of higher education (HE) institutions is likewise growing, with national, European and international policies (e.g., International Society for Technology Education, 2016, 2017; OECD, 2015a, 2015b; Redecker, 2017) acknowledging "the need to equip all citizens with the necessary competences to use digital technologies critically and creatively" (Redecker, 2017, p. 12). Given the link that higher levels of ICT skills has with higher wages (Falck, Wiederhold, & Heimisch, 2016), and the risk of job losses in the future due to computerisation and automation (Hajkowicz et al., 2016), an onus is on HE institutions to implement digitalization strategies that will foster a range of twenty-first century skills, enabling students to use technology in

flexible, adaptive and innovative ways (Claro & Ananiadou, 2009; Oliver & Jorre de St Jorre, 2018; Redecker, 2017). Despite earlier claims that the current generation innately possesses these skills (e.g. Prensky, 2001), a range of international empirical evidence shows this is not the case (Akçayır, Dündar, & Akçayır, 2016; Barak, 2018; Henderson, Selwyn, & Aston, 2017; Lai & Hong, 2015), resulting in calls for further research into how teachers and students are using educational technology in HE (Englund, Olofsson, & Price, 2017; Henderson et al., 2017; OECD, 2018a, 2018b; Selwyn, 2016b), before wide-sweeping institutional policies are successfully implemented.

Whilst it is recognised that the current trend towards pushing digitalization occurs rather uncritically (Castañeda & Selwyn, 2018), equipping students with digital competencies as part of their HE experience is nevertheless necessary, in order to empower their "agency and identity in digital spaces" (Kühn Hildebrandt, 2019, p. 4), and to prepare them for the inevitable shift caused by digital transformation, influencing every part of societal and professional life (EDUCAUSE, 2018). It goes unquestioned that merely employing educational technology is not the sole driver of student-centred teaching and learning; face-to-face teaching and learning can be equally as or more effective. However, using the affordances of digital technology can make teaching and learning more flexible, and lead to increased student agency and lifelong learning skills (Blaschke & Hase, 2015).

This article highlights the digitalization of HE within Germany, recognised as a critical challenge by policy makers (Hochschulforum Digitalisierung, 2016), and investigates how educational technology is being used by teachers and students. Following a sketch of central policy initiatives to foster digitalization within German HE, our main aim is to explore the micro-level of the university classroom. Following an exploration of international research into how teachers and students are using technology for learning, this research focuses on the context of one specific university; the University of Oldenburg. This preliminary investigation seeks to uncover which digital and educational technology is currently used in teaching and learning processes, as perceived by students and teachers.

Literature review
Educational technology in higher education

Whilst the development of ICT skills has been recognised as vital to students' full and active societal participation in the future (OECD, 2015b, 2015a), using digital media in teaching and learning does not automatically guarantee active student engagement (Kirkwood, 2009) or high achievement (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). The pedagogical competence of teachers in using educational technology is crucial (Englund et al., 2017; Kirkwood, 2009; Kirkwood & Price, 2005; Ng, 2012; OECD, 2018a), alongside modelling good digital citizenship (Choi, Cristol, & Gimbert, 2018; Redecker, 2017), as "change does not take place by simply placing [teachers] in contact with technology" (Marcelo-García, Yot-Domínguez, & Mayor-Ruiz, 2015, p. 122). Indeed, novice teachers have been found to be more adept at rapid change and development than more experienced teachers (Englund et al., 2017), who also cite a lack of digital skills as inhibitors to using more educational technology in the classroom, as well as systemic problems, such as access to technology and workload,

(Jääskelä, Häkkinen, & Rasku-Puttonen, 2017; Marcelo & Yot-Domínguez, 2018; Margaryan, Littlejohn, & Vojt, 2011).

A recent report from the UK digital education organisation Jisc, surveyed over 22,000 students from 74 UK and 10 international organisations, finding that "the full benefits of technology to support learning are yet to be realised, with technology more commonly used for convenience rather [than supporting] more effective pedagogy" (Newman & Beetham, 2017, p. 5). In a study of 941 university teachers in Spain (Marcelo-García et al., 2015), 44.4% were found to seldom use technology, which was generally limited to multimedia presentations, email and Learning Management Systems (LMS). A higher frequency of more teacher-centered uses of technology was also found in another study in Spain (Marcelo & Yot-Domínguez, 2018), with three of the most used being presentations, selecting text documents and facilitating videos for students. The study of 291 academics found that those in the Social Sciences were more likely to implement assimilative technologies, teachers in English and Architecture used a greater number of experiential learning activities, and those in the Health Sciences used more communicate learning activities. This cautious attitude towards the use of tools was reflected in a longitudinal study in Finland (Jääskelä et al., 2017), where concerns about using technology often related to beliefs about students' digital competencies or their own ability, which was also found in the UK (Margaryan et al., 2011).

There has been a range of international research investigating student use of technology for learning, undertaken in Australia (e.g. Henderson et al., 2017; Ng, 2012; Parkes, Stein, & Reading, 2015; Selwyn, 2016b), Israel (e.g. Barak, 2018), New Zealand (e.g. Lai & Hong, 2015), the United States (e.g. Bowe & Wohn, 2015; Thompson, 2013, 2015), the UK (e.g. Margaryan et al., 2011; Newman & Beetham, 2017), Canada (e.g. Bullen, Morgan, & Qayyum, 2011) and Turkey (e.g. Sumuer, 2018). Whilst research has found that students who are ICT proficient, as well as collaborative learners, are more likely to be less resistant to change and more flexible thinkers (Barak, 2018) - considered to be crucial graduate attributes now and into the future (Claro & Ananiadou, 2009; Hajkowicz et al., 2016; OECD, 2018b; Oliver & Jorre de St Jorre, 2018) - these studies all report the same findings; student use of technology in HE is mostly limited to basic tasks (Henderson et al., 2017; Margaryan et al., 2011; Parkes et al., 2015; Thompson, 2013), students need more explicit help in understanding why technology is important (Kirkwood & Price, 2005; Margaryan et al., 2011; Thompson, 2013), and they require increased scaffolding to be able to use it effectively (Ng, 2012; Sumuer, 2018; Thompson, 2013).

In an Australian study of 1658 students (Henderson et al., 2017), students identified the LMS as the most useful technology related to their studies. However, in a study on student preparedness for eLearning environments (Parkes et al., 2015), students were rated 'Poorly Prepared' for demonstrating knowledge of the LMS. This indicates that, whilst students appreciate its use as a content repository (Margaryan et al., 2011), they do not necessarily know how to use more advanced features, with five out of eight students interviewed either not knowing what a blog was, or never having read or written a blog entry (p. 436). Likewise, collaborative technologies such as Google Docs, simulations, live polling and creating content using Web 2.0 tools, have also been found to be rarely used (Henderson et al., 2017; Newman & Beetham, 2017; Ng, 2012; Thompson, 2013). In their study of 880 students, Lai and Hong (2015) found that almost 40% of students spent only

10 h or less per week using digital technologies for university purposes, which could help explain the narrow use of technologies used by university students.

The German context

In Germany, despite young people (aged 14–29) being the biggest consumers and users of the internet and digital tools, they place less importance on the teaching of digital media in schools than other age groups (Initiative D21, 2015). Whilst 99.4% of German school students have a computer at home and spend 114 min on average weekdays using technology, only 14 min is spent using technology at school per day, which is lower than the OECD average (OECD, 2015b). So too in German HE; more than 99% of students have internet access at home and are well equipped with digital devices (Zawacki-Richter, Dolch & Müskens, 2017). The same study showed that German HE students own five different digital devices on average, whilst one third own more than six devices. Within a period of 3 years (2012 to 2015) the possession of smart phones increased from 56 to 91%, which clearly highlights the trend towards using mobile digital devices. Furthermore, students were asked how important the use of digital teaching and learning tools are for their studies (demand) and how often those tools are actually used (supply). The only occasion where supply was meeting demand, was providing course materials on the LMS (Zawacki-Richter, Dolch & Müskens, 2017). The study found a consistently higher demand than supply, which indicates that there is scope to expand digital teaching and learning within German HE.

In terms of university teachers' perspectives, it is often said that they are the driving forces for implementing and developing digital teaching and learning, and for this reason, technical as well as pedagogical guidance, is recommended (Pensel & Hofhues, 2017, p. 28–29). In a systematic review of media use in HE, Riplinger and Schiefner-Rohs (2017) found that the media use and competence of university teachers are rarely discussed in German empirical studies (p. 36). Given the prevalence of content creation and communication in the European Union DigCompEdu framework (Redecker, 2017), as well as the increasing importance of HE institutional use of digital technologies in Germany (e.g. Bundesministerium für Bildung und Forschung, Referat Digitaler Wandel in der Bildung, 2016; Hochschulforum Digitalisierung, 2016), it is therefore timely to further consider how German university students and teachers are using educational technology, and how useful they find it for teaching and learning.

Digital higher education in Germany

When looking at the process of digitalization within the context of German HE, three complementing axes are noteworthy; the federal digital agenda, the think tank 'Hochschulforum Digitalisierung', and calls for research proposals by the federal government, which foster research on digitalization in HE through funding by the German Ministry of Education and Research (BMBF). In order to realise major societal, political and economic transformation, the German government devised a national digital agenda from 2014 to 2017, addressing all education levels (Die Bundesregierung, 2014). The federal government sees digitalization as a way to enable knowledge transfer and innovation in science, however it also expects its citizens to be digitally literate, in order to be able to fully participate in education and society (pp. 27–28).

In order to focus on a broad range of digitalization aspects within the HE context, such as internationalization, organizational change, and the transformation of teaching and learning, an expert forum was established, called the Hochschulforum Digitalisierung[1] [The German Forum for Higher Education in the Digital Age, HFD, 2018]. This think tank generated and disseminated working papers and policy statements between 2014 and 2016, including 20 central theses on digitalization and HE (Hochschulforum Digitalisierung, 2016). Of these theses, several address the context of teaching and learning, stating for example:

- "Innovations in digital teaching are not just technical innovations but rather academic, curricular, organisational and structural innovations"
- "The use of digital media contributes to the improvement of higher education teaching"
- "Technological change not only creates new virtual learning environments but also alters existing physical learning environments".
- "There is no shortage of digital teaching and learning innovations at universities but their structural and strategic advancement is deficient"
- "The integration of digital media in teaching and learning is a complex process of negotiation between different stakeholders within the universities" (Hochschulforum Digitalisierung, 2016, n.p.)

This expert forum will continue until 2020, including peer to peer coaching[2] for HE institutions wanting to develop digitalization strategies.

The prominence of digitalization also features in project calls by the Federal Ministry of Education and Research, targeting research proposals to further analyze the state of digitalization within education, including conducting systematic reviews. Following a first call in 2016, 20 projects are now being funded that revolve around the three main topics of 'Adaptive Learning and Assessment environments', 'Interactivity and multimediality of digital learning environments' and 'Researching theory and practice in digital learning environments' (Bundesministerium für Bildung und Forschung, Referat Digitaler Wandel in der Bildung, 2018). A second call followed in 2017, in which the innovative potential of digitalization for HE, including technological, organizational and pedagogical aspects, are being investigated, using interdisciplinary approaches (ibid.).

However, whilst public discussion and funding advance, individual HE institutions are still only now embarking on their journey into the digital age. For example, a preliminary screening of digitalization strategies of doctoral degree granting universities in Germany ($n = 155$) reveals that only four have publicly available digitalization strategies in place, with another six currently (2017/18) engaged in a peer to peer coaching process, in order to develop their respective strategies (Hochschulforum Digitalisierung, n.d.). Whilst it could be assumed that strategies and plans are being developed due to current government digital policy initiatives, this planning process is still very much in its early stages. Thus, investigating deeper into the status of individual institution progress within Germany is needed.

Case example: University of Oldenburg

Established in 1973, the University of Oldenburg (Oldenburg, Lower Saxony) has over 15,600 students (data from Winter Semester 2017/18[3]) and more than 1900 faculty

members. It offers on-campus undergraduate and postgraduate studies, alongside life-long training, at two campuses. Educational technology informed teaching at the university relies primarily on the diverse functions, provided by the open source institutional platform, Stud.IP. Every course has a virtual space within Stud.IP, which is primarily used for administrative purposes, such as the registration of students into courses. The Center for Teaching and Learning (Hochschuldidaktik) supports faculty members at the university, including introductory courses in using Stud.IP for teaching and learning, as well as a range of courses for professional development related to university teaching. Some of these courses are connected to the use of digital tools and methods for blended and online learning, with a focus on student-centered learning (the renewed area of e-Didactics,[4] established in 2017).

The institution-wide implementation of digital media to enhance on-campus learning is seen by the university management as a strategic issue and an area in need of further development. Thus, a task force has been established, involving various stakeholders from university management and strategic planning, as well as the faculties and departments for continuing education and teacher training, in a top-down/bottom-up approach. Given the vital need to consider institutional culture and assumptions of technology-supported learning prior to implementing digitalization strategies (Henderson et al., 2017; OECD, 2018a; Selwyn, 2016b), an important preliminary work has been a survey of the current media usage by students and faculty members at the University of Oldenburg, along with their perceptions of the usefulness of digital media for teaching and learning.

Method

To explore the assumptions of technology-supported learning at the University of Oldenburg, the perceived usefulness and use of digital media by teachers and students were investigated. This study is descriptive in nature, and does not aim to compare both aspects statistically. A secondary data analysis was conducted using data from the 2017/2018 Internal Teacher Evaluation,[5] as well as a large-scale student media usage study (Author, 2015, 2015, 2016). Applied consent was assumed by people filling out the survey and University Ethics Board approval was not sought for the student questionnaire at that time, as the study was deemed free of ethical constraints. Whilst the teacher and student data were not sourced from the same survey, one measuring on a 4-point and one on a 5-point Likert scale, they nevertheless address the same issue and are a suitable starting point through which to begin exploring teacher and student use and perceptions of educational technology, informing the degree of digitalization of the University of Oldenburg. Therefore, the extreme values (labelled 'very useful' and 'not useful at all') of the identical questionnaire items in both datasets were compared.

The authors are aware that methods exist to convert different Likert scales to a common scale (e.g. IBM, 2016) to allow for statistical comparison, which has been used in prior research in other fields (e.g. Xiang, Coleman, Johannsson, & Bates, 2014). However, the distance between ordinal scale responses such as these is not necessarily equal (Sullivan & Artino Jr, 2013), and therefore it is inappropriate to combine them in this case (Jamieson, 2004). The authors are also aware that the time difference between the surveys is a substantial limitation, and therefore another iteration of the 2015 student

study (Author, 2016) is being conducted in late 2018, using the same instrument and scale for both students and teachers.

Teacher data

The teacher data was obtained from a questionnaire[6] conducted by the Internal Evaluation Unit (Winter Semester 2017/2018) of the Presidential Department for Study Affairs. The Internal Evaluation Unit of the university is responsible for ensuring the continuous and sustainable optimization of the quality of courses and teaching. The questionnaire was delivered online via email through the internal teacher distribution list for all faculties, university-wide. Three hundred eighty-one teachers (47% male and 53% female) across the six faculties (see Fig. 1) answered the questionnaire, from a total of 1946 (20%) teachers. In regards to age, 4% were below 26 years of age, 17% were between 26 and 30, 32% were between 31 and 40, 22% were between 41 and 50, 18% were between 51 and 50, and 6% were over 60 years.

The third section of the questionnaire was directed at the use and perceived usefulness of digital tools for teaching. Using a 4-point Likert scale (1 = in every lesson; 2 = in many lessons; 3 = in a few lessons; 4 = in no lessons) teachers were asked in how many courses they used a digital tool at least once during the last year. Teachers also rated the perceived usefulness of these tools with a 4-point Likert scale (1 = very useful; 2 = quite useful; 3 = not very useful; 4 = not useful at all).

Fig. 1 Percentage of teachers by faculty
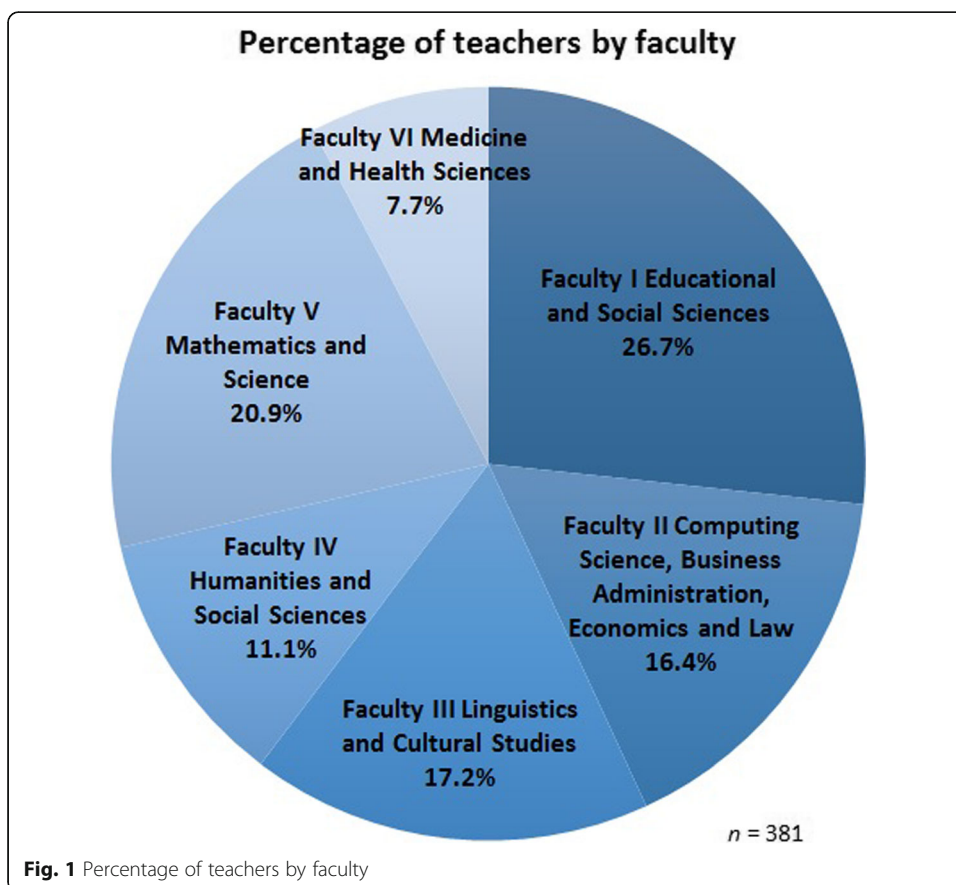
Student data

The student data was obtained from a 2015 survey of student media usage in German tertiary education (see Author, 2015, 2015, 2016),[7] which included general universities and universities of applied sciences around the country. Of the participating 1327 students across Germany, from a range of disciplines and campus programmes (on-campus, blended learning, online learning and integrated vocational study programmes), 200 of these were on-campus (face-to-face) students at the University of Oldenburg.[8] One third of the students was male, 67% female. On average the students were 24.25 years old. Seventy-two percent were younger than 26 years, 21% were between 26 and 30, 6% were between 31 and 40 years and only 1% was between 41 and 50 years old. The 200 on-campus students were from all six faculties of the University of Oldenburg (see Fig. 2), and constitute the student sample for this study.

In the questionnaire, students rated their frequency of use (5 = several times a day; 4 = almost every day; 3 = regularly during the week; 2 = rather irregularly; 1 = never) and perceived usefulness (5 = very useful; 1 = not useful at all) of 51 digital tools and services on a 5-point Likert scale. The student data is then complemented by one selected item from the student survey of the Internal Evaluation Unit (Winter Semester 2017/2018),[9] regarding which further tools and services students would like to use in their studies.

Results

Teacher use and perceptions

The majority of teachers at the University of Oldenburg use the institution-wide LMS (Stud.IP) in every course (80%). However, most of the integrated tools, such as cliqr

Fig. 2 Percentage of students by faculty
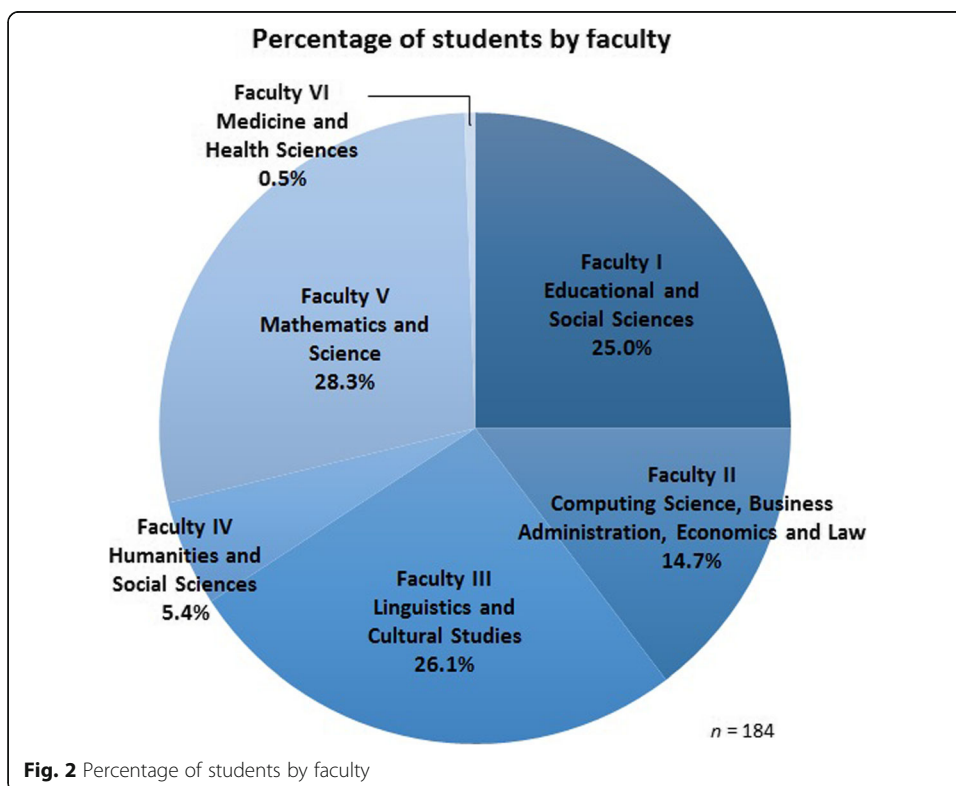
(audience response system), Bubbler (micro-blogging tool) or Meetings (video conferencing tool), are mainly dismissed, with more than 80% of the teachers stating that they did not use those tools in any of their courses (see Table 1). The minor exception are forums and, to a lesser extent wikis, which are also integrated into the LMS; 42% of teachers use forums in at least 'a few lessons', whilst 26% use wikis in at least 'a few lessons'. This indicates an overwhelmingly administrative use of the LMS, supporting management rather than learning per se (Selwyn, 2016a).

Although the teachers' use of integrated tools is rather scant, their perception of tool usefulness is a bit more optimistic (see Table 2). They appreciate the value of Stud.IP, with 93% evaluating it as 'very' or 'quite useful', and other tools are also seen positively, including forums (53%), video recordings of lectures (52%) and the institutional cloud storage (62%). The remaining tools surveyed, however, are considered less useful by teachers. Non-institutional tools - those not embedded within the LMS - that were positively valued, were collaborative mindmaps (53%), collaborative annotation tools (57%) and collaborative reference management software (61%).

Student use and perceptions

University of Oldenburg students predominantly use search engines, computers outside the university (e.g. laptops, home desktop computers), the LMS (Stud.IP) and e-mail accounts for studying (see Table 3). Search engines are used almost every day or several times a day by 94% of students. Computers outside the university and Stud.IP are used

Table 1 Ranking by mean - 'In how many lessons have you used the following tools this year?'

Rank	Digital Media	*n*	*mv*
1	learning management system (Stud.IP)	304	1.51
2	forum[a]	298	3.26
3	Aufgaben[a] (Exercises)	302	3.52
4	wiki[a]	304	3.56
5	insitutional cloudstorage (OwnCloud)	302	3.57
6	lecture recordings	298	3.63
7	DoIT![a]	295	3.74
8	other	185	3.76
9	student creation of videos	301	3.79
10	Cliqr[a]	300	3.80
11	audience response system (e.g. clickers)	299	3.80
12	ePortfolio	297	3.85
13	Seminarblogs	296	3.88
14	WordPress[a]	304	3.90
15	Meetings[a]	300	3.91
16	Blubber[a]	298	3.92
17	eAssessment	299	3.92
18	virtual webinars (e.g. Adobe Connect)	297	3.93
19	CoWriter[a]	301	3.98

n = number of teachers who ranked the tool
1 = in every lesson, 2 = in many lessons, 3 = in a few lessons, 4 = in no lessons
[a] = tool within Stud.IP LMS

Table 2 Ranking by mean - 'How useful do you find the following tools for your teaching?'

Rank	Digital Media	n	mv
1	learning management system (Stud.IP)	280	1.41
2	insitutional cloudstorage (OwnCloud)	279	2.35
3	forum[a]	274	2.50
4	lecture recordings	280	2.52
5	Aufgaben[a] (Exercises)	275	2.62
6	wiki[a]	278	2.66
7	DoIT![a]	268	2.76
8	student creation of videos	283	2.80
9	other	155	2.81
10	Cliqr[a]	277	2.85
11	audience response system (e.g. clickers)	277	2.88
12	ePortfolio	274	2.92
13	virtual webinars (e.g. Adobe Connect)	274	2.98
14	WordPress[a]	276	3.02
15	Seminarblogs	274	3.04
16	eAssessment	275	3.09
17	CoWriter[a]	275	3.11
18	Meetings[a]	276	3.19
19	Blubber[a]	277	3.51

n = number of teachers who ranked the tool
1 = very useful, 2 = quite useful, 3 = not very useful, 4 = not useful at all
[a] = tool within Stud.IP LMS

on a daily basis by 84% of students. Other tools such as instant messaging, lecture recordings, the institutional cloud storage and reference management software are used rather irregularly. The frequency mean for 19 out of the 51 questioned digital tools and services is less than 1.5. This indicates that tools like virtual seminars, online exams and professional networks are used extremely infrequently. With this dataset it is not possible to distinguish whether infrequent use is a result of not wanting or not being able to use the tools, rather this should be considered as an area for future research.

When it comes to the perceived usefulness of digital tools, search engines, word processing software, Stud.IP and computers outside the university top the list, with more than 82% of students finding them 'very useful' for studying (see Table 4). The mean perceived usefulness for 20 out of the 51 questioned digital tools and services is more than 3.5. This indicated that digital tools, such as lecture recordings, the institutional cloud storage, forums that are integrated into Stud.IP, and instant messaging, are seen to be quite useful for studying by the students. Only seven tools, including blogs and micro-blogging, have a mean below 2.0, indicating that students do not perceive them as useful for their studies.

Teacher and student perceptions in comparison

Comparing the teacher and student results of digital media perceived usefulness for teaching and learning (see Fig. 3 and Additional file 1), complementing as well as opposing trends are noted. Here, only the tools that were common in both questionnaires

Table 3 Ranking by mean - 'How often do you use these digital media tools for studying?'

Rank	Digital Media	n	mv
1	search engines	200	4.63
2	computers outside the university (e.g. laptops, home desktop computers)	198	4.33
3	learning management system	199	4.28
4	e-mail account (external)	200	4.2
5	university e-mail account	200	3.94
6	word processing software	200	3.88
7	electronic texts	199	3.65
8	printed texts	199	3.61
9	social networks	200	3.4
10	chat/instant Messaging	196	3.35
11	videos (e.g on YouTube)	200	3.14
12	mailing list for courses	194	3.04
13	music (e.g iTunes)	199	3.03
14	presentation software	197	3.02
15	wikis	190	2.96
16	online library services	199	2.88
17	lecture recordings	186	2.63
18	spreadsheet software	200	2.62
19	file storage/file sharing (external)	191	2.58
20	computer terminals on campus	196	2.57
21	file storage/file sharing (internal)	180	2.33
22	internal university forums	188	2.19
23	cloud computing	159	2.17
24	forums/newsgroups	188	2.09
25	graphics software	188	1.77
26	reference management software	118	1.68
27	Skype (1:1 call)	198	1.64
28	statistical software (e.g. SPSS)	162	1.64
29	E-Portfolios	120	1.59
30	multimedia learning software of the university	130	1.59
31	blogs	191	1.54
32	audio software	162	1.51
33	podcasts/vodcasts (e.g. on iTunes)	163	1.45
34	multimedia learning software online (e.g. at iTunesU, OpenCourseWare)	129	1.43
35	virtual seminars/webinars, synchronal	124	1.43
36	online exams/tests	166	1.43
37	video software	172	1.41
38	photo communities	166	1.39
39	etherpads	61	1.38
40	software for qualitative text analysis	137	1.38
41	Skype (conference call)	197	1.34
42	presentation sharing (e.g. Slideshare)	144	1.31
43	microblogging (e.g. Twitter)	196	1.29
44	MOOCs	42	1.29

Table 3 Ranking by mean - 'How often do you use these digital media tools for studying?' (Continued)

Rank	Digital Media	n	mv
45	business networks (e.g. Xing, LinkedIn)	169	1.27
46	RSS feeds (Rich Site Summary)	120	1.26
47	virtual worlds (e.g. Second Life)	165	1.24
48	simulations or learning games	140	1.24
49	social bookmarking (e.g. delicio.us, Mister Wong)	105	1.15
50	virtual labs	113	1.12
51	geo tagging (e.g. Layar)	117	1.04

n = number of students who ranked the tool

were considered for comparison (see Tables 2 and 4 for a full list). Teachers (69%) as well as students (83%) tend to assess Stud.IP as 'very useful'. The use of reference management software also shows a consistent picture for teachers and students, with 23% of both groups finding it 'very useful'. The situation is different for the perceived usefulness of instant messaging, the institutional cloud storage and lecture recordings, which highlights opposing teacher and student opinions. Fifty-four percent of teachers find instant messaging 'not useful at all', as opposed to 30% of students finding it 'very useful', and so too the cloud storage, with 22% of teachers finding it 'not useful at all', despite 46% of students finding it 'very useful'.

One of the most notable results was the number of teachers (27%) who find lecture recordings 'not useful at all', which is in stark contrast to the 57% of students who find them 'very useful'. This finding reflects that of previous studies (e.g., Gosper et al., 2008; Marcelo & Yot-Domínguez, 2018), highlighting a need to address teacher perceptions of lecture recordings, and to address the chasm between institutional mandate and teacher uptake and belief in the technology (O'Callaghan, Neumann, Jones, & Creed, 2017). Furthermore, the results from the student survey by the Internal Evaluation Unit show that 39% of students at the University of Oldenburg want more online opportunities for preparation and follow-up of courses, and 31% desire more online courses as a substitute for face-to-face courses. However, this brings forth questions such as "how is the university going to support students to develop the requisite skills for using digital tools?" and "how can student perceptions of tool usefulness be improved, in order to prepare them for such online study?"

Discussion

The teacher results show that they are using the institutional platform (Stud.IP) mostly as an organisational tool for their classes, for example to check class enrolments, plan seminar topics and upload materials, and not for promoting student-centered, technology-enhanced learning within the course (in a blended or online format) or, actually, as a 'learning management system', considered more sophisticated and necessary (Englund et al., 2017). This is consistent with the findings of Marcelo and Yot-Domínguez (2018), whose survey and semi-structured interviews of teachers in Spain revealed that teaching-learning processes continue to be mostly teacher-centered, with the most frequent uses of digital technologies being assimilative. Likewise the study by Marcelo-García et al. (2015), in which assimilative uses of technology frequently occurred, regardless of instructor age or technical ability.

Table 4 Ranking by mean - 'How useful do you find these digital media tools for your studies?'

Rank	Digital Media	n	mv
1	search engines	199	4.81
2	word processing software	197	4.78
3	learning management system	194	4.77
4	computers outside the university (e.g. laptops, home desktop computers)	194	4.74
5	online library services	191	4.62
6	university e-mail account	198	4.6
7	presentation software	196	4.53
8	computer terminals on campus	192	4.43
9	printed texts	198	4.41
10	lecture recordings	176	4.34
11	e-mail account (external)	197	4.25
12	mailing lists for courses	186	4.18
13	spreadsheet software	183	4.16
14	file storage/file sharing (external)	168	4.14
15	file storage/file sharing (internal)	159	4.13
16	electronic texts	197	4.09
17	wikis	171	3.89
18	statistical software (e.g. SPSS)	120	3.65
19	internal university forums	162	3.59
20	chat/instant messaging	174	3.54
21	cloud computing	122	3.42
22	multimedia learning software of the university	80	3.34
23	reference management software	87	3.31
24	software for qualitative text analysis	87	3.29
25	videos (e.g on YouTube)	189	3.16
26	virtual seminars/webinars, synchronal	81	3.1
27	graphics software	134	3.1
28	E-Portfolios	59	3.08
29	online exams/tests	117	3.06
30	forums/newsgroups	150	3.01
31	social networks	188	2.91
32	Skype (1:1 call)	149	2.89
33	multimedia learning software online (e.g. at iTunesU, OpenCourseWare)	84	2.85
34	virtual labs	59	2.73
35	Skype (conference call)	139	2.67
36	video software	123	2.67
37	presentation sharing (e.g. Slideshare)	89	2.62
38	simulations or learning games	80	2.59
39	audio software	116	2.59
40	etherpads	37	2.43
41	podcasts/vodcasts (e.g. on iTunes)	100	2.42
42	music (e.g iTunes)	168	2.36
43	business networks (e.g. Xing, LinkedIn)	77	2.17
44	MOOCs	23	2.17

Table 4 Ranking by mean - 'How useful do you find these digital media tools for your studies?' *(Continued)*

Rank	Digital Media	n	mv
45	blogs	130	1.96
46	RSS feeds (Rich Site Summary)	55	1.78
47	social bookmarking (e.g. delicio.us, Mister Wong)	49	1.57
48	photo communities	117	1.47
49	microblogging (e.g. Twitter)	147	1.44
50	geo tagging (e.g. Layar)	58	1.33
51	virtual worlds (e.g. Second Life)	123	1.18

n = number of students who ranked the tool

The fact that most of the teachers did not agree with the usefulness of institutional tools other than Stud.IP, forums, video recordings for lectures and the institutional cloud storage, could be interpreted as having tried them and not having experienced good results with them, not having used them yet or not knowing about their use, or as a reluctance to use them at all (Jääskelä et al., 2017). This aligns with the findings of Margaryan et al. (2011), where three broad issues were found when it comes to the use of educational technology by university teachers in the UK; a lack of digital skills, systemic problems, and a reluctance to change. Ongoing professional development of faculty in the use of educational technology is vital, especially for experienced teachers (Englund et al., 2017; Marcelo-García et al., 2015) or for teachers who perceive their IT skills as weak (Jääskelä et al., 2017; Marcelo & Yot-Domínguez, 2018). In this case, one recommendation could be to hold sessions, or a "dialogue forum" (Jääskelä et al., 2017, p. 209), in which best practices are shared by teachers. In the case of teachers who have not used the tools yet, more workshops and support by the Teacher Training Unit could be given, as well as providing incentives to teachers for actively engaging with technology in their teaching (for instance, recognition for teachers with prizes or further funding). Furthermore, as stated by the HFD (Hochschulforum Digitalisierung, 2016) in thesis twelve, the often decentralized character of HE institutions can impede collaboration when experimenting and innovating with educational technology. Thus, digitalization strategies are needed, that aim for a coherent institutional framework to implement technology into teaching.

The perceived usefulness of external-institutional tools by the teachers, could provide insight into the kinds of tools that could be integrated into the university LMS, or could be utilised as institutional tools. This integration highlights the need to consider hybrid systems that include institutional and external tools, which enhance teaching and learning processes at higher levels of openness and student implementation. This issue has already been explored, often within the concept of (institutional) personal learning environments ((i)PLE) (Casquero, Portillo, Benito, Ovelar, & Romo, 2010; García-Peñalvo, Alier, Casany, & Conde, 2011). This construct also embraces the idea of moving learners from passive consumers to active prosumers (producers and consumers) (Glud, Buus, Ryberg, Georgsen, & Davidsen, 2010), which would also be a challenge, given the student results obtained in this study.

Almost all students at the University of Oldenburg use Stud.IP and computers outside of the university (e.g. laptops) daily, as well as search engines and email, either daily or almost every day. These results echo those of other studies (Lai & Hong, 2015;

Fig. 3 Student and teacher perceived usefulness of tools
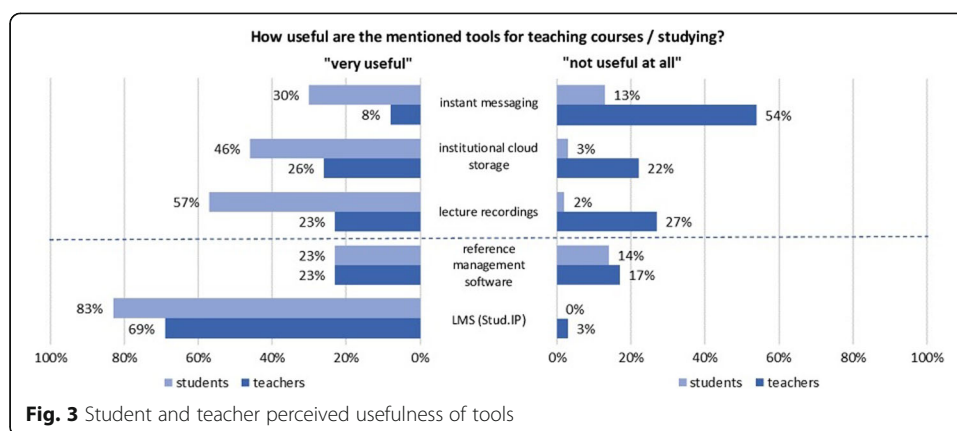
Margaryan et al., 2011; Ng, 2012; Thompson, 2013), which have found that student uses of technology for learning are centered on the "'logistics' of university study" (Henderson et al., 2017, p. 1575), rather than on content creation or collaborative activities. It is unsurprising then that the top three digital competences found by Parkes et al. (2015) were download and upload information/resources, respond to others with respect, and seek information through own enquiries. Students were found to be particularly ill-prepared for working in collaborative environments, which is somewhat reflected in the results of this study by the irregular or extremely infrequent use of instant messaging, virtual seminars, and professional networks. In their study of 160 students in the UK, Margaryan et al. (2011) found that students never used virtual chat, podcasts, simulations, YouTube or blogs for learning, which was also echoed by Lai and Hong (2015) in New Zealand. However, given the importance placed on collaborative and communication skills for graduates (OECD, 2015a; Oliver & Jorre de St Jorre, 2018; Redecker, 2017), it is vital that students are able to further develop these skills. Teachers are therefore highly encouraged to integrate collaborative tools within their courses, ensuring that students have a thorough understanding of the pedagogical purpose behind its use from the beginning of a course, as well as training in how to use the technology (Peterson, 2012), and how to work collaboratively with others (Biasutti, 2017).

In terms of usefulness, students find search engines, word processing, Stud.IP and computers outside of the university 'very useful', and lecture recordings, cloud storage, forums within Stud.IP and instant messaging 'quite useful'. This result was also found by Henderson et al., 2017, where students found the LMS, laptops, word processing software, lecture recordings and search engines the most useful technology for learning. Again, these are more passive forms of technology, rather than collaborative or creative tools. Indeed, students in this study find that blogs and micro-blogging are not useful for learning at all, which could explain the low level of use found in previous studies (Lai & Hong, 2015; Margaryan et al., 2011; Ng, 2012; Thompson, 2013). Parkes et al. (2015) found that critiquing website content, interacting with others in learning communities, and commenting upon or critiquing lecturer responses in forums, were the three lowest ranked competences showed by students. A broad study of final year Spanish university students ($n = 2054$) obtained similar results regarding the low use of digital tools for learning and the preference of analogical formats, despite the extended

use of social networks in their everyday life for informal purposes (Prendes, Castañeda, Gutierrez, & Roman, 2016).

In order to improve student - and teacher - perceptions of using digital tools for learning, it is essential to help them understand why technology is important in their professional lives as lifelong learners (Kirkwood & Price, 2005; O'Callaghan et al., 2017; Thompson, 2013). However, students may not be prepared to use digital tools for learning and they may ask for guidance and support (Kuhn, 2017; Kühn Hildebrandt, 2019). Thus, pedagogical interventions within study programs that combine the LMS and commonly used tools by students, that go beyond passive ways of teaching and learning and encourage self-regulated learning techniques, are also necessary, and may be a good strategy towards that aim (e.g., Dabbagh & Kitsantas, 2012; Marín, Negre, & Pérez Garcias, 2014; Pérez Cascante, Salinas, & Marín, 2016).

Conclusion and future research

Drawing on international literature, this study highlights the situation of face-to-face educational technology use at a mid-sized German university. The results provide an initial insight into how teachers and students use digital tools for teaching and learning, which points to the need for increased teacher professional development, in order to address academic digital literacy (Ng, 2012; Redecker, 2017). This study also highlighted that students have access to a range of tools and are open to using digital media for academic learning. However, this depends upon teachers implementing digital media, and the university fostering policies to this effect.

As this study only focused on one university, the results cannot be generalized, and we therefore recommend further analysis within a range of German universities, of varying characteristics and geographic locations, to gain a deeper understanding of teacher and student use and perceptions of digital tools. For example, universities that have always provided distance education, such as the FernUniversität in Hagen, may provide rather different results, as opposed to results obtained in face-to-face universities, such as the University of Oldenburg, which only employs online distance education in a few select programs. Another measure to continue tracking the degree of HE digitalization would be to conduct longitudinal studies that look at the changes in technology use and perceptions over time. Digitalization strategies in Germany are only just taking off, and the results derived from these implementations may take time to crystallize into the micro-level of teaching and learning in classrooms. When planning to integrate digital media into teaching, it seems advisable to also consider students' informal and daily media usage, in order to design and implement more effective digital learning practices in formal contexts in higher education, in line with the (i)PLE conception (Casquero et al., 2010; García-Peñalvo et al., 2011).

The use of different questionnaires and the time period in which the results were obtained, were also limitations for this study, as it has not enabled us to do statistical analysis. Whilst there was a time differenc of two and a half years betweeen the two studies, in which a policy-induced push towards integrating digital media into teaching and the further development of digital tools as such occurred, the uptake and use in German HE has not followed the same trajectory. Furthermore, both questionnaires focused on the *use* of tools rather than *how* they are being used, thereby limiting the extent to which this study can deepen understanding on how educational technology is

being used to support learning (Castañeda & Selwyn, 2018). Therefore, further research is planned to conduct another iteration of the 2015 student study (Author, 2016) in late 2018, which will also use the same instrument and scale for teachers, enabling statistical comparisons to be made and inferences to be drawn, across varying disciplines and student year levels. Additionally, conducting in-depth interviews with students and teachers, in order to gain a deeper understanding of their reticence to use certain tools, as well as the pedagogic use of tools, would have added value to this study, and is seen as the next phase of this research.

To drive the digital transformation of teaching and learning within German higher education institutions, it is paramount to understand the technology skills and knowledge of both teachers and students, to discover their respective needs, and to aim for a mutual understanding of both perspectives (bottom-up). Beyond that, a sustainable implementation of digital media can only succeed if the overall project 'Digital Transformation in Higher Education' is grounded within the current context of the university, and is supported and pushed by the university administration (top-down).

Endnotes

[1]The HFD is initiated by the Stifterverband für die Deutsche Wissenschaft, the Center for Higher Education (CHE) and the German Rector's Conference and sponsored by the German Federal Ministry of Education and Research. https://hochschulforumdigitalisierung.de

[2]https://hochschulforumdigitalisierung.de/peer2peer

[3]University statistics can be found at: https://www.uni-oldenburg.de/zahlen-fakten

[4]https://www.uni-oldenburg.de/lehre/hochschuldidaktik/e-didaktik-lehren-und-lernen-mit-digitalen-medien/

[5]Source: Presidential Department for Study Affairs - Internal Evaluation Unit. The whole questionnaire dataset and the original instrument (both in German) are publicly available at https://uol.de/lehre/evaluation/interne-evaluation/lehrendenbefragung/aktuelle-ergebnisse/

[6]The whole questionnaire dataset and the original instrument (both in German) are publicly available at https://uol.de/lehre/evaluation/interne-evaluation/lehrendenbefragung/aktuelle-ergebnisse/

[7]The survey was funded by the BMBF-program "OffeneHochschulen" ["Open Universities"].

[8]As mentioned before, only the C3L offers online programmes at the university. See https://www.uni-oldenburg.de/c3l/.

[9]Source: Presidential Department for Study Affairs - Internal Evaluation Unit. The student questionnaire dataset can be found at https://www.uni-oldenburg.de/lehre/evaluation/interne-evaluation/studierendenbefragung/.

Additional file

Additional file 1: Student and Teacher perceived usefulness of tools. (DOCX 327 kb)

Publisher's Note

References

Akçayır, M., Dündar, H., & Akçayır, G. (2016). What makes you a digital native? Is it enough to be born after 1980? *Computers in Human Behavior*, 60, 435–440. https://doi.org/10.1016/j.chb.2016.02.089.

Zawacki-Richter, O. (2015). Zur Mediennutzung im Studium – unter besonderer Berücksichtigung heterogener Studierender. Zeitschrift Für Erziehungswissenschaft, 18(3), 527–549. https://doi.org/10.1007/s11618-015-0618-6.

Zawacki-Richter, O., Müskens, W., Krause, U., Alturki, U., & Aldraiweesh, A. (2015). Student media usage patterns and non-traditional learning in higher education. International Review of Research in Open and Distributed Learning, 16(2), 136–170. Retrieved from https://files.eric.ed.gov/fulltext/EJ1061134.pdf.

Zawacki-Richter, O., Kramer, C., & Müskens, W. (2016). Studiumsbezogene Mediennutzung im Wandel. Querschnittdaten 2012 und 2015 im Vergleich. Schriftenreihe Zum Bildungs- Und Wissenschaftsmanagement, 1, 1-42. Retrieved from http://openjournal.uni-oldenburg.de/index.php/bildungsmanagement/article/view/101/PDF.

Zawacki-Richter, O., Dolch, C., & Müskens, W. (2017). Weniger ist mehr? Studentische Mediennutzung im Wandel. Synergie. Fachmagazin Für Digitalisierung in Der Lehre, 3, 70-73. Retrieved from https://www.researchgate.net/publication/317721766_Weniger_ist_mehr_Studentische_Mediennutzung_im_Wandel.

Barak, M. (2018). Are digital natives open to change? Examining flexible thinking and resistance to change. *Computers & Education*, 121, 115–123. https://doi.org/10.1016/j.compedu.2018.01.016.

Biasutti, M. (2017). A comparative analysis of forums and wikis as tools for online collaborative learning. *Computers & Education*, 111, 158–171. https://doi.org/10.1016/j.compedu.2017.04.006.

Blaschke, L. M., & Hase, S. (2015). Heutagogy: A holistic framework for creating twenty-first-century self-determined learners. In B. Gros et al. (Eds.), The future of ubiquitous learning, lecture notes in educational technology, (pp. 25–40). Berlin Heidelberg: Springer. https://doi.org/10.1007/978-3-662-47724-3_2.

Bowe, B. J., & Wohn, D. Y. (2015). Are there generational differences?: Social media use and perceived shared reality. Proceedings of the 2015 International Conference on Social Media & Society, 1–5. https://doi.org/10.1145/2789187.2789200.

Bullen, M., Morgan, T., & Qayyum, A. (2011). Digital learners in higher education: Generation is not the issue. *Canadian Journal of Learning and Technology / La Revue Canadienne de L'apprentissage et de La Technologie*, 37(1). https://doi.org/10.21432/T2NC7B.

Bundesministerium für Bildung und Forschung, Referat Digitaler Wandel in der Bildung [Ministry of Education and Research] (2016). *Bildungsoffensive für die digitale Wissensgesellschaft Strategie des Bundesministeriums für Bildung und Forschung*. Berlin: BMBF Retrieved from https://www.bmbf.de/files/Bildungsoffensive_fuer_die_digitale_Wissensgesellschaft.pdf.

Bundesministerium für Bildung und Forschung, Referat Digitaler Wandel in der Bildung [Ministry of Education and Research]. (2018). *Bildung digital. Digitale Hochschulbildung*. Retrieved April 20, 2018, from https://www.bmbf.de/de/digitale-hochschullehre-2417.html

Casquero, O., Portillo, J., Benito, M., Ovelar, R., & Romo, J. (2010). Strategy approach for eLearning 2.0 deployment in Universities. *Digital Education Review*, 18, 1–8 Retrieved from https://dialnet.unirioja.es/descarga/articulo/3633703.pdf.

Castañeda, L., & Selwyn, N. (2018). More than tools? Making sense of the ongoing digitzations of higher education. *International Journal of Educational Technology in Higher Education*, 15(22), 1–10. https://doi.org/10.1186/s41239-018-0109-y.

Choi, M., Cristol, D., & Gimbert, B. (2018). Teachers as digital citizens: The influence of individual backgrounds, internet use and psychological characteristics on teachers' levels of digital citizenship. *Computers & Education*, *121*, 143–161. https://doi.org/10.1016/j.compedu.2018.03.005.

Claro, M., & Ananiadou, K. (2009). *21st Century Skills and Competences for New Millennium Learners in OECD Countries (OECD Education Working Papers No. 41)*. https://doi.org/10.1787/218525261154.

Dabbagh, N., & Kitsantas, A. (2012). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. *The Internet and Higher Education*, *15*(1), 3–8. https://doi.org/10.1016/j.iheduc.2011.06.002.

Die Bundesregierung [German Federal Government] (2014). *Digitale Agenda 2014–2017*. München: Retrieved from https://www.bmwi.de/Redaktion/DE/Publikationen/Digitale-Welt/digitale-agenda-legislaturbericht.html. Accessed 20 April 2018.

EDUCAUSE. (2018). *Report from the 2018 EDUCAUSE Task Force on Digital Transformation*. Retrieved from https://library.educause.edu/~/media/files/library/2018/11/dxtaskforcereport.pdf. Accessed 29 Nov 2018.

Englund, C., Olofsson, A. D., & Price, L. (2017). Teaching with technology in higher education: Understanding conceptual change and development in practice. *Higher Education Research and Development*, *36*(1), 73–87. https://doi.org/10.1080/07294360.2016.1171300.

Falck, O., Wiederhold, S., & Heimisch, A. (2016). *Returns to ICT Skills (OECD Education Working Papers No. 134)*. https://doi.org/10.1787/5jlzfl2p5rzq-en.

García-Peñalvo, F. J., Alier, M., Casany, M. J., & Conde, M. Á. (2011). Opening learning management systems to personal learning environments. *Journal of Universal Computer Science*, *9*. https://doi.org/10.3217/jucs-017-09-1222.

Glud, N., Buus, L., Ryberg, T., Georgsen, M., & Davidsen, J. (2010). Contributing to a learning methodology for web 2.0 learning - identifying central tensions in educational use of web 2.0 technologies. In *Proceedings of the Seventh International Conference on Networked Learning*, (pp. 934–942) Retrieved from https://www.researchgate.net/publication/242601556_Contributing_to_a_Learning_Methodology_for_Web_20_Learning_-_Identifying_Central_Tensions_in_Educational_Use_of_web_20_Technologies.

Gosper, M., Green, D., McNeill, M., Phillips, R., Preston, G., Woo, K. (2008). The impact of web-based lecture technologies on current and future practices in learning and teaching. Retrieved from https://www.mq.edu.au/lih/altc/wblt/docs/report/ce6-22_final2.pdf.

Hajkowicz, S., Reeson, A., Rudd, L., Bratanova, A., Hodgers, L., Mason, C., & Boughen, N. (2016). *Tomorrow's Digitally Enabled Workforce*. Brisbane: CSIRO Retrieved from http://www.csiro.au/~/media/D61/Files/16-0026_DATA61_REPORT_TomorrowsDigiallyEnabledWorkforce_WEB_160204.pdf?la=en.

Henderson, M., Selwyn, N., & Aston, R. (2017). What works and why? Student perceptions of "useful" digital technology in university teaching and learning. *Studies in Higher Education*, *42*(8), 1567–1579. https://doi.org/10.1080/03075079.2015.1007946.

Hochschulforum Digitalisierung [The German Forum for Higher Education in the Digital Age]]. (2018). Strategien für Hochschulbildung im digitalen Zeitalter. Retrieved April 20, 2018, from https://hochschulforumdigitalisierung.de/de/peer2peer.

Hochschulforum Digitalisierung [The German Forum for Higher Education in the Digital Age] (2016). *Discussion paper. 20 theses on digital teaching and learning in higher education. Working paper no. 18*. Berlin: Hochschulforum Digitalisierung Retrieved from https://hochschulforumdigitalisierung.de/sites/default/files/dateien/HFD_AP_Nr%2018_Discussion_Paper.pdf.

IBM. (2016). Transforming different Likert scales to a common scale. IBM Support. Retrieved from http://www-01.ibm.com/support/docview.wss?uid=swg21482329. Accessed 9 July 2018.

Initiative D21. (2015). D21-Digital-Index 2015: Die Gesellschaft in der digitalen Transformation. Retrieved from https://initiatived21.de/app/uploads/2017/01/d21_digital-index2015_web2.pdf. Accessed 15 Apr 2018.

International Society for Technology Education. (2016). ISTE standards for students. ISTE. Retrieved from https://www.iste.org/standards/for-students. Accessed 27 Mar 2018.

International Society for Technology Education. (2017). ISTE standards for educators. ISTE. Retrieved from https://www.iste.org/standards/for-educators. Accessed 27 Mar 2018.

Jääskelä, P., Häkkinen, P., & Rasku-Puttonen, H. (2017). Teacher beliefs regarding learning, pedagogy, and the use of technology in higher education. *Journal of Research on Technology in Education*, *49*(3–4), 198–211. https://doi.org/10.1080/15391523.2017.1343691.

Jamieson, S. (2004). Likert scales: How to (ab)use them. *Medical Education*, *38*(12), 1217–1218. https://doi.org/10.1111/j.1365-2929.2004.02012.x.

Kirkwood, A. (2009). E-learning: You don't always get what you hope for. *Technology, Pedagogy and Education*, *18*(2), 107–121. https://doi.org/10.1080/14759390902992576.

Kirkwood, A., & Price, L. (2005). Learners and learning in the twenty-first century: What do we know about students' attitudes towards and experiences of information and communication technologies that will help us design courses? *Studies in Higher Education*, *30*(3), 257–274. https://doi.org/10.1080/03075070500095689.

Kuhn, C. (2017). Are students ready to (re)-design their personal learning environment? The case of the e-dynamic.space. *Journal of New Approaches in Educational Research*, *6*(1), 11–19. https://doi.org/10.7821/naer.2017.1.185.

Kühn Hildebrandt, C. (2019). Whose interest is educational research serving? Who is included and who is excluded? *Revista Iberoamericana de Educación a Distancia, 22*(1), (version preprint). https://doi.org/10.5944/ried.22.1.22293.

Lai, K.-W., & Hong, K.-S. (2015). Technology use and learning characteristics of students in higher education: Do generational differences exist?: Technology use and learning characteristics of students. *British Journal of Educational Technology*, *46*(4), 725–738. https://doi.org/10.1111/bjet.12161.

Marcelo, C., & Yot-Domínguez, C. (2018). From chalk to keyboard in higher education classrooms: Changes and coherence when integrating technological knowledge into pedagogical content knowledge. *Journal of Further and Higher Education*, 1–14. https://doi.org/10.1080/0309877X.2018.1429584.

Marcelo-García, C., Yot-Domínguez, C., & Mayor-Ruiz, C. (2015). University teaching with digital technologies. *Comunicar*, *23*(45), 117–124. https://doi.org/10.3916/C45-2015-12.

Margaryan, A., Littlejohn, A., & Vojt, G. (2011). Are digital natives a myth or reality? University students' use of digital technologies. *Computers & Education*, *56*(2), 429–440. https://doi.org/10.1016/j.compedu.2010.09.004.

Marín, V. I., Negre, F., & Pérez Garcias, A. (2014). Construction of the foundations of the PLE and PLN for collaborative learning. *Comunicar*, *21*(42), 35–43. https://doi.org/10.3916/C42-2014-03.

Newman, T., & Beetham, H. (2017). Student digital experience tracker 2017: The voice of 22,000 UK learners. Jisc. Retrieved from http://repository.jisc.ac.uk/6662/1/Jiscdigitalstudenttracker2017.pdf. Accessed 15 Apr 2018.

Ng, W. (2012). Can we teach digital natives digital literacy? *Computers & Education*, *59*(3), 1065–1078. https://doi.org/10.1016/j.compedu.2012.04.016.

O'Callaghan, F. V., Neumann, D. L., Jones, L., & Creed, P. A. (2017). The use of lecture recordings in higher education: A review of institutional, student, and lecturer issues. *Education and Information Technologies*, *22*(1), 399–415. https://doi.org/10.1007/s10639-015-9451-z.

OECD (2015a). *Schooling redesigned*. OECD Publishing. https://doi.org/10.1787/9789264245914-en.

OECD (2015b). *Students, computers and learning*. OECD Publishing. https://doi.org/10.1787/9789264239555-en.

OECD (2018a). *Teaching for the future : Effective classroom practices to transform education*. OECD. https://doi.org/10.1787/9789264293243-en.

OECD (2018b). *The future of education and skills: Education 2030*. OECD Retrieved from http://www.oecd.org/education/2030/OECD%20Education%202030%20Position%20Paper.pdf. Accessed 16 Apr 2018.

Oliver, B., & Jorre de St Jorre, T. (2018). Graduate attributes for 2020 and beyond: Recommendations for Australian higher education providers. *Higher Education Research and Development*, 1–16. https://doi.org/10.1080/07294360.2018.1446415.

Parkes, M., Stein, S., & Reading, C. (2015). Student preparedness for university e-learning environments. *The Internet and Higher Education*, *25*, 1–10. https://doi.org/10.1016/j.iheduc.2014.10.002.

Pensel, S., & Hofhues, S. (2017). Digitale Lerninfrastrukturen an Hochschulen. Systematisches Review zu den Rahmenbedingungen für das Lehren und Lernen mit Medien an deutschen Hochschulen. Retrieved from http://your-study.info/wp-content/uploads/2018/01/Review_Pensel_Hofhues.pdf. Accessed 24 Apr 2018.

Pérez Cascante, L., Salinas, J., & Marín, V. I. (2016). Use of an institutional personal learning environment to support learning actions in higher education. *AtoZ: Novas Práticas Em Informação E Conhecimento*, *5*(1), 53. https://doi.org/10.5380/atoz.v5i1.46937.

Peterson, M. (2012). EFL learner collaborative interaction in second life. *ReCALL*, *24*(1), 20–39. https://doi.org/10.1017/S0958344011000279.

Prendes, M. P., Castañeda, L., Gutierrez, I., & Roman, M. (2016). Still far from personal learning: Key aspects and emergent topics about how future professionals' PLEs are. *Digital Education Review*, *29*, 15–30 Retrieved from https://files.eric.ed.gov/fulltext/EJ1106180.pdf.

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the Horizon*, *9*(5), 1–6. https://doi.org/10.1108/10748120110424816.

Redecker, C. (2017). *European Framework for the Digital Competence of Educators*. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/159770.

Riplinger, T., & Schiefner-Rohs, M. (2017). Medieneinsatz in der Hochschullehre. Akademische Lehr-Lernkonzepte zwischen Zumutung und Zu-Mutung. Retrieved from http://your-study.info/wp-content/uploads/2018/01/Review_Riplinger_Schiefner_Rohs.pdf. Accessed 24 Apr 2018.

Selwyn, N. (2016a). Minding our language: Why education and technology is full of bullshit… and what might be done about it. *Learning, Media and Technology*. https://doi.org/10.1080/17439884.2015.1012523.

Selwyn, N. (2016b). Digital downsides: Exploring university students' negative engagements with digital technology. *Teaching in Higher Education*, *21*(8), 1006–1021. https://doi.org/10.1080/13562517.2016.1213229.

Sullivan, G., & Artino Jr., A. (2013). Analyzing and interpreting data from likert-type scales. *Journal of Graduate Medical Education*, *5*(4), 541–542. https://doi.org/10.4300/JGME-5-4-18.

Sumuer, E. (2018). Factors related to college students' self-directed learning with technology. *Australasian Journal of Educational Technology*, *34*(4), 29–43. https://doi.org/10.14742/ajet.3142.

Tamim, R. M., Bernard, R. M., Borokhovski, E., Abrami, P. C., & Schmid, R. F. (2011). What forty years of research says about the impact of technology on learning: A second-order meta-analysis and validation study. *Review of Educational Research*, *81*(1), 4–28. https://doi.org/10.3102/0034654310393361.

Thompson, P. (2013). The digital natives as learners: Technology use patterns and approaches to learning. *Computers & Education*, *65*, 12–33. https://doi.org/10.1016/j.compedu.2012.12.022.

Thompson, P. (2015). How digital native learners describe themselves. *Education and Information Technologies*, *20*(3), 467–484. https://doi.org/10.1007/s10639-013-9295-3.

Xiang, H., Coleman, S., Johannsson, M., & Bates, R. (2014). Workplace stress and job satisfaction among biologics development professionals. *Health*, *6*, 1790–1802. https://doi.org/10.4236/health.2014.614211.