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Adoption, Usage, and Pedagogy of E-Learning Tools in University Teaching (19)

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Abstract

The increasing role of information technology changes the way university lecturers teach and adopt electronic learning tools in the preparation, execution, and reworking phase of lectures in higher education. This paper investigates which learning tools lecturers use, why these learning tools are chosen, and which learning tasks they are used for. In particular, promotors and inhibitors for the tool selection as well as infrastructural and organisational limitations are discussed. To this end, the paper presents an exploratory mixed-method approach.

Keywords: learning tools, learning tasks, pedagogy, mixed-method approach

1.0 Introduction

Information and Communication Technology (ICT) shapes many aspects of our daily life. In higher education, the relevance of ICT in particular for e-learning steadily increases, resulting in educational innovations facilitated by technology (Garrison and Vaughan, 2008). Accordingly, ICT changes the way lecturers teach at universities. New electronic learning tools are being used, e.g. screen recordings, blogs, or wikis (Bower *et al.*, 2010). Consequently, additional learning paradigms and methods are used such as programmed instructions or cognitive tutors (Melzer and Schoop, 2014). In summary, universities started to combine conventional and modern teaching methods (Attwell, 2007; McGill and Hobbs, 2008; Persike and Friedrich, 2016).

Whilst the selection and use of learning tools by students (and thus by learners) has been examined (Gross *et al.*, 2016), the lecturer's perspective needs to be assessed to complete the picture. Our research goal is thus the analysis of the complete process of how university lecturers select and use learning tools for teaching. Learning tools are defined as software and hardware used for the preparation, execution, and reworking of lectures. To reach our goal, the following research questions need to be answered:

- (RQ1) Which learning tools are used by lecturers in practice?
- (RQ2) Why are these learnings tools selected?
- (RQ3) Which learning tasks are these tools used for?

As it is crucial to reconstruct the learning environment to seize the advantages of our digital world (Williams, 2002), the factors affecting the tool selection along with the complex connection between learning tasks and learning tools need to be established. The paper reports on our research project conducted as IS Master students in a course on IS research methods. The following sections will discuss the theoretical background, methodology, and results and present a conclusion and outlook.

2.0 Theoretical Background

This section provides the theoretical background of our study. Besides a classification of learning tools required for RQ1, a theoretical framework of influencing factors for usage and acceptance of learning technologies forms the basis for analysing RQ2 and a pedagogic classification of learning tasks is relevant for RQ3.

2.1 Classification of Learning Tools

There is a relationship between the lecturer's use of technology and the employed pedagogies (Okojie *et al.*, 2006). A tool is usually applied to fulfil a certain task in the lecturing process (e.g. presentation tools can be used for the transmission of knowledge), so lecturers use various kinds of tools for different kinds of pedagogies.

There is an enormous number of different pedagogies which can be used to convey knowledge. Bower *et al.* (2010) classifies them according to the degree of negotiation and production. Negotiation means the degree of collaboration by a certain tool (e.g. working via shared document tools); production means creating an artefact by using a certain tool (e.g. developing software by an integrated development environment). The combination of these two dimensions results in four groups, namely "transmissive" (no-product, non-negotiated), "dialogue" (no-product, negotiated), "constructive" (product, non-negotiated) and "co-constructive" (product, negotiated), cf. figure 1. While Gross *et al.*, (2016) used this classification for the learners' perspective, it is also suitable for the lecturers' perspective, because both sides need tools for negotiating and producing

artefacts. Unfortunately, a clear assignment of each tool to the pedagogic groups is not always possible. Hence, we assigned the tools to the groups with the best fit. Furthermore, we considered merely those groups of tools that are commonly used as electronic learning tools. Due to further tool-specific innovations and developments, the groups of tools are not exhaustive. Figure 1 shows the taxonomy of pedagogies and the corresponding tool categories, whereby the bold categories are extensions of the model of Gross *et al.*, (2016).

Tools of transmissive pedagogic classification are used for the provision of course content to a large number of students in a traditional way (Costenson and Lawson, 1986). Typical tools are screen recording, classroom management tools, and calculation and statistic tools.

Dialogue oriented pedagogy focuses on the interaction and communication between students and lecturers. It is supported e.g. by blogging, podcast, social bookmarking, and communication and knowledge organisation tools.

In a constructive pedagogy, the lecturer primarily focuses on developing a product, e.g. by creating artefacts with students as a course outcome (Mascolo and Fischer, 2005). In this regard, mind mapping, video consumption and creation, presentation, writing/annotation, and modelling tools can be assigned to support a constructive teaching pedagogy.

Co-constructive pedagogy encourages lecturers to co-create such artefacts together with students conducting a series of goal-related tasks (Reusser, 2001). Electronic learning tools such as wikiing, shared document creation and (software) developing tools are used.

University organisation tools (e.g. for room reservations) and LMSs cannot be assigned to a certain category because they are used in all pedagogies.

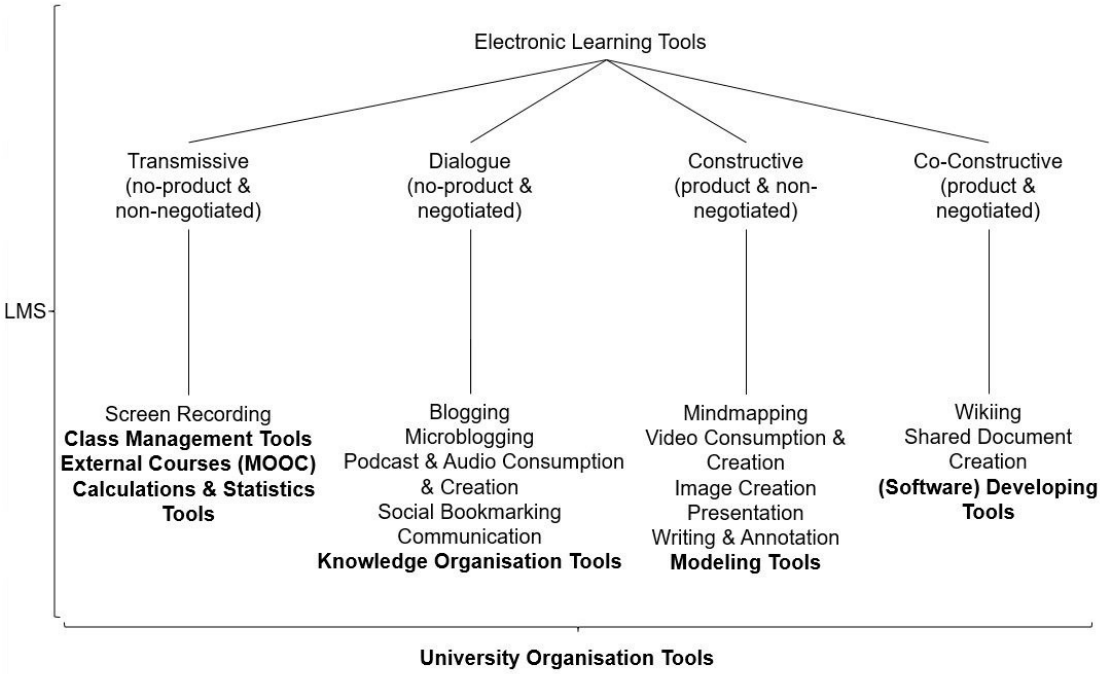

Figure 1. Taxonomy of pedagogies with corresponding tool categories (adapted from Bower *et al.* 2010, p.182; Gross *et al.* 2016, p.4, additions marked bold)

2.2 Individual Factors: Task Technology Fit and Technology Acceptance Model

Task-Technology Fit (TTF) (Goodhue and Thompson, 1995) can explain the relationship between learning tasks and learning tools. The fit is the degree to which a technology provides features supporting the requirements of a task (Melzer and Schoop, 2015). Rationally, lecturers will choose those tools that support them in completing their task with the highest usefulness. Software that does not offer sufficient advantage will not be used (Dishaw *et al.*, 2002).

In contrast, the Technology Acceptance Model (TAM) explains how users accept and use a technology (Davis *et al.*, 1989; Davis, 1985). TAM considers the perceived ease of use and the usefulness of a software which determines a user's decision on how and when to use a software. Previous studies have applied the model to e-learning (Punnoose, 2012; Park, 2009; Masrom, 2007).

Whilst TAM focuses on technological aspects and considers tool support only indirectly through perceived usefulness, TTF concentrates on the ability of technology to support users while conducting tasks (Dishaw and Strong, 1999). Hence, the combination of both models represents utilisation in a direct way through the fit between technology

and task. Additionally, Dishaw and Strong (1999) found that the integrated model provides more useful results and offers a greater explanatory power. In this study, we use the extended TTF and TAM model from Gross *et al.* (2016) based on Dishaw and Strong (1999) including exogenous and individual factors in the context of learning tools.

2.3 Exogenous Factors

Exogenous factors are factors regarding tool selection and use which have an extrinsic effect on the lecturer. Figure 2 shows all exogenous factors adapted from Gross et al. (2016).

Venkatesh and Davis (2000) extended TAM by including social norm while further studies confirmed its influence on perceived usefulness or intention of use in particular for e-learning (Gross *et al.*, 2016; McGill and Klobas, 2009; Selim, 2007; Younghwa Lee *et al.*, 2003).

Social norm represents social influences a lecturer perceives from the peer group such as critical mass or the university as an institution (Venkatesh and Davis, 2000; Fishbein and Ajzen, 1975). Environmental limitations are infrastructural conditions such as the quality of technology used in lecturers, e.g. of microphones or electronic blackboards (Sun *et al.*, 2008). They influence actual tool usage and functionality since availability of the required infrastructure is an important prerequisite of tool usage.

An organisational assistance centre can support lecturers in tool selection and usage. Research shows that supporting end-users enhances their abilities and self-efficacy (Compeau and Higgins, 1995; Igbaria and Iivari, 1995). In addition, awareness of a tool's functionalities increases actual tool usage and perceived usefulness (Lopez and Manson, 1997).

Output quality is defined as "the degree to which one thinks that a new system can perform required tasks" (Wu *et al.*, 2011, p. 137) and influences perceived usefulness (Wu *et al.*, 2011; Chismar and Wiley-Patton, 2002; Maamuom *et al.*, 2015). The continuous lines in figure 2 illustrate direct relationships whereas the dotted lines represent indirect relationships (Dishaw and Strong, 1999).

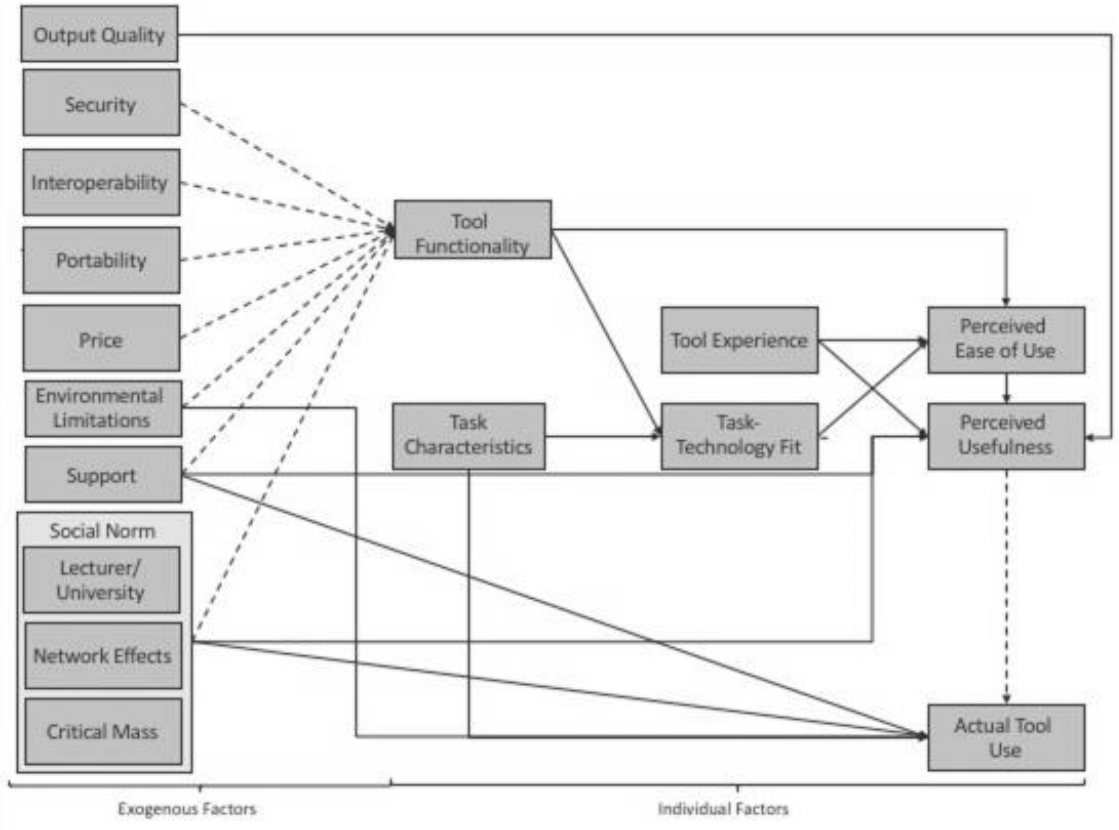

Figure 2. Exogenous and individual factors influencing selection and usage of learning task and tools (adapted from Gross *et al.*, 2016, p. 7)

2.4 Classification of Learning Tasks

One of the main tasks of a lecturer is the knowledge transfer from the lecturer to the learner. To structure this knowledge transfer process, we use Bloom's Taxonomy of Educational Objectives for the classification of the learning objectives (Krathwohl, 2002; Bloom et al 1984) considering both the knowledge and the cognitive process dimension.

The knowledge dimension consists of four categories which cut across subject matter lines: (1) factual knowledge - basic knowledge learners have to know; (2) conceptual knowledge - interrelationships among basic elements within a larger structure; (3) procedural knowledge - methods and techniques on how to do something; (4) metacognitive knowledge - knowledge on cognition in general and self-awareness of one's own knowledge (Krathwohl, 2002).

The latter describes cognitive processes ordered from lower-order thinking skills (e.g. remembering) to higher-order thinking skills (e.g. creating) with lower-order thinking skills forming prerequisites for higher-order skills (Krathwohl, 2002). Anderson and

Krathwohl (2009) describe several learning tasks a thinking skill consists of (e. g. remembering can be implemented by listening). Churches (2008) extends these with sub-processes especially related to digital learning (e. g. remembering can be implemented by listening and/or bookmarking).

The revised taxonomy of Anderson and Krathwohl (2009) can be used to structure both learning processes ex ante from a teacher's perspective as well as ex post from a researcher's perspective (Gross *et al.*, 2016). In the current paper, the taxonomy will be used to structure the tasks of a lecturer in the context of higher education. Figure 3 presents a summary of thinking skills and their corresponding presence and online learning tasks

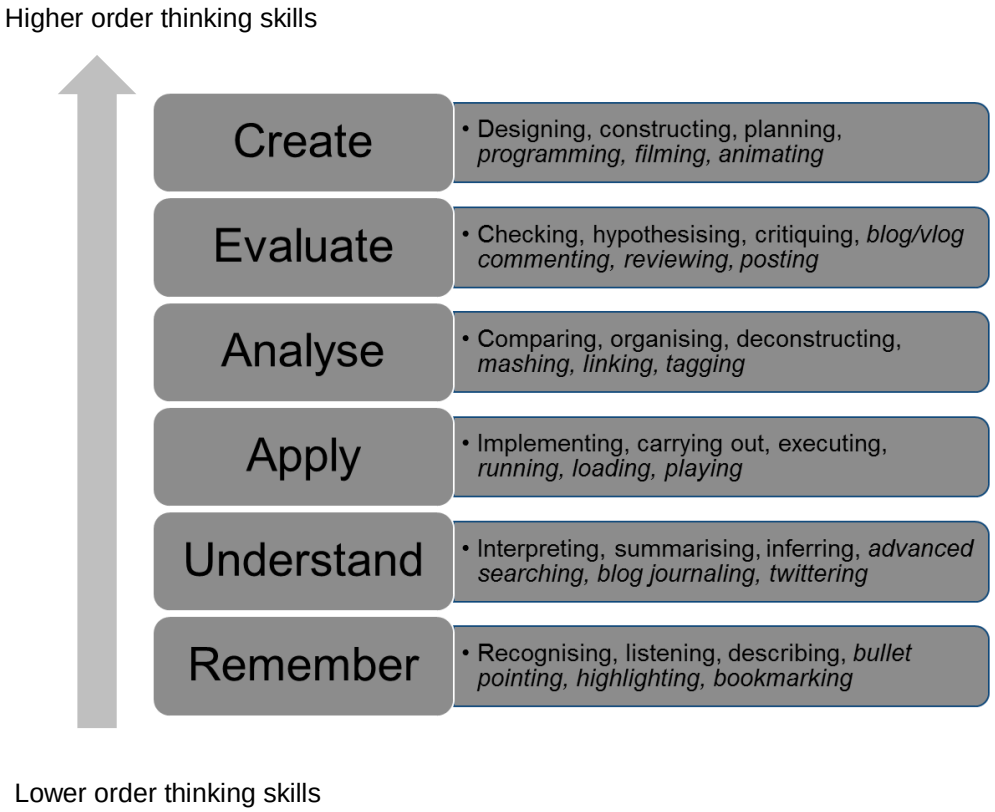

Figure 3. Cognitive Process dimensions with presence learning tasks and online learning tasks (in italics) (adapted from Bower *et al.*, 2010; Bloom 1984)

Although a lecturer usually does not have to fulfil a learning task for an authority the way a student has to, (s)he fulfils certain tasks to prepare, conduct, or revise a lecture. It is thus useful for a lecturer to consider the types of thinking and processes a learner is required to engage in before identifying technologies that will facilitate them best (Bower *et al.*, 2010) when preparing, conducting, and revising a lecture. As the

interaction between lecturers and students usually takes place during a lecture (execution phase), the processes and thinking (tasks) that are conducted before and after a lecture (preparation respectively reworking phase) will not be seen as learning objectives of the learners. Rather, they will be perceived as objectives of the lecturer that have to be fulfilled for conducting the lecture and, therefore, setting the learning objectives of the learners.

To summarise, we introduced an adapted taxonomy of pedagogies and the corresponding tool categories of Gross *et al.*, (2016) to classify the selected tools. Building on this, we adapted the extended TTF and TAM from Gross *et al.* (2016) in order to measure which factors influence the selection and usage of learning tasks and tools of lecturers. Finally, we used Bloom's Taxonomy to structure the tasks of a lecturer in the context of higher education.

3.0 Methodology – An Exploratory Mixed-Method Approach

Having discussed the theoretical framework for analysing how university lecturers select and use their learning tools, we will now link the theoretical framework to our methodology. We used a mixed-method approach with an exploratory strategy to answer our research questions. An exploratory strategy involves a qualitative data collection process which is followed by a quantitative data collection (Creswell, 2009). Related to this, our main objective is to elicit and use questionnaire data to verify or falsify the interpretations from our qualitative findings from semi-structured interviews and observations.

3.1 Interviews

In the first step, we collected qualitative data by conducting semi-structured interviews at five different universities in southern Germany. The goal was to get first insights into the research environment. The interviews were conducted with an open mind for new ideas and opinions from the interviewees.

Regarding the interview guide, we used the SPSS-method proposed from Helfferich (2011). Questions were structured by topic and type. Apart from an introduction and an opening and a closing question, the interview guide consisted of (1) general questions about didactic education, learning methods, and technology affinity; (2) processual

questions regarding the preparation, execution and reworking of lectures; (3) supplementary questions regarding influencing factors for tool selection, limitations for tool usage, and missing tools. Demographic data was also collected.

Each question was divided into three sub-questions: guiding questions which were formulated openly, maintenance questions for sustaining the narrative flow, and concrete enquiries regarding the content (Helfferich, 2011).

The sample consisted of five professors and one freelance lecturer of Economics, Information Systems, IT-Management, Software Engineering, and Anatomy from five universities.

The analysis of the collected data was performed by a transcription of the interview recordings, summarising and comparing all answers. followed by generalisation and interpretation (Mayring, 2002, 2010).

3.2 Observations

After the interviews, we conducted three observations at two different universities in southern Germany to identify discrepancies and commonalities between what the lecturers said in their interviews and what they actually did. For data collection, we used ethnographic research where we observed our target users in their natural and real-world setting to gather insight into e.g. how lecturers use their learning tools (Brewer, 2000).

The sampling included professors (all male) from the subjects Economics, Information Systems, and Anatomy. Being Master students, we acted as participants-as-observers during the observation phase (Schensul *et al.*, 1999). This enabled us to conduct interviews and to get permission for collecting data. The observation team attended the lectures as students and focused on aspects such as the size and equipment of the auditorium, number of participants, type of presentation style, used tools and technologies, and behaviour of the lecturer in general. Following the completion of the observations, the observational notes were analysed by summarising the central findings, which were compared to the findings of the interviews.

3.3 Questionnaire

By collecting qualitative data in a first step, we were able to construct a quantitative data collection process in order to analyse the tool selection (RQ1, RQ2) and tool usage (RQ3), which helped us to verify or falsify the previous findings (Sale *et al.*, 2002). For

this purpose, we used a quantitative online survey to reach a large number of lecturers in a short time.

Besides a general introduction into the research topic, demographic data such as age, gender, academic degree, subject, years of lecturing experience, and type of university were documented. The participants were asked to estimate their technology affinity and how much time they spend with electronic devices.

To find out which tools lecturers use in the different phases of the lecturing process (preparation, conduct and revision), they were asked to estimate the frequency of use for different tool categories such as image editing tools, writing and annotation tools, presentation tools, and tools for content delivery (e.g. for provision of lecture notes).

Furthermore, the questionnaire treated the influencing factors affecting tool selection and usage. The participants were asked to estimate the perceived relevance of different individual and exogenous factors. Furthermore, questions regarding limitations in tool selection, frequency of use concerning hardware devices, and satisfaction about the current software offerings at university were included.

Out of 160 enquiries, 70 lecturers (19 female, 51 male) aged between 25 to 66 years (M = 46.38) completed the survey. The participants were full professors, lecturers, post-doctoral researchers, and research and teaching assistants in natural sciences, social sciences, linguistics, computer science, engineering, economics, and art from universities and universities of applied sciences.

4.0 Results

In this chapter, we present our results based on the mixed-method approach described in chapter 3. At first the interview findings are described, followed by the results of the observations and questionnaire.

4.1 Interview Results

Only very few interviewees reported to have gone through a dedicated compulsory or complementary form of didactic training. According to the interviews, they use the same tools for lectures and example classes or tutorials. Furthermore, they even reported to use identical tools throughout all phases of the lecture process. Finally, lecturers consider learning tools mainly as supporting elements for teaching.

However, the interviewees pointed out three major problems regarding tool selection. The first problem is the lack of information since universities often provide scarce information regarding available learning tools requiring individual internet research. Secondly, the lecturers reported a lack of time to familiarise oneself with interesting learning tools. There are many different tools on the market for the same issue, but the lectures do not have the resources to get to know all of them. The third major problem is the lack of incentives to search for alternatives. The wide range of tools and difficult information retrieval lead to a complex search procedure which is not rewarded by the institution. Therefore, lecturers miss an information centre which supports and advises them on the tool selection.

4.2 Observation Results

The basic objective of our observation was the validation of the interview results. It was only possible to observe the conduct of the lecture but not the preparation or revision phase. All observations have confirmed the collected qualitative knowledge of the interviews. As the lecturers told us in the interviews, they mostly use presentation tools during the lecture.

4.3 Questionnaire Results

One goal of the questionnaire was to get to know the tasks for which the selected tools are used. Table 1 shows the top five tools for preparation, conduct, and revision phases based on a five-point Likert scale from 1 = “never use” to 5 = “very frequent use”.

Preparation		Conduct		Revision	
Tool	**Mean (SD)**	**Tool**	**Mean (SD)**	**Tool**	**Mean (SD)**
presentation tools (n = 70)	4.66 (0.81)	presentation tools (n = 68)	4.47 (1.01)	writing and annotation tools (n= 69)	3.22 (1.54)
writing and annotation tools (n = 70)	4.09 (1.14)	LMSs (n = 66)	2.94 (1.71)	presentation tools (n = 65)	3.06 (1.58)
LMSs (n = 68)	3.84 (1.51)	writing and annotation tools (n = 66)	2.76 (1.61)	LMSs (n = 67)	3.00 (1.64)
university organisation tools (n = 70)	3.14 (1.27)	audio- and video playback tools (n = 68)	2.41 (1.28)	calculation-/ statistic tools (n = 67)	2.45 (1.46)
calculation-/ statistic tools (n= 70)	2.99 (1.38)	calculation-/ statistic tools (n = 68)	2.29 (1.45)	communication tools (n = 67)	2.22 (1.40)

Table 1. Top five used tools of different phases

Also, we wanted to know how different universities provide course specific content (cf. Table 2). The clear majority uses LMSs (75.7%, n = 70). In contrast, a minority uses websites (11.4%, n = 70) or printed documents (4.3%, n = 70).

Additionally, we analysed whether there are potential differences between universities and universities of applied sciences. While all universities provide their data online (100%, n = 32), universities of applied sciences have a minority of lecturers who do not use the internet for providing lecture content (15.8%, n = 38).

Tool	Usage
LMSs	75.7%
Website	11.4%
File sharing	4.3%
Printing	4.3%
LMSs & website	2.9%
Library	1.4%

Table 2. Providing course documents (n = 70)

Another goal of the questionnaire was to get an idea as to the reasons of tool selection (RQ2). We analysed the perceived relevance of individual and exogenous factors based on our theoretical model (Figure 2) using a five-point Likert scale ranging from 1= “not

relevant" to 5 = "very relevant". Our results show that on average the individual factors (M = 4.20, SD = 0.67, n = 70) are more important for the tool selection than the exogenous factors (M = 3.00, SD = 0.70, n= 70). Also, the social norm factors (M = 2.03, SD = 0.77, n = 70) are not as important as the other factors (M = 3.51, SD = 0.61, n = 70). Table 3 shows all requested criteria, the ones in italics are the social norm factors and the corresponding factor to our theoretical model (Figure 2) are in brackets.

Criteria	**Factor**	**Mean (SD)**
Suitability for certain lecturing activities (Ease of Use) (n = 69)	Individual	4.43 (0.96)
Utility considering goal achievement (Task-Technology Fit) (n = 66)	Individual	4.42 (0.88)
Usability of the tool (Perceived Ease of Use) (n = 70)	Individual	4.39 (0.80)
Tool experience (n = 70)	Individual	3.84 (0.94)
Output quality of the tool (n = 70)	Exogenous	3.83 (1.02)
Complexity of the tool (Tool Experience) (n = 69)	Exogenous	3.81 (0.96)
Security (n = 70)	Exogenous	3.63 (1.21)
Price (n = 70)	Exogenous	3.43 (1.31)
Portability (n= 69	Exogenous	3.10 (1.44)
Number of students in the lecture (Environmental Limitations) (n = 69)	Exogenous	3.04 (1.43)
Technical support at the university (n = 67)	Exogenous	3.01 (1.34)
Guideline of the university considering selection and usage of tools (Lecturer/University) (n= 67)	Exogenous	2.91 (1.26)
High distribution among students (Critical Mass) (n = 69)	Exogenous	2.84 (1.28)
Potential to integrate with other tools (Interoperability) (n = 69)	Exogenous	2.80 (1.23)
Possibility to collaborate with others (Network Effects) (n = 70)	Exogenous	2.67 (1.35)
Advice / information for tool selection at your university (Support) (n = 68)	Exogenous	2.63 (1.23)
Possibility to link up to others (Network Effects) (n = 70)	Exogenous	2.61 (1.25)
High distribution among colleagues (Critical Mass) (n = 68)	Exogenous	2.13 (1.21)

Table 3. Influence factors for learning tool selection

On average, the output quality is significantly more important if the course size is lower than 40 ($M = 4.21$, $SD = 0.58$, $n = 14$) compared to course size greater or equal than 40 ($M = 3.33$, $SD = 0.99$, $n = 12$), representing an effect with small effect size ($t(17.21) = 2.72$, $p < 0.05$, $r = 0.12$).

To get to know why lecturers use the selected tools we also needed to know whether they perceive any limitations using the tools. We distinguish between infrastructural factors (i.e. infrastructure of the rooms, hardware of the lecturer, and size of the rooms) and organisational factors (i.e. guidelines of the university). Both categories have little impact on the tool selection. Infrastructural factors ($M = 2.10$, $SD = 0.89$, $n = 70$) are slightly more important than organisational factors ($M = 1.56$, $SD = 0.83$, $n = 70$), also based on a five-point Likert scale from 1 = "not limited" to 5 = "very limited".

To summarise, we observed that presentation, writing, and annotation tools are mostly used in the different phases of the lecturing process and that the tool selection process is mostly influenced by individual factors. Furthermore, the majority of universities provide their course specific content with LMSs.

5.0 Discussion

In our study, we focused on tool selection and usage of lecturers in the context of higher education. For this, we used a mixed-method approach including observations, interviews, and an online survey to examine which tools are used by the lecturers in practice (RQ1), why these tools are selected (RQ2), and which tasks these tools are used for (RQ3). Hence, in this section we will discuss the individual research questions step by step in a structured manner. After discussing the respective results of the research questions, we will throw light on limitations the research team was confronted with during the research process.

With respect to RQ1, our results show no major differences in tool usage regarding the different phases of a lecture. This might be mainly rooted in compatibility issues and can, therefore, be attributed to the personal tool experience which has a strong effect on the perceived ease of use (Brown, 2002), that is associated with the perceived usefulness of a tool and, therefore, has an impact on the actual tool usage (Dishaw and Strong, 1999). However, one difference in the tool usage regarding the preparation and revision phase of a lecture is the use of university organisation tools. Whilst this category was among the top five tools used in the preparation phase, it was replaced by

communication tools in the revision phase of a lecture. Our results from the interviews show that whereas lecturers have to fulfil more organisational tasks when preparing a lecture (e.g. booking a course room), the revision phase focuses more on the communication with students (e.g. evaluation of the course) or employees (e.g. coordination of reworking tasks). Reflecting all three phases of a lecture, presentation tools, writing and annotation tools together with LMSs were always among the top three used tools. The five least used tools throughout all phases include microblogging tools, blogging tools, audio editing tools, and classroom management tools. It is noticeable that the most frequently used tool categories refer to constructive and co-constructive pedagogies, whereas the least used tools refer to transmissive and dialogue pedagogies. So, lecturers prefer tools which focus on the creation of artefacts.

When it comes to providing lecture content to the students, the type of university becomes an important factor. While all university lecturers provide their lecture content online, only 84.2% of the lecturers from universities of applied sciences do so. This might be due to the substantially higher number of students in university courses resulting in an increased need to distribute the materials and, therefore, higher printing costs.

In RQ2, we focused on the reasons for selecting a specific tool. Altogether, lecturers are free to choose any tool when preparing, conducting, and revising a lecture. Referring to the combined TAM and TTF model, environmental limitations have a weak direct influence on actual tool usage as well as on tool functionality. Additionally, the existing infrastructure seems good enough to employ the analysed tools and functionalities. Nevertheless, our results show that compared to organisational factors (e.g. university guidelines), infrastructural factors (e.g. equipment of a course room) have a significantly stronger influence when selecting a tool, as the equipment of a course room can limit the tool functionalities (e.g. no presentation tools can be used due to missing beamer).

Comparing individual and exogenous influencing factors, the individual factors (e.g. tool experience) from TAM and TTF have a bigger influence on the tool selection than the exogenous factors (e.g. price).

Furthermore, the exogenous social norm factors “lecturer/university”, “network effects” and “critical mass” have a subordinate position when choosing a tool. In contrast, several studies point out the importance of critical mass as influencing factor on the perceived usefulness and actual tool usage (van Slyke *et al.*, 2007; Shen *et al.*,

2009). Our interview results show that lecturers usually work in small groups or on their own. In such settings, social norms are of low importance. Comparing these findings with the perspective of the learners, the social norms have a bigger influence on the learners than on the lecturers. Gross *et al.* (2016) point out that the lecturer's type of presentation and type of material have a strong influence on the learner's tool selection. Further, their results show the particular importance of critical mass, especially when viewed in the context of group activities. In contrast, lecturers usually do not have guidelines from a person or from the institution, so they can set their own software agenda.

Moreover, our results show that the course size affects the individual importance of the output quality of a tool when it is selected. If course size is smaller than 40 students, the importance of output quality and, therefore, the influence on the perceived usefulness of a tool increases.

Regarding RQ3, our results show a general decrease in tool usage throughout the phases of a lecture. Our interviews pointed out that the majority of the workload is located in the preparation phase of the lecture. This is also the phase where tools are used in a constructive way addressing higher order thinking skills as lecture content has to be created. Similarly in the revision phase, lecture content must be revised and new artefacts have to be created addressing again higher order thinking skills.

When it comes to conducting a lecture, the tools are used in a transmissive way addressing lower order thinking skills. Furthermore, the usage of audio-/video-playback tools (representing dialogue pedagogy), which were located among the top five tools especially in the conduct phase, emphasises the focus of knowledge transfer.

Overall, the majority of lecturers refer to tools rooted in the constructive and co-constructive pedagogy. In the last decade, constructivist teaching in theory and practice received increasing attention. It is about constructing individual understanding on the basis of interactions between what the learners already know and which new knowledge they get into contact with (Richardson, 2003).

According to the questionnaire results, LMSs are used very often as they provide a broad range of functionalities from personalised learning, learner-centred decision making, staff productivity, and curriculum development and, therefore, address all kinds of pedagogies (Phillipo and Krongard, 2012).

Comparing our results with the learners' perspective, Gross *et al.* (2016) showed that learners prefer pen and paper for higher order thinking skills such as image creation or

the creation of mind maps. In contrast to this, our results show that lecturers stick to electronic learning tools when performing higher order thinking skills (e.g. preparing a lecture). This might be rooted in the fact that lecturers have to make their lecture content available to a broad audience of students and, therefore, save time and effort using electronic tools.

However, lecturers and learners also show similarities regarding tool usage. As shown before, the majority of tool usage can be attributed to the constructive and co-constructive pedagogy especially in the preparation phase. The same pattern can be observed for students as the majority also refers "to tools mostly rooted in the constructive and co-constructive type of pedagogy" (Gross *et al.*, 2016, p. 13). Whilst lecturers usually create artefacts for distribution to a broader audience, students usually create artefacts for themselves, their peer group, or the lecturer.

There are certain aspects which limit the generalisability of our results. With regard to the interviews, we had a relatively homogenous interviewee group as all of the interviewees were male and the majority of them located in the STEM fields. As a consequence, the observations were also located in the STEM fields. Due to the fact that they were conducted at the end of the semester, lecturers focused more on exam preparation than on applied knowledge or tool usage. Through the nature of the observations, we could only observe one out of three lecture processes, namely the conduct phase. Therefore, obtaining a complete picture of the lecture process including all phases was not possible. As with the interviews and the observations, one limitation regarding the questionnaire was that the majority of participants was located in the STEM fields. Further, the questionnaire focused on universities in southern Germany. The key limitation concerning the questionnaire was the start of the questionnaire partly in parallel to the interviews.

6.0 Conclusion and Outlook

This study reports on a graduate student research project investigating the tool selection and tool usage of lecturers in the preparation, execution, and reworking phase of lectures.

Regarding RQ1 (Which learning tools are used by lecturers in practice?), our results show that presentation tools, writing and annotation tools, and LMSs are those with the highest frequency of use during all phases. Furthermore, constructive and co-

constructive tools with their focus on artefact-creation are preferred to transmissive and dialogue-oriented tools. Furthermore, all kinds of tools are used more often in the preparation phase than in the other phases.

Investigating RQ2 (Why are these learnings tools selected?), individual factors play a major role, whereas exogenous factors have a subordinate position. While infrastructural limitations are slightly more relevant than the organisational ones, both remain rather unimportant for the lecturers. Also, there is no significant difference in tool selection between the preparation and revision of lectures. Tool selection should be performed acknowledging different types of lecturers, lectures, the applied pedagogy, and size of the course. Additionally, didactic trainings can support the tool selection and tool usage.

Finally, concerning RQ3 (Which learning tasks are these tools used for?) the results show that there is a general decrease in tool usage in all phases. However, LMSs offer a wide range of features which can replace tools from personalised learning via learner-centred decision making through to curriculum development and, therefore, address all kinds of pedagogies (Phillipo and Krongard, 2012). To use the LMS as a central platform, high ease of use and usability for lectures as well as for students is necessary and requires mobile technologies. Then the LMS can be used as a digital learning environment for students and as an administrative system for lecturers to manage their courses.

Multiple implications can be derived from the findings. First of all, an increased focus on supporting lecturers through software consulting centres at universities or trainings can ensure an efficient and effective use of software and hardware tools. Furthermore, a good infrastructure must be provided for teaching.

Finally, comparing the findings to Gross (2016) who investigated the tool selection and tool usage from the learners' point of view, pen and paper are not favoured by the lecturers at all. Additionally, social norm influences lecturers less than learners. This can be linked to the fact that most lecturers work in smaller groups or on their own.

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