Digital Media in Higher Education – The Use and Importance of Digital Media in Contemporary University Studies

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Summary

Digitalisation affects many areas of everyday life and has long since arrived in higher education: Electronic systems make it possible to book courses, organise studies and provide course materials; lecture recordings and video conferences complement (or even replace) classroom teaching and social media platforms enable a new type of social networking and collaboration within the framework of studies. Research on digital media use at universities, in a national and international context, has indicated a wide distribution and use of digital media in the education context. However, this type of research is often limited to descriptive elements and is not integrated into higher education models of study success factors. On the other hand, research based on these models, which are already well established for factors such as goal orientation, self-efficacy or social background, for instance, often ignores the prevalence of digital media in higher education and therefore potentially appears to be no longer fully adapted to contemporary university studies. Thus, the aim of the present dissertation is therefore to investigate the use and relevance of digital media in contemporary German university studies, based on current data from 2018 and an interdisciplinary theoretical perspective on factors of academic success. On the basis of social cognitive theory, a model for academic achievement was used. This model was extended by digital media self-efficacy and digital media behaviour. In this dissertation, this model and the results of four empirical studies are discussed. First, a suitable questionnaire instrument was developed and psychometrically tested. The data was then used to identify media user types among students. In a multi-stage analysis, the influences of, for example, self-efficacy, social backgrounds and digital media use on academic achievement were then examined. Finally, subject differences regarding study-related technology use were analysed. The results showed first indications that certain patterns of media use, which are characterised, for example, by a high level of scepticism towards digital media combined with a high level of interest and (self-assessed) skills, can have a positive effect on academic performance. Regarding media-related self-efficacy, the assumed high relevance of the construct is confirmed, especially for the analysis of digital media-related behaviour and attitudes. In addition, this offers possible starting points for interventions. In this regard, the theoretically well-founded and newly developed scale for digital media self-efficacy can be easily implemented. Furthermore, the results show that socioeconomic differences still exist in academic self-efficacy, the associated goal orientations and academic performance. However, an influence of social background was not observed for digital media self-efficacy. On the other hand, clear gender-related differences were evident for digital media self-efficacy and for academic self-efficacy and different types of media use. Overall, the results of this dissertation provide a comprehensive insight into student (media) behaviour in the modern university context, possible determinants of academic achievement and group-specific differences (e.g. regarding gender, subject or socioeconomic background). These findings are of practical value, for example, for curriculum planning and for identifying opportunities and

barriers to the integration of technologies in the study context – especially in the transition to digital teaching formats, as has often been necessary, for example, in 2020 due to the COVID-19 pandemic. Altogether, the studies carried out in the context of this dissertation lead to a significant gain in knowledge for research in higher education and offer various opportunities for further research and practice at universities.

Zusammenfassung

Digitalisierung betrifft viele Bereiche des alltäglichen Lebens und ist längst auch an Hochschulen angekommen: Elektronische Systeme ermöglichen Kursbuchung und Studienorganisation und das Bereitstellen von Materialien; Vorlesungsaufzeichnungen und Videokonferenzen ergänzen (oder ersetzen) Präsenzlehrveranstaltungen und Soziale Medien ermöglichen eine neue Art von sozialer Vernetzung und Kollaboration im Rahmen des Studiums. Forschung zu digitaler Mediennutzung an Hochschulen, im nationalen und internationalen Kontext, zeigt eine weite Verbreitung und Nutzung von digitalen Medien im Studium. Leider bleibt diese Art von Forschung oft auf deskriptive Elemente beschränkt und ist nicht in übergeordnete Modelle zu Studienerfolgsfaktoren integriert. Forschung auf Basis dieser Modelle hingegen, die für Faktoren wie zum Beispiel Zielorientierung, Selbstwirksamkeit oder soziale Hintergründe bereits gut etabliert sind, blendet oft die Verbreitung von digitalen Medien in der Hochschulbildung aus und erscheint daher nicht mehr ganz angepasst an das zeitgemäße Studium. Das mit der vorliegenden Dissertation verfolgte Ziel ist daher die Erforschung der Verwendung und Relevanz von digitalen Medien im heutigen Universitätsstudium in Deutschland, auf der Basis von aktuellen Daten aus dem Jahr 2018 und einer interdisziplinären theoretischen Perspektive zu Studienerfolgsfaktoren. Ausgehend von der Sozial-Kognitiven-Lerntheorie wurde daher ein Modell für Studienleistung entwickelt, welches um medienbezogene Selbstwirksamkeit und Medienhandeln ergänzt wurde. In dieser Dissertation werden dieses Modell und die Ergebnisse von vier empirischen Studien diskutiert. Zunächst wurde ein geeignetes Fragebogeninstrument entwickelt und psychometrisch getestet. Die Daten wurden anschließend explorativ hinsichtlich der Identifikation verschiedener Mediennutzungstypen unter Studierenden analysiert. In einer mehrstufigen Analyse wurden daraufhin die Zusammenhänge von z. B. Selbstwirksamkeit, sozialen Hintergründen, Mediennutzung und Studienleistung untersucht. Abschließend wurden Fächerunterschiede hinsichtlich der studienbezogenen Technologienutzung analysiert. Es zeigten sich erste Anhaltspunkte dafür, dass sich bestimmte Mediennutzungsmuster, die z. B. durch eine hohe Skepsis gegenüber digitalen Medien bei gleichzeitig hohem Interesse und (selbst eingeschätzten) Fähigkeiten gekennzeichnet sind, positiv auf die Studienleistungen auswirken können. Mit Blick auf medienbezogene Selbstwirksamkeit bestätigt sich die angenommene hohe Relevanz des Konstruktes, insbesondere für die Analyse von Handeln und Einstellungen in Bezug auf digitale Medien. Darüber hinaus ergeben sich hier mögliche Ansatzpunkte für gezielte Fördermaßnahmen. Die theoretisch fundierte und neu entwickelte Skala für medienbezogene Selbstwirksamkeit erlaubt dabei eine leicht umzusetzende Messung des Konstrukts. Außerdem zeigen die Ergebnisse, dass sozioökonomische Unterschiede hinsichtlich der akademischen Selbstwirksamkeit und der damit verbundenen Zielorientierungen und Studienleistungen nach wie vor bestehen. Ein Einfluss des sozialen Hintergrunds ist bei medienbezogener Selbstwirksamkeit jedoch nicht erkennbar. Hierbei zeigten sich allerdings deutliche geschlechtsbezogene Unterschiede, ebenso wie auch bei

der akademischen Selbstwirksamkeit und verschiedenen Mediennutzungstypen. Die Ergebnisse dieser Dissertation geben insgesamt einen umfassenden Einblick in das studentische (Medien-)Handeln im modernen Hochschulkontext, in mögliche Determinanten der Studienleistung und in gruppenspezifische Unterschiede (z. B. hinsichtlich Geschlecht, Fach oder sozioökonomischem Hintergrund). Diese Erkenntnisse sind von hohem praktischen Wert, z.B. für die Curriculumsplanung und für die Identifizierung von Chancen und Barrieren bei der Integration von Technologien in den Studienkontext - insbesondere bei einem Übergang zu digitalen Lehrformaten, wie es z.B. im Jahr 2020 aufgrund der COVID-19-Pandemie häufig notwendig wurde. Insgesamt führen die im Rahmen dieser Dissertation durchgeführten Studien zu einem signifikanten Erkenntnisgewinn für die Forschung im Hochschulbereich und bieten vielfältige Möglichkeiten für weitere Forschung und Praxis an Hochschulen.

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1 Introduction

'Online learning is not the next big thing, it is the now big thing' (Donna J. Abernathy, 2002) is a statement that, in 2020, seems more accurate than ever before. Since this statement was made in 2002, a shift towards mobile digital devices, such as tablets, laptop computers and smartphones, and away from static desktop computers, as well as an expansion of bandwidth and wireless network connections has allowed for rapid digitalisation processes that have changed industry and everyday life. As is to be expected, these processes did not stop at educational institutions such as universities (Grosch & Gidion, 2012; Schulmeister, 2007). As skills regarding digital media and computers become increasingly important in many occupational fields (see e.g. Ally & Prieto-Blázquez, 2014), it is plausible that these would become more and more integrated in higher education as well. Additionally, digital media can, in general, have a positive impact on learning outcomes, as was demonstrated, for example, in the school context (Cavanaugh, Barbour, & Clark, 2009; Q. Li & Ma, 2010; Tienken & Wilson, 2007). Therefore digital media might also impact learning outcomes in higher education (HE).

In the course of increasing digitalisation processes, empirical studies on higher education students' media use have tracked changes in distribution, usage habits and attitudes (e.g. Al-Husain & Hammo, 2015; Dahlstrom, Brooks, Grajek, & Reeves, 2015; Grosch & Gidion, 2011; Schulmeister, 2006; Zawacki-Richter, 2015). This research on students' digital media use indicates that students varying in, for example, age, family status, or ambitions show differing patterns of digital media use in academic settings (e.g. Grosch & Gidion, 2011; Zawacki-Richter, Kramer, & Müskens, 2016; Zawacki-Richter, Müskens, Krause, Alturki, & Aldraiweesh, 2015). From 2012 to 2015, the number of students who own a smartphone, tablet or notebook has increased significantly (Zawacki-Richter, Dolch, & Müskens, 2017), which resulted in the almost omnipresence of laptops and smartphones among higher education students in 2015. Studies conducted by the EDUCAUSE Center for Analysis and Research between 2004 and 2015 focused on the development of undergraduate students' technology use for higher education institutions in the United States and up to 15 other countries. For this international context, the researchers found a similar increase in the spread of technology and the use of mobile devices in both the private and academic sectors over time (Dahlstrom & Bichsel, 2014; Dahlstrom et al.,

2015). In view of this growing prevalence, in-depth research of digital media use at universities also seems increasingly relevant (see also Chapter 4). However, this previous work on digital media in higher education has been predominantly based on empirical studies that describe different types of media usage patterns. Thus, the instruments used were often limited to the assessment of behaviour and use of digital media and applications. As a result, relationships with underlying factors otherwise influencing students' academic behaviour and achievements remain unconsidered. Therefore, little is known about the relevance of digital media for mastering academic studies, in the light of growing digitalisation.

Higher education research on student success and academic achievement is often focused on the identification of relevant predictors that may explain differences between students in line with, for example, psychological or pedagogical models and, where applicable, allow for interventions. Commonly identified influential factors for academic attainment are self-efficacy beliefs (meaning the individual perception of being capable of successfully performing a certain behaviour; see Chapter 2.3) and motivation, respectively, as well as goal orientation, which in turn are related to each other (e.g. Pajares, 1996; Putwain, Sander, & Larkin, 2013; Schunk & Pajares, 2002; Zimmerman, Bandura, & Martinez-Pons, 1992). In particular, the crucial role of self-efficacy was repeatedly confirmed (see meta-analytic review by Richardson, Abraham, & Bond, 2012), also in more recent research on students' success (e.g. Bartimote-Aufflick, Bridgeman, Walker, Sharma, & Smith, 2016). In their meta-analysis, Honicke and Broadbent (2016), in addition to academic self-efficacy, also substantiated the relevance of motivational variables such as goal orientation. Other studies, considering study-related emotions, perceptions and personality traits, identified anxiety (Hsieh, Sullivan, Sass, & Guerra, 2012), perceived control over actions and outcomes (Pekrun, 2006) and conscientiousness (Lievens, Ones, & Dilchert, 2009) as additional (mediating) influences in the self-efficacy-achievement relationship (see also Chapter 5).

Research on academic attainment is often combined with research on student drop-out, as retention is indirectly affected by factors such as self-efficacy, in combination with social adjustment, institutional commitment, and grade point average (GPA; e.g. Bowman, Miller, Woosley, Maxwell, & Kolze, 2019). At this point, processes of inequality among students with different backgrounds, such as in socioeconomic status (SES), can become visible (e.g. Lörz, Quast, & Roloff, 2015; McKay & Devlin, 2014; Weiser & Riggio, 2010). In particular, inequality in the German higher education system manifests through a lower number of beginners, bachelor's degree graduates and especially master's students and graduates, among those students from non-academic families, research shows that the relation of students with non-academic and academic backgrounds is 1:6, once the master level is reached, and 1:10 during a doctoral degree (Stifterverband für die Deutsche Wissenschaft & McKinsey & Company, 2017/2018). Reasons

for the drop-out of disadvantaged students, for instance, with regard to socio-demographic characteristics or SES, often lie in alternative vocational options because of former vocational training and financial struggles, but especially academic achievement (Lörz et al., 2015; Stifterverband für die Deutsche Wissenschaft & McKinsey & Company, 2017/2018; Stoessel, Ihme, Barbarino, Fisseler, & Stürmer, 2015). Further, research indicates that the relation between students' socioeconomic status and their academic achievement may be mediated by self-efficacy (Gecas & Schwalbe, 1983; Weiser & Riggio, 2010, see also Chapters 3 and 5).

However, while the results of the studies mentioned above are often consistent and integrated into well-established theoretical models – for example the framework of *social-cognitive theory* (SCT) and self-efficacy by Bandura (e.g. 1986, see Chapter 2.3) – the transferability of the results is uncertain, since the research is often located outside of Europe, based on low case numbers or limited to a specific group of students, for example psychology students (see for example review studies by Bartimote-Aufflick et al., 2016; Honicke & Broadbent, 2016). Furthermore, it is questionable whether these models can still adequately reflect the study situation in a higher education environment increasingly characterised by digital media integration into teaching and learning as well as the organisational infrastructure. Research on the dissemination and use of digital media among higher education students, on the other hand, is rarely combined with these larger (theoretical) models for academic success. Therefore, factors such as underlying motivations, emotions, or self-efficacy, which are typically investigated in higher education research on academic achievement, are hardly considered in studies on students' media use. A study by Horvitz, Beach, Anderson, and Xia (2015), for example, examined faculty's self-efficacy regarding online teaching. However, it did not take the students' views into account. Often, research on the effects of digital media or technology-enhanced learning is limited to school contexts (e.g. Li, Garza, Keicher, & Popov, 2019; Sangkawetai, Neanchaleay, Koul, & Murphy, 2018), for example, K–12 Online Learning (see e.g. review studies of Cavanaugh, Barbour, & Clark, 2009; Li & Ma, 2010). Others pursue a narrow focus, such as in the studies by Kirschner and Karpinski (2010) and Lau (2017) who examined social media and its relation to GPA (see Chapter 5). Overall, the examination of digital media in higher education that is based on a comprehensive, contemporary theoretical model for academic success is lacking in research. In consequence, the trend towards digitalisation in higher education has not been sufficiently considered in the assessment of student performance and academic success, i. e. the relevance of digital media in contemporary academic studies, has gone largely unexplored.

The aim of the present dissertation is to fill this gap by investigating the use and importance of digital media in contemporary German higher education programmes based on recently gathered empirical data and with an interdisciplinary perspective. In this context, digital media use is

to be depicted as comprehensively as possible and integrated into a general theoretical model. Therefore, the overarching research questions are as follows:

1. How can digital media use and related beliefs be integrated in the measurement and analysis of factors for academic success?
2. Are there distinguishable types of media users among higher education students, and how can these be described?
3. How is academic performance affected by digital media behaviour and related beliefs?
4. How are digital media behaviour and related beliefs affected by students' social background?
5. Are there discipline-related differences in the use of technology for study purposes?

As noted above, an integration of media use and related attitudes and beliefs has thus far been lacking in empirical studies on study performance. Therefore, the first research question in the measurement of factors for academic success leads to the construction of an appropriate survey instrument. 'Beliefs' (such as self-efficacy, see Chapter 2) are considered to overcome the rather descriptive nature of the above-mentioned prior media usage studies. For a more diverse and up-to-date student population in comparison to this prior research, the second question aims to identify media user types among higher education students, which provides explorative insight into current media use at the universities covered in the sample. The next two questions lead to empirical findings on contemporary factors for academic success and the relevance of digital media in higher education. Finally, discipline-related differences in the use of technology for study purposes are analysed to gain deeper insights into patterns of media use that cannot be explained purely by individual characteristics but that are also affected by contextual factors specific to the higher education environment. Regarding these research questions, an interdisciplinary approach, i. e. the combination of different concepts from educational and social psychology as well as sociology, allows for the consideration of individual characteristics, social background factors and contextual influences. Thereby, this dissertation contributes to research in higher education by comprehensively capturing the factors that determine students' success in today's academic studies, while simultaneously identifying potentially disadvantaged groups and highlighting possible points of intervention and future research. Overall, this leads to new, relevant findings regarding the use of digital media at universities and also extends prior research by filling gaps and overcoming some of the weaknesses (e.g. small, very specific samples). In particular, theoretical models for academic success based on motivational determinants are extended to include digital-media-related beliefs and behaviour. This interdisciplinary approach leads to further theory development and provides

starting points for future research, both psychological and sociological.

In the following chapter, the comprehensive theoretical framework to analyse digital media use in the context of higher education is presented. This framework is based on a motivational theory, precisely the SCT (Bandura, 1986), supplemented with theories that focus on cultural reproduction (e.g, Bourdieu & Passeron, 1971), integrated into a theory of 'technology mediated learning' (Bower, 2019), and applied to the context of higher education. Subsequently, four studies that were conducted to answer the research questions are integrated into this framework. Chapters 3–6 cover these studies, which were written for publication in peer-reviewed journals and are therefore independent and self-contained. In Study 1, the development and psychometric analysis of a survey instrument to measure digital media use, related beliefs and other previously examined factors in academic achievement, is discussed (Pumptow & Brahm, 2020, see Chapter 3). An explorative analysis of how higher education students differ in the use of digital media – i. e. an identification and subsequent analysis of types of digital media users – is the focus of Study 2 (Pumptow, n.d., see Chapter 4). The questions regarding how academic achievement is affected by digital media behaviour and related beliefs as well as how these, in turn, may be affected by students' social background are the focus of the third study (Pumptow & Brahm, n.d.-b, see Chapter 5). The fourth study covers an analysis of differences in digital media use among different disciplines (Pumptow & Brahm, n.d.-a, see Chapter 6). Finally, this dissertation concludes with a joint discussion of the results of the four studies with regard to the research questions, the overall framework and implications for future research and practice in Chapter 7.

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2 A Theoretical Framework to Analyse Digital Media Use in the Context of Higher Education

The adequate measurement and analysis of digital media usage behaviour and related beliefs requires a theoretical framework which on the one hand is based on established constructs and on the other hand allows for the addition of contemporary constructs in connection with digital media in an educational context. In this chapter, an overview of theoretical approaches to digital media use, integration and role of technology in educational contexts, motivational theories for academic behaviour and finally the underlying theory of the present dissertation – which allows for integration of the analysis of technology use in higher education – is provided. The chapter concludes by embedding the four empirical studies that have been conducted to address the research question in this overall theoretical framework.

2.1 Digital Media in Higher Education

For some time now, digital media have been part of everyday life and university studies, whether they are explicitly integrated into learning settings – for example, in e-learning or blended learning formats – or serve to organise studies, for example in course bookings or exam administration in the electronic online systems (Getto & Kerres, 2018). In addition, there are also digital media that at first glance are not explicitly connected with technology-enhanced teaching, but which, for example, enable self-organisation in learning groups (e.g. via WhatsApp groups), exchange of information and materials or acquisition of knowledge, for example, YouTube videos or websites such as Wikipedia (Getto & Kerres, 2018). Both formal and informal use of digital media might influence study success, which is why the focus in the present work is not limited to technology that is explicitly and formally embedded in teaching and learning.

Digital media can promote academic achievement, as was demonstrated in a meta-analysis of meta-analyses comparing learning settings with and without the use of technology for a

period of over 40 years (in high school contexts). This was especially evident in cases where technological media was an addition to classical classroom teaching methods (Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). However, the effect is not necessarily inherent in the nature of the media itself but is determined by complex interdependencies of media (use) and learning (Kerres, 2003). As Ross, Morrison, and Lowther stated (2010, p. 19), 'Educational technology is not a homogeneous "intervention" but a broad variety of modalities, tools, and strategies for learning. Its effectiveness, therefore, depends on how well it helps teachers and students achieve the desired instructional goals'. Still, digital media offer potential for the individualisation of learning processes, self-directed learning, cooperation and exchange (Kerres, 2013). Individualisation refers to the contents that are chosen, time and place, or the type of media presentation according to the preferred format (auditory, visual, text-based etc.). Temporal flexibility through available-anytime (online) media leads to a more independent and self-determined type of studying. For example, students may use commuting to prepare for seminars and lectures, study at night or early in the morning or attend courses at the same time, if they do not require personal attendance. All this contributes to self-directed learning, since – given a certain amount of information and media literacy as well as self-monitoring (e.g. self-tests) – students are free to choose difficulty levels based on their level of knowledge, learning pace, format, and contents, thus following their interests and preferences (Grosch, 2012). In addition, digital media can help support cooperation and exchange, for example, through messenger services (e.g. WhatsApp) or video conferencing systems (e.g. Skype, Zoom). In this respect, learning groups can either be formed independently by the students or used specifically in teaching, such as in the form of computer-based group exercises (e.g. via break-out rooms) (Grosch, 2012).

In general, it can be assumed that German higher education (HE) students are equipped with and use digital technologies on a day-to-day basis, as past studies (Kleimann, Weber, & Willige, 2005; Kleimann, Özkilic, & Göcks, 2008) within the framework of the HISBUS panel surveys have shown. This has been repeatedly confirmed in multiple national and international studies (e.g. Dahlstrom, Brooks, Grajek, & Reeves, 2015; Grosch & Gidion, 2011; Margaryan, Littlejohn, & Vojt, 2011; Waycott, Bennett, Kennedy, Dalgarno, & Gray, 2010; Zawacki-Richter, Dolch, & Müskens, 2017).[1] Access to technology and the Internet in Germany is almost entirely granted.[2] However, regarding adolescents Schulmeister (2009a) found that the educational background seems to have an impact on their usage behaviour and media competency. As HE students generally seem to display a quality-oriented internet usage (Grosch, 2012), it remains to be examined whether differences in study-related media use behaviour may become apparent

[1] For a (German language) systematic review of research on HE students' media use see Steffens, Schmitt, and Aßmann (2017) (see also state of research discussions in Chapters 3-6 and the introduction in Chapter 1).
[2] 94 % of the German population use the Internet at least occasionally (ARD/ZDF, 08.10.2020).

regarding socioeconomic backgrounds (see Chapter 5). HE research on digital media, such as in the present dissertation, is often interdisciplinary in focus and draws on different disciplinary approaches and theoretical concepts because the field represents many overlapping areas. Thus, in the following subsections, first the definition for digital media in the present work is provided and subsequently, some of these approaches are briefly described to provide an overview of the field of media research.

2.1.1 Definition of Digital Media in the Present Dissertation

In research on digital media, many different definitions and theoretical conceptions exist, often focused on, for example, smaller-scale digital learning environments (see also following section, 2.1.2). However, for the present research aim, which is focused on the large-scale and rather general digital media environment and its use in HE, a practical procedure is followed. In this sense, a working definition that is not intended to provide a conclusive definition of the field or to unite as many theoretic approaches as possible is formulated (see e.g. Panke, 2006). Digital media are understood here as technological media through which information is communicated or disseminated, for example in the form of electronic representations of text, sound, video or images. More specifically, these digital media could be online applications that can be used both with a computer and/ or mobile devices, for example, with smartphones, tablets, or notebooks. These applications can include websites, e-books, learning environments, e-mail, and social media plattforms and are therefore not limited to specific applications. Accordingly, digital media behaviour is defined as the application of digital media with different devices, for study purposes and also for leisure or social activities. These definitions of digital media and digital media behaviour refer to an everyday understanding and were implemented in this form in the questionnaire (see Chapter 3 and appendix A). It was therefore ensured that this underlying definition was reflected in the survey and the students' answers. While this understanding may not be sufficient – for example, for analytical purposes from the perspective of media or communication science – it is appropriate for the present social science perspective and the epistemological claim of this work.

2.1.2 Theoretical Approaches to Digital Media Use

As mentioned above, research on digital media use is conducted from different disciplinary perspectives: for example media and communication science, media psychology and sociology,

or media-related education science. This leads to a corresponding heterogeneity of theoretical approaches. These approaches – for example, concepts from media-related education science – are often focused on specific areas, such as media-based learning environment concepts in certain e-learning applications (Röll, 2005) or personal learning environments (Taraghi, Ebner, & Schaffert, 2009), which are often reduced to technical-medial dimensions and therefore do not consider social or other components of the learning environment (Schulmeister, 2009b; for a detailed discussion see also Grosch, 2012, p. 22). In the broad context of students' media use, however, social, communicative factors, and study-organisational usage habits also appear relevant since they are important for academic success. Thus, a theoretical perspective that is only applicable to a specific field of media usage does not seem effective for the present purpose.

Another strand of research concentrates on media typologies: for example, those originally described by Pross (1972), who, from a media science perspective, defined media as means of communication and distinguished these according to the degree of their mechanisation into primary (not technological), secondary (one-sided technological support, i.e. only the communicator uses tools, the recipient does not), and tertiary media (technological tools on both sides). This approach was modernised and supplemented by computers as a quaternary medium by Faßler (1997). However, the focus on technological aspects of communications is again too narrow for the purpose at hand. In closely related approaches, from a communication science perspective, a theoretical definition of media is often led by a differentiation between individual and mass media (Maletzke, 1963), technical and institutional media (Saxer, 1987) or modes of communication (Hasebrink, 2004; see also Grosch, 2012, p. 23). These perspectives also seem insufficient for the present work, especially considering the large number of different media applications available at HE institutions and on the Internet in general, some of which overlap and some of which vary greatly in reach, publicity and communication purposes.

Research from a media psychology perspective is often focused on media choice models, i.e. an analysis of the motivation to use specific digital media (applications), either referring to rational choice concepts (e.g. Döring, 2003) or media richness theory (e.g. Daft & Lengel, 1986). However, social and contextual influences are often left out of these concepts. In contrast, sociological approaches – for example by Johnsson-Smaragdi (1994, based on the bioecological model of human development by Bronfenbrenner, Lüscher, and Cranach, 1981, 2007) – consider media as a micro-system from a systems theory point of view, taking into account these social and contextual aspects but, in this case, at the expense of a differentiated view of psychological aspects of media use (see Grosch, 2012, p. 23).

Overall, these approaches are not sufficient for the overarching research aim of the present

work, but rather offer theoretical concepts or additions for smaller-scale analyses. Therefore, the approach of Johnsson-Smaragdi (1994), for example, is taken up again in one of the empirical analyses (see Chapter 4). However, in these theories, often either the reference to the educational context is missing or the focus is too narrow (e.g. reduced to PLEs). Consequently, they appear less suitable for the overall objective. Therefore, to gain general insights into student media-usage behaviour and its relevance for achievement in higher education, another approach is needed. Thus, in the following subsection, a theory that integrates different perspectives into one framework for technology in educational contexts is briefly described.

2.1.3 An Approach for the Integration of Technology in Educational Contexts

What is missing so far is a comprehensive theoretical perspective that is more oriented towards the influence of technology on learning, which was provided by Bower (2019), who combined the most common theoretical approaches in the field of technology-related educational psychology research into a 'technology mediated learning theory' (TML) (see also Chapter 6). Following this approach, learning is mediated by technology, while the technology itself does not have any intentions, but is the object used to convey meaning; that is, the intentional agency lies with the humans (Bower, 2019). This partly corresponds to actor network theory (Latour, 2005) but more strongly emphasises the asymmetry between persons and non-living objects in terms of intentionality (see Bower, 2019). In this approach, TML is defined in a way that 'technology is the means by which information is conveyed and people are linked together' (Bower, 2019, p. 1036).

With reference to different theoretical strands, Bower outlined several key points that define this TML. The key points concern the mediating function of technology itself (referring to Activity Theory by Engeström, 1987), the roles of educators (e.g. according to the technology, pedagogy and content knowledge [TPACK] model, Mishra and Koehler, 2006) and learners (e.g. with respect to digital literacies, see Littlejohn, Beetham, and McGill, 2012), in design (e.g. Dalziel et al., 2013), implementation, affordances and utilisation of technology (e.g. Bower,2008; Cochrane and Bateman, 2010; Conole and Dyke, 2004). Further key points include social and interactive elements (e.g. Moore, 2013; Wenger, McDermott, and Snyder, 2002) and their impact on learning (e.g. Goodyear and Carvalho, 2014b; Goodyear and Carvalho, 2014). In total, Bower (2019) formulates seven premises, which are illustrated in Figure 2.1. Based on activity theory by Engeström (1987), it is assumed that technologies serve as a mediator between the participants (educators and students) in order to achieve a desired (learning) outcome (1).

According to SCT (Bandura, 1986), the participants' beliefs, knowledge, and practices and the environment reciprocally influence one another (2); and the learning design and implementation of technologies by educators are based on learners' feedback (3). The affordances of the technologies – meaning the specific characteristics and the way these technologies can be used for what purpose – determine the effective utilisation of the technologies (4). Information processing and interpretation through students are influenced by the combination and use of the modalities (representational resources such as images, sound, text, and video), which affect the degree to which these are beneficially utilised (e.g. do not lead to cognitive overload) (5). In technology-based networks (for example, for collaborative tasks) learners interact by using technology, which therefore mediates learning (6). Finally, the arrangement and use of technologies, among contents, teachers and peers, affect the learners' perceived sense of presence and community (7).

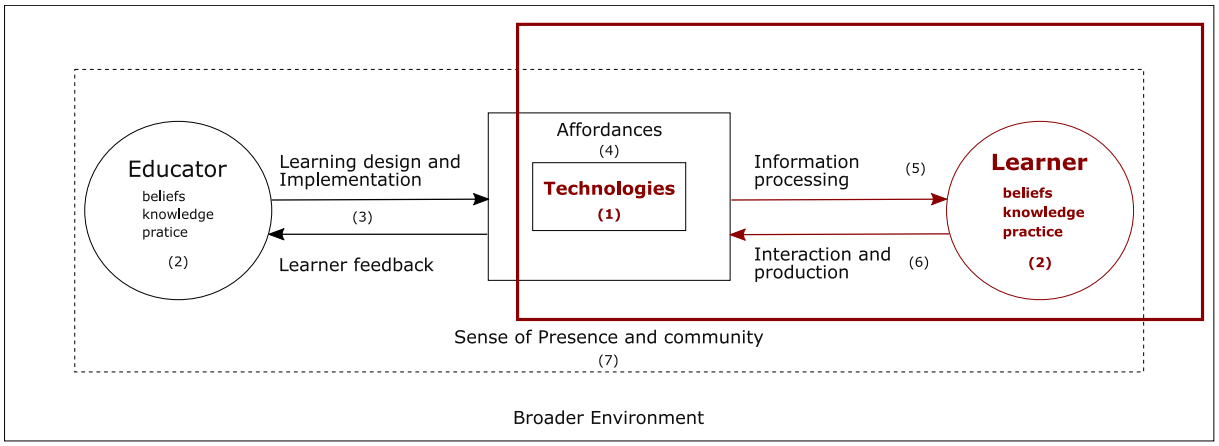

Figure 2.1: Conceptual illustration of technology-mediated learning theory (modified representation based on Bower, 2019, p. 1042).

One core area within this theoretical model concerns the reciprocal influence of TML contexts, participants' beliefs, participants' knowledge, and participants' practices and environments within the social learning settings (see Bower, 2019, p. 1038). This sub-area of TML corresponds to the subject of the present work, which relates to the media-related beliefs and actions of students within an HE context. In Figure 2.1, the part of theory that is covered with the present dissertation is highlighted. The focus is on learners – i.e. the students and their beliefs, knowledge, and practice – and their usage of technology within the university context and against the personal background. However, the aim is not to analyse learning outcomes in specific (e.g. course) settings or mediated by specific technologies, but to explore the effect of different types of digital media usage and related beliefs in the general study context, with a focus on overall academic achievement. Therefore, this subject area still needs to be embedded in a more general model for analysing factors influencing academic success and behaviour. With regard to the highlighted

component, Bower has referenced by Bandura (1986), which is implicitly or explicitly taken into account in many of the approaches to technology-based learning mentioned above (for a detailed discussion see Bower, 2019, pp. 138–142) and is also one of the approaches commonly used in the research of academic achievement models. In the following section this is shown in comparison to other commonly applied conceptualisations.

2.2 Behaviour, Motivation, and Academic Achievement

Regarding the analysis of behaviour in academic settings, it is crucial to conceptualise students' motivation to learn or, in general, their motivation to engage in activities that promote academic achievement. Motivation in educational settings can be defined as 'the process whereby goal-directed activities are instigated and sustained' (Schunk, 2014, p. 5). Contemporary theories on this process, in contrast to earlier theories on motivation, include cognitive components and a social-interactive component (Cook & Artino, 2016; Gecas, 1989). Therefore, they constitute a conceptualisation of mental processes leading to observable behaviour and a dependency on social contexts, rather than a focus on individual independent and purely observable (not mental) processes (Cook & Artino, 2016; Gecas, 1989). In a comprehensive review of five contemporary theories, Cook and Artino (2016) presented an overview of the key components in the expectancy value theory (EVT) (Wigfield & Eccles, 2000), attribution theory (AT) (Weiner, 1985), goal orientation theory (GOT) (Elliot & Harackiewicz, 1996), self-determination theory (SDT) (Ryan & Deci, 2000) and social-cognitive theory (Bandura, 1986). Based on their frequency in studies and reviews (e.g. Eccles & Wigfield, 2002; Graham & Weiner, 2012; Schunk, 2014; Schunk & Zimmerman, 2006), these five theoretical approaches appear to be the most common in education research on motivation and academic achievement. All these theories share basic concepts of some type of beliefs about competency (i. e. beliefs in being able to perform a certain act), value beliefs (i. e. the perceived personal value of the outcome of the behaviour), attribution (establishment of a causal link between personal action and outcome) and social-cognitive interactions (Cook & Artino, 2016). However, the theories differ in their respective central concepts and priorities, as shown in Table 2.1.

In the EVT, the focus is on *task value* and *expectancy of success*. The former refers to the personal gain – namely, the perceived personal value arising when completing the task. Expectancy of success is the central competence concept of this theory and it refers to motivational beliefs shaped by goals (i. e. learning objectives), self-concept (i. e. perception about personal capacity in the certain task domain), and task difficulty (meaning the perceived difficulty of the specific

Table 2.1: Overview of motivational theories often applied in educational contexts.

Theory	Main representative(s)	Core Concept(s)	Focus
Expectancy Value Theory	Wigfield & Eccles (e.g. 2000)	task value and expectancy of success	competence/ value attribution
Attribution Theory	Weiner (e.g. 1985)	locus	attribution
Goal Orientation Theory	Elliot & Harackiewicz (e.g. 1996)	mastery goal and performance goal	value/attribution
Self-Determination Theory	Ryan & Deci (e.g. 2000)	intrinsic motivation (vs. extrinsic motivation)	value/attribution
Social-Cognitive Theory	Bandura (e.g. 1986)	self-efficacy	competence/ social-cognitive interactions

task) (Wigfield & Eccles, 2000). The central concept of AT, on the other hand, is the *locus*[3], i. e. the cause of an action, which can be internal (e.g. up to one's ability in a specific area) or external (e.g. up to an educator) (Weiner, 1985). Therefore, this theory places a stronger emphasis on the attribution component, while EVT is more centred around competency and value beliefs. GOT builds upon the core theory of *mastery goal* and *performance goal*, which both refer to (subconscious) orientations in learning, either more related to the intrinsic value of learning (mastery goal) – i.e. acquiring new knowledge – or more concerned with the external perception by others (e.g. fellow students) and the relative success compared to these others (performance goals) (Elliot & Harackiewicz, 1996). This is also closely related to the attribution of causes, respectively, the ability to learn, since students with performance goals tend to believe more in a fixed and uncontrollable prerequisite for academic success (e.g. skill, intelligence); and students with a mastery goal orientation rather believe in changeable and influenceable causes (e.g. through effort) (Dweck, 2000). Next, SDT is mainly focused on *intrinsic motivation*, which is defined as the 'natural inclination toward assimilation, mastery, spontaneous interest, and exploration that is so essential to cognitive and social development and that represents a principal source of enjoyment and vitality throughout life' (Ryan & Deci, 2000, p. 70; Csikszentmihalyi & Rathunde, 1993). In contrast, extrinsic motivation is dependent on external demands, such as by supervisors, through deadlines, societal values, etc. This extrinsic motivation varies in the degree of internalisation and integration, which is influenced by a sense of relatedness (i.e. belongingness with others/a group), competence, and autonomy (Ryan & Deci, 2000). Finally, SCT's core principle is *self-efficacy*, defined by Bandura (1986, p. 391) as 'people's judgement of their capabilities to organize and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has but with judgements of what one

[3] not to be confused with *locus of control*, see Weiner, 1985

can do with whatever skills one possesses', thus referring to the competency component. In contrast to the related but (theoretically and empirically) distinct conception of self-concept from EVT, these beliefs are more task-, context- and domain-specific (Zimmerman, 2000). Altogether, this theory stresses the social-interactive and cognitive processing of prior experience, observed behaviour and environments.

Overall, these theories on motivation for behaviour (in learning settings) cover similar areas, but with different emphases and slightly different conceptualisations, as was intended to show in this summary overview. Although the theories cannot be discussed in complete detail, the differences are clear: While some focus more on attribution or value beliefs, others emphasise competency beliefs or social-cognitive interactions, as is shown in a simplified representation in Table 2.1. Nevertheless, in the present dissertation, SCT and the core principle of self-efficacy are chosen for the baseline theoretical model for three reasons. First, (a) the overall research questions presented in Chapter 1 include the assumption of contextual (e.g. social background or subject related) influences on behaviour that are emphasised in SCT. In addition (b), the task and domain specificity of self-efficacy allows for a conceptualisation and measurement of influences of self-efficacy on both academic and media-related behaviour in HE settings. Finally, (c), as briefly shown in Chapter 1 and as is also presented in the following chapters, 3–6, there are already many empirical studies in HE research that are based on SCT, which has thus often been tested empirically but at the same time needs to be extended to include the aspect of digital media use, which has not yet been considered. In the following section, this theory is described in more detail.

2.3 Social Cognitive Theory

In 1977, Bandura and Walters first presented an extension for the so-called social learning theory that built upon behavioural and cognitive theories of learning. Later, this theory was further developed and re-named into 'social cognitive theory', placing more emphasis on the cognitive components and therefore on beliefs and perceptions of causality, agency, or control (Bandura, 1986). The central concept of self-efficacy is clearly differentiated from another core element of this theory, *outcome expectancy*, which is defined as 'a person's estimate that a given behavior will lead to certain outcomes' (Bandura, 1977, p. 193). The outcome may be dependent on the individual's performance or beyond individual control, and the expectation is influenced by self-efficacy beliefs. However, outcome expectations do *not* refer to the ability to perform a certain behaviour or task to achieve the outcome (Bandura, 1977). This belief about what

a person *can* do is the central meaning of self-efficacy and serves as the foundation for the motivation to act: 'Unless people believe they can produce desired effects by their actions, they have little incentive to act' (Bandura, 2000, p. 16). According to SCT, outcome expectancies play only a minor role in motivation, compared to self-efficacy (Bandura, 1986), which was empirically verified in work by Shell, Murphy, and Bruning (1989), for instance.

Self-efficacy beliefs originate in enactive attainment, vicarious experience, verbal persuasion and physiological states (Bandura, 1977). Enactive attainment refers to personal mastery experiences, i. e. previous success in mastering a task. These personal experiences can be considered the most influential source of self-efficacy beliefs. Vicarious experience means the observation of modelling behaviour, where the degree of influence on self-efficacy is based on the perceived similarity (e.g. a comparably skilled person) and success of the model. In the HE context, for example, a peer student would be considered more similar than a lecturer. Therefore, the observation of a peer successfully mastering, for example, a programming task would have a greater influence on the students' self-efficacy than seeing a professor do the same. Verbal persuasion – that is, a person telling another that he or she is able to do something – has a weaker influence since the acceptance depends strongly on the perceived credibility of the person trying to persuade. In addition, this kind of source lacks the observational component since it is based on words and not prior (self-conducted or observed) behaviour. Physiological states are, for example, emotional arousals, such as anxiety or stress that could be interpreted as physical incapability (Bandura, 1997). For instance, panic-inducing test anxiety can lead to the examinee showing low self-efficacy for the exam, even if he or she is otherwise well prepared.

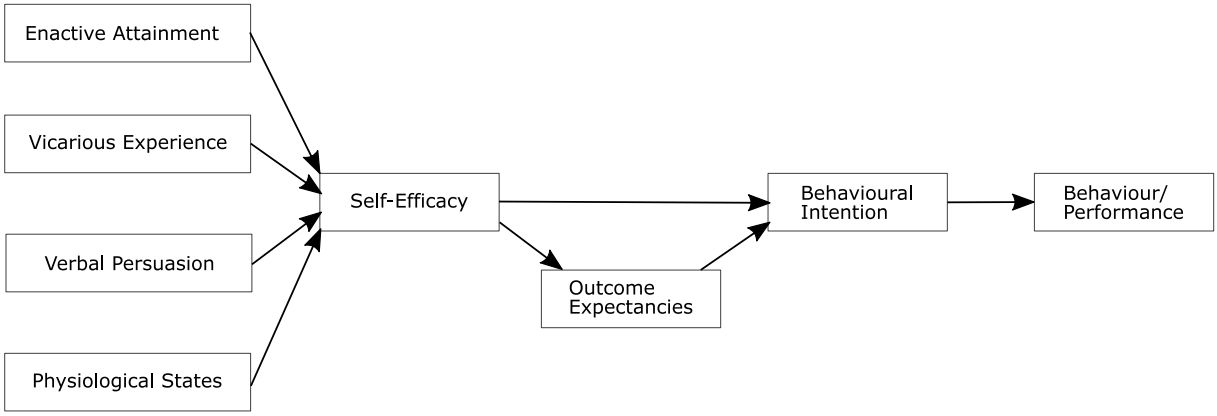

Figure 2.2: Behavioural model according to social cognitive theory (own illustration based on Bandura, e.g. 1986, 1997)

In combination, these four sources determine self-efficacy beliefs, which affect outcome expectancies and lead to behavioural intention. This intention is the basis for actual behaviour. These relationships, as assumed according to SCT, are shown in Figure 2.2. However, the direction of causality between self-efficacy and outcome expectancies is not always clear in

empirical research, as Williams (2010) has argued. Due to the ambiguity in empirical analyses (see Williams, 2010) and the above-mentioned overarching relevance of self-efficacy in the relationships outlined, however, the focus of the present work is on self-efficacy beliefs. Therefore, the directions of causality as assumed in the SCT are followed here.

Due to the mentioned influences on self-efficacy beliefs, human behaviour is determined by personal, behavioural, and environmental influences. The observation of performed behaviour and the resulting consequences evoke cognitive processing of the observed behaviour, initiating learning and imitation. In a triadic reciprocal causation, as illustrated in Figure 2.3, individuals interpret the results of their performance attainments, which in turn informs and changes their environment and their self-beliefs. This again, informs and changes the subsequent behaviour (Pajares, 1996, p. 544). In this triadic reciprocity between personal factors, behaviour and environment, individuals are viewed 'both as products and as producers of their own environments and their social systems' (Pajares, 2008, p. 112).

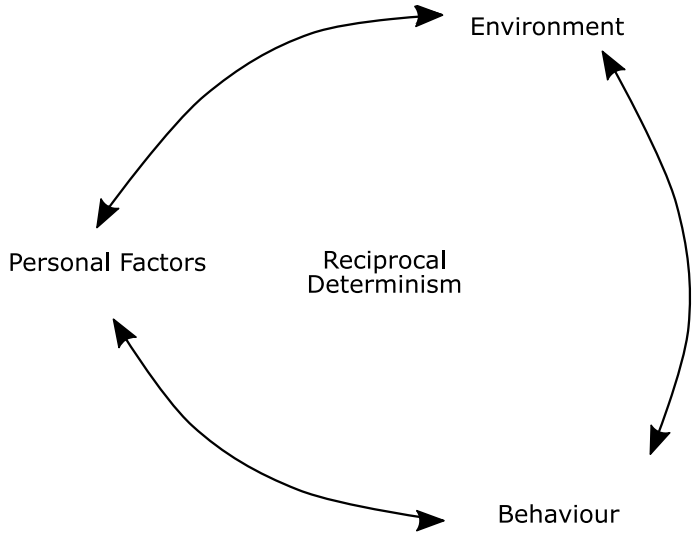

Figure 2.3: Triadic reciprocity between personal factors, behaviour and environment (own illustration based on Bandura, e.g. 1986, 1997).

2.3.1 Academic Self-Efficacy

High self-efficacy is considered particularly beneficial in academic settings: The higher the self-efficacy belief, the greater the effort people will expend on an activity, the longer they will keep up when confronting obstacles, and the more resilient they will prove in the face of adverse situations (Pajares, 1996, p. 544). In academic contexts, self-efficacy may, for example, refer to the goal of successfully mastering exams. Based on the students' perceptions of their capabilities

to reach this goal, SE determines how much learning effort and confidence is shown during the exam situation. The more capable students perceive themselves to be, the more challenging are the goals these students set themselves (Zimmerman, Bandura, & Martinez-Pons, 1992). Goal setting as well as strategy use, self-evaluating, and self-monitoring are self-regulatory processes that are crucial for academic performance and are dependent on self-efficacy beliefs (Pintrich, 2004; Zimmerman, 2000; Zimmerman et al., 1992). Furthermore, self-efficacy beliefs can reduce perceived stress and anxiety (Bandura, 1997), which may also be benefical for academic attainment (Zimmerman, 2000).

Based on the theoretical foundation of SCT, academic self-efficacy in HE contexts can be defined as a students' perceived ability to successfully master the tasks and demands of the study programme. It includes confidence in problem-solving skills and the ability to successfully deal with difficult situations and obstacles they could encounter while studying. Academic self-efficacy does not refer to actual academic abilities or competences but rather the students' *perceived* abilities. This means that even equally performing students may differ in terms of their academic self-efficacy. Self-efficacy beliefs can, of course, just as well be related to specific challenges in certain subjects, courses, or single assignments. This definition (following Schwarzer and Jerusalem, 1999), however, deliberately refers to study-related self-efficacy. The focus is on general study requirements which apply in principle to all students but which are assessed individually against the respective personal and subject background. This allows for the simultaneous observation and analysis of numerous subjects and, moreover, a comparison between these, which corresponds to the objectives of the present dissertation (see also Chapter 3).

2.3.2 Digital Media Self-Efficacy

To include and analyse digital media use in a model of academic performance based on SCT, it seems reasonable to conceptualise self-efficacy beliefs that are related to students' digital media behaviour. Earlier conceptualisations of self-efficacy somehow related to digital media have often been rather specific, such as internet search self-efficacy by Eastin and LaRose (2000), social media self-efficacy by Hocevar (2013) or information search self-efficacy by Vishwanath (2007). The more general concept of media self-efficacy by Hofstetter, Zuniga, and Dozier (2009), on the other hand, includes non-technological media, such as books or newspapers. Therefore, this definition seems too broad for the present research aim. Computer self-efficacy, as conceptualised and applied for an analysis of managers and professionals computer use by Compeau and Higgins (1995), is limited to computers and also slightly outdated since it was created more than two

decades ago and is thus not adapted to the technological advancement in the last 20 years. Nevertheless, Compeau and Higgins (1995) were able to demonstrate that, among others factors, outcome expectations, computer use, and emotional reactions to computers were significantly related to computer self-efficacy. In line with these results and due to the general influence of self-efficacy expectations on behavioural intentions according to SCT, it can be assumed that students' digital media behaviour is influenced by digital media self-efficacy. For example, the willingness to deal with new technologies, to try out new applications or digitally supported learning environments, and to stay on track even when facing difficulties depends on how much a person relies on their skills and problem-solving abilities in dealing with these technologies – in other words, their media-related self-efficacy (see Pumptow & Brahm, 2020). Comparable to the above definition of academic self-efficacy, digital media self-efficacy is therefore defined as a students' perceived capability to successfully master the tasks and demands that occur with using digital media (applications). Within the framework of the present dissertation, a suitable scale to measure digital media self-efficacy following this definition has been developed, tested, and analysed (see Chapter 3). Again, it is important to note that media-related self-efficacy is not an objective measurement of digital media competence or literacy but instead refers to the perceived successful application of digital media, which, for instance, could be more associated with quick access to new technological applications or a confident reaction when faced with problems than with competent and responsible media-usage behaviour.

2.3.3 Reproduction of Educational Inequalities

In HE research, grades, persistence with education, and general academic success are often linked to SES (e.g. Gottfried, Gottfried, Bathurst, Guerin, & Parramore, 2003; Jury et al., 2017; Teachman, 1987). This is explained, for example, by the availability of economic and cultural resources (e.g. de Graaf, 1986) and is in line with an assumption of cultural reproduction according to Bourdieu and Passeron (1971). Accordingly, socialisation processes vary for individuals with differing social backgrounds, resulting in different educational achievement and occupational chances. This might be because students with lower socioeconomic backgrounds experience a higher social and cultural distance from the educational system and institutions (e.g. Bourdieu & Passeron, 1971; Lareau, 2015). Familiarity with educational institutions (such as universities), individual expectations, and pathways within the educational systems are affected by learned 'cultural frames', which differ between varying socioeconomic backgrounds (Hartmann & Kopp, 2001). A similar line of argumentation was followed by Lörz, Quast, and Roloff (2015), who studied the transition from Bachelor's to Master's programmes in the German HE system, showing that students' varying familial background leads to differences in academic behaviour –

that is, in risk aversion and academic performance (for a more detailed discussion see Chapter 5). However, resource or culture-oriented justifications are often difficult to measure and have little explanatory power for the concrete mechanisms by which socioeconomic backgrounds influence educational decisions and academic performance. Self-efficacy expectations can provide a central theoretical link at this point and lead to more insights in this respect (see also chapters 3 and 5).

As Bandura (1997) pointed out, the parental influence on childrens' and adolescents' development of self-efficacy is crucial. Regarding the formation of self-efficacy beliefs, how many resources the family environment offers (e.g. in terms of money and time) is not the only important factor. How parents respond to, support, and encourage their children are also key, in addition to the degree of coercion and achievement demands. These factors all form their children's resulting perceptions of successful performance and thus their self-efficacy beliefs (see Gecas, 1989, pp. 300, and also Coleman & Karraker, 1998). Initially, the family environment and especially parents, as the most important parts of their childrens' environment predominantly define their self-efficacy beliefs. In this respect, the socioeconomic background also has considerable influence on some (e.g. academic) self-efficacy beliefs, since it sets the frame for an individual's opportunities (e.g. with respect to schools or workplaces) and defines the ideological belief system in which actions are evaluated – meaning what is to be perceived as a success or a desirable goal (Gecas, 1989, p. 302). Persons from socioeconomically weaker households have less confidence in their own abilities to meet the demands of an academic environment. Higher SES is usually positively related to self-efficacy and the perception of mastery, while lower SES is accompanied by lower self-efficacy and an impression of powerlessness (Bandura, 1997; Gecas, 1989). Self-efficacy may therefore explain differences in academic achievement and educational path-choices between students of high and low socioeconomic backgrounds. In connection with socioeconomic backgrounds, there are other familial factors relevant to the development of academic self-efficacy, such as the quality of parents' relationship with each other and the child (e.g. Cutrona, Cole, Colangelo, Assouline, & Russell, 1994), the levels of parental school involvement (e.g. Crouter, MacDermid, McHale, & Perry-Jenkins, 1990; Grolnick & Ryan, 1989), and parents' educational aspirations (e.g. Parsons, Adler, & Kaczala, 1982).

While these factors, in addition to the socioeconomic background, are well suited for a study concerning an earlier stage of education – for example with primary and middle school students or a study on educational path choices and transitions – the focus of this work is on university students. Accordingly, most educational decisions have already been made and factors such as the parental involvement could only be examined in retrospect. Therefore, these will not be considered further in the present dissertation. The socioeconomic background, however, which

should still strongly reflect that of the family background during the course of study, is suitable for an analysis of the remaining differences in HE and also with regard to possible associations with self-efficacy expectations (see e.g. Tong & Song, 2004; Weiser & Riggio, 2010).

The significance of academic self-efficacy for academic achievement and its dependence on SES withstands theoretical argumentation and empirical testing but the role of digital media self-efficacy is unclear. According to SCT, one can be assume that personal and environmental factors influence digital media self-efficacy, especially since parents' knowledge, experiences, and regulation activities most likely determine their childrens' media usage, particularly at younger ages (e.g. Cingel & Krcmar, 2013; Nikken & Schols, 2015). However, the above-mentioned influence of socioeconomic backgrounds on, for example, the familiarity of educational institutions and processes, along with higher confidence to meet the demands of studying, do not necessarily apply to digital media-related aspects in the same way, mainly for two reasons: In contrast to digitalisation processes in general, the institutional requirements of the education system change more slowly, making intergenerational transmission of traditional academic 'skill-sets' (including hidden rules) much more likely than that of a skill-set for academically useful digital media behaviour. Secondly, with regard to the fact that younger generations often show considerably different media behaviour than older (parent) generations and also a quicker adoption to new technologies (e.g. Nelissen & van den Bulck, 2018), a strong influence of familial background on HE students' media behaviour appears even more unlikely. As mentioned in the introduction, the clarification whether digital media usage and digital media self-efficacy beliefs are related to students' SES and academic performance is one of the main goals of this work (see Chapter 5).

Another potentially important inequality dimension is gender. In general, females tend to have a lower sense of self-efficacy (Gecas, 1989), also regarding academic tasks (Pajares, 1996). Especially in achievement situations, this might be an indicator of learned helplessness (Dweck, Davidson, Nelson, & Enna, 1978). 'Males describe themselves as more powerful, ambitious, energetic, and as perceiving themselves as having more control over external events than females' while 'females describe themselves as more generous, sensitive, nurturing, considerate, and concerned for other' (Block, 1983, pp.1339). Although this observation was made some time ago, results for gender differences in self-efficacy are still consistently found for self-efficacy in general (e.g. Diseth, Meland, & Breidablik, 2014; C. Huang, 2013; Schunk & Pajares, 2002) also in terms of technology use and technology-related self-efficacy (Durndell & Haag, 2002; W.-H. D. Huang, Hood, & Yoo, 2013; Vekiri & Chronaki, 2008). As part of HE students' personal characteristics, gender can therefore be considered an important background part of the self-efficacy–behaviour– achievement relationship that is analysed in the present research, both

with regard to digital media and in general academic terms (see also chapters 5 and 6).

2.4 Overall Framework & Integration of Studies

The overall framework of the present dissertation builds upon the presented SCT by Bandura (e.g. 1986, 1997), including extensions to cover, such as goal orientation and emotional aspects (e.g. Schunk & Pajares, 2002; Zimmerman, 2000) as well as the results of previous research (e.g. Bartimote-Aufflick, Bridgeman, Walker, Sharma, & Smith, 2016; Honicke & Broadbent, 2016). Accordingly, self-efficacy beliefs are at the centre of the analyses. Following the assumptions of their origination in enactive attainment, vicarious experience, verbal persuasion and physiological states, and a reciprocal determinism (see figures 2.2 and 2.3), these self-efficacy beliefs are dependent on personal and environmental factors. Examples for personal and environmental factors include socioeconomic background, gender and the study context, for example, characterised by study subject. The behavioural influence manifests, for example, via (mastery or performance) goal orientation, via emotions (such as anxiety), via specific outcome expectancies, or directly. Studying behaviour is assumed to influence academic performance through extensive preparation for exams due to an interest in gaining further knowledge in the respective field of study, for example (indicating mastery goal orientation). Through the conception of digital media self-efficacy, digital media use is considered in this overall model. This allows for an analysis of the relevance of these beliefs and subsequent behaviour for achievement, while at the same time considering background characteristics potentially influential as well.

In Figure 2.4, a simplified illustration of the above-described overall theoretical framework based on SCT is provided. In the inner square, the study context is represented, which covers the university, subject, fellow students, etc. Within and partially influenced by this context, as indicated by the dotted arrows, the individual beliefs, study-related behaviour, and performance are arranged. Arrows represent the relationships between the different constructs. Both academic and digital media self-efficacy are assumed to affect emotion, goal orientation and potentially other factors that are not further defined here, which in turn affect behaviour (indicated by [...], e.g. different kinds of outcome expectations, see Section 2.3 and chapters 3–6). Study and digital media behaviour, then, presumably affect academic performance. The belief-behaviour-outcome relationships within the study context are embedded in the individual students' personal and familial background. These background characteristics, such as gender or SES, may affect self-efficacy beliefs, the (perceived, influenced and chosen) study context and other behaviour

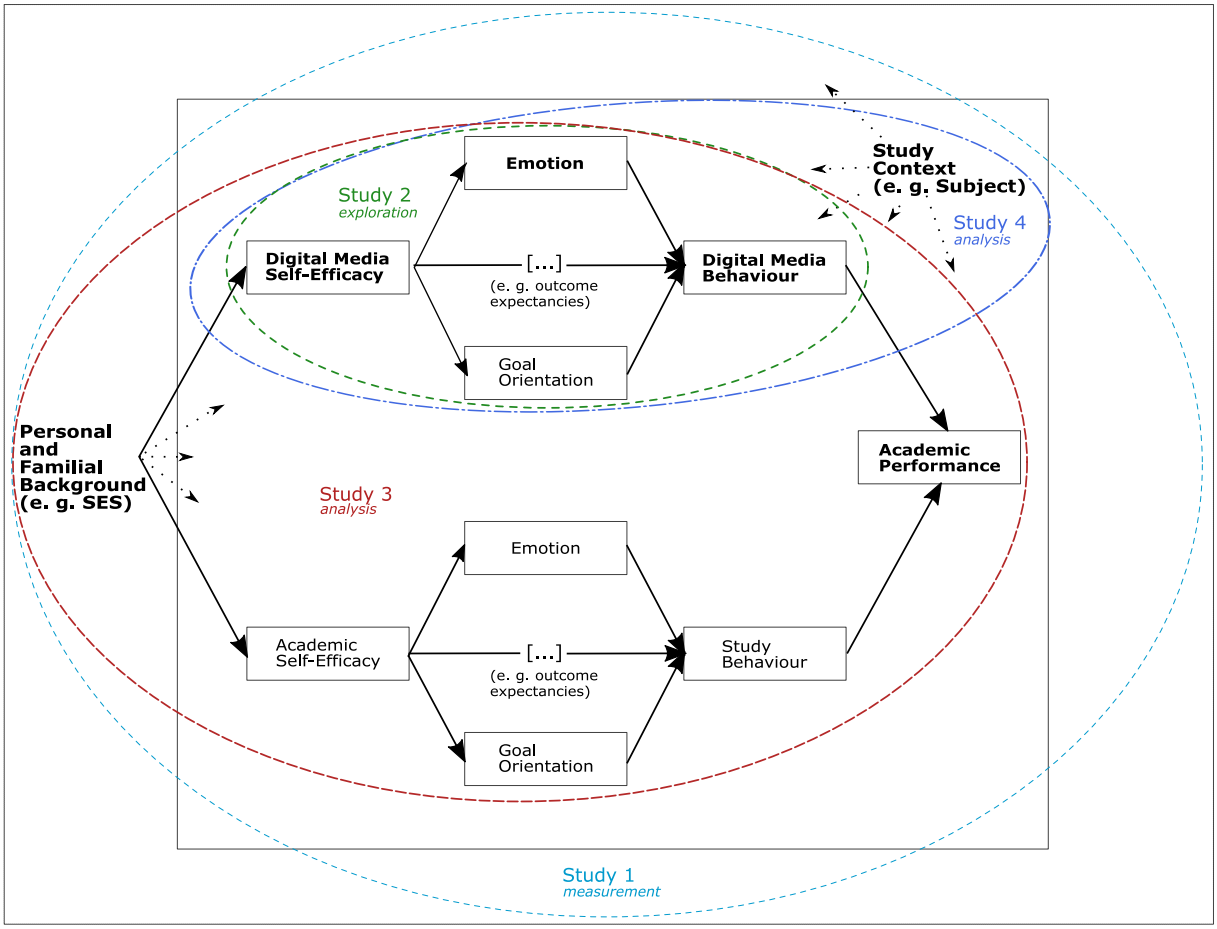

Figure 2.4: Schematic representation of the theoretical framework with reference to the four studies.

and attitudes within this context, as indicated by the solid and dotted arrows. According to the triadic reciprocity, personal factors such as these influence behaviour, which affects environment (study context), which in turn influences personal factors and vice versa. This is represented by the dotted arrow from study context towards personal background. The present work's main foci and contributions to research are highlighted in bold, i. e. the relationships between digital media self-efficacy, digital media behaviour and academic performance, in the light of study-related and personal background characteristics. Naturally, this illustration is a very simplified presentation. However, it illustrates the central concepts and interrelationships and, in addition, it allows the content of the four individual studies to be allocated and related to each other.

The first study of the present dissertation is focused on the development and validation of a survey instrument to measure the potential predictors for academic achievement, which include the above mentioned self-efficacy constructs, socioeconomic backgrounds and the often observed motivational or emotional aspects and indicators related to digital media behaviour. The instrument development and empirical analysis are replications and extensions of prior

research, especially regarding the German media-usage studies by Grosch (e.g. 2012); Zawacki-Richter, Kramer, and Müskens (e.g. 2016). This makes it possible to compare the findings and simultaneosly extends previous research by integrating the findings into a more general social-psychological model of academic performance in contemporary university studies. It is, therefore, connected to the overall framework by measuring the different constructs and by generating the data base for the subsequent analyses. Accordingly, the ellipse for Study 1 in Figure 2.4 covers all areas of the schematic representation.

The second study focuses on an analysis that includes the identification of media-user types and analyses of their relationships with study subject, gender, and digital media self-efficacy. The choice of media applications in this analysis refers to a model of media use by Johnsson-Smaragdi (1994) and Bonfadelli, Fritz, and Köcher (1993) – including environment, socialisation, behaviour and personality aspects – and follows and extends a media-classification typology of Grosch and Gidion (2011). This study is conducted mainly with the aim of gaining explorative insights into media use and related beliefs at the universities of Bochum, Cologne, Kaiserslautern and Tübingen and accordingly covers this part of the framework focused on digital media, as represented by the ellipse for Study 2 in Figure 2.4.

In the third study, an in-depth multi-stage analysis of the relationships of media-user types, digital media self-efficacy, socioeconomic backgrounds and the 'classical' predictors for academic success, such as academic self-efficacy and goal orientation, is conducted. In this study, theoretical references to cultural reproduction of social inequality (e.g. Bourdieu, 1994; Lareau, 2015) are established and empirically tested in conjunction with SCT, in a hypothesis testing procedure. This study builds upon the second study and therefore again covers the students' media behaviour but with an additional focus on familial background, i.e. SES, and the outcome, i.e. academic performance, as shown by the ellipse for study 3 in Figure 2.4.

Finally, a multilevel analysis of study-related technology use is performed, considering both differences between disciplines on a subordinate level and individual characteristics on the lowest level. In this fourth study, the theoretical approach described above is supplemented by the perspective of an organisational culture, more specifically by the assumption of a socialisation process into discipline-specific culture (e.g. Tierney & Rhoads, 1993). Therefore, this study adds an analysis of the contextual component within the overall framework. This is represented by the ellipse for Study 4 in Figure 2.4. The more detailed individual models and the derivation of the concrete research guiding hypotheses are presented in the respective manuscripts in the following chapters.

The empirical data and (partial) funding of this dissertation were provided for the joint- project 'You(r) Study'.[4] In a pre-test study, data was collected at three HE institutions in Switzerland and Germany – namely the University of St. Gallen, the Zeppelin University and the Virtual University of Bavaria – in November and December of 2017. A total of 171 responses were received (response rate of approximately 8.6 %). The full-scale data was collected during summer term 2018 at the Universities of Bochum, Kaiserslautern, Cologne, and Tübingen with a response of 3,342 in total (response rate approximately 2.5 %). Access to this full-scale data set can be requested from the Deutsches Zentrum für Hochschul- und Wissenschaftsforschung (DZHW) research data centre. The data manipulation and anonymisation steps conducted in the preperation of this dataset are documented in Aksoy et al. (n.d.).

[4] You(r) Study was funded by the German Federal Ministry of Education and Research (BMBF) under the funding line 'Förderung von Forschung zur digitalen Hochschulbildung' (engl.: promotion of research on digital higher education) 2017-2020 (funding number: 16DHL1018).

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3 Study 1 - Students' Digital Media Self-Efficacy and its Importance for Higher Education Institutions - Development and Validation of a Survey Instrument[5]

Abstract

Although digital media are in general very common, their role in academic settings and their relevance for academic achievement are not satisfactorily explored. A research gap that is particularly apparent during the corona crisis in 2020 when university processes in many countries are suddenly almost completely digitalised. Research suggests a link between students' diversity, in particular, their socioeconomic background, academic self-efficacy expectations, study-related attitudes, and academic achievement. However, previous empirical studies on digital media at universities predominantly describe different types of media usage patterns but little is revealed about the students' study-related attitudes and performance. The present study aims at developing a survey instrument to explore the relationship of individual, contextual as well as social background factors concerning academic achievement, with a special focus on academic and digital media self-efficacy expectations (DMSE). For this purpose, a new scale for DMSE has been constructed, based on existing psychological research. After pre-testing the instrument in 2017, data was collected at four German universities in summer 2018 (n = 2039). Validity and reliability are shown and the instrument appears suitable for further research in order to explore the interplay of student learning and digital media use in higher education, integrating the institutional and social context.

Keywords: academic self-efficacy, digital media self-efficacy, psychometric properties, questionnaire development

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3.1 Introduction

How to integrate digital media in university is an important topic which is addressed both in research and is of practical relevance since Higher Education (HE) practitioners are struggling how to integrate digital media in study programs and infrastructure. This integration is assumed to offer innovative potential for teaching and learning at Higher Education Institutions (HEIs). However, the relatively new trend towards 'Digitalisation' in HE has not been sufficiently considered in the evaluation of student performance and academic success yet. For instance, the comprehensive multidimensional instrument to evaluate university teaching by Lemos, Queirós, Teixeira, and Menezes (2011) includes the dimension teaching methods but does not yet include digital media.

However, just as digital media is affecting everyday life, a change of academic studies and demands might be assumed, not least because skills concerning computers or digital media, in general, are more and more required in many occupational fields (see e.g. Ally & Prieto-Blázquez, 2014), but also as the corona-crisis in 2020 and the associated rapid digitalisation of university teaching show very clearly. Notwithstanding the amount of existing research concerning media use of lecturers and students in recent years, for instance in Germany (Dolch & Zawacki-Richter, 2018; Grosch, 2012; Grosch & Gidion, 2011; Müßig-Trapp & Willige, 2006; Persike & Friedrich, 2016; Schulmeister, 2009; Vogel & Woisch, 2013; Zawacki-Richter, 2015; Zawacki-Richter, Dolch, & Müskens, 2017; Zawacki-Richter, Kramer, & Müskens, 2016; Zawacki-Richter, Müskens, Krause, Alturki, & Aldraiweesh, 2015) and internationally (Al-Husain & Hammo, 2015; Dahlstrom & Bichsel, 2014; Dahlstrom, Brooks, Grajek, & Reeves, 2015; Dahlstrom, de Boor, Grunwald, & Vockley, 2011; Dahlstrom & Walker, 2012; Dahlstrom, Walker, & Dziuban, 2013) both the use of digital media in HE settings as well as the impact of digital media on studying itself are still insufficiently investigated. With 2339 students in 2012 and 1327 students in 2015, from several HEI's that offered online courses and study programs at the time, Zawacki-Richter et al. conducted surveys addressing digital media usage (Zawacki-Richter et al., 2017). In 2012 only 56 % of the students owned a smartphone, 86 % a laptop, and 9 % a tablet and in 2015, already 91 % owned a smartphone, 92 % a laptop, and 40 % a tablet (Zawacki-Richter et al., 2017). The EDUCAUSE Center for Analysis and Research (ECAR) has researched undergraduate students and IT between 2004 and 2015, based on 4,123 in 2004 to 50,274 students in 2015 from HEI's in the USA and up to 15 other countries (Dahlstrom et al., 2015). Those studies have shown a similar increase in the spread of technology and the use of mobile devices in both the private and academic sectors over time (Dahlstrom & Bichsel, 2014).

This increase is only one indicator for the increasing relevance of digital media at HEIs and thereby the need for research on digital media behaviour of university students. In addition to further, mainly descriptive analyses of media use and distribution, Zawacki-Richter et al. (2015) established a media usage typology based on the 2012 survey of 2339 university students. In several subgroup analyses, they found, among other things, significant differences between male and female students (Zawacki-Richter et al., 2015). This corresponds to previous studies, such as by W.-H. D. Huang, Hood, and Yoo (2013), who also investigated the use and acceptance of various (web 2.0) applications, for 432 college students, and found significant gender differences as well.

Above all, in the studies mentioned, factors such as underlying motivations, emotions, self-evaluations, or self-efficacy are hardly considered, and students' social background is not taken into account either. A notable exception is a study by Horvitz, Beach, Anderson, and Xia (2015) who examine faculty's self-efficacy regarding online teaching, however, this study does not take the students' view into account. Other studies examine the interplay in the context of school education (e.g. Y. Li, Garza, Keicher, & Popov, 2019). A recent study by Nouri (2018) with about 500 students at a Swedish university investigated multimodal literacy and the learning design during self-studies. It finds that technology indeed changed university students' self-studies and knowledge building, however, this study does not reveal how these multimodal learning practices affect academic success. Therefore, there is a need for a comprehensive evaluation instrument to explore the connection between students' background factors and their study respectively media behaviour including the link with academic performance.

Research regarding students' academic performance mainly focuses on individual characteristics, often using concepts from educational psychology but does not specifically address digital media in academic contexts. Concepts often used are for example the 'expectancy-value theory of achievement motivation' by Wigfield and Eccles (2000) or the framework of social-cognitive theory (SCT) and self-efficacy by Bandura (e.g. 1977). Most research is also located outside of Europe; in consequence, little is known about the transferability of this research to the European context. Also, as research is often characterized by low case numbers and a predominant focus on psychology students, results are often not generalizable respectively valid for other disciplines (see for example review studies by Bartimote-Aufflick, Bridgeman, Walker, Sharma, & Smith, 2016; Honicke & Broadbent, 2016). In addition to these short-comings, family background or other social and contextual factors are hardly taken into account in the aforementioned research strand. These factors, in turn, are addressed in social-science research. Due to increasing heterogeneity of students, not only at German HEI, such studies focus for example on the identification of groups with certain characteristics that are in some ways disadvantaged in

academic studies (e.g. Röwert, Lah, Dahms, Berthold, & von Stuckrad, 2017). In these studies, however, the important mechanisms and variables at the individual level, which would allow for further implications regarding possible interventions, are not considered. An integrative model considering social cognitive, individual characteristics as well as contextual or familial factors in terms of students' performance and digital media behaviour at HEI is lacking so far.

Research shows that academic achievement varies between different social groups, such as migrants, students with children, or low socioeconomic status (SES) (Röwert et al., 2017). Often, this relation leads to lower academic achievement of those students whose parents are characterized by lower educational background. In addition to students' socioeconomic background, students' self-efficacy expectations and motivation are related to their academic achievement and goal setting (e.g. Komarraju & Dial, 2014; Pajares, 1996; Putwain, Sander, & Larkin, 2013; Schunk & Pajares, 2002; Zimmerman, 2000a, 2000b; Zimmerman, Bandura, & Martinez-Pons, 1992). Assuming a link between social backgrounds, e.g. parents' educational background, certain self-efficacy expectations, and behaviour in academic settings in general (Zimmerman, 2000b; Zimmerman et al., 1992), the same factors might be relevant in terms of students' digital media behaviour, this needs to be further explored.

In sum, the introduced study aims to supplement current research in the field of digital media in Higher Education by developing a survey instrument that allows addressing the multi-faceted character of academic studies and digital media behaviour. Particularly, a new scale for Digital Media Self-Efficacy Expectation (DMSE) is constructed to allow for a further examination of the determinants for observable media usage patterns and their potential links to students' social backgrounds. Our instrument is designed to comprehensively capture the relevant individual, contextual, and social factors for academic performance and therefore, lead to a deeper understanding of the mechanism for the disadvantage of certain student groups, the relevance of digital media in HE and also further research on possible interventions at the same time. Thus, the developed evaluation instrument contributes to extending research on digital media in Higher Education. Furthermore, this focus on digital media in our research instrument also complements the study of Brahm and Jenert (2015) on university students and their attitudes towards studying, which is therefore partly replicated and also validated once more. However, this paper exclusively focuses on the development and validation of a survey instrument and some first descriptive insights, therefore, we do not present the results of the above mentioned potential analyses in the paper at hand. Nevertheless, we want to point out the possible applications of this instrument and promising starting points for further research. As a practical contribution, the instrument can also be used by other HEIs to evaluate their own digital media use and to determine in which ways their students are benefiting (or hindered) from using digital media, in particular concerning the

disadvantage of certain groups of students.

The pre-test survey was conducted in December 2017 and the full data set was collected in summer 2018. In the following, the theoretical background of the evaluation instrument as well as the evaluation procedure is presented. In a second step, the results of validation procedures as well as first (descriptive) results regarding university students' digital media attitudes and behaviour.

3.1.1 Theoretical Background

Bandura's social cognitive theory (SCT) (e.g. Bandura, 1977, 1986, 2011) offers a theoretical frame to analyse thoughts, motivation, and behaviour and therefore appears to be well suited to the aim of the study at hand. According to this theory, human behaviour, in general, is caused by personal, behavioural as well as environmental influences. In a reciprocal determinism, individuals interpret the results of their performance attainments in a certain way, which in turn informs and changes their environment and their self-beliefs. This again, informs and changes the subsequent behaviour. One central aspect of the SCT is self-efficacy which Bandura (1986, p. 391) defines as 'people's judgement of their capabilities to organize and execute courses of action required to attain designated types of performances'. The higher the self-efficacy belief, the higher the effort people will expend on an activity, the longer they will keep up when confronting obstacles, and the more resilient they will prove in the face of adverse situations (Pajares, 1996, p. 544). In reference to the HE context, academic self-efficacy beliefs are based on students' perceptions of their abilities to achieve a certain goal, e.g. to complete a course or to pass an exam. This may determine their learning effort that is spent on the activities to reach such goals.

Self-efficacy expectations and behaviour in academic settings may also be linked to students' success of integration at a higher education institution (HEI). In line with the 'Model of Institutional Departure' by Tinto (1993), the failure to become or remain incorporated in the intellectual and social life of the institution is one of three crucial factors for student dropout, in addition to academic difficulties and the inability of individuals to resolve their educational and occupational goals. While incorporation in intellectual life refers to integration into the academic system, incorporation in social life refers to students' social integration. Both integration aspects depend on the terms determined by the HEI such as the course of studies as well as on external factors such as the social background. Although Tinto focusses on the identification of courses of action for HEI to reduce student dropout, the model and especially the aspect of integration

may in combination with self-efficacy expectations and other non-cognitive factors, such as goal orientation, be appropriate to describe reasons for academic achievement and behaviour in academic settings as well.

Due to the general behaviour-determining influence of self-efficacy expectations, it can be assumed that students' media behaviour is influenced by media-related self-efficacy expectations. For example, the willingness to deal with new technologies, to try out new applications or to try out digitally supported learning environments, and to stay on track even when facing difficulties, depends on how much a person relies on their skills and problem-solving abilities in dealing with these technologies, in other words: their media-related self-efficacy. However, research concerning media use in HE so far is limited to either the assessment of media applications in specific contexts (e.g. lectures, seminars) or analyses of media usage patterns for a rather broad student population (see above and the following section). In consequence, it has hardly been investigated whether, in addition to general academic behaviour, media use could also affect academic success. Furthermore, there is hardly any empirical evidence concerning the role of digital media self-efficacy for media-behaviour in academic contexts, and again its relevance for academic performance and the relationship with socioeconomic backgrounds. Thus, the dual focus on both academic and digital media self-efficacy may be useful in terms of further examining students' learning behaviour and digital media use. Also, since self-efficacy expectations depend on environmental aspects that are deemed highly relevant in SCT in general, it is important to take contextual as well as social factors into account which illustrates once more the relevance of a comprehensive survey instrument to analyse study behaviour in the digital era. This is especially true in times of rapid acceleration of digitalisation processes, such as during the corona crisis in 2020, where traditional models of academic behaviour may reach their limits.

3.1.2 State of Research

Research concerning the link between students' self-efficacy expectations, motivation, and academic attainment (e.g. Komarraju & Dial, 2014; Pajares, 1996; Pajares & Schunk, 2001; Putwain et al., 2013; Zimmerman et al., 1992) identifies self-efficacy expectations as an important predictor for academic goal setting and achievement.

For example, Bartimote-Aufflick et al. (2016) and Honicke and Broadbent (2016) found a connection between self-efficacy and study success. In line with the theoretical concept, i.e. reciprocal determinism (Bandura, 1977), former experiences such as past grades in the academic

context may influence subsequent self-efficacy expectations. This has also been shown in empirical studies (Klassen & Usher, 2010; Lindsley, Brass, & Thomas, 1995; Talsma, Schüz, Schwarzer, & Norris, 2018). However, for the context of physiotherapy education, Jones and Sheppard (2012) showed that previous experience was only related to self-efficacy in two distinct fields. Also motivation and goal orientation (Hsieh, Sullivan, & Guerra, 2007) because of their relevance for interest and self-regulation (Honicke & Broadbent, 2016); emotions like anxiety (Hsieh, Sullivan, Sass, & Guerra, 2012); perceived control over actions and outcomes (Pekrun, 2006), and certain personality traits like conscientiousness due to its link to self-discipline (Lievens, Ones, & Dilchert, 2009) are relevant for the self-efficacy-achievement relation.

Furthermore, academic achievement varies between different social groups, such as migrants, students with children, or low socioeconomic status (SES) (Röwert et al., 2017). In this regard, research suggests that students' SES may affect academic achievement via self-efficacy (Gecas & Schwalbe, 1983; Weiser & Riggio, 2010). Students stemming from lower socioeconomic backgrounds show higher academic performance when indicating higher self-efficacy; however, usually, such students are equipped with lower self-efficacy expectations (Weiser & Riggio, 2010).

In our research, two instruments, in particular, have proven to be reliable and often used for investigating academic self-efficacy: The academic self-efficacy scale as designed by Jerusalem and Schwarzer (2002) and the scale used in the Motivated Strategies for Learning Questionnaire (Duncan, Pintrich, Smith, & Mckeachie, 2015). Since we focus on German university students and developed a survey instrument in the German language, the academic self-efficacy scale (Jerusalem & Schwarzer, 2002) seems most appropriate to our intentions.

Recent research concerning students' digital media use shows that students varying in e.g. age, family status, or ambitions show differing patterns of digital media use in academic settings (Grosch & Gidion, 2011; Zawacki-Richter, 2015; Zawacki-Richter et al., 2016). Since digital media are a global phenomenon and can have a positive impact on learning outcomes (Cavanaugh, Barbour, & Clark, 2009; Q. Li & Ma, 2010; Tienken & Wilson, 2007), some relevance can also be assumed for HEI. Under the assumption that digital media behaviour is at least partly affected by self-efficacy expectations regarding digital media (applications), a closer look at digital media self-efficacy seems promising to analyse factors for study success.

To our knowledge, there is no up-to-date and suitable scale for assessing media-related self-efficacy. Possible scales are either outdated (Compeau & Higgins, 1995) or rather specific, focusing on internet search (Eastin & LaRose, 2000), social media (Hocevar, 2013), information

search (Vishwanath, 2007), or communication. The scale for Media Self-Efficacy (Hofstetter, Zuniga, & Dozier, 2009) on the contrary is too broad for our purposes. In consequence, we developed a scale for investigating Digital Media Self-Efficacy Expectation (DMSE) that is not too specific, in order to address a broad range of different digital media and also not to wide-spread, to assure for validity and reliability of the scale.

3.2 Design and Sample

In order to empirically observe determinants of students' academic behaviour, media use, and related attitudes, we developed a standardized questionnaire. Multiple instruments are arranged in three thematic blocks to capture self-efficacy expectations as well as emotions, motivation, media-usage behaviour, and socioeconomic factors. On that account, we chose instruments that are either research standards used in current research in the subject area or were constructed based on those standards, as is briefly described below.

3.2.1 Instrument Design

In Tables 1 and 2, a list of the scales addressing attitudes, motivation, and behaviour either in the general academic context (Table 1) or related to digital media (Table 2) and an example item for each of the scales is shown. We consistently used 7-point Likert scales for all of the psychometric measurements, e.g. ranging from 'totally disagree' to 'totally agree'.

Evaluation concerning studying (including emotions, motivation, and attitudes) is undertaken by partly adapting the scales for the 'Assessment of Students' Attitudes towards Studying' (Brahm & Jenert, 2015) and CHE-Quest[6] (Leichsenring, 2011), which includes a scale for integration (Tinto, 1993). The instruments used in Brahm and Jenert (2015) appear to be well suited to the present research project since they address attitudes towards the university as an institution and therefore the students' social and contextual environment and attitudes towards studying (e.g. support from important people, emotions of anxiety and joy), while taking into account self-efficacy expectations and attitudes towards learning (e.g. autonomy in learning processes). Academic Self-Efficacy Expectation (ASE) is measured with the corresponding instrument by Jerusalem and Schwarzer (2002). Additionally, instruments for intrinsic motivation and extrinsic

[6] 'CHE' stands for 'Centrum für Hochschulentwicklung' (Center for Higher Education Development) and ‚Quest' is used as an abbreviation for 'questionnaire'.

goal orientation as well as perceived academic achievement are included from Brahm and Jenert (2015). To measure the Big Five personality traits, we as well included the BFI-10, a 10-item scale with two items each for the dimensions extraversion, agreeableness, conscientiousness, emotional stability, and openness Rammstedt, Kemper, Klein, Beierlein, and Kovaleva (2013).

Table 3.1: Scales and example items for attitudes and study-related motives.

Scale	Example Item
Identification with University	'I can identify myself with the NAME OF UNIVERSITY'
Subjective Norm	'My family thinks it's good that I study at the NAME OF UNIVERSITY'
Enjoyment (in studying)	'I enjoy dealing with the subject matter of my studies'
Anxiety (in studying)	'I'm worried if I can even cope with my studies'
Active participation	'I contribute my own ideas and opinions to university courses'
Intrinsic Motivation	'I study because I am interested in the learning content'
Extrinsic goal-orientation	'I want to do well in my studies because it is important for me to show my abilities to my family and friends'
Task value	'I am sure that the content of my studies will be useful for me'
Social Integration	'During my studies I cultivate close relationships with my fellow students '
Academic Self-Efficacy	'I face difficulties in my studies calmly because I can trust my abilities'
Big-Five	'I see myself as someone who. . .is reserved'

Aim and frequency of students' media use and different attitudes regarding those media are questioned according to approved instruments by Grosch and Gidion (2011) and Zawacki-Richter (2015). Computers, tablets, and smartphones are seen as digital media equipment, while software tools (e.g. for text or spreadsheet processing, picture editing), research tools, search engines, and other online media tools, are summarized as digital media itself. The measurement of attitudes towards digital media is divided into several units, dealing with the overall evaluation for example of usefulness and concerns (e.g. privacy and data security concerns) and also the evaluation of usefulness with regard to academic studies.

Based on the general self-efficacy scale by Schwarzer and Jerusalem (2010), a scale for DMSE is newly constructed to capture students' media-related self-efficacy. Self-assessed knowledge

resp. skills regarding digital media applications are included as well.

Constructs and scales for age, educational qualification, nationality, occupational status, and income are based on a study conducted at a German university in 2014 (Lang & Hillmert, 2014). In line with this study, parental characteristics (e.g. educational qualification) are measured as well. The data will allow classifying the respondents' socioeconomic status according to the 'International Socio-Economic Index of Occupational Status (ISEI)' (Ganzeboom & Treiman, 2003). Besides, gender, subject of study and the number of semesters are included which will allow for subgroup analyses regarding gender, subjects and study experience, in addition to the four university contexts.

Table 3.2: Scales and example items for media behaviour and media-related attitudes.

Scale	Example Item
Frequency of usage (media applications)	'How often do you use the following media applications/offers for your studies?' e.g. 'online exercises, WBTs or interactive tests and self-tests'
Perceived Usefulness (media applications)	'How useful do you find the following media applications/offers for your studies?' e.g. 'electronic textbooks, specialist books or journals'
Digital Media Self-Efficacy	'It's not difficult for me to reach the objectives I have associated with a media application'
Digital Media Knowledge/Skills	'How well do you rate your knowledge in the following areas?' e.g. 'Use of online and literature databases (e.g. Web of Science, websites with specialist journals such as JSTOR, etc.)'

In summary, the questionnaire includes scales for self-efficacy, goal orientation, emotions associated with studying, media use, and related attitudes and demographic factors. All in all, this comprehensive instrument, thus, allows data to be collected for analyses of the complex relationships described above. Since the psychometric quality of the instrument must be guaranteed for these analyses, the instrument's validity and reliability are the focus of the study at hand.

3.2.2 Data

To ensure the adequacy of the chosen scales and items, a first version of the developed instrument was given to experts in the field of educational research. These experts were three professors and four graduate students. After implementing the received feedback, the revised version of the online-questionnaire was given to two undergraduate students to finally check for wording, comprehensibility, and processing time[7]. Both the pre-test version and the final version of the questionnaire have been approved by the ethics committee for psychological research at the university Q.

We decided to recruit participants partly via mass emails to invite them to participate voluntarily.[8] Due to this nonprobability sampling method, the representativeness of the sample collected was not guaranteed. However, our goal was to reach a wide variety of participants from all faculties of the universities and not a representative sample. To attract more participants, we also used flyers and posters, information screens (e.g. in the library), and announcements in lectures. Also, we raffled vouchers and prices such as IPads or speakers.

The pre-test-survey was conducted using the online-questionnaire at three HEI in Switzerland and Germany at the end of 2017. In total, about 2000 students of different subjects received a link to the questionnaire. A total response of 171 cases was gained (response rate approximately 8,6 %) of which 63 responded to every question of the survey.

The data of the main study was collected in the summer term 2018 at four German Universities X, Y, Z, and Q. In sum, 135,464 enrolled students were addressed and 3342 participated (response rate approx. 2.5 %). The number of participants who completed the whole questionnaire is 1925 (response rate for complete questionnaires: 1.4 %). Table 3.3 shows the absolute response number per HEI. The statistics reported below refer to the data of the main study but are roughly consistent with those found for the pre-test data unless otherwise stated.

The proportion of female participants in the sample is 59.6 %, 39.6 % are male. The students' mean age is $M = 24.03$ ($SD = 4.01$, $min = 18$, $max = 59$). As expected, our sample is not representative of the German students' population in general since female students are slightly overrepresented in our sample.[9]

[7] The students reported a processing time of 45-50 minutes, which is in line with the calculated average processing time of the pre-test online-survey. After the pre-test, the questionnaire was shortened to a processing time of about 30-35 minutes.

[8] All respondents were asked to give their consent to scientific use and publication of their data before filling in the questionnaire.

[9] The proportion of female students in Germany in 2017 was 48 % compared to 60 % in our sample (Statistisches

Table 3.3: Higher Education Institutions of the participating students.

University	Count
X	1114
Y	372
Z	685
Q	1171

We purposefully addressed students enrolled in a multitude of different subjects to reach enough variability in our sample to establish the instrument's psychometric quality. In future studies, it would, therefore, be possible to analyse sub-populations in order to complement other studies (e.g. Zawacki-Richter, 2015) who for instance, did not include the humanities' students. Also, in contrast to those studies, we focus on traditional students since our data was collected at universities without a considerable amount of distance or online education programs in 2018. Thus, the data allows exploring the digital media usage patterns of a more general, heterogeneous student population, while highlighting differences in study subjects and gender.

In our analyses (see below), we included only cases with at least 50 completed pages of the 119 pages of the questionnaire, resulting in 2039 cases. However, some analyses required complete cases so the number of cases was reduced due to missing values in some instances, as is mentioned below. To ensure construct validity and reliability, exploratory and confirmatory factor analyses, as well as correlation and internal consistency analyses, were applied on the pre-test data as well as on the full-scale data. The data analyses were conducted in R (R Core Team, 2019).

3.3 Results

3.3.1 Internal Consistency Analyses

Each value of Cronbach's Alpha for the main study data (see supplementary material for the results of the analyses for the pre-test) is above the common threshold of 0.70 (see Table 3.4). Any item showing an item-scale correlation lower than 0.50 was not part of the main survey resp. excluded afterward.

Bundesamt, 2018).

Table 3.4: Internal consistency measure by Cronbach's Alpha of the used scales.*

Scale	No. Items	Cronbach's Alpha	Item-Scale cor. (min/max)
Identification with the University	3	0.86	0.71/0.77
Subjective Norm	3	0.75	0.52/0.65
Enjoyment (in studying)	3	0.80	0.61/0.71
Anxiety (in studying)	3	0.82	0.57/0.73
Active participation	3	0.80	0.53/0.67
Intrinsic Motivation	3	0.84	0.64/0.74
Extrinsic goal-orientation	3	0.76	0.55/0.60
Task value	3	0.78	0.55/0.67
Social integration	3	0.86	0.65/0.88
ASE	7	0.92	0.74/0.80
DMSE	7	0.92	0.69/0.89

*Based on a number of cases of $n = 1753 - 1813$, depending on the number of missing values for each item.

Both self-efficacy scales show high values for Cronbach's Alpha (ASE $\alpha = 0.92$; DMSE $\alpha = 0.92$) and also high item-scale correlations ($r > 0.69$) for each item, for the full-scale survey.[10] However, in order to further reduce the number of items, two items that referred to similar aspects of self-efficacy as two other remaining items (explicit problem-solving and reaction to surprising situations) were excluded for the revised instrument. An additional item was excluded from the main study data because of its low item-scale correlation (< 0.50). Each scale now consisted of seven instead of ten items. The mean scores of both self-efficacy dimensions show only a moderate correlation of $r = 0.38$. Moreover, a joint exploratory factor analysis of the 20 original items of both scales in the pre-test data clearly leads to the two dimensions of ASE and DMSE. Therefore, based on the pre-test data and also the full-scale data, the scales appear to provide valid and reliable measurements for both distinct self-efficacy dimensions.

[10] Due to the higher number of items for both self-efficacy scales compared to the other scales (seven instead of three), we also calculated the Cronbach's Alpha values for fewer items. In case of three items, we found an Alpha of 0.86 for both the ASE and the DMSE-Scale.

3.3.2 Validity Analyses

Exploratory Factor Analyses

For the pre-test data, the attitude and motivation scales taken from Brahm and Jenert (2015), CHE, the two scales for ASE, and DMSE were tested for construct validity by conducting several exploratory factor analyses (EFA)[11]. Due to a large number of expected factors, a single factor analysis containing all items was not useful. Instead, the analyses were carried out at the construct level. However, theoretically close constructs, e.g. intrinsic motivation and enjoyment in studying, were also checked in a comprehensive factor analysis including items of more than one construct.

First, each of the scales was evaluated in terms of the Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy test ($KMO > 0.60$) and the Bartlett's test of sphericity. The factor models itself were evaluated in terms of Scree Plots, factor loadings (higher than 0.30), parallel analyses (comparison to the structure of random data), and in accordance with theoretically expected factor structure and interpretability. For each scale, items that showed loadings greater than 0.30 on more than one factor are excluded for interpretation and also for the revised survey instrument, used for the full-scale data collection (see also supplementary material, Table A1). Still, it was ensured that there were at least three items for every uni-dimensional scale.

Most of the scales showed the expected one-factor structure. However, against our theoretical expectation, the factor structure of the original social integration scale (Leichsenring, 2011) could not be replicated. In consequence, only those items that could be uniquely defined as reflecting social integration, both theoretically and empirically, for the pre-test and also full-scale data, will be considered in further data analyses.

Furthermore, in contrast to our theoretical expectation, two factors can be suggested in case of the original social integration scale Leichsenring (2011), based on the pre-test data analysis. These might roughly be interpreted as social and academic integration since the items of one factor refer to private activities, partly with fellow students (e.g. private meetings, attendance of parties), and those of the other factor refer to learning activities with classmates (e.g. group learning activities). The scale was unchanged for the full-scale data collection and the exploratory factor analysis was repeated. For the full-scale data, a three factor solution seems most appropriate,

[11] Because of the data limitations and nature of the psychological constructs, minimum residuals (MINRES) method was used for factor extraction and Oblimin for rotation of the resulting factors (see Izquierdo, Olea, & Abad, 2014).

based on the EFA. Those three factors distinguish between social and academic integration, as suggested above, but also free-time activities. As a consequence, only those items that could be uniquely defined as reflecting social integration, both theoretically and empirically, for the pre-test and also full-scale data, will be considered in further data analyses.

Confirmatory Factor Analyses

The final 11 factor-solution was validated for the full-scale data by conducting a Confirmatory Factor Analysis (CFA). The results confirm a good fit of the model, based on Comparative Fit Index ($CFI > 0.95$), Tucker Lewis Index ($TLI > 0.95$), Root Mean Square Error of Approximation ($RMSEA < 0.05$), and Standardized Root Mean Square Residuals ($SMRM < 0.05$) values (Brown, 2015). The fit indices are reported in Table 3.5 (see also Output 1, supplementary material).

Table 3.5: Fit indices for 11-factor CFA based on the full-scale data (n = 1457)

Chi square (p)	2087.513 (0.000)
CFI	0.960
TLI	0.955
RMSEA(90 % conf. int)	0,034 - 0,038
SMRM	0.036

Correlation Analyses

In Table 3.6, the Pearson product-moment correlation coefficients of test scores for the scales are given to check if these are in line with the reported results of Brahm and Jenert (2015). The nomological validity of ASE is shown by expected correlations with other constructs (see section 1.2), e.g. a negative correlation with anxiety when studying ($r = -0.52$) or a positive correlation with motivation ($r = 0.39$). Also, motivation is positively correlated with enjoyment ($r = 0.84$), active participation in classes ($r = 0.31$) or identification with the university ($r = 0.43$). Students who are supported by their personal environment (subjective norm) in studying at their university also show a high identification with this institution ($r = 0.45$). Altogether, these results confirm the reported findings of Brahm and Jenert (2015).

Table 3.6: Pearson product-moment correlation coefficients (using pairwise exclusion of missing values) of test scores for each scale (n = 1931).

	ident	subj. Norm	enjoy	anxiety	act. part.	intr. mot.	ex. GO	task val.	Integr.	ASE	DMSE
ident											
subj. norm	0.45										
enjoy	0.45	0.29									
anxiety	-0.16	-0.15	-0.24								
act. part.	0.21	0.12	0.34	-0.18							
intr. mot.	0.41	0.31	0.83	-0.23	0.31						
ex. GO	0.16	0.13	0.22	-0.03	0.12	0.26					
task val.	0.43	0.3	0.72	-0.16	0.22	0.7	0.29				
Integr.	0.32	0.34	0.24	-0.18	0.1	0.24	0.09	0.23			
ASE	0.3	0.27	0.41	-0.53	0.3	0.39	0.19	0.39	0.3		
DMSE	0.13	0.1	0.15	-0.09	0.06	0.14	0.07	0.15	0.04	0.38	

We have refrained from presenting P-values in connection with these correlations, as all but two of them are significant at a level of $p < 0.05$, presumably partly due to the number of cases. The two exceptions are the ones that show correlations close to zero: Goal Orientation – Anxiety ($p = 0.18$) and DMSE – Integration ($p = 0.06$).

Variables: ident - Identification with the HEI; subj. norm - subjective norm; enjoy - enjoyment (in studying); anxiety - anxiety (in studying), act. part. - active participation; intr. mot.- intrinsic motivation; ex. GO - extrinsic goal-orientation; task val.- task value; integr - social integration; ASE - Academic Self-Efficacy; DMSE - Digital Media Self-Efficacy.

Additional correlation analyses (not included in Table 6) of DMSE, self-assessed digital media knowledge/skills, and frequency of usage of certain media applications also appear plausible. Self-assessed skills in e-learning applications or programming are positively correlated with DMSE, in medium strength ($r = 0.35$ for e-learning; $r = 0.37$ for programming), whereas research in library catalogues or general online literature research are less strongly correlated with DMSE ($r = 0.14$ for library research; $r = 0.20$ for general literature research), to name only a few examples. Since the former presumably also require more elaborated skills in dealing with these media applications, a stronger correlation with a perceived high ability to deal with digital media in general (high DMSE) seems to be reasonable. In contrast, less elaborated skills are probably needed when dealing with literature databases or library online-services, so the ability to successfully face difficulties regarding digital media applications seems less relevant and the link between those is less strong. Similar results occur when analysing the relationship between DMSE and frequency of usage of certain media applications, such as cloud services ($r = 0.29$) or cooperation tools ($r = 0.21$) in comparison to no visible relationship at all between DMSE and usage of library services ($r = 0.02$) or the university webpages ($r = 0.03$).

Again, this could be explained by the different demands on the skills required, with higher skills needed for online tools than for browsing through simple webpages. In sum, the relationship between DMSE and on the one hand self-assessed capabilities as well as on the other hand the frequency of use of certain media applications seems to vary depending on the requirement level of these applications, which seems plausible to us and thereby underlines the validity of the DMSE scale.

3.3.3 Distributions of Self-Efficacy Scales and Descriptive Results

In Figure 3.1 (a) and (b), the distribution of the two self-efficacy dimensions is shown. In both cases, skewness differs from a normal distribution, slightly tending to the right. Still, a reasonable amount of variance is given in the data and the emphasis lies on the middle area of the Likert scale. Thus, multivariate analysis procedures such as regression analyses seem to be applicable.

Based on the pre-test and full-scale data, first descriptive results show the aims and frequency of students' media use. While nearly each of the respondents owns either a laptop (94 %) and a smartphone (96 %) and has internet access (99 %), a tablet-PC is owned by 45 % of the students. According to the data, these mobile devices are mostly used on campus, for example, to look up something online, for online research (for study purposes), text messages, or

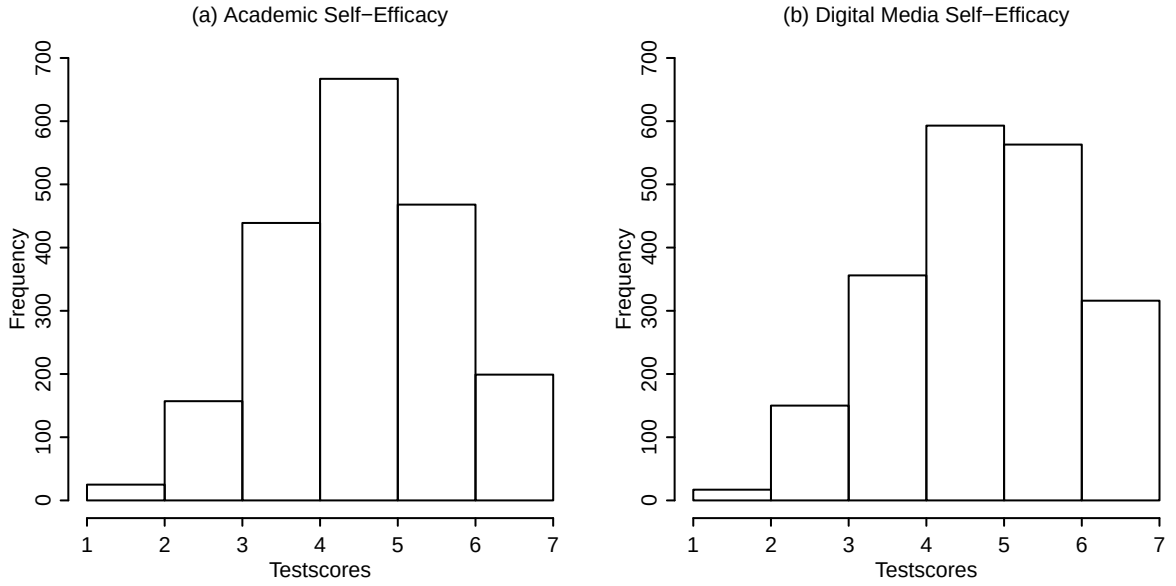

Figure 3.1: Histograms of testscores (average itemscores) for (a) Academic Self-Efficacy and (b) Digital Media Self-Efficacy (n = 1955)

e-mails to lecturers. The usage varies depending on the device type, for example, smartphones are used predominantly for communication and search purposes whereas laptops are used for access to university platforms, internet search, and also writing tasks (e.g. assignments). In contrast, location-based services, taking pictures, posting content, or communication on learning management systems (LMS) are rarely mentioned by the respondents. In terms of certain media applications, text-processing software, search engines, university e-mail account, chats, and e-books are used very frequently while e.g. Massive Open Online Courses (MOOCs), blogs, e-portfolios or twitter are seldom used, if at all. However, these many different media applications and differences in frequency of use as well as relatedness to study purposes allow for a more detailed analysis of media usage types and its link to study performance in subsequent investigations.

3.4 Discussion

Different instruments are available to assess student teaching and learning, however, instruments assessing the different facets of academic studies in the context of digitalisation are rare and currently more relevant than ever. In consequence, this study aimed to develop a comprehensive survey instrument that addresses the multi-faceted character of academic studies and digital media behaviour. Existing survey instruments such as (Brahm & Jenert, 2015), the CHE-Quest

(Leichsenring, 2011), and scales regarding students' media use and attitudes (Grosch & Gidion, 2011; Zawacki-Richter, 2015) were combined to assess all aspects of students' studying. In addition to these established scales, students' self-efficacy expectations regarding digital media use have not been assessed up to now. In consequence, it was necessary to develop a new scale building upon the established self-efficacy scale by Jerusalem and Schwarzer (2002).

Both with pre-test data and the main study, the instrument proved to show valid and reliable results. In accordance with Bandura's SCT (Bandura, 2011) and also in line with other empirical research, the study showed positive correlations of students' self-efficacy with motivation and goal orientation (Hsieh et al., 2007), interest (Honicke & Broadbent, 2016) as well as study success (Bartimote-Aufflick et al., 2016; Honicke & Broadbent, 2016). In contrast, a negative correlation with anxiety (Hsieh et al., 2012) could be confirmed. These correlations were shown both in the study by Brahm and Jenert (2015) as well as in our data, thus, indicating nomological validity of the survey instruments. However, we could not replicate the social integration scale according to (Leichsenring, 2011), with our available data. Furthermore, the pre-test and main surveys led to different results. For future analyses, therefore, only those three items that can be clearly assigned to a scale for social integration should be considered.

In addition to this replication, a new scale for DMSE was developed and could be separated from the well-established construct of students' academic self-efficacy (Jerusalem & Schwarzer, 2002). Correlation analyses of the relationship between DMSE and self-assessed capabilities as well as the frequency of usage of certain media applications show a varying strength of the relationship with DMSE, depending on the requirement level of the application of consideration, which appears to be plausible. Our results, therefore, point to a valid scale for DMSE here as well.

Another important result concerns students' aim and frequency of media use which matches those reported by Zawacki-Richter et al. (2017). We found a further increase in the dissemination of smartphones, laptops, and tablets, in comparison to the findings based on a survey in 2012 and 2015 Grosch and Gidion (2012); Zawacki-Richter (2015) with 96 % of our student sample owning a smartphone, 94 % a laptop, and 45 % a tablet. This increase again highlights the increasing relevance of digital media at universities and thereby of research on digital media behaviour of university students.

3.4.1 Limitations

It is always challenging to obtain a sufficiently large sample. Of course, the use of large samples can lead to more reliable results and can further enhance instrument validity tests. This scale development is based on a small pre-test and a larger main study, thus, the validity and reliability of this newly developed scale should still be examined in further research. Results are already promising, however, the scale has up to now only been used in one Swiss and six German HEIs. Further research will be required to replicate and extend these findings in diverse contexts, i.e. different kinds of HEIs, such as universities of applied sciences or colleges in order to establish broad applicability of the scale. In addition to institutional diversity, the study could also be replicated outside the German-speaking higher education context.

The most notable limitation is the exclusive use of self-reported data in the questionnaire. In the meta-analysis by Kuncel, Credé, and Thomas (2005) the reliability of self-reported results is related to students' school performance. This means that self-reported grades are appropriate measures of actual grades for students with good grades, but not for those with low grades. In consequence, other measures may be needed.

Furthermore, the validity of the instrument must be considered preliminary since this study focused on evaluating the factor structure, internal consistency, concurrent validity, and the divergent validity of the newly developed scale. Future research should include a more comprehensive evaluation of the scale, such as the test-retest reliability and criterion-related validity. Since convergent and discriminant validity could be established, criterion-related validity can be assumed, however, needs to be checked, ideally using longitudinal data.

3.4.2 Research and Practical Implications

Since the prevalent use of digital media for study purposes are confirmed in this study, it is necessary to extend existing instruments on teaching and learning (e.g. Lemos et al., 2011) by integrating the usage of digital media as well as self-efficacy beliefs concerning digital media. Furthermore, our study confirms the importance of our initial overarching questions. As we assume that students' social backgrounds, e.g. parents' educational background are linked to their DMSE and behaviour in academic settings in general (Zimmerman, 2000b; Zimmerman et al., 1992), it should be investigated whether students equipped with higher DMSE can accomplish study demands better. Accordingly, research is needed on whether students' individual and

subject-specific academic and media behaviour depend upon other measured constructs such as motivation, attitudes, and their socioeconomic background. Particularly about media behaviour, major subject-related differences, for example between engineering and humanities, can be expected, and especially regarding students' self-efficacy expectations, and gender differences (C. Huang, 2013; Pintrich & Schunk, 2002; Schunk & Pajares, 2002; Zawacki-Richter, 2015).

Since the instrument has good psychometric properties, it can be recommended for application at other HEIs to examine students' digital media usage and study behaviour. Also only selected parts of the instrument could be used, depending on the (research) question the applicants of the instruments have. In the summer semester 2020, for example, the instrument presented is used to conduct a longitudinal study on changes in media-related behaviour, attitudes, and self-efficacy as a result of the (at least partially) digitalised teaching during the corona-crisis. Besides, for example, the use and acceptance of learning platforms and campus information systems at universities could be evaluated to guide quality enhancement processes at HEIs. In this context, a study using the instrument could give insights into the purposes that widespread digital devices, such as smartphones and laptops, are actually used for. If a HEI, for instance, intends to increase the use of LMS as part of students' learning environment, and if students often use the LMS with their smartphones, it is advisable to make them universally usable with smartphones. Based on the assumption that a high level of media-related and academic self-efficacy motivates students and promotes their goal orientation (van Dinther, Dochy, & Segers, 2011), interventions for enhancing the students' (academic and digital media) self-efficacy expectations, potentially especially focusing on disadvantaged students, could be developed and evaluated, using the presented scales (see Brahm & Pumptow, 2020).

In particular, the role of DMSE should be addressed in future research since digital media are prevalent in teaching and learning. A possible approach would be to model different clusters of media usage types, based on the data concerning digital media. This would allow for further analysis of students' media behaviour in line with concepts resp. dimensions of media-usage by Johnsson-Smaragdi (2005; see also Zawacki-Richter, 2015). Such an analysis could provide insights into the determinants of digital media behaviour and also regarding its relevance for academic achievement.

3.4.3 Conclusion

Overall, this study contributes to further differentiation of established scales to evaluate students' behaviour (e.g. Brahm & Jenert, 2015; Lemos et al., 2011). Above all, it adds a new perspective

to this research stream by developing a new scale to assess DMSE which seems to be an important construct to further explore students' use of digital media in HEI. In this respect, the research also makes an initial contribution to extend Bandura's SCT towards digital media usage in the context of HE: Academic self-efficacy and digital media self-efficacy can be conceptualized as two separate constructs. This distinction could, in turn, be used to make clearer differences between various student groups and better cater to their respective needs in teaching and learning. In summary, the instrument can be recommended for wider application at other HEIs to find out more about students' digital media usage and its implications for other facets of learning.

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4 Study 2 - A Typology of Higher Education Students' Media-Usage Behaviour[12]

Abstract

This study extends previous research on German higher education (HE) students' media usage, considering attitudes towards digital media and exploring gender and subject-related differences. Data is based on a standardised online survey conducted from May to July 2018 at four German universities (n = 1684). Latent profile analysis (LPA) was conducted to identify a typology of media-usage patterns and attitudes, based on the average frequency of usage of different media applications (such as e-books, communication tools, study-related online tools etc.), attitudes towards digital media according to several dimensions (e.g. curiosity/interest and scepticism) and self-assessed skills regarding for example media technology, literature databases and research, and programming. The resulting types of media users were then analysed in terms of relationships with gender, study subjects and digital media self-efficacy. The results of this explorative study provide further insights into media use in HE, based on current data and for a diverse student sample, and allow for in-depth follow up research.

4.1 Introduction

The ongoing trend of digitalisation has led to changes concerning higher education (HE) student's private life and, more slowly, also their studying behaviour. In recent years, empirical studies have increasingly focused on investigating HE students' media use, both in a national and international context (e.g. Al-Husain & Hammo, 2015; Dahlstrom, Brooks, Grajek, & Reeves,

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2015; Grosch & Gidion, 2011; Schulmeister, 2006; Zawacki-Richter, 2015). With 2,339 students in 2012 and 1,327 students in 2015, from several higher education institutions (HEIs) that offered online courses and study programmes at the time, Zawacki-Richter et al. conducted surveys addressing students' media-usage patterns and the dissemination of mobile digital devices (Zawacki-Richter, Dolch, & Müskens, 2017). From 2012 to 2015, the proportion of students who own a smartphone, tablet or notebook increased significantly (Zawacki-Richter et al., 2017). Studies conducted by the ECAR between 2004 and 2015 focused on the development of undergraduate students' technology use, for HEI's in the United States and up to 15 other countries. Based on the responses from 4,123 students in 2004 up to 50,274 students in 2015, they found a similar increase in the spread of technology and the use of mobile devices in both the private and academic sectors over time (Dahlstrom & Bichsel, 2014; Dahlstrom et al., 2015). This increase might highlight the increasing relevance of digital media at universities and thereby of research on digital media behaviour of university students.

In addition, for the international context, Gidion, Capretz, Grosch, and Meadows (2016) presented the results of a study regarding the use of new and traditional media of undergraduate HE students, for Western University in London, Ontario, Canada in 2012 and 2013. With 100 students in the first wave and 803 students in the second wave, they analysed the differences in technology use over the course of four years of study. The results indicated that, while overall the use of technology increased from first to the fourth-year students, the satisfaction with technology decreased (Gidion et al., 2016). A more detailed picture emerges when these technology applications are considered in a more differentiated way. The frequency of use of, for example, online self-tests and online exams, as well as social media (Facebook), decreases, while the frequency of using services such as Wikipedia, Google books, the library's online services, and computer labs on campus increase. Unfortunately, multivariate analyses are not applied in this study and potential differences between faculties are not considered.

Nouri (2018) focused on how technologies influence knowledge acquisition and learning during HE students' self-study. For this purpose, the authors analysed the use of learning material in different modalities: text, image, audio and video. The mixed-method study was based on 2015 questionnaire data (n = 505) and 14 face-to-face interviews with computer and systems sciences students at Stockholm University. The findings suggest that videos are more frequently used among the students than texts and taking pictures (e.g. of drawings and notes from the lecturer) occurred almost as frequently as the production of digital texts. Therefore, self-studying has shifted from primarily using text-based learning material to using learning material from multiple modalities. In addition, personal preference might further influence what modalities the students use in their studies (Nouri, 2018).

Zawacki-Richter, Müskens, Krause, Alturki, and Aldraiweesh (2015) established a media-usage typology based on a survey addressing digital media usage by 2,339 university students in 2012 to formalise differences between students in their technology use. The survey instrument was operationalised according to the dimensions of the model of media use by Johnsson-Smaragdi (1994) and Bonfadelli, Fritz, and Köcher (1993), which includes environment (media and learning environment), socialisation (educational and media-related sociodemographic dimensions), behaviour (media use and learning behaviour) and personality (educational and media-related dispositions), resulting in 49 different media applications, tools and services. Following a typology by Grosch and Gidion (2011), media was then classified as printed and digital text media, general web tools and services and e-learning tools and services. In addition to mainly descriptive analyses of media use and distribution, Zawacki-Richter et al. (2015) conducted a latent class analysis to develop a typology of media-usage patterns. Based on items regarding the frequency of use as well as acceptance of different media applications and application purposes of, for example, social networks, they found a four-cluster solution. These four clusters could be described as entertainment users, peripheral users, advanced users and instrumental users. With a focus on non-traditional students, they conducted several subgroup analyses, finding, among other things, significant differences between genders (Zawacki-Richter et al., 2015). This is also in line with the results of previous studies, for example by W.-H. D. Huang, Hood, and Yoo (2013), who focused on college students' use and acceptance of Web 2.0 applications and found significant gender differences as well.

In contrast to these predominantly exploratory-descriptive studies, general research in the HE context is often more theory-driven, since there is a broad base of existing concepts and findings. One prominent concept to analyse behaviour, attitudes and outcome in academic settings is the self-efficacy (SE) belief, based on the social cognitive theory (SCT) (Bandura, 1977, 1986, 2011). In general, SE beliefs are defined as the perception of 'how well one can execute courses of action required to deal with prospective situations' (Bandura, 1986, p. 391). SE beliefs are, for example, analysed concerning motivational processes and student success and are perceived as an important predictor for academic behaviour and achievement (e.g. Komarraju & Dial, 2014; Putwain, Sander, & Larkin, 2013; Schunk & Pajares, 2002; Zimmerman, 2000). While SE beliefs can be applied to computer-related attitudes and experiences (e.g. Durndell & Haag, 2002) or, in educational settings, associated with tasks and subjects including technology and computers (e.g. C. Huang, 2013), a comprehensive study that allows the integration of an analysis of students' media use into models of academic behaviour is lacking so far.

Although, in this study an exploratory approach is pursued as well, additionally the concept of the SE is incorporated for two reasons. first, to gain initial insights into the relationship between

SE beliefs and media behaviour of HE students; and second, this approach enables follow-up research to integrate these insights into theory-based models on behaviour and attitudes in HE, including media use as a potentially relevant factor in contemporary academic studies. In the context of this study, SE beliefs apply to trust in the ability to successfully use digital media applications, even if problems occur or the application is unfamiliar. SE beliefs in the present study are therefore referred to as digital media self-efficacy (DMSE).

Therefore, based on previous studies focusing on media usage this study examines student media use patterns by using latent profile analysis (LPA) of a survey conducted in 2018 at four German universities. In contrast to the study by Zawacki-Richter et al. (2015) described above, which consisted largely of engineering, economics and science students, our dataset additionally represents a large proportion of humanities' students, allowing an analysis of differences in media usage between study subjects. As previous frameworks have mostly analysed the frequency of use and purpose of use, research of media-usage patterns is extended here by including attitudes towards digital media in the profile analysis. In contrast to this previous research, with regard to the classification of digital media applications, there is an additional distinction between communication tools and university platforms. Beyond that, as the previous study focused on non-traditional students in distance and online-learning settings (see Zawacki-Richter et al., 2015), the aim of the present study is to explore digital media usage patterns of a more general student population. Further, this study examines how the resulting types of digital media users differ according to gender and subject and how DMSE is linked to the user types. Therefore, as an extension of the reported previous research, the focus is on the following research questions:

Which media-user types can be found based on usage frequency, self-assessed skills and attitudes towards digital media?

How do these user types differ in terms of gender, subject and digital media self-efficacy?

The aim of this study is to gain further insights into media use in HE, based on current data and for a diverse student sample, overcoming the limitations of the reported studies. This exploratory study can provide the basis for further in-depth research, using the knowledge gained to analyse, for example, the relevance of media use behaviour to study success in different disciplines.

4.2 Method

4.2.1 Instrument Design

For data collection, a standardised online survey instrument, mostly based on scales developed in previous research, was used. Aim and frequency of students' media use and different attitudes regarding those media were inquired about according to approved instruments by Grosch and Gidion (2012) and Zawacki-Richter et al. (2015). The items were used to categorise digital media use as the frequency of use of different media applications in five groups: e-books (books and electronic articles), university platforms (e.g. homepage, e-learning portal, online library services), communication tools (e.g. Facebook, WhatsApp), study-related online tools (virtual lectures, literature databases, cooperation tools such as Google Docs), and general online tools (search engines, Wikis, cloud services).

Additionally, the Technology Usage Inventory (TUI) developed by Kothgassner et al. (2012, modified by Zawacki-Richter et al., 2015) was used to measure attitudes towards digital media applications. Computers, tablets, and smartphones are seen as digital media equipment, while software tools (e.g. for text or spreadsheet processing, picture editing), research tools, search engines, and other online media tools, are summarised by digital media itself. The measurement of attitudes towards digital media was divided into several units, dealing with the overall evaluation, for example of usefulness and concerns (e.g. privacy and data security concerns) and also the evaluation of usefulness with regard to academic studies. For our data, five factors were found using confirmatory factor analysis, describing the dimension's curiosity/interest, scepticism, anxiety, usefulness, and accessibility (Pumptow & Brahm, 2020). Additionally, self-assessed knowledge and skills regarding digital media applications are included as well. The scale for DMSE was constructed after the model of the general self-efficacy scale by Schwarzer and Jerusalem (2010) to capture students' digital media-related self-efficacy (Pumptow & Brahm, 2020).

For all the above-mentioned scales, the students were each presented with statements and were asked to indicate on a scale from 1 = 'not at all' to 7 = 'fully' or 'very often" to what extent the statements apply to them. For example, in the case of using mobile digital devices on campus, on of the statements was 'Sending text messages to other students'. For all scales, a test value was calculated for each person by determining the mean value of the indicators (see Table 4.1, below, for a list of the scales and descriptive statistics).

Based on the information on study subjects, these were classified into seven different subject-groups, which correspond to a classification of disciplines in the German HE system (Statistisches Bundesamt, 2018), and one residual category. The resulting subject-groups are humanities, engineering, art, science, medicine, law, economics and social sciences, sports and other.

4.2.2 Sample

The data was collected in summer term 2018 at four German universities. The students were invited to participate in the online-survey via e-mail, via postings and flyers, info-screens, and in lectures. In sum, 135,464 enrolled students were addressed and 3,342 participated (response rate approx. 2.5 %), of which 2,039 cases remain after excluding cases due to a high amount of (> 50 %) missing values. According to psychometric analyses, all scales of the questionnaire seem valid and reliable (Pumptow & Brahm, 2020). The proportion of female participants in the overall dataset was 59.6 %, 39.6 % were male. The students' mean age was $M = 24.03$ ($SD = 4.01$, $min = 18$, $max = 59$). As expected, our sample was not representative of the German student population in general since female students were slightly overrepresented in our sample.

4.2.3 Date Analysis

Latent profile analysis (a.k.a. gaussian finite mixture modelling) was conducted to identify a typology of media-usage patterns and attitudes. The items included in the analysis were the average usage frequency of different media applications according to the above-mentioned categorisation (e-books, university platforms, communication tools, study-related online tools, and general online tools), attitudes towards digital media according to the dimension's curiosity/interest, scepticism, anxiety, usefulness, and accessibility and self-assessed knowledge or skills regarding the dimensions media technology, office tools, literature databases and research, methods of social research tools, and programming. For the analysis, the R (R Core Team, 2020) package mclust (Scrucca, Fop, & Murphy, 2016) was used. Based on the best models according to the lowest BIC value and at the same time theoretically meaningful solution, six latent profiles were identified . Indicators were excluded, when they did not show a meaningful item-profile relationship – i.e. when there were only minor differences in scale means among all six profiles – as these variables did not contribute to the separation of members along with the profiles. This concerns the variables usage of general online tools and communication tools, self-assessed

skills for using office software, and anxiety with technology.

Based on the resulting classification, a variable was constructed to mirror the profile membership of each person. In this regard, the profile with the highest probability based on the LPA estimation was chosen for each student. To describe the relationship of the media-user types and gender, as well as study subject, cross-table analyses, including Chi-square tests of independence, were then conducted.

In the next step, the six identified profiles were used as a dependent variable for multinomial logistic regression analysis. To find out how the membership in the respective profile is affected by gender, subject and DMSE, these were included as independent variables. For the DMSE variable, the mean scores of the seven items were used. The average DMSE value is 4.85 ($SD = 1.20$, $n = 1995$). Causal relationships are not assumed, e.g. for academic performance causing a certain type of media behaviour (although there might be a causal relationship), but the intention is rather a simultaneous analysis of several correlations. In addition, cross-sectional data were used which does not allow for testing causally directed effects. The interest is, however, in the connection between the type of media use, DMSE, and gender. Again, R (R Core Team, 2020) was used for the analysis.

4.3 Results

4.3.1 Descriptive Statistics

The mean, standard deviation and number of cases for each variable included in the LPA are provided in Table 4.1. Each of the scales was measured by several items on a 7-point Likert scale that were then averaged to a single variable for each scale. The variables were divided into the frequency of use, attitudes, and self-assessment of skills measures. Study-related online tools (e.g. virtual lectures, literature databases, and cooperation tools such as Google Docs) were used least often, on average, in comparison to e-books or university platforms (e.g. homepage, e-learning portal, and online library services). Digital media applications were generally perceived to be very useful, as the comparatively high mean indicates. On the other hand, scepticism concerning digital media was also relatively pronounced. Overall, curiosity towards digital media, scepticism, and perceived accessibility showed similar mean values, each in the middle scale range. Larger differences occurred regarding the self-assessed skills, especially in terms of literature databases and research, with a rather high mean, and programming, with a relatively low

mean. In addition, skills concerning media technology and methods of social science research tools were, on average, perceived to be rather low. However, this self-assessment of skills may be greatly influenced by the subjects studied and their contents.

Table 4.1: Descriptive statistics for the scales included in the LPA.

	M	*SD*	*n*
Frequency of use:			
e-books	3.175	1.679	1986
university platforms	3.511	0.933	2034
study-related online tools	2.426	0.882	2034
Attitudes towards digital media:			
curiosity/interest	3.844	1.459	1996
scepticism	3.814	1.344	1995
perceived usefulness	5.992	1.206	1976
perceived accessibility	3.938	1.324	1983
Self-assessed knowledge/skills:			
media technology	2.857	1.526	1911
literature databases and research	4.332	1.491	1961
methods of social research tools	1.883	1.277	1783
programming	2.471	1.908	1875

4.3.2 Latent Profile Analysis

In the LPA, 1,684 complete cases were included. To decide the final number of profiles as well as variable shape, orientation and distribution, BIC values were assessed and bootstrap likelihood ratio test (*BLRT*) were conducted, with simultaneous consideration of theoretical interpretability. The absolute proportions, mean class probabilities and scale means based on the final six-profile-solution (ellipsoidal, equal shape [VEV]) are displayed in Table 4.2 (see also Figure A.1, supplementary material). Please see output A.1 in the supplementary material for further information regarding estimation parameters.

Based on the scale means of the variables included in the analysis, the six profiles can be described as follows:

Table 4.2: Absolute proportions, mean class probabilities and scale means for the six profiles of digital media usage behaviour and attitudes.

	medium users	*inexp. sceptics*	*study users*	*frequent users*	*marginal users*	*exp. sceptics*
absolute proportions	81	321	84	349	706	143
mean class probabilities	0.05	0.20	0.05	0.21	0.40	0.09
curiosity/interest	3.93	3.85	3.98	4.97	3.16	4.18
usefulness	5.48	5.98	5.38	7.00	5.88	4.99
accessibility	4.14	4.07	3.99	4.39	3.61	3.99
scepticism	3.73	3.94	3.90	3.60	3.82	4.08
university platforms	3.82	3.47	3.77	3.58	3.47	3.34
e-books	3.77	3.29	3.65	3.78	2.79	3.01
study related online tool	2.99	2.32	3.47	2.84	2.20	2.02
media technology	3.32	2.90	3.26	3.60	2.05	3.32
literature databases/research	4.43	3.82	4.61	4.78	4.23	4.49
soc. science tools	3.05	1.00	3.06	2.49	1.36	2.92
programming	2.80	3.12	4.29	3.48	1.00	3.51

- *marginal users* (mean class probability 40 %) with the lowest mean scale values for curiosity/interest, accessibility, usage of e-books, self-assessed skills regarding media technology and programming compared to all other profiles, and also relatively low scale means for the remaining indicators.

- *medium users* (mean class probability 5 %), where the second-highest scale means can be found for accessibility, usage of e-books, and study-related online tools and self-assessed skills regarding social research tools, and also the highest scale mean for university platforms.

- *frequent users* (mean class probability 21 %), where the highest scale mean levels for the variables curiosity/interest, usefulness, accessibility, usage of e-books, self-assessed skills regarding media technology and literature databases were found, but the lowest for scepticism.

- *inexperienced sceptics* (mean class probability 20 %) where, on the one hand, high values for usefulness but also for scepticism can be found, as well as the lowest values for self-assessed skills regarding literature databases and social research tools.

- *experienced sceptics* (mean class probability 9 %) with relatively high scale means for

curiosity/interest and scepticism, as well as for self-assessed skills regarding media technology and programming, and low values for usefulness, usage of university platforms, and use of study-related online tools.

- *study users* (mean class probability 5 %) with high scale means for the usage of university platforms and study-related online tools, self-assessed skills regarding literature databases, social science research tools (e.g. for statistical analyses) and programming.

4.3.3 Digital Media User Types and Gender

In Table 4.3 the distribution of media types by gender is shown in absolute numbers as well as the relative proportion per gender (in parentheses). Of the above 1,684 cases, 47 cases had to be excluded due to lack of information on gender. Thirteen students declared their gender as 'undetermined'; because of the small number, this category was not included in the analysis. Overall, 40 % of the students included in this analysis were male and 60 % were female.

Especially for the group of marginal users, there was a notable difference in the representation of both genders considered. Whereas 53 % of the female students belong to the group of marginal users, only 26 % of male students do. In addition, larger differences were indicated with regard to frequent users and inexperienced sceptics. In this case, larger proportions of male students (27 % and 24 %, respectively) were represented than of female students (17 % and 16 %, respectively). The remaining digital media user types did not show remarkable differences concerning the proportions within the respective gender groups. Based on a Chi-square test there is a significant relationship between gender and media-user type χ^2 (5, N = 1624) = 112.46, $p < 0.001$.

Table 4.3: Distribution of the six media-user types by gender.

	Exp. Sceptics	*Frequent Users*	*Inexp. Sceptics*	*Marginal Users*	*Medium User*	*Study Users*	*Total*
Male	71 (0.110)	174 (0.269)	156 (0.241)	171 (0.264)	35 (0.054)	41 (0.063)	648
Female	65 (0.067)	162 (0.166)	152 (0.156)	515 (0.528)	43 (0.044)	39 (0.040)	976
Total	136	336	308	686	78	80	1624

4.3.4 Digital Media User Types and Study Subject

A cross-table analysis was also conducted for the relationship between study subject and digital media user types. The absolute numbers, as well as relative proportion per subject-group (in parentheses), are shown in Table 4.4. In addition, for the connection between subject and media-usage type, the chi-square test of independence suggested a significant relationship with χ^2 (40, N = 1377) = 241.14, p < 0.001. In total, there were many students in engineering (25.7 %), the humanities (25.5 %), economics and social sciences (25.2 %), and science (19.7 %) but considerably fewer in art (1.5 %), sports (1.9 %), medicine (0.3 %), and other (0.1 %). Because of the low representation of the medicine and other subject-groups, these are not mentioned below but are listed in the table for information purposes.

Table 4.4: Distribution of the six media user types by study subject.

	Exp. Sceptics	*Frequent Users*	*Inexp. Sceptics*	*Marginal Users*	*Medium User*	*Study Users*	*Total*
Humanities	18 (0.051)	52 (0.148)	51 (0.145)	213 (0.605)	12 (0.034)	6 (0.017)	352
Engineering	34 (0.096)	108 (0.305)	107 (0.302)	60 (0.169)	17 (0.048)	28 (0.079)	354
Art	2 (0.100)	3 (0.150)	0	15 (0.750)	0	0	20
Science	22 (0.081)	56 (0.206)	76 (0.279)	87 (0.320)	12 (0.044)	19 (0.070)	272
Medicine	1 (0.250)	0	0	2 (0.500)	1 (0.250)	0	4
Law/ Econ./ Soc. Sciences	42 (0.121)	74 (0.213)	26 (0.075)	164 (0.473)	23 (0.066)	18 (0.052)	347
Sports	2 (0.077)	5 (0.192)	1 (0.038)	14 (0.538)	3 (0.115)	1 (0.038)	26
Other	0	2 (1.000)	0	0	0	0	2
Total	121	300	261	555	68	72	1377

In the case of the humanities' students, the largest proportion (60.5 %) belonged to the group of marginal users, who showed low interest in digital media tools and also self-assessed their skills as quite low. In comparison, among the engineering students, about 60 % of the students were equally distributed between frequent users, who use digital media often and rate their skills as high, and inexperienced sceptics, with great scepticism and a low assessment of their own abilities. Of the art students, many belonged to the marginal users' type (75 %), similar to the humanities students. Science students showed high proportions of marginal users as well (32 %)

but also of inexperienced sceptics (27.9 %) and frequent users (20.6 %). Students of economics and social sciences also largely belonged to the groups of marginal users (47.3 %) and frequent users (21.3 %) but showed the highest proportion, compared to all other subject-groups, among the experienced sceptics (12.1 %), who show high scepticism but also assess their skills regarding media technology and programming relatively high. For sports students, it was also the case that the largest proportion were marginal users (53.8 %) and fewer were frequent users (19.2 %).

4.3.5 Results of Multinomial Regression Analysis

Based on the LPA results, a categorical variable was constructed to mirror the profile membership of each person. This variable was then used as the dependent variable in multinomial logistic regression analysis. The category 'marginal users' was chosen for the baseline model since it was the most frequently represented and therefore the most common category, from which all other categories can be considered as less frequent deviations. With regard to the subject of study, art, medicine, and sports were combined with the others category due to the small number of cases. The results of the analysis are displayed in Table 4.5. In the rows, the five media-usage types for which the comparison to the base category is made and the independent variables – DMSE, gender, and subject – are arranged. In the columns, the coefficients, standard errors, relative risk values, Wald values, and the corresponding p-values are shown. Significant coefficients are highlighted in bold.

Overall, a significant (p-value < 0.05) relationship of the probability of belonging to a certain profile in comparison to the baseline profile and DMSE was found for each case. This means a higher DMSE, in general, leads to a higher probability for any other group in comparison to the baseline category of marginal users. Furthermore, the probability of female students belonging to the group of frequent users, inexperienced sceptics, and experienced sceptics (instead of to the group of marginal users) was significantly lower than for male students.

With regard to the subject, for medium users, frequent users, experienced sceptics, and study users, students of engineering, science, and economics and social sciences demonstrated a significantly higher probability than humanities' students to belong to these user types in comparison to the marginal users. However, for the inexperienced sceptics, there seemed to be no significant difference between humanities and economics and social sciences students regarding the probability to be this type of media user in comparison to the marginal users.

Table 4.5: Multinomial logistic regression of media usage types, gender, subject and digital media self-efficacy (n = 1684).

	Effect	*Estimate*	*SE*	*exp(Beta)*	*Wald*	*p*-Value
$\frac{P(Y_i=Med.\ User.)}{P(Y_i=Marg.\ User)}$	Intercept	**-3.824**	0.707	0.022	-5.407	0.000
	DMSE	**0.287**	0.120	1.332	2.382	0.017
	Gender:female	-0.455	0.281	0.634	-1.621	0.105
	Engineering	**1.302**	0.418	3.675	3.114	0.002
	Science	**0.882**	0.431	2.417	2.046	0.041
	Law/ Econ./ Soc. Sciences	**0.886**	0.376	2.426	2.355	0.019
	Other	0.805	0.614	2.237	1.311	0.190
$\frac{P(Y_i=Freq.\ User.)}{P(Y_i=Marg.\ User)}$	Intercept	**-6.664**	0.523	0.001	-12.731	0.000
	DMSE	**1.096**	0.087	2.992	12.655	0.000
	Gender:female	**-0.427**	0.175	0.652	-2.441	0.015
	Engineering	**1.557**	0.249	4.743	6.261	0.000
	Science	**1.052**	0.259	2.863	4.060	0.000
	Law/ Econ./ Soc. Sciences	**0.684**	0.235	1.983	2.912	0.004
	Other	0.332	0.436	1.393	0.761	0.446
$\frac{P(Y_i=Inexp.\ Scept.)}{P(Y_i=Marg.\ User)}$	Intercept	**-3.191**	0.460	0.041	-6.940	0.000
	DMSE	**0.469**	0.080	1.599	5.869	0.000
	Gender:female	**-0.609**	0.178	0.544	-3.431	0.001
	Engineering	**1.624**	0.236	5.071	6.882	0.000
	Science	**1.273**	0.232	3.570	5.484	0.000
	Law/ Econ./ Soc. Sciences	-0.492	0.278	0.612	-1.766	0.077
	Other	-2.024	1.034	0.132	-1.958	0.050
$\frac{P(Y_i=Exp.\ Scept.)}{P(Y_i=Marg.\ User)}$	Intercept	**-3.442**	0.576	0.032	-5.975	0.000
	DMSE	**0.336**	0.098	1.399	3.436	0.001
	Gender:female	**-0.879**	0.223	0.415	-3.934	0.000
	Engineering	**1.509**	0.343	4.522	4.402	0.000
	Science	**1.047**	0.356	2.848	2.938	0.003
	Law/ Econ./ Soc. Sciences	**1.141**	0.312	3.131	3.663	0.000
	Other	0.413	0.597	1.511	0.691	0.489
$\frac{P(Y_i=Study.User)}{P(Y_i=Marg.\ User)}$	Intercept	**-4.746**	0.798	0.009	-5.948	0.000
	DMSE	**0.305**	0.123	1.357	2.483	0.013
	Gender:female	-0.519	0.280	0.595	-1.857	0.063
	Engineering	**2.676**	0.515	14.525	5.192	0.000
	Science	**2.101**	0.528	8.171	3.981	0.000
	Law/ Econ./ Soc. Sciences	**1.559**	0.518	4.755	3.009	0.003
	Other	0.287	1.116	1.333	0.257	0.797

4.4 Discussion & Conclusion

The main aim of this study was to replicate and extend the previous studies on student media use, based on current data and for a diverse student sample. Based on a survey at four universities in 2018, several exploratory analyses were conducted. For a sample of over 1500 students, six different types of media users could be distinguished based on their attitudes towards digital media and the frequency of use of different tools. The differences in these user groups were further analysed regarding gender and subject groups.

The results of the LPA led to a six-profile solution, and these were labelled based on the mean scale values of the indicators: marginal users, medium users, frequent users, inexperienced sceptics, experienced sceptics, and study users. Overall it can be stated that a high proportion of students show low interest in digital media tools, rate the accessibility low and consider their skills regarding media technology and programming to be poor (i.e. they belong to the marginal users). For female students, this proportion was considerably higher than for male students, who, on the other hand, tended to have a higher representation in the groups of students who assess their skills higher and also show high interest (frequent users) or who find digital media tools quite useful, but at the same time are very sceptical and have a rather low assessment of their abilities (inexperienced sceptics).

In addition, significant differences were identified concerning subjects of study. As could be expected based on the general frequency distribution, the marginal users category had the highest shares for all subjects, except for engineering. For example, more than half of the humanities' students were marginal users, while the same proportion of engineering students were either frequent users or inexperienced sceptics. When comparing this relationship with the gender differences described above, there are common features that can be attributed to a correlation between the choice of subject and gender. Compared to the other subjects, a relatively high proportion of economics and social sciences students (12.1 %) belonged to the experienced sceptics category. This media-user type is characterised by high scepticism but also high interest and high assessment of skills regarding media technology and programming.

The differences between media-user types and gender, as well as subjects, remained significant even when analysed simultaneously in the context of a multinomial regression. Overall, in this study, different types of media users could be identified for a sample of traditional students of different disciplines, whereby, like Zawacki-Richter et al. (2015) did for non-traditional students, differences between genders were also found. These differences still existed for most of the differentiated user types, even when the discipline was included in the analysis. In addition,

significant relationships of media user types and digital media self-efficacy were found. All other types of media use show, on average, higher values for DMSE than that of the marginal users. The highest difference occurred in comparison to frequent users. In line with the concept of SE (Bandura, 1977, 1986) and results of studies focusing on academic self-efficacy and subsequent behaviour (e.g. Komarraju & Dial, 2014; Pajares & Schunk, 2001; Putwain et al., 2013; Zimmerman, 2000), this influence of DMSE on behaviour and attitudes in relation to digital media was expected.

Overall, these differences could relate both to the requirements and contents of the subjects and self-selection into these subjects according to individual characteristics that are also expressed in the types of users differentiated here. This relationship could not be investigated in this explorative study and thus could be an interesting area for future work. In addition, this study offers an interesting starting point for further analyses, including individual factors, such as motivation and personality type. Beyond that, further characteristics such as academic performance and social background and their interrelationships with media use should be considered. This could help to explore the relevance of types of media use and related SE beliefs for academic performance, in a model that does not only include motivational or academic behavioural factors traditionally considered while analysing academic performance, but also mirrors a more contemporary university context, which is increasingly characterised by digital media.

Beyond that, the findings on media-usage behaviour in various subjects are highly relevant to the current challenges during the COVID-19 pandemic and in view of the now prevalent digital teaching in many countries. These show that lecturers are confronted with a wide variety of conditions regarding the use and acceptance of digital media in their teaching context. Therefore, adaptation of the (digital) teaching plans to these identified differences and types of media use represents a direct practical implication. In addition, the promotion of DMSE, which often goes along with a higher level of expertise and a more media-affine usage behaviour, could be a proper starting point to compensate for greater differences in the students' prerequisites for successful digital learning.

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5 Study 3 - The Relevance of Digital Media Self-Efficacy and Media Usage for Achievement in Higher Education[13]

Abstract

Research suggests a link between students' academic self-efficacy expectations, their motivation and media-related attitudes, their socioeconomic background, and their study achievement. However, although digital media are prevalent in several areas of everyday life – more than ever during the COVID-19 crisis in 2020 – their relevance for academic achievement have not yet been satisfactorily explored. Furthermore, whether digital media usage is related to social background factors has not yet been sufficiently researched in this context. In consequence, it is unknown whether existing inequalities in higher education (HE) are stable, further enhanced, or even reduced in the era of 'digitalisation'. The present study explores the relationships between individual and social background factors, with a special focus on academic and digital media self-efficacy (DMSE) expectations. Data were collected at four German universities in summer 2018 (n = 2039). The results of structural equation models indicate that DMSE is not related to students' socioeconomic backgrounds, while academic self-efficacy (ASE) is. However, DMSE and the digital media user type 'experienced sceptics' are related to students' academic performance. Overall, this study contributes to the literature on students' study behaviour in the digital era by examining students' digital media behaviour as well as their media-related self-efficacy.

Keywords: Digital Media Self-Efficacy, Digital Media Use, Higher Education, Academic Performance, Academic Self-Efficacy, Social Cognitive Theory

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5.1 Introduction

In the past decade, digitalisation has led to immense changes in higher education (HE) as study programmes and university infrastructure attempt to match the emerging demands of the labour market and technological development in general. The COVID-19 crisis in 2020 has sped up the necessity of higher education institutions (HEIs) and their students using digital media for studying. Although digital media are prevalent in several areas of everyday life, their role in academic settings and their relevance for academic achievement have not yet been satisfactorily explored – while there is a prevalence of research on other factors that are deemed essential for academic success in HE.

In this regard, the question of how to alleviate inequality in the academic context – i.e. unequal opportunities with regard to students' socioeconomic or educational backgrounds – remains unsolved. Selectivity in the HE system does not stop after the initial decision for or against studying has been made; in other words, once a student chose to study, this does not automatically lead to his or her academic success. In particular, research has indicated that the proportion of students with non-academic vs. academic backgrounds is 1:6 once the master's level is reached and 1:10 during a doctoral degree (Stifterverband für die Deutsche Wissenschaft & McKinsey & Company, 2017/2018), thus indicating a so-called leaky pipeline phenomenon[14]. Inequality in the German HE system manifests mainly through a lower number of beginners, bachelor graduates and especially master's students and graduates stemming from non-academic families. Often, lower academic achievement, alternative vocational options because of former vocational training, or financial struggles lead to disadvantaged students dropping out. Some of these disadvantages involve socio-demographic characteristics or socioeconomic status (SES) (Stifterverband für die Deutsche Wissenschaft & McKinsey & Company, 2017/2018; Stoessel, Ihme, Barbarino, Fisseler, & Stürmer, 2015). As non-cognitive factors (e.g. self-efficacy, self-discipline) indirectly affect college retention, mediated by social adjustment, institutional commitment, and GPA (e.g. Bowman, Miller, Woosley, Maxwell, & Kolze, 2019), it is not surprising that research on student dropout is often combined with research on academic achievement. Furthermore, academic attainment is often found to be linked to students' self-efficacy (SE) expectations (e.g. Komarraju & Dial, 2014; Putwain, Sander, & Larkin, 2013; Schunk & Pajares, 2002; Zimmerman, 2000). Above all, research suggests that the relationship between students' SES and their academic achievement may be mediated by SE (Weiser & Riggio, 2010). Students with lower socioeconomic backgrounds show higher academic performance when they indicate higher self-efficacy; however, lower-SES students are often equipped with lower SE expectations (Weiser & Riggio, 2010). Therefore, in addition to the skills needed to successfully master a

[14] In a broader, not only gender-related sense of this phenomenon.

course of study, SE expectations and motivation (e.g. Komarraju & Dial, 2014) may be important factors in the SES-achievement relationship.

Surprisingly, whether media usage is related to social background factors remains largely unknown in this context. Previous work on digital media at universities has predominantly been based on empirical studies that describe different types of media-usage patterns. These studies have demonstrated that students with different characteristics (e.g. age, family status or ambitions) show various patterns of digital media use in academic settings (Grosch, 2012; Zawacki-Richter, Dolch, & Müskens, 2017; Zawacki-Richter, Müskens, Krause, Alturki, & Aldraiweesh, 2015). However, as these studies focused on such media-usage patterns, the scales were naturally limited to the assessment of behaviour and use of digital media and applications. As a result, in these earlier digital media studies, little has been revealed about the study context and students' individual study behaviour and media-related attitudes. Factors such as their underlying motivation or attitudes which have been identified in HE research (such as students' SE), were not considered. In addition, little is known about the relevance of digital media for mastering academic studies. In consequence, it is unknown whether existing inequalities in HE are stable, further enhanced or reduced through digitalisation.

Therefore, the intention of the present study is to analyse the relevance of digital media usage for contemporary academic studies at German universities by embedding measures for media behaviour and media-related attitudes in a comprehensive model, considering psychological measures and at the same time applying sociological constructs for inequality in educational contexts, thereby addressing the question of inequality in academic achievement with an interdisciplinary study approach. Thus, we analyse the relation of different types of media-usage behaviour with academic achievement. Furthermore, we examine the link between students' media behaviour and digital media self-efficacy (DMSE). Additionally, we examine whether students' socioeconomic backgrounds are related to their DMSE in a way that is similar to the often found relationship between familial background factors and ASE. By addressing these research questions, we contribute to research on individual differences in the HE system in at least two ways: First, we bring together sociological, psychological and media-related research streams which have not been connected in the context of digitalisation. Second, we shed further light on the relations between students' digital media behaviour by going beyond previous studies on students' usage of digital media in HE. Our study is based on data which was collected by using a recently developed survey instrument that allows the multi-faceted character of academic studies and digital media behaviour to be addressed (Pumptow & Brahm, 2020).

5.1.1 Theoretical Background

For this study, both individual behaviour and social influences on the reproduction of social (educational) inequalities, are important. First, we use Bandura's social cognitive theory (SCT) (e.g. Bandura, 1977, 1986, 2011) which offers a theoretical framework to analyse thoughts, motivation, and behaviour and therefore appears well suited to the aim of the study at hand. Second, Bourdieu's social reproduction theory is used (1994).

Based on SCT, human behaviour, in general, is caused by personal, behavioural, and environmental influences (Bandura, 1986). In a reciprocal determinism, individuals interpret the results of their performance attainments in a certain way, which in turn informs and changes their environment and their self-beliefs. This then informs and changes the subsequent behaviour. As a result, there is triadic reciprocity between personal factors, behaviour, and environment, and individuals are viewed both as products and as 'producers of their own environments and their social systems' (Pajares, 2008, p. 112). As one major aspect of his theory, Bandura introduced self-efficacy beliefs (SE), which are defined as 'people's judgement of their capabilities to organize and execute courses of action required to attain designated types of performances' (Bandura, 1986, p. 391). These self-efficacy beliefs help to determine how much effort is spent on a certain task or how resilient a person is when confronted with problems (Pajares, 1996, p. 544). Accordingly, SE affects several determinants for human behaviour: for example, goals, inclinations, and opportunities but also perceived obstacles and barriers. In academic contexts, SE may, for example, refer to the goal of successfully mastering exams; based on the students' perceptions of their capabilities to reach this goal, SE determines how much learning effort and also confidence during an exam is shown. Thus, focusing on SE may be useful in examining both learning behaviour and digital media use. Furthermore, the fact that SE depends on environmental aspects according to SCT illustrates the importance of taking social factors into account when analysing study outcomes.

Bandura (1997) also stressed the importance of parental influence on children's and adolescents' development of SE, for example, through offering opportunities for mastery experience. Accordingly, for the development of SE beliefs during childhood and adolescence, the amount of resources the family environment offers (e.g. in terms of money and time) is highly relevant. However, SE can also depend on the parents' experiences. This points to a cultural reproduction that is primarily studied in sociological research, for example in Lareau's (unequal) childhood studies (e.g. 2011). In line with Bourdieu and Passeron (1971), Lareau (2015) argued that socialisation processes vary for individuals with differing social backgrounds, resulting in different educational achievement and occupational chances. This might be because students with

lower-SES backgrounds experience a higher social and cultural distance from the educational system and institutions. Lareau (2015) was able to demonstrate this relation for young adults in the United States in a longitudinal qualitative study[15].

Overall, socialisation shapes the individual's internalised sense of natural behaviour and how he or she perceives 'the world' (habitus). This habitus is shared by social groups with similar backgrounds (Bourdieu, 1994). The amount of cultural capital (next to social and economic capital, see Bourdieu, 1986) – i.e. the resulting set of 'skills' that individuals acquire in the course of their socialisation and against the background of their habitus – also differs according to social background and can be exchanged for other forms of value, especially in educational institutions. Thus, cultural capital is partly perceived as informal knowledge about educational organisations' rules that are necessary to successfully pass through the educational institutions (Lareau, 2015).

Similarly, Lörz, Quast, and Roloff (2015) referred to cultural reproduction theories (Bourdieu & Passeron, 1971) in their study on the transition from Bachelor's to Master's programmes in the German HE system. In a study with 1,822 students, they demonstrated that students' varying familial backgrounds lead to differences in academic behaviour, more precisely in risk aversion and academic performance. The so-called 'cultural frames' might explain differences regarding the familiarity with educational institutions, such as Universities, between varying socioeconomic backgrounds. These frames affect individual expectations and pathways within the educational systems (see also Hartmann & Kopp, 2001). In summary, the individuals' educational success depends not only on institutional conditions and selection processes but also on their individual expectations and decisions which are based on experiences and their knowledge as well as their parents' knowledge about the (formal and informal) rules of the educational system.

To sum up, we combined Bandura's approach and the often empirically found social differences regarding ASE and academic success with a sociological approach of cultural reproduction according to Bourdieu as our theoretical foundation. Based on this argumentation and the assumption that people with higher familiarity with and knowledge of the educational systems are better equipped to meet the demands of studying, we expect students' familial background, ASE expectations, and academic success to be related.

In contrast, we do not expect to observe a link between students' family background and DMSE expectations (DMSE). The above-described mechanisms of passing on informal knowledge

[15]This study is a follow-up to the unequal childhoods study (Lareau, 2011), in which several persons aged 10 and 20 and their families were interviewed. In this case, data is based on information of eight of those families and interviews were conducted with five 30-year olds, with middle class and working class backgrounds.

about organisational rules, resulting in the familiarity with educational institutions and processes – and presumably in higher confidence to meet the demands successfully – do not apply to digital media processes and media-related requirements in the same way. Nevertheless, based on the SCT, we still assume that DMSE expectations are influenced by environmental factors in general, especially since digital media usage is determined by parental knowledge, experiences and regulation, particularly for younger children (e.g. Cingel & Krcmar, 2013; Nikken & Schols, 2015). However, the theoretical assumptions and study results available so far show that neither parental knowledge and regulation nor students' DMSE should differ to a significant extent due to students' socioeconomic background. In this respect, it is important to note that media-related self-efficacy does not directly imply competent and responsible usage of digital media but rather addresses the 'successful' handling of digital media, which, for example, could be more associated with quick access to new applications or confident reaction to problems. Furthermore, in contrast to general technological progress, the institutional requirements of the education system change little and rather slowly, making intergenerational transmission of certain aspects much more likely than can be expected for the use of digital media where younger generations often show different behaviour than older (parent) generations and quicker adaptation (e.g. Nelissen & van den Bulck, 2018).[16] However, we nevertheless assume that certain types of media behaviour nowadays are relevant in terms of successful studying. In turn, this could change the demands of studying to the extent that the aspects associated with cultural capital become less important, at least temporarily, if our assumption concerning the independence of DMSE and familial background holds. In summary, whether digital media usage and DMSE expectations are related to family backgrounds and academic success needs to be clarified empirically.

5.1.2 State of Research and Hypotheses

In 1996, Pajares stated in his seminal literature review on students' SE and their relation to academic achievement, that specific instruments are needed to capture different SE. Furthermore, he found that SE is a good predictor for academic success and related to other motivational constructs, e.g. motivation or goal-orientation (Pajares, 1996). In addition, in more recent years, numerous empirical studies have examined the relationship between SE, motivation, and academic achievement (e.g. Komarraju & Dial, 2014; Putwain et al., 2013; Schunk & Pajares, 2002; Zimmerman, 2000; Zimmerman, Bandura, & Martinez-Pons, 1992). For instance, in their meta-analytic review study of 217 articles published between 1997 and 2010, Richardson, Abraham, and Bond (2012) tested five cognitive and 42 non-cognitive constructs, including motivational variables such as SE and goal orientation to determine whether they are related with

[16] This is, again, not related to competence, but to different ways of access and application.

students' GPA. For ASE, a medium positive correlation could be found ($r = 0.31$). However, there was significant heterogeneity in effect size across studies ($I^2 = 90.94\ \%$). Concerning intrinsic motivation, learning goal orientation, and avoidance goal orientation (negatively correlated), small correlations were found. Honicke and Broadbent (2016) conducted a meta-analysis on the influence of ASE based on 53 studies published between 2003 and 2015 and also found a moderate positive relationship between ASE and academic performance ($r = 0.33$). Additional mediation analyses again identified motivational variables such as goal orientations as crucial. The significant heterogeneity across studies may partially be explained by inter-study differences in the operationalisation of academic self-efficacy (ASE) and academic performance. Based on the theoretical argumentation and these findings, the following hypotheses can be formed:

H1: Academic self-efficacy and academic achievement show a positive correlation.

H2: Academic self-efficacy expectations are connected to mastery and performance goal orientation, and these, in turn, are positively related to study achievement.

According to, for example, Pekrun (2006); Zeidner (2007); and Lewis, Haviland-Jones, and Barrett (2008); emotions can have both positive and negative effects on academic goal setting and achievement. Hsieh, Sullivan, and Guerra (2007) and Hsieh, Sullivan, Sass, and Guerra (2012) found that anxiety about not being able to meet the demands of study and SE expectations are linked and lead to lower academic achievement (similar: Brahm, Jenert, & Wagner, 2017). This leads to the third hypothesis:

H3: Academic self-efficacy is negatively related to anxiety, and this, in turn, is negatively related to academic achievement.

In research on students' self-efficacy, gender differences are often found, indicating higher self-efficacy beliefs for male persons. These differences occur in academic contexts (e.g. Schunk & Pajares, 2002) as well as concerning computer SE in general (Durndell & Haag, 2002), and also regarding academic tasks and subjects associated with technology and computers (W.-H. D. Huang, Hood, & Yoo, 2013). Therefore, hypothesis four is formulated as follows:

H4: Female students show lower academic and digital media self-efficacy than male students.

Weiser and Riggio (2010) analysed a convenience sample of 93 undergraduate psychology students from a US. university to explore the relationship between family background, SE, and academic outcomes. The results indicate a significant relationship between family background,

measured by socioeconomic background, quality of relationship with both parents and parental involvement, and the students' feeling of competence and perceived academic abilities. Those were found to be related to grades and expectations of academic success. Only partial support was found for SE as a mediator in the relationship between family background and academic outcomes since there was a significant mediation effect of SE and parental involvement but not for the other background variables. Contrary to the theoretical assumptions, higher SES was found to be linked to lower levels of self-efficacy. Weiser and Riggio stated that this may be due to the unique student population making up the sample which consisted mainly of Hispanic-American, first-generation college students of lower SES.

In a study with adolescents from Hong Kong, Keung and Ho (2020) used the capability approach, which shares some similarities with SE. Using multilevel modelling of data from the 2012 PISA study and its longitudinal extension, the authors found a positive relationship between students' SES and their expectation of earning a bachelor's degree, which can be considered similar to a measure of students' ASE. For their final model, including family-related, school-related and student capability factors, 'school-mean SES [...] consistently exerts a great influence on adolescents' expectations of pursuing a bachelor degree' (Keung & Ho, 2020, p. 289).

In line with this study and in contrast to Weiser and Riggio's (2010) study, we assume a positive relationship between SES and ASE, based on the theoretical assumptions stated above, and also because our data includes a broader sample of students stemming from different universities, subjects, and backgrounds.

H5a: Students with higher socioeconomic backgrounds show higher academic self-efficacy.

Finally, as described above, there is no theoretical or empirical evidence for a link between DMSE and family background. Furthermore, the field of media-related SE, as well as the newly developed scale, is still relatively unexplored, especially in terms of a relationship with socioeconomic background. Thus, there is, at least to our knowledge, no empirical evidence so far. Accordingly, we formulate the following explorative sub-hypothesis:

H5b: Digital media self-efficacy is independent of students' socioeconomic backgrounds.

Research on the effects of digital media or technology-enhanced learning is often limited to school contexts or specific applications or technology, for example, K–12 Online Learning (see e.g. review studies of Cavanaugh, Barbour, & Clark, 2009; Li & Ma, 2010). More recent studies in the HE context, for example, have focused on social media use, such as a study by Kirschner

and Karpinski (2010). The results for 219 students from a Midwestern US university indicate that Facebook users have lower GPAs and spend fewer hours per week studying than nonusers. Lau (2017) analysed a sample of 348 undergraduate students of a university in Hong Kong and differentiated between social media use for academic and for non-academic purposes as well as social media multitasking. The latter two were significantly negatively related to academic performance (Lau, 2017).

In conclusion, smartphones as well as laptops and other mobile devices offer the opportunity to use a large variety of different media applications, for study purposes and for leisure activities or socialising. Building upon these empirical results leads to the following assumption: The dominant digital media usage behaviour of a person is related positively or negatively to study achievement. Moreover, due to the determinant influence of SE expectations on media-based behaviour, we expect academic performance to be at least indirectly affected by DMSE. We, therefore, aim to explore the relationships of different types of media-use behaviour and DMSE with academic achievement, allowing for a potential mediated effect of DMSE on academic performance through several different media-user types. As there is hardly any empirical evidence of this so far, we formulate the last hypotheses rather broadly as follows:

H6a: Digital media self-efficacy is related to media-user types.

H6b: Different media-user types are associated distinctly with academic achievement.

H6c: Digital media self-efficacy is associated with academic achievement.

A sketch of the assumed relationships is shown in Figure 5.1. In addition to the hypothesised relationships, we also control for a direct effect of SES and gender on academic performance, since we do not expect them to be completely mediated by SE expectations.

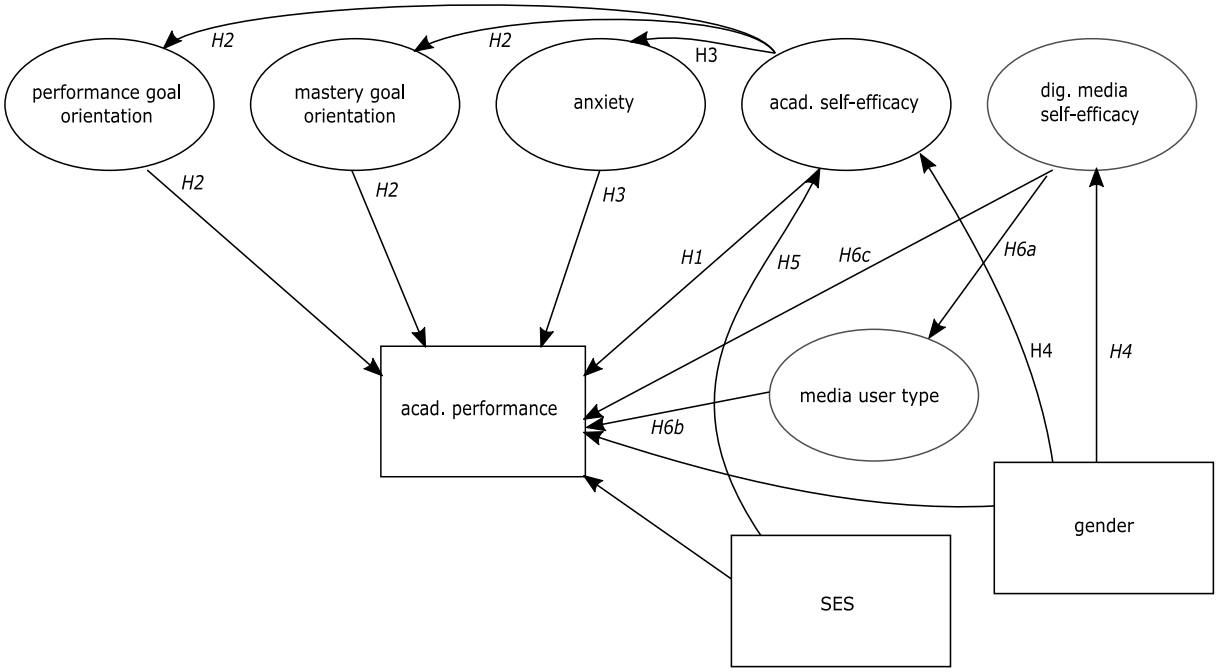

Figure 5.1: Path diagram of the theoretically assumed relationship of constructs.

5.2 Methods

5.2.1 Instrument Design and Operationalisation of Constructs

To analyse these hypotheses, data were collected using a standardised online survey instrument that allows one to capture SE expectations, attitudes, and media use (Pumptow & Brahm, 2020). The scales in the questionnaire are based on approved scales, taken from instruments in current research in the subject area (Brahm & Jenert, 2015; Duncan, Pintrich, Smith, & Mckeachie, 2015; Jerusalem & Schwarzer, 2002; Leichsenring, 2011).

Since, to our knowledge, no up-to-date scale for assessing media-related SE is available, we constructed a new scale for SE in terms of digital media, based on the general SE scale by Schwarzer and Jerusalem (2010) to capture students' media-related SE (Pumptow & Brahm, 2020).

Aim and frequency of students' media use and different attitudes regarding those media are inquired according to approved instruments (Grosch, 2012; Zawacki-Richter, 2015). We used the items to categorise digital media use as the frequency of usage of different media applications in

five categories: e-books (books and electronic articles), university platforms (e.g. homepage, e-learning portal, online library services), communication tools (e.g. Facebook, WhatsApp), study-related online tools (virtual lectures, literature databases, cooperation tools such as google docs), and general online tools (search engines, Wikis, cloud services).

Zawacki-Richter (2015) also used and modified the Technology Usage Inventory (TUI) by Kothgassner et al. (2012) to measure attitudes towards digital media applications. For our data, we found five factors using confirmatory factor analysis, describing the dimension's curiosity/interest, scepticism, anxiety, usefulness, and accessibility (Pumptow & Brahm, 2020). Furthermore, self-assessed knowledge and skills regarding digital media applications are included as well.

For all the above-mentioned scales, the students were each presented with statements and were asked to indicate on a scale from 1 = 'not at all' to 7 = 'fully' the extent to which these statements apply to them. For example, in the case of mastery goal orientation (MGO), one of the statements was 'I work and learn for my studies because I am interested in the learning content'.

Furthermore, demographics were assessed (in alignment with Lang & Hillmert, 2014). In addition to parental characteristics (such as their education), data on the parents' occupations were used to classify the respondents' SES according to the 'International Socioeconomic Index of Occupational Status (ISEI)' (Ganzeboom & Treiman, 2003). In case an ISEI value was present for both parents, the higher ISEI value was selected to indicate SES by a single value for each person.

Academic performance is measured by average grades weighted according to the ECTS[17] points achieved in relation to the number of ECTS points that should have been achieved in the respective semester according to the study plan. This index has been logarithmised due to its skewed distribution.

5.2.2 Sample

Data were collected in summer term 2018 at the Universities of W, X, Y, and Z. The students were invited to participate in the online survey via e-mail and, additionally, via postings and flyers, info-screens, and in lectures. In sum, 135,464 enrolled students were addressed and 3,342 participated (response rate approx. 2.5 %), of which 2,039 cases remain after excluding cases due

[17] European Credit Transfer System.

to missing values. Table 5.1 shows the absolute response number from each participating HEI. According to psychometric analyses, the scales seem valid and reliable (Pumptow & Brahm, 2020).

Table 5.1: Higher Education Institutions of the participating students.

University	Count
W	1114
X	372
Y	685
Z	1171

The proportion of female participants in the sample was 59.6 %, and 39.6 % were male, with female students being slightly overrepresented. The students' mean age is $M = 24.03$ ($SD = 4.01$, $min = 18$, $max = 59$).

5.2.3 Media User Typology

Based on the above-mentioned categorisation of the average frequency of usage of different media applications (e.g. university platforms, communication tools), the attitudes towards digital media according to the TUI dimensions (e.g. curiosity/interest, scepticism), and self-assessed knowledge resp. skills (e.g. regarding media technology, office tools), a typology of media-user types was created, using a latent profile analysis (see supplementary material Table D.1 for more information). This resulted in six different media-user types, which can be described as follows:

- *marginal users* (mean class probability (MCP) 40 %) show the lowest interest in digital media tools and also rate their accessibility as low. Additionally, these students use e-books least frequently and consider their skills with media technology and programming lower than the other media-user profiles.

- *medium users* (MCP 5 %) consider digital media as relatively accessible and use e-books as well as study-related online tools and the university platforms frequently. These students also rate their own abilities regarding social research tools comparatively high.

- *frequent users* (MCP 21 %) are highly interested in digital media tools and consider them generally useful and accessible. Moreover, these students use e-books most often and rate their skills regarding media technology and literature databases high. This group of students shows the lowest value for scepticism.

- *inexperienced sceptics* (MCP 20 %), on the one hand, consider digital media tools quite useful but, on the other hand, show high scepticism. This group of students considers their skills regarding literature databases and social research tools lowest.

- *experienced sceptics* (MCP 9 %), are interested in digital media tools but show high scepticism as well. They also indicate low values for usefulness of digital media and the usage of university platforms or study-related online tools. However, these students assess their own skills regarding media technology and programming relatively high.

- *study-oriented users* (MCP 5 %) show a focus on the usage of university platforms and study-related online tools and rate their skills regarding literature databases, social research tools (e.g. for statistical analyses) and programming high.

Based on this categorisation, a variable was constructed to mirror the profile membership of each person.

5.2.4 Data Analysis

In order to analyse the assumed relationships as shown in Figure 5.1, we conducted structural equation model (SEM) analyses for $n = 1784$ cases, using the software package lavaan (Rosseel et al., 2019) in the free software environment for statistical computing and graphics R (R Core Team, 2019). We used full information maximum likelihood estimation to deal with missing values. Due to the otherwise sharp increase in complexity in model estimation from adding a non-binary categorical variable representing the six media user types, we decided to test *H6a* separately, using linear regression analysis. Although we modelled DMSE as the dependent variable, this does not reflect the assumed direction of causality[18]. We considered only mean differences in DMSE between media-user types. However, we chose the numeric variable DMSE as the dependent one to achieve a less complex model in comparison to a multinomial regression model, which would have been necessary to model the categorical variable of media user types

[18] Due to the cross-sectional nature of the available data, all assumed causalities are in any case purely theoretical and can neither be adequately reflected by the data nor statistically modelled.

adequately. For the multiple linear regression analysis of digital media user types, DMSE, and academic performance (*H6b* and *c*), including also control variables[19], we used the predicted values of the latent variables based on the fitted SEM. Due to missing values in the variables of interest, the sample was reduced to *n =1046* observations for this analysis. We kept the sample constant for all four models. The standard errors of the coefficients and t-tests are based on heteroscedasticity-robust covariance estimation (White's standard errors) since the regression diagnostics we performed indicated heteroscedasticity. Again, R (R Core Team, 2019) was used for the analyses.

5.3 Results

In our analyses, we aimed to explore the assumed relationships, especially concerning digital media usage, SE expectations, SES, goal orientation and study performance. Below, some descriptive results, the results of the structural equation analysis and the subsequent regression analyses are provided.

5.3.1 Descriptive Results

Digital devices are common among students as nearly everyone owns a smartphone and a notebook. We found that, in 2018, 96 % of our student sample owned a smartphone, 94 % owned a laptop, and 45 % owned a tablet. That said, these devices differ regarding the amount of usage on campus and also regarding applications: smartphones are used very often on average (M = 6.2, on a scale from one to seven), laptops less often (M = 4.1) and tablets the least often (M = 3.6). On campus, laptops are mainly used for visiting the university (e-learning) platforms and for writing tasks. Smartphones, in comparison, are often used for text messaging, social networks (in particular, WhatsApp and Facebook), or internet searches. Independent of the device, of those students who used social networks for study purposes (81 %), students mostly exchange questions (77 %), also regarding exams (82 %), and send each other class and study materials (88 %).

Regarding their SE, the students in our sample tended to trust their ability to deal with digital media applications ($M(DMSE) = 4.8, SD = 1.14$). This value was slightly higher than their

[19] Which variables were included as controls is based on the results of the SEM-analysis.

self-assessed ability to successfully deal with academic tasks ($M(ASE) = 4.6, SD = 1.22$). The two scales show a moderate correlation of $r = 0.34$, which indicates that, although they are not completely independent, they are nevertheless clearly different dimensions of students' SE expectations.

5.3.2 Analyses Using Structural Equation Models

Figure 5.2 shows a simplified representation of the model, including only the path model but not the measurement model, and is based on the visualisation of the theoretical assumptions in Figure 5.1. An illustration of the complete model is shown in Figure D.1 in the supplementary material D. Table D.3 contains mean values, standard deviation, and internal consistency measure Cronbach's Alpha, with composite reliability and average variance extracted (AVE). In Figure 5.2, manifest variables are indicated by rectangles, and latent variables are indicated by ovals. Arrows represent the theoretically assumed direction of the effects and the coefficients and standard errors in parentheses are added next to the arrows. The common significance levels[20] are marked with asterisks. For each dependent variable, R squared values are shown in parentheses. The grey box on the upper left-hand side contains model fit indices and the number of observations.

The model is based on 1,784 observations and the fit indices attest to an acceptable model fit according to the comparative fit index ($CFI = 0.965$), tucker lewis index ($TLI = 0.96$), and root mean square error of approximation ($RMSEA = 0.040; 95\ \% CI[0.038, 0.043]$) as well as standardized root mean square residuals ($SMRM = 0.041$) value, which are all below or above the common thresholds (e.g. Hu & Bentler, 1999). In the SEM, we allowed the residual variances of ASE and DMSE to correlate, due to the moderate correlation[21] of both variables ($r = 0.41$). This model fit the observed data better than a model without any correlated residual variances, based on the above-mentioned fit indices, AIC values and BIC values.

Following *H1*, ASE should be significantly related to academic performance. Based on the correlation analysis (see Table D.2, supplementary material), this can be confirmed. However, after including anxiety and goal orientation in our overall SEM, the direct relationship between ASE and academic performance is weakened. Hypothesis 2 is partially supported by our results since ASE is significantly related to MGO and also to performance goal orientation (PGO). This implies that students who trust their academic abilities also show higher interest, for example,

[20] Significance codes: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $.p < 0.1$.

[21] Since both scales measure types of self-efficacy, this correlation is expectable. However, as was tested in exploratory (pre-test data) and confirmatory factor analyses (full scale data), academic and digital media self-efficacy are two distinct factors for different self-efficacy beliefs (Pumptow & Brahm, 2020).

in the learning contents (in the case of MGO) and in achieving good grades (in the case of PGO). PGO is also significantly positively linked to academic performance. In contrast, no such relationship is found for MGO and academic performance. The third hypothesis is fully supported by our empirical results: Anxiety is significantly related to ASE, in the sense that higher ASE expectations are associated with fewer worries of not meeting the demands of study. Furthermore, anxiety is significantly negatively related to academic performance. As assumed (*H4)*, female students showed significantly lower SE expectations than male students, both regarding academic matters and digital media. In addition, as assumed in *H5*, our results sugges a significant relationship between ASE and SES but not between DMSE and SES, resulting in slightly higher ASE expectations of persons with higher SES.

In addition to the hypothesised relationships, there was also evidence for a significant direct relationship between SES as well as gender and academic performance. Higher SES and being female are significantly linked to higher academic achievement.

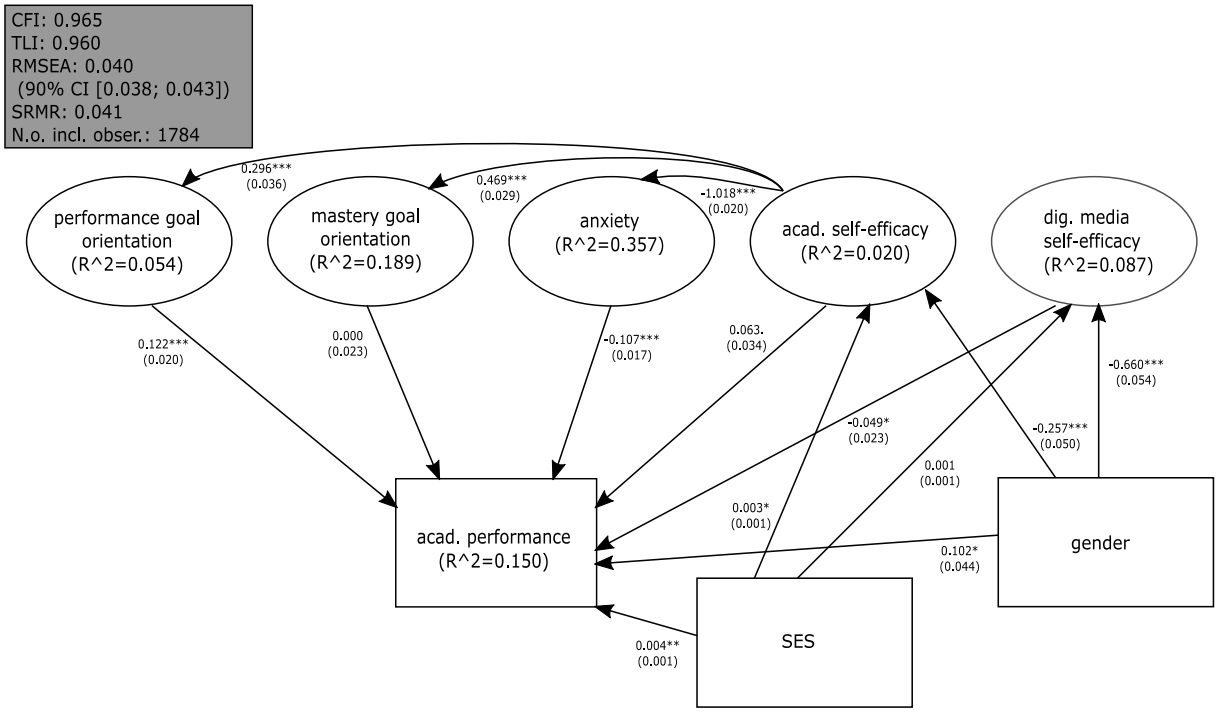

Figure 5.2: Simplified representation of the SEM with path models only, regression coefficients, standard errors in parentheses, significance levels represented by asterisks and R squared values of the depended variables.

5.3.3 Results of Regression Analyses

To analyse the relationship of DMSE, media-user types, and academic performance – as described in *H6* and shown in Figure 5.3 – we modelled the variables using linear regression in a multi-stage analysis. First, we analysed the relationship between DMSE and media-user types. Then we analysed the effects of DMSE and digital media user types on academic performance simultaneously in a separate analysis.

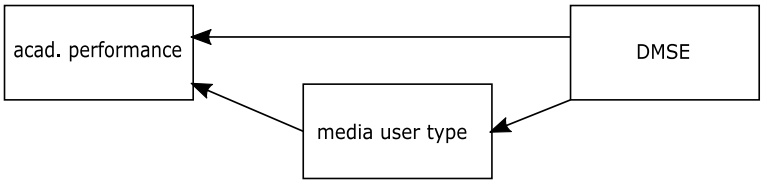

Figure 5.3: Assumed relationship of DMSE, media-user type and academic performance.

Digital Media User Types and Digital Media Self-Efficacy

Table 5.2: Results of linear regression analysis of DMSE on media-user types (n = 1684).

	$B(SE)$
Intercept	4.350***
	(0.041)
Experienced	0.573***
Sceptics	(0.100)
Frequent	1.346***
Users	(0.071)
Inexperienced	0.711***
Sceptics	(0.073)
Medium	0.458***
Users	(0.128)
Study Users	0.528***
	(0.126)
R^2	0.179

Significance codes: $^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $.p < 0.1$.

The results of the analysis of digital media user type and DMSE are displayed in Table 5.2. The explained variance of DMSE through digital media user type was 17.9 %. The base category of user types in this model is marginal users since it is the most frequent occurring category. The mean DMSE for this category was 4.35, as is shown by the intercept. All other types of media use show, on average, significantly higher values for DMSE than the marginal users, which is

indicated by the positive and significant ($p < 0.001$) coefficients for each of the categories. The biggest difference in means was in comparison to frequent users (5.696), and the smallest was in comparison to medium users (4.808). The experienced sceptics, study users, and medium users showed very similar average values for DMSE. Larger differences only occurred for frequent users and inexperienced sceptics. These results are in line with *H6a*, which assumes a relationship between DMSE and media-usage behaviour.

Digital Media User Types, Digital Media Self-Efficacy, and Academic Performance

For the next step, we added the variables anxiety, PGO, gender and SES as controls since these significantly affect academic performance according to the results of the SEM (see section 5.3.2). In order to be able to model an approximation to the complex relationships of the SEM described above, we included interaction effects of ASE with MGO, PGO, anxiety, gender and SES in initial analyses. We then tested these for significance and only left the significant interaction effects in the base model (ASE and gender, ASE and PGO) for the following regression analyses, as is indicated in Table 5.3.

We used stepwise model-building, starting with a model containing only the control variables, then adding DMSE and media-user types successively and finally both at the same time. For the first model, we saw relations similar to those of the previous analysis in the SEM and an explained variance of 15.8 % of the dependent variable academic performance. Despite the non-significance of ASE in the SEM, there is a significant relation to academic performance in this model, when including the interaction effects with gender and PGO, thus, supporting Hypothesis 1. Adding DMSE in the next model only led to a slight increase in explanatory power (to 16 %). However, a significant negative effect on academic performance was also observed ($p < 0.05$). The next model contained the five media-user type categories in reference to the type 'marginal users'. Adding this variable did not lead to a notable change in explanatory power compared to the baseline model due to the insignificance of each of the categories. For the full model, including DMSE, media-user types, and controls, a significant positive relation between the media-user type 'experienced sceptics' and academic performance was found; i.e. students who belong to this category show significantly higher academic performance also after controlling for DMSE. This model explains 16 % of the variance in academic performance. Since only the direct relation of the media-use type 'experienced sceptics' was found in the simultaneous examination with DMSE, *H6b* can only be partially supported for the link between this media-user type – in comparison to marginal users– and academic performance but not for the other user types. Finally, *H6c* is supported because of the small but significant negative

relation between DMSE and academic performance.

Table 5.3: Multiple regression analyses of academic performance on DMSE, media-user types and control variables (n = 1046).

	Base Model	*DMSE Model*	*Media User Model*	*Full Model*
	$B(SE)$	$B(SE)$	$B(SE)$	$B(SE)$
(Intercept)	1.237***	1.252***	1.231***	1.229***
	(0.085)	(0.084)	(0.088)	(0.088)
DMSE		-0.047*		-0.055*
		(0.022)		(0.024)
exp. sceptics			0.105.	0.123*
			(0.059)	(0.059)
frequent users			0.022	0.068
			(0.055)	(0.058)
inexp. sceptics			-0.051	-0.026
			(0.071)	(0.071)
medium users			-0.076	-0.055
			(0.089)	(0.090)
study users			-0.011	-0.031
			(0.117)	(0.116)
gender female	0.157***	0.134**	0.160***	0.141**
	(0.045)	(0.046)	(0.047)	(0.047)
SES	0.004**	0.004**	0.004**	0.004**
	(0.001)	(0.001)	(0.001)	(0.001)
ASE	0.147**	0.176***	0.141**	0.172***
	(0.047)	(0.050)	(0.047)	(0.050)
anxiety	-0.102***	-0.092***	-0.102***	-0.092***
	(0.020)	(0.020)	(0.020)	(0.020)
PGO	0.117***	0.114***	0.118***	0.115***
	(0.021)	(0.020)	(0.020)	(0.021)
gender female*ASE	-0.183***	-0.181***	-0.178***	-0.178***
	(0.051)	(0.051)	(0.050)	(0.050)
ASE*PGO	-0.077***	-0.077***	-0.077***	-0.077***
	(0.019)	(0.019)	(0.019)	(0.018)
R^2 (adjusted)	0.158	0.160	0.157	0.160

Significance codes: $***p < 0.001; **p < 0.01; *p < 0.05; .p < 0.1$.

However, caution is required when interpreting this relation. In bivariate correlation analysis, a correlation close to zero was found; nevertheless, both SEM and the regression analyses indicate a significant relationship with academic performance (still with a small effect size). This could be due to misspecification in terms of omitted variable bias in the bivariate analysis but may also

be related to the correlation between ASE and DMSE. The increase of the effect of ASE after including DMSE in the model and the fact that DMSE is significant with $p < 0.05$ can be a hint of a potential suppressor effect (see e.g. Conger, 1974).[22]

5.4 Discussion and Conclusion

Based on comprehensive data from four German universities, our multi-stage analyses examined the relationship between academic performance, two types of goal orientation (mastery and performance), anxiety in studying, ASE and DMSE, media-user types, gender, and SES.

With its complex and interdisciplinary design, our study contributes to further examining the intertwined relationship of these different variables and their relation to academic performance. Concerning our hypotheses about the relation of academic achievement and ASE, we found mixed results. In line with the study by Honicke and Broadbent (2016), our study indicated a mediated effect of ASE on academic performance via goal orientation. However, only PGO was significantly related to academic performance (*H2*), leaving the potential indirect effect of ASE on this goal orientation factor (and not on the theoretically also assumed MGO). Nevertheless, as expected according to, for example, Komarraju and Dial (2014), there was a significant positive relationship between ASE and both PGO and MGO. Anxiety about not meet the demands of studying was also significantly negatively related to academic performance. In line with other research (Bledsoe & Baskin, 2014; Brahm et al., 2017; Lewis et al., 2008; Pekrun, 2006; Zeidner, 2007), the results at hand suggest that negative emotions such as anxiety negatively affect academic goal setting and achievement (*H3*), and they are in turn connected to ASE, which was demonstrated, for example, by Hsieh et al. (2007, 2012). Due to its significant relation to academic performance, anxiety could also serve as a mediator in the ASE – academic performance relationship, which, as well as the above-mentioned goal orientation factors, should be further examined in future studies.

As has often been shown in empirical studies, there is a significant gender-related difference in SE expectations, both regarding academic tasks (see e.g. Schunk & Pajares, 2002) and digital media (see e.g. Durndell & Haag, 2002; C. Huang, 2013). This relation was again confirmed in our study, also concerning DMSE (*H4*), with females showing lower SE than males. As is shown in the interaction term of the regression analysis, female students, on the one hand, show higher academic performance on average but at the same time show lower values of ASE, and

[22] There is no indication of multicollinearity on the basis of Variance Inflation Factors (all $VIF < 4$).

they therefore benefit less from the positive relation between ASE and academic performance.

According to the theoretical assumptions based on Bandura (1986), Bourdieu and Passeron (1971), and Lareau (2015) (see Hypothesis *5a*), we found a significant positive relationship between parents' SES and ASE in the data used here, again confirming the impression that students with higher SES appear to feel slightly more competent and perceive their academic abilities better than students with lower SES. This result, while contradicting the rather surprising result of Weiser and Riggio (2010), is based on a broad student population of more diverse backgrounds and is in line with the theoretically expected outcome.

Additionally, there is a significant direct link between SES and academic performance, which is in line with the theoretical assumptions (Bourdieu & Passeron, 1971; Lareau, 2015) and many empirical studies (e.g. Devlin, 2013). In addition to ASE, other study-relevant personal factors are related to higher parental SES, resulting in an better overall academic performance of students with higher SES.

In the case of DMSE (*H5b*), we assumed no relation to socioeconomic background since the mechanisms of intergenerational transmission of informal knowledge about institutional rules cannot equally be applied to DMSE as for ASE. Accordingly, we do not assume that the mechanism of higher familiarity with educational institutions and more positive experiences assumed and confirmed for ASE also hold for DMSE. For digital media-related skills and experiences as well as for DMSE, at least for today's HE students, these mechanisms are not likely due to the fast development of new technologies. This hypothesis (*5b*) is supported by our empirical results. However, a general DMSE scale of this kind has, to our knowledge, not yet been analysed, so this result is rather explorative in nature and should be confirmed in further empirical studies.

Finally, *H6* concerns the relation of DMSE, media-user types, and academic performance and was explored using regression analyses. In the first step, a significant relationship between DMSE and all media-user types was found. In the analysis of academic performance, DMSE, and digital media user type, in our final model, only one of the media-user types – i.e. experienced users in comparison to marginal users – was significantly related with academic performance. Furthermore, there was a rather small but significant negative relationship between DMSE and academic performance. This implies that students with higher trust in their abilities to deal with problems associated with digital media show lower academic performance. One reason for this could be that these individuals use digital media more frequently for non study-related purposes, which, according to other studies (Kirschner & Karpinski, 2010; Lau, 2017), has a negative

effect on study performance. However, this result should be interpreted with caution as there are indications that this may be a statistical artefact since the link between DMSE and academic performance seems to be influenced by covariates in a way that goes beyond the implied (partial) mediation through the differentiated media-user types. Accordingly, it is advisable to re-address this question if possible, using a different (longitudinal) data basis, with an additional focus on the mediation and a potential suppressor effect. This would be necessary to reconsider and potentially confirm the result. In addition, a different operationalisation of media-user types can be considered a pathway for future studies. It would be worthwhile to further distinguish between study-oriented behaviour and leisure or social networking activities to gain more insights in the theoretically sound assumption of nature of DMSE and its link with academic performance, building on the results of Lau (2017).

5.4.1 Limitations

Although many of the hypothesised relationships were supported by our data analyses, there were also limitations in this study, some of which were mentioned above. The assumed mediated effects are supported by our results but would also need to be specifically tested in mediation analyses, which go beyond the scope of this paper and should be based on longitudinal data. Generally, due to the cross-sectional nature of our database, we can only make statements about correlations and can only assume causality theoretically. Therefore, all causal assumptions should also be tested with the help of longitudinal data sets.

Another limitation was the non-representational character of the data this study was based on. Although the sample was a reasonable size, we cannot generalise the results found for this sample to a German student population but only to the covered population of four universities, that slightly over-represents female students at these HEIs. Additionally, we only used self-reported data. Especially in case of our academic performance measurements, the resulting variable may be biased. However, since Kuncel, Credé, and Thomas (2005) found in their meta-analysis that the reliability of self-reported results is related to students' actual school performance, it can be assumed that self-reported grades are appropriate measures of actual grades for students with good grades but possibly not for those with low grades. In consequence, other measures for students' academic performance are needed.

5.4.2 Conclusion: Theoretical and Practical Implications

Despite its limitations, this study demonstrated that digital media devices are widespread among HE students and that many different media applications are used for various purposes. This allowed for the identification of separate types of media users and thus, contributes to further developing empirical research on students' usage of digital media, enhancing previous studies on students' media usage (e.g. Grosch, 2012; Thompson, 2013; Zawacki-Richter, 2015). Further insights into students' digital media behaviour are nevertheless still needed and can be gained by examining these types of media users more intensively. Additionally, potential differences between students' subjects and different HEIs should be examined. In a further step, a comparison of universities in different national contexts could also provide relevant insights into country-specific variation in the relevance of digital media use for success in HE.

Above all, the study was able to connect three different research streams: sociological and psychological research were interlinked with research on digital media in HE. This interrelation of different research approaches made it possible to demonstrate how students' SES and students' ASE are related. A similar relation was examined in a qualitative study (Lareau, 2015), and has now been confirmed in a quantitative study. Accordingly, our study contributes to further theoretical development regarding the relation of students' social background, their SE and their academic performance.

From a practical point of view, this connection can be used, for instance, by supporting students' SE early on in their studies in order to overcome the leaky pipeline syndrome (Brahm & Pumptow, 2020). In addition to students from lower SES, female students, in particular, should be addressed in such endeavours because the present study once again confirmed the gender-related differences that have already been frequently found in research. Possible solutions could be to support students with lower SE by offering them additional support at the beginning of their studies, for instance, regarding how to navigate through university. To design such interventions, other research on the transition into HE could be complemented (e.g. Brahm et al., 2017). Additionally, panel studies would provide more insights into the change of SE expectations and media-use behaviour in the course of study, and would allow for a better understanding of students' development. This would also help in identifying appropriate timing for interventions.

Beyond that, it was shown that DMSE may influence study performance in a way that, unlike other non-cognitive factors, is independent of SES. Therefore, including DMSE in future analyses of HE students' academic achievement seems promising since it represents a contemporary extension of the attitude and motivation scales, usually used in psychological research of this

kind. The instrument for DMSE and media use may also supplement research on student dropout and the probability of academic success adapted to the modern and media-influenced university context (Authors, under review).

Overall, this study combines research on digital media in HE and the 'classical' approaches to investigating academic success. In this respect, Bandura's SCT is extended in two ways: First, we included digital media usage in the academic context by adding DMSE as a relevant antecedent for academic performance. The exact kind of relation of DMSE, however, still needs to be determined. Second, we extend SCT by linking it with the more sociologically-oriented theory of cultural capital. Our results highlight the importance of considering students' SES, thus offering some starting points for further interdisciplinary research. This research could focus on directly measuring cultural capital instead or in addition to SES and also include a more in-depth analysis of the relationship between cultural capital and ASE. In any case, interdisciplinary research in this field of research on academic success and digital media use in HE appears promising.

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6 Study 4 - Differences in Higher Education Students' Technology Use Depending on Discipline Culture and Individual Characteristics[23]

Abstract

Recent research has indicated that digital media use is widespread among higher education (HE) students. However, technology use was predominantly examined as part of mainly descriptive studies. Although differences between disciplines were often found, they were not the focus of the investigations. The use of technology in different subject areas could depend on the content of the studies, leading to, for example, differences between science, engineering or humanities. Beyond this, disciplines may also differ according to their traditions, norms and values which form the discipline-specific cultures. Thus, based on the theoretical perspectives of social cognitive theory and organisational culture, the aim of the present study is to examine students' technology usage in different HE disciplines. In a multilevel analysis, data from four German universities were analysed, including more than 1,200 students from 105 disciplines. The findings suggest that students in different disciplines vary substantially in average usage of study-related technology. Furthermore, on the individual level, study-related technology use is affected by perceived usefulness of technology, digital media self-efficacy, and social integration. However, technology use appears to be independent of the progress (semester) of study. The results of the present study contribute to further extending our knowledge about student technology use in HE and, additionally, the conceptual and methodical models can serve as a theoretical and empirical basis for future studies.

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Keywords: Media in education, Post-secondary education, Applications in subject area

6.1 Introduction

Technology usage in Higher Education (HE) is especially relevant not only because the COVID-19 crisis has led to a very rapid digitalisation of teaching and learning. Even before the pandemic, digital media applications were being increasingly integrated into academic studies (e.g. Grosch, 2012). Technology use, however, was predominantly examined as part of mainly descriptive studies or studies that focus on finding clusters, i.e. identifying types of media users according to their preferences in different dimensions of media usage (Pumptow, n.d.; Zawacki-Richter, Müskens, Krause, Alturki, & Aldraiweesh, 2015). In these studies, differences between subjects were regularly found. However, they were not systematically analysed. The use of technology in different disciplines could depend on the content of the studies. It seems obvious that engineering or computer science, for example, require students to use more technology than cultural studies or other humanities because technology usage is inherent in the nature of the subject. Furthermore, self-selection of the students into the disciplines based on their personal characteristics can be assumed (Bardi, Buchanan, Goodwin, Slabu, & Robinson, 2014; Windolf, 1995), resulting in students willing or able to use technology to study such disciplines.

Beyond this, disciplines may also differ according to the traditions, norms and values which form the discipline-specific cultures (Tierney, 1997; Tierney & Rhoads, 1993). These, however, are only partially related to the content of the subject. Such discipline-specific cultures are passed on to the students during their courses of study, in addition to the formal contents of the studies and therefore may also alter the individual characteristics of the students (Tierney, 1997). Since the major research studies on organisational culture, subculture and discipline-dependent characteristics in HE date from the 1980s and 1990s (e.g. Becher, 1987; Birnbaum & Edelson, 1989; Tierney & Rhoads, 1993), only few studies have considered digital media usage at Higher Education Institutions (HEIs) since this phenomenon is still rather recent (e.g. Lin & Ha, 2009). Lin and Ha, for example, analyse the use of the learning management system Blackboard at a US Midwestern university from an organisational culture perspective. However, the focus of their mixed-method study was on faculty and staff members and their differences in Blackboard use (Lin & Ha, 2009). Collins, Bulger, and Meyer (2012) focused on researchers' more general digital technology use and related attitudes for six case studies in the UK, finding differences between (humanities) disciplines that are affected by disciplinary habits. Lam, McNaught, Lee, and Chan (2014) found disciplinary differences in daily usage of technology and use of

technology for teaching and learning for Chinese university students from 2009. However, their analysis based on the Biglan (1973) model was limited to a differentiation between soft/hard and pure/applied disciplines and conducted in several separate MANOVAs. Thus, a comprehensive analysis for specific disciplines is still lacking. Furthermore, the database is somewhat outdated, so it is not clear whether the findings are still valid today. This paucity of studies investigating students' digital media and technology usage and potential differences regarding HE disciplines based on current data is remarkable, given the omnipresence of digital media in students' lives.

Consequently, the aim of this study is to apply the theoretical lens of organisational culture and social cognitive theory (SCT) to examine students' technology usage in different HE disciplines. Due to the interaction of the meso-level of the institutions with the students' individual behaviour, students' characteristics must to be considered as well. This multilevel assessment is intended to answer the question *how study-related technology usage by higher education students differs according to discipline and individual characteristics*. With our study, we extend previous research by applying the theory of organisational culture to the field of digital media in HE. Accordingly, our study can serve as a theoretical and empirical modelling basis for future studies focusing on the digitalisation processes during and possibly following the COVID-19 pandemic. Our data is based on self-reported student surveys and reflects the situation at four German universities in 2018 (n = 1284). After introducing the theoretical background of organisational culture and individual study behaviour, several hypotheses considering the two levels of analysis are formed.

6.2 Conceptual Framework and Hypotheses

To integrate the meso- and the micro-level of technology usage in HE, relationships on both levels need to be theoretically described. Starting from the individual level, several hypotheses are formulated based on a technology-mediated learning (TML) assumption and SCT. These are then further extended by meso-level relationships, which are derived using the theoretical assumption of a disciplinary culture.

6.2.1 Technology-Mediated Learning

The micro-level of students' attitudes and beliefs is situated within the organisational culture of the higher education institution (HEI) and the relevant discipline. The TML process involves

educators and students. Their behaviours and interaction can be analysed based on a variety of different theories, which are brought together and summarised within the framework of TML by Bower (2019) who considers learning to be mediated by technology, while the technology itself does not have any intentions, but is the object used to convey meaning. However, the intentional agency lies with the humans (Bower, 2019).

By considering the most common theoretical approaches to the field, Bower identified seven key premises based on these theories. First, with reference to Engeström's (1987) activity theory, the technologies serve as a mediator between the participants (educators and students) in order to achieve a desired (learning) outcome. Second, in line with Bandura's (1986) SCT, the participants beliefs, knowledge and practices and the environment reciprocally influence one another. Third, educators consider the learners' feedback in the design and implementation of technologies. Fourth, the affordances of the technologies – meaning the properties and the way these can be used for what purposes – determine the effective utilisation of the technologies. Fifth, students' information processing and interpretation are influenced by the combination and use of the modalities – i.e. the representational resources such as images, sound, text and video – and therefore affect the degree to which these are beneficially utilised (e.g. do not lead to cognitive overload). Sixth, the learners' interaction through technology-based networks that are, for example, used to collaboratively complete a task, affects the outcome of the learning task and therefore mediates learning. Seventh, the sense of presence and community that are experienced by the learners, are related to the contents, the teacher, and the peers but also to the arrangement and use of technologies.

This comprehensive model allows us to integrate different theoretical strands to analyse the use and mediating role of technology in learning settings. While each of the key premises requires its own theoretical and empirical consideration, the overall model at this point serves to provide a theoretical and conceptual classification of the present study. In this case, the focus is on the reciprocal influences of the environment and the attitudes, knowledge, and practices of the persons involved, following SCT (Bandura, 1986) and applying it to the context of HE students' technology use.

6.2.2 Social Cognitive Theory

Bandura's (1986) SCT offers a theoretical framework to analyse thoughts, motivation and behaviour. According to this theory, human behaviour in general is caused by personal, behavioural and environmental influences as the observation of performed behaviour and the resulting con-

sequences evoke a cognitive processing of the observed behaviour: respectively, learning and imitation. In reciprocal determinism, individuals interpret the results of their performance attainments in a certain way, which in turn informs and changes their environment and their self-beliefs. This then informs and changes the subsequent behaviour. As a result, there is a triadic reciprocity between personal factors, behaviour, and the environment; and individuals are viewed as both products and 'producers of their own environments and their social systems' (Pajares, 2008, p. 112). This reciprocal relationship can be transferred to the use of technology.

One central aspect in SCT are self-efficacy beliefs, i.e. expectations regarding one's ability to successfully master given individual or study-related tasks and situations. Bandura (1986, p. 391) defined self-efficacy as 'people's judgement of their capabilities to organize and execute courses of action required to attain designated types of performances'. A person's self-efficacy belief affects several determinants of human behaviour, such as his or her goals, proclivities, and perceived opportunities, and may also serve as a predictor for motivation and actual behaviour (Bandura, 1995). The degree of self-efficacy determines the level of commitment, how the person deals with challenges, and how long they stay engaged, even when facing difficult circumstances (Pajares, 1996, p. 544). Starting from the assumption of a general behaviour-determining influence of self-efficacy expectations, it seems plausible that students' technology use is influenced by their self-efficacy expectations regarding digital media. For example, confidence in one's own ability to successfully use technology influences how new and unfamiliar applications are dealt with. For example, when facing technological difficulties in connection with digital learning environments students may react differently depending on their self-efficacy beliefs (Pumptow & Brahm, 2020). The relationship between DMSE and several digital media user types was shown in a study using the same database as the present study (Pumptow & Brahm, n.d.). Accordingly, it can be assumed that DMSE expectations influence the use of study-related technology:

Hypothesis 1a: Digital media self-efficacy (DMSE) is positively related to study-related technology use.

According to SCT, outcome expectancies, in addition to and in combination with self-efficacy, also influence behavioural intentions, which, in turn, predict behaviour. Outcome expectancies are, in contrast to self-efficacy, not related to the assessment of one's own ability to successfully carry out an action, but instead relate to the expected effect (or benefit) of that action. Regarding technology use, these outcome expectancies can therefore be understood as the expected usefulness of this technology for study purposes. Empirical studies have repeatedly found perceived usefulness to be a good predictor of technology use (Baker-Eveleth & Stone, 2008; Henry &

Stone, 1997, 2001). For example, Baker-Eveleth and Stone (2008) investigated faculty members' readiness for mobile learning with a sample of 154 faculty members of a US university. They found that the extent to which faculty perceived the technology as useful was positively related to their attitudes and behavioural intentions towards using digital technology. Based on prior empirical studies and in line with SCT, it can, therefore, be assumed that students' outcome expectations (perceived usefulness) regarding the technology is related the extent of using it:

Hypothesis 1b: The perceived usefulness of study-related technology is positively related to its use.

Additionally, in line with SCT's reciprocal determinism, environmental factors, such as peer students and teachers, may affect individual behaviour (see also next section). On the individual level, it therefore seems relevant to include a measure for the degree of students' involvement in their environment. Thus, based on Tinto's (1993) 'Model of Institutional Departure', a measure of social integration is used as an indicator of the extent to which students are included in the group of fellow students and are thus potentially peer-oriented:

Hypothesis 2: The degree of social integration is related to the degree of study-related technology use.

6.2.3 Organisation Culture and Discipline

Within the meso-micro-model of technology usage in HE, *organisational culture* serves as the meso-level of the institution. It can be defined as a 'pattern of shared basic assumptions that the group [e.g. HE students] learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems' (Schein, 1992, p. 12). Applied to HEIs, Tierney and Rhoads (1993) analysed faculty socialisation – in the sense of these adaptation and integration processes – at different stages, such as at undergraduate and graduate levels, as well as subsequent academic stages. They considered several levels of culture, including national, professional, disciplinary, and institutional, as well as individual cultural differences from a social-constructivist point of view. *Discipline* is then understood as a (personal) unit of association, wherein people of similar departments across universities are associated through personal networks, ideas, interests, norms and values, and professional styles, while members of other departments, even at the same HEI, are not (Ladd Jr & Lipset, 1975). Nevertheless, individual differences are still prevalent (Tierney & Rhoads, 1993). In addition,

the authors focused on several stages of socialisation processes that form faculty members' integration of culture and, reciprocally, how this alters, for example, the disciplinary culture. This basic idea of a process can also be assumed for undergraduate-level students, who are at the beginning of this process. Students are confronted with the culture of their discipline by the research practice and, above all, through the faculty members' teaching practices (Biglan, 1973; see also Berry, 1997). Regularly, faculty members have already internalised cultural norms and therefore represent (at least parts of) the disciplinary culture (Collins et al., 2012).

In another study, Lin and Ha (2009) applyíed theories of organisational culture to technology usage practices of academic staff members. Referring to a critical mass theory by Markus (1987), a substantial group of people is needed to take the initiative to use the medium. Additionally, technology should be used by important organisational members in order to be accepted and widely used (Markus, 1987). Management support and training can also contribute to technology use (Sharma & Yetton, 2003, 2007). These potential influencing factors of technology use are shaped by the respective subculture (referred to here as disciplinary culture). Therefore, they differ between subgroups (here: disciplines) (Lin & Ha, 2009). Based on these assumptions, teaching practices and in particular technology use, should differ across disciplines; and in this context, the integration of technology in teaching and the formal and informal requirements for successful completion of study programmes should differ depending on the discipline.

Therefore, in line with the assumption of a socialisation process into a discipline-specific culture, it can be assumed that students are confronted with the cultural environment of their discipline, for example via attending courses but also via the demands placed on them. Based on this, it can be assumed that students' technology use depends on their discipline:

Hypothesis 3: HE students' study-related technology use differs depending on their discipline.

In line with this assumption of a discipline-specific culture and its impact on technology use (Collins et al., 2012), it is likely that the relations between students' individual attitudes and beliefs and their technology usage differ between the disciplines. According to SCT, the disciplinary culture is seen as the environment, which influences students' beliefs regarding technology use. Consequently, we hypothesise that the strength of the relationship between the outcome expectations (perceived usefulness) as well as DMSE and technology use differs from discipline to discipline:

Hypothesis 4a: The degree to which digital media self-efficacy is related to study-related technology use varies in relation to the discipline.

Hypothesis 4b: The degree to which perceived usefulness of study-related technology use is related to its actual use varies depending on the discipline.

Furthermore, based on the described theoretical assumptions concerning discipline-specific culture, the socialisation process normally begins in the first year of a study programme. Hence, beginning students may not yet have fully internalised the disciplinary culture. We assume that they will gradually adapt, and, accordingly, greater differences in technology use will be found over the course of the study. Especially at the beginning of the socialisation process during undergraduate studying, differences between less advanced and advanced students should exist. Since the present cross-sectional data base does not allow for longitudinal perspectives, students earlier in their studies and further along in their studies are compared concerning their study-related technology use:

Hypothesis 5: Differences in study-related technology use are related to the students' progress of studying, with students who are further advanced in their studies showing higher levels of study-related technology usage.

In summary, as illustrated in Figure 6.1, both personal characteristics, such as beliefs, and institutional or cultural influences, such as the disciplinary culture as described above, may affect students' behaviour. Regarding the context of technology use, this means that students are part of a study and learning environment that includes different degrees and means of technology usage. These degrees and means of use are partly defined by the students themselves; their personal experiences; and their knowledge, beliefs, and motivation regarding technology. At the same

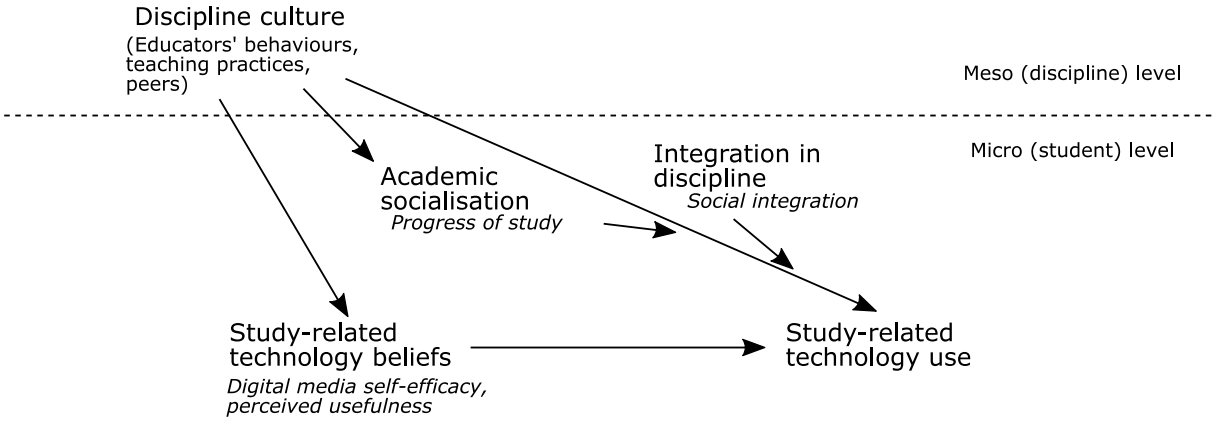

Figure 6.1: Schematic representation of micro-meso-relationships.

time, they are dependent on the environmental influences that set the frame – for example, if an educator willingly applies a certain technology in a course and thus serves as a role model. The educators – i.e. above all, faculty members – were influenced by the culture of their discipline

during academic socialisation processes, of which they are then both constituent parts and representatives. This disciplinary culture affects research and teaching practices (Biglan, 1973; Smart & Elton, 1982). The educator's role model function and the corresponding teaching activity in turn lead to discipline-specific differences regarding the study and learning environment and accordingly the degrees and means of technology usage by the students. Discipline culture affects beliefs in relation to technology, such as digital media self-efficacy and perceived usefulness of technology for study purposes, which in turn affect technology behaviour. The influence of discipline culture on students' technology use is, however, also dependent on their degree of integration into the discipline (social integration) and their position within the academic socialisation process (progress of study). However, in line with SCT, it is also reasonable to assume that personal factors (e.g. interests, preferences) that exist prior to entering the HE system affect subject choice (see e.g. Bardi et al., 2014; Windolf, 1995). Therefore, how extensive this posterior influence of the disciplinary culture actually is, in addition to the individual factors and the self-selection into a specific discipline that has already taken place, remains to be analysed.

Overall, the present work's conceptual model of HE students' technology use integrates the theoretical concept of discipline culture, as the meso level, and the micro level of (individual) beliefs and behaviour, based on the SCT and embedded in a comprehensive model of TML.

6.3 Data and Method

To assess students' technology use, related attitudes, beliefs, demographic information – such as age and gender – as well as field and semester of study, we used a standardised online survey instrument in which we applied predominantly replicated scales of validated instruments (Brahm & Jenert, 2015; Duncan, Pintrich, Smith, & Mckeachie, 2015; Jerusalem & Schwarzer, 2002; Kothgassner et al., 2012; Leichsenring, 2011; Zawacki-Richter, 2015). A new scale for DMSE was also added. All scales show sufficient psychometric properties, both for the data of a pre-test and for the data of the main survey (Pumptow & Brahm, 2020).

The frequency of students' technology use (on a scale of 1 = 'never' to 7 = 'several times a day') was measured according to instruments, originally used by Grosch (2012) and replicated and adjusted by Zawacki-Richter (2015). The items can be used to categorise digital media use as the frequency of usage of different technology applications in five categories: e-books (books and electronic articles), university platforms (e.g. homepage, e-learning portal, online library services), communication tools (e.g. Facebook, WhatsApp), study-related online tools

(virtual lectures, literature databases, cooperation tools such as Google Docs), and general online tools (search engines, Wikis, cloud services). For this study, we focused on study-related online tools because they are most relevant for our research aims. The average test score ($\alpha = 0.72$) for this category is based on the following items: virtual lectures, literature databases, Google Scholar, literature management, online exercises, online cooperation tools, learning videos and presentation tools. Regarding perceived usefulness, items for the same technology applications measured whether these are considered useful for study purposes (on a scale from 1 = 'not at all' to 7 = 'very useful', asking for the degree agreement with each item statement, $\alpha = 0.73$). The scale for DMSE was constructed based on the general self-efficacy scale by Schwarzer and Jerusalem (2010) to focus on digital media (Pumptow & Brahm, 2020). Again, we calculated an average test score, in this case based on seven items ($\alpha = 0.92$).

The scale for students' integration is based on the CHE-Quest (Leichsenring, 2011). For our data, we were not able to reproduce the assumed one-factor structure (see Pumptow & Brahm, 2020). Consequently, only three items that could be uniquely defined as reflecting social integration, both theoretically and empirically, were considered in the data analyses of the present study, in the form of an average test score ($\alpha = 0.83$).

6.3.1 Sample

Data were collected at four German universities in 2018. The students were invited to participate in the online-survey via e-mail and additionally, via postings and flyers, info-screens, and lectures.[24] The total number of 2,039 cases was reduced due to an exclusion of all students enrolled in teacher education courses, as they study several majors, which prevents clear assignment to a single discipline. For all students earning a major and a minor ($n = 141$), only the major was considered in the analysis. In addition, only cases which did not show missing values for any of the variables of interest were included in the analysis. Especially due to missing information about the subject of study, the grouping variable, the final sample size was reduced to 1,284.[25]

On the basis of gender differences often found in empirical on digital media use in HE (e.g. Zawacki-Richter et al., 2015), and specifically regarding academic tasks associated with technology and computers (e.g. Durndell & Haag, 2002; Huang, Hood, & Yoo, 2013), we additionally

[24] The questionnaire has been approved by the ethics committee for psychological research at the university conducting the study. All respondents were asked to give their consent to scientific use and publication of their data before filling in the questionnaire.

[25] To ensure comparability of estimated (nested) models, the same sample was used for all models. We refrained from imputing missing values as these were mainly present in the grouping variable.

controlled for gender.

Table 6.1: Proportions of participants divided into grouped disciplines.

	absolute	relative
Humanities	247	0.192
Engineering	400	0.312
Arts	17	0.013
Science	242	0.188
Medicine	4	0.003
Law, Economics, Social Sciences	350	0.273
Sports	24	0.019
$\sum$	1284	1

A total of 105 different study programmes are covered in our data, some of which are represented by very few students. Each of the 105 study programmes was included in the analysis, but interpretations were limited to those programmes represented by 30 or more students in the data. Table 6.1 shows the proportions of participants divided into disciplinary groups, which correspond to a classification of disciplines in the German HE system (Statistisches Bundesamt, 2018) (see supplementary material, Table E.1, for a complete list of all 105 disciplines).

The students' mean age was M = 23.93 (SD = 3.99, min = 18, max = 59). The proportion of female participants in the sample was 56 %, and 44 % were male. Female students are slightly overrepresented in our data.[26] As was expected, due to non-randomised sampling, our sample is therefore not representative of the overall German student population.

6.3.2 Method

During the description of the conceptual framework and the hypotheses, two levels were defined: the first (micro) level, regarding students' technology use, and the second (meso) level, concerning the discipline to which the student belongs. Therefore, the method of multilevel analysis allows for an appropriate modelling of the available data material according to the hypotheses. The first-level units – in this case the students – are clearly assigned to the second-level units: in this case the disciplines. Similarities between individuals within a discipline could thus be considered, while also considering differences between students in different disciplines. The

[26] Of all participants, 0.9 % indicated 'undetermined' as gender. Due to the small number of these responses in comparison to the other two gender groups, these cases were not included in the analyses.

estimation of the parameters is based on the respective subsamples, whereby the number of observations for each of the level-2 units – thus, the large differences in the number of cases for the disciplines – was taken into account. The implicit weighting allows to avoid false conclusions between the levels. The following equation applies to a multilevel (mixed) model that corresponds to the one to be analysed here:

$$\text{Level 1:} \quad Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + e_{ij} \tag{6.1a}$$

$$\text{Level 2:} \quad \beta_{0j} = \gamma_{00} + u_{0j} \tag{6.1b}$$

$$\beta_{1j} = \gamma_{10} + u_{1j} \quad . \tag{6.1c}$$

The model consists of the explanatory individual variable X_{ij} of student i ($i = 1, \ldots, n_j$) in discipline j ($j = 1, \ldots, m$), which affects the dependent variable Y_{ij} of this student. The influence of X_{ij} on Y_{ij} also differs depending on the discipline j. A separate model is estimated for each discipline unit j. The intercept β_{0j} therefore varies depending on the discipline, just as the effects β_{1j} of the individual variables. So, in this case, the estimated coefficients contain level-2-dependent random components, u_{0j}, for the intercept, and u_{1j}, for the coefficient β_{1j} which means these coefficients can be understood as a function of level-2 parameters. Substitution led to the following:

$$Y_{ij} = \left[\gamma_{00} + \gamma_{10}X_{ij}\right] + \left[u_{0j} + u_{1j}X_{ij} + e_{ij}\right] \quad . \tag{6.2}$$

This model is a mixed model because the regression coefficients on the first level vary depending on level-2 units. The model thus contains both systematic (fixed) and random components. The first square bracket of the equation (6.2) represents the systematic, and the second square bracket represents the random part of the model. Removing all the explanatory variables leads to a (intercept-only) null model, which only contains the regression constant. The model from equation (6.2) was then reduced to the following:

$$\text{Null model:} \quad Y_{ij} = \gamma_{00} + u_{0j} + e_{ij} \quad . \tag{6.3}$$

It therefore only consists of γ_{00}, which represents the expected value of the dependent variable, u_{0j} as the error component of the second level and the e_{ij} as the error component on the first level. The variance of the dependent variable is thus distributed over the variance of the two error terms $\sigma^2_{u_0}$ and σ^2_e. Due to the specifics of the error terms, this model is estimated using the maximum likelihood method. For the variance estimators based on the residuals for both error components, the intra-class correlation coefficient (ICC) can be used (for the null model) as an estimator for the proportion of variance that is explained by the level-2 assignment (e.g. Goldstein, 2011). The ICC (ρ) is defined as:

$$\rho = \frac{\hat{\sigma}^2_{u_0}}{\hat{\sigma}^2_{u_0} + \hat{\sigma}^2_e} \quad . \tag{6.4}$$

Thus, the ICC consists of the proportion of the estimated variance at the second level $\hat{\sigma}^2_{u_0}$, i.e. between contexts, in the estimated total variance $\hat{\sigma}^2_{u_0} + \hat{\sigma}^2_e$, which is the sum of the variance between discipline and the variance within disciplines.

The model according to the formulated hypotheses can be expressed in the following equations:

$$\text{Level 1:} \quad TU_{ij} = \beta_{0j} + \beta_{1j}DMSE_{ij} + \beta_{2j}PU_{ij} + \beta_3 INT_{ij} + \beta_{4j}PRO_{ij} + \beta_5 GEN_{ij} + e_{ij} \tag{6.5a}$$

$$\text{Level 2:} \quad \beta_{0j} = \gamma_{00} + u_{0j} \tag{6.5b}$$

$$\beta_{1j} = \gamma_{10} + u_{1j} \tag{6.5c}$$

$$\beta_{2j} = \gamma_{20} + u_{2j} \tag{6.5d}$$

$$\beta_{4j} = \gamma_{40} + u_{4j} \quad . \tag{6.5e}$$

Or expressed in a single equation:

$$TU_{ij} = \left[\gamma_{00} + \gamma_{10}DMSE_{ij} + \gamma_{20}PU_{ij} + \beta_3 INT_{ij} + \gamma_{40}PRO_{ij} + \beta_5 GEN_{ij}\right] \tag{6.6}$$

$$+ \left[u_{0j} + u_{1j}DMSE_{ij} + u_{2j}PU_{ij} + u_{4j}PRO_{ij} + e_{ij}\right] \quad . \tag{6.7}$$

The model represents the relationship between level-1 variables and the dependent variable technology use (TU), taking into account the students' (i) affiliation to their discipline (j). It includes the random effect (*hypotheses 4a,b* and *5b*), i.e. student-level variables for digital media self-efficacy (*DMSE*), perceived usefulness (*PU*), social integration (*INT*) and study progress (*PRO*). The influence of the controls for age and gender do not vary across disciplines.

The model estimation is conducted in R (R Core Team, 2020), all independent variables except for gender have been mean-centred. Table 6.2 shows the mean value and standard deviation for each of the included independent variables and the dependent variable. See Table E.2 in supplementary material for the results of correlation analyses between the variables.

Table 6.2: Mean and standard deviation for DMSE, the perceived usefulness of study-related technology (PU), social integration (INT), progress of study (PRO) and study-related technology use (TU) (n = 1,284).

	M	SD
DMSE	4.96	1.18
PU	4.76	1.1
INT	4.82	1.51
PRO	7.06	5.12
TU	2.44	0.89

In the analysis, several models are estimated step by step and compared with each other (Hox, Moerbeek, & van de Schoot, 2010). The restricted maximum likelihood estimation method (REML) was used as the estimation procedure, which, in comparison to the unrestricted maximum likelihood (ML), leads to more realistic estimates of the coefficients, by taking the number of parameters into account in the variance estimator (Bryk & Raudenbush, 1992). However, the variance estimates then depend on the number of parameters to be estimated, which prevents model comparison. Therefore, the variance values, as well as deviance measures AIC, BIC, and the log-likelihood value in Table 6.3, are based on re-estimated models for which the ML method was used instead. The variance components for the random effects indicate un-modelled variability and thus lower values suggest a higher amount of modelled variability through the included parameters. Since deviance-based measures are reduced due to a higher number of parameters in the model and thus suggest a better fit model, the model comparison is based on a chi-square likelihood ratio test for improved fit (also using the models fit by ML). If this difference in the log-likelihood values of the two nested models is not significant, the more complex model is rejected (Hox, 1995). The inferential statistics of the estimated coefficients are based on t-tests. If, in the hypothesis testing, there is no statistical evidence to support the hypothesis, either for the estimated model as a whole or for the individual parameter estimates,

the hypothesis is rejected. The model was built step by step: First, the control was added; then, following the order of the hypotheses and including tests for random slopes according to the Hypotheses *4a* and *4b*, the covariates were added; and finally, a full model was built. The reports on these steps focus on the significance of the coefficients and the variance reduction. Table 3 contains the estimated coefficients and the corresponding standard deviations, levels of significance are marked with asterisks.

6.4 Results

In the first step, the **null model** was estimated as the reference model, which contained no predictors but only a regression constant that varied for the disciplines. For this model, the intra-class correlation (ICC) was determined according to the formula (6.4). The ICC is used to check the proportion of the total variance that can be explained by discipline affiliation. In this case, the ICC was $\rho = 0.13$; i.e., 13 % of the total variance in students' technology use is due to the variance between disciplines.[27] This also means that, conversely, in this model, 87 % of the variance in students' technology use can be attributed to individual factors. A significance test of the intercept-only model in comparison to a model without a varying intercept was performed by conducting a chi-square test for the difference in deviance (likelihood ratio test). This resulted in significantly ($\chi^2\,(1) = 91.287, p < .0001$) better adaptation, i.e. reduction of deviance, for the model including the random intercept. Based on these results the estimation of a multilevel model seems appropriate, and also Hypothesis 3 was supported.

Building on the null model, a model including only the control for gender was estimated. The results are documented in Table 6.3 for **Model 1**. This model did not indicate a significantly ($\chi^2\,(1) = 2.226, p = .1357$) improved adaptation to the data (reduced deviance), compared to the null model. This model additionally led to only to a small reduction of the variance components. Based on this model, there was no evidence for significant differences in study-related technology use for female or male students.

In **Model 2**, the variables DMSE and perceived usefulness of study-related technology (PU) were added to test hypotheses *1a* and *1b*.[28] The model was then compared with Model 1, in this

[27] To determine whether there are also major differences between the universities, we calculated the ICC based on a model considering the 4 HEI's as a level-2 unit. This led to $\rho = 0.036$, which is so close to zero that it could be ignored.

[28] Based on SCT, there is a (partial) causal relationship between self-eficacy and outcome expectancies (Bandura, 1997). However, the correlation between DMSE and PU was rather low ($r = 0.11$, see Appendix E, Table E.2) and model diagnostics did not indicate any issues with multicollinearity.

case resulting in a significant reduction of deviance (χ^2 (2) = 176.081, $p < .0001$). Both DMSE and PU showed a significantly positive relationship with study-related technology use as was suggested in hypotheses *1a* and *1b*.

Next, hypotheses *4a* and *4b* were, analogous to the comparison of the null models, tested for a significant model fit improvement by including a random slope for the two variables and comparing the model to the otherwise identical fixed slope model. In the case of DMSE, a random slope model did not lead to an improved model fit for the data (χ^2 (1) = 0.041, p = .9796). Thus, hypothesis *4a* was not supported. For PU, a random slope model indeed led to a significant reduction of deviance (χ^2 (1) = 30.59, $p < .0001$), which is in line with hypothesis *4b*. Furthermore, this model reduced the amount of un-modelled variance for the random effects, as can bee seen when comparing the variance components of the final Model 2 with the previous models in Table 6.3.

For the next model, **Model 3** in Table 6.3, social integration (INT) was added to test Hypothesis *2*. As assumed, this variable was significantly positively related to study-related technology use. Also, including INT in the model leads to a significant reduction of deviance (χ^2 (1) = 7.413, p = .007). Hypothesis 2 was, therefore, maintained.

Finally, for Hypothesis *5*, progress of study (PRO) was added (**Model 4** in Table 6.3). Since no significant relationship between semester of study and study-related technology use was observed, Hypothesis *5* was rejected. Additionally, including PRO did not reduce deviance significantly (χ^2 (1) = 1.161, p = .281). Furthermore, these models three and four, not including variables for DMSE and PU, do not considerably contribute to a reduction of the variance components for the random effects.

Table 6.3: Results of multilevel-analysis for study-related technology use on gender, DMSE, the perceived usefulness of study-related technology (PU), social integration (INT), and progress of study (PRO).

	Null model	Model 1	Model 2	Model 3	Model 4	Model 5
	B(*S E*)	*B*(*S E*)	*B*(*S E*)	*B*(*S E*)	*B*(*S E*)	*B*(*S E*)
(Intercept)	2.433***	2.479***	2.469***	2.483***	2.477***	2.470***
	(0.047)	(0.056)	(0.050)	(0.056)	(0.056)	(0.047)
Gender: female		-0.078	-0.056	-0.086	-0.074	-0.059
		(0.052)	(0.050)	(0.052).	(0.052)	(0.049)
DMSE			0.066***			0.060**
			(0.020)			(0.020)
PU			0.274***			0.273***
			(0.027)			(0.027)
INT				0.044**		0.037*
				(0.016)		(0.015)
PRO					0.005	0.005
					(0.005)	(0.004)
AIC	3272.095	3271.869	3099.788	3266.456	3290.417	3088.850
BIC	3287.568	3292.500	3130.734	3292.245	3316.206	3140.428
Log Likelihood	-1633.047	-1631.934	-1543.894	-1628.228	-1640.209	-1534.425
Num. Obs.	1284	1284	1284	1284	1284	1284
Num. Groups	105	105	105	105	105	105
Var: group	0.1009	0.0957	0.0521	0.0938	0.0963	0.0521
Var: PU			0.0184			0.0179
Var: residual	0.7005	0.7006	0.5987	0.6969	0.7098	0.6045

Significance codes: $^{***}p < 0.001$;$^{**}p < 0.01$;$^{*}p < 0.05$; .$p < 0.1$.

The final model including all independent variables and a random slope for PU, is shown in Table 6.3, **Model 5**. Based on the deviance measure AIC and BIC as well as in terms of variance reduction, this final model is the best of all estimated models to describe the available data set. Compared to the null model, it led to a significant reduction in deviance ($\chi^2(7) = 214.705, p < .0001$). The intercept of $B = 2.473$ was the estimated mean value for study-related technology use across all disciplines and at the mean for all independent variables, for male students. In the case of female students, the mean value was slightly (but not significantly) smaller. DMSE and social integration indicated a small but significant relationship with study-related technology use; i.e. an increase in these variables is associated with a small increase in the frequency of using study-related technology. The perceived usefulness of study-related technology displayed the largest effect on technology usage and varied in strength depending on the discipline.

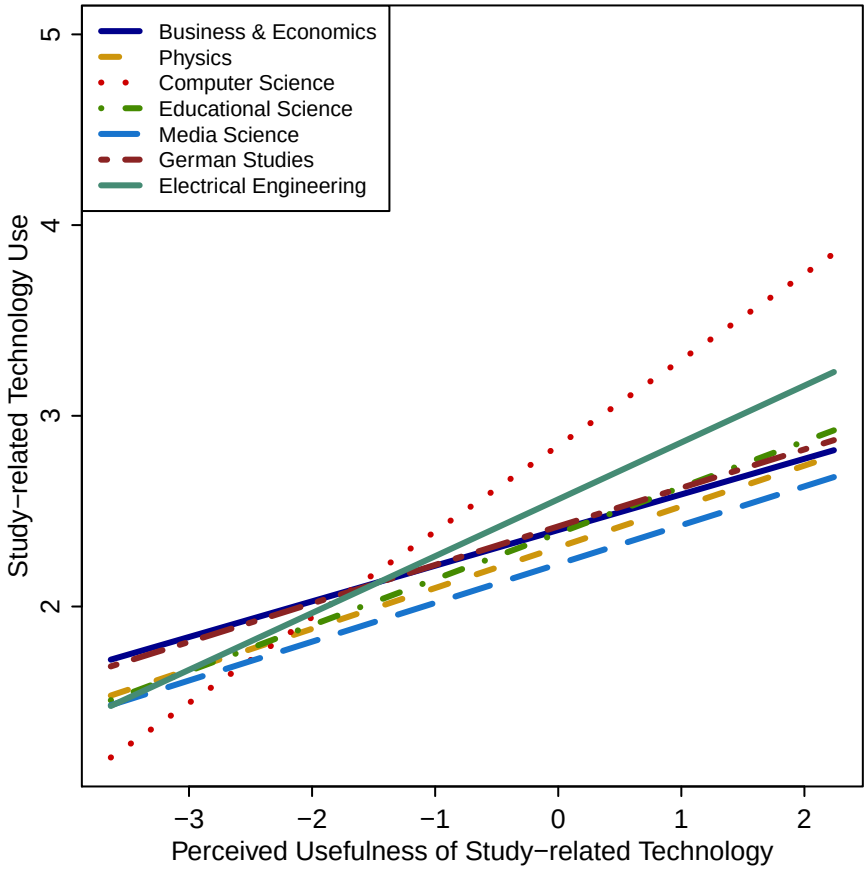

Figure 6.2: The varying effect of PU on TU for seven exemplary disciplines.

In Figure 6.2, the varying effect of perceived usefulness of study-related technology on technology usage is shown for seven example disciplines. The disciplines were chosen based on their number of cases (≥ 30) and representation of different disciplinary groups (see also Section 6.3.1 and Table 6.1). The disciplinary groups represented are engineering (computer science and electrical

engineering), science (physics), social science (business and economics and educational science), and humanities (media science and German studies). Predicted values based the final model, i.e. empirical bayes estimates (posterior means), were used for the visualisation of the effects. For the calculation of the visualised effects, the remaining numeric variables included in Model 5 (see Table 6.3), were fixed on their means and gender was set to male. However, as there was no significant difference between genders, these effects are approximately valid for female students as well. Due to mean-centering, the value zero for PU represents the average perceived usefulness.[29] Overall, a higher perceived usefulness of technology goes along with more frequent use of study-related technology for all disciplines represented in Figure 6.2. The most noticeable effect can be observed for computer science, where the variation in the use of study-related technology depending on the perceived usefulness is the strongest. However, a considerable difference in technology usage between people with low and high usefulness ratings is also evident for educational science. The other disciplines represented in Figure 6.2 only show small differences both regarding the intercept and the slope of perceived usefulness.

6.5 Discussion

The aim of this study was a multilevel assessment of HE students' study-related technology use in terms of differences between disciplines and individual characteristics. Therefore, the conceptual framework included a combination of a model for technology mediated learning with the theoretical concept of organisational culture. By using this framework, it was possible to consider theories on individual behaviour, such as SCT (Bandura, 1986) and simultaneously integrate a superordinate level of a discipline-dependent culture. Such disciplinary differences could result from socialisation processes, which start at the beginning of undergraduate studies. The multilevel analysis was based on recent data from German HE students, including more than 1,200 students in 105 disciplines. In sum, this study bridges HE students' disciplinary context and individual-level characteristics with the aim of examining and partially explaining differences in the frequency of use of study-related technology. It also connects the micro-level of studying (using SCT) and the meso-level of the discipline (applying an organisational culture perspective).

One noteworthy result shows that 13 % of the differences in study-related technology use could be attributed to variation between disciplines. This is in line with the theoretical assumptions

[29] The dependent variable TU was not mean-centered, so in this case the axis represents the original scale (see Section 6.3) beginning at the value one.

within the framework of disciplinary culture, determining students technology use (based on e. g. Tierney & Rhoads, 1993) and extends the corresponding empirical results (e.g. Collins et al., 2012; Lam et al., 2014; Lin & Ha, 2009). However, as we could not include any explanatory variables at the discipline level, such as a specific measure of discipline culture, it remains unclear which characteristics can explain these differences. This could be more closely examined in a future study including, for example, a measure for technology integration in study programmes or discipline-dependent teachings styles as a second-level explanatory factor.

In addition to disciplinary differences, it was argued that discipline culture, in the form of the reciprocal determinism (see SCT, Bandura, 1986) between behaviour, environment, and personal factors, influences student beliefs with regard to technology use, i.e. their self-efficacy and outcome expectancies. This has also been demonstrated in previous research (Baker-Eveleth & Stone, 2008; Henry & Stone, 1997, 2001) and corresponds to the result for Hypothesis *4b*: Both DMSE and the perceived usefulness of study-related technology use positively affect study-related technology use (Hypotheses *1a* and *1b*). In case of DMSE, this effect was the same for all disciplines, resulting in Hypothesis *4a* being rejected. Since this effect of DMSE on technology use does not vary between the disciplines, it could therefore be related to personal experiences and preconditions. However, the degree to which perceived usefulness of study-related technology influences the corresponding behaviour indeed differs for the disciplines (Hypothesis *4b*). According to our theoretical framework on TML (Bower, 2019) combined with disciplinary culture and its influence on teaching practices (Biglan, 1973; Smart & Elton, 1982), differences between disciplines – respectively, the technology-related beliefs – might be attributable to different teaching practices. These could encompass different degrees of technology integration in the courses of study. This varying degree of technology integration also corresponds to the different types of media users predominant in various disciplines that were found in empirical studies, for example, by Zawacki-Richter et al. (2015) and Pumptow (n.d.). In future studies, the discipline-specific characteristics in teaching practices and technology integration could be examined in more detail to also further investigate and explain the differences. In our study these are particularly noticeable for the disciplines computer science and educational science. These two disciplines, as representations of engineering and social science, differ considerably from the other representatives of the same disciplinary groups and also from the science and humanities representatives. While the database does not permit a more detailed explanation, it becomes evident that a rough distinction between discipline groups or a classification into soft/hard and pure/applied disciplines (e. g. Lam et al., 2014) cannot reflect these particularities and, therefore, an analysis at disciplinary level, such as the one carried out here, is necessary.

Study-related technology use seems to be independent of the progress of study (Hypothesis *5*

was rejected). Accordingly, no indication of a socialisation process in terms of study-related technology use can be seen. This is at least the case at the undergraduate level and for our cross-sectional data base. Nevertheless, students' orientation towards fellow students seems to be relevant, since the degree of social integration is related to students' technology use (Hypothesis *2*). Therefore, at this stage of academic socialisation, peers may be of greater importance for the students' behaviour regarding technology use than researchers and lecturers representing the discipline, for example. Furthermore, the differences in the disciplines with regard to student technology behaviour might partially reflect preferences that exist before starting a course of study, leading to a selection of a major that suits these preferences (see e.g. Bardi et al., 2014; Windolf, 1995). This result is in line with the so-called self-selection thesis. It is therefore plausible that there is a greater homogeneity of students within a subject and, in contrast, a greater heterogeneity between students of different subjects right from the start. In future studies based on longitudinal data, starting at the end of high school and then monitoring the development during studies, this could be further examined. Beyond that, this study only focused on behaviour concerning study-related technology use. How this study-related technology use affects students' learning and how it is related to learning outcome was not considered here and should be analysed in future research, since previous studies indicated that certain types of technology enhanced learning can serve as predictors for grades (e. g. Dunn & Kennedy, 2019).

Further limitations concern the database of the study. Although there is a sufficiently large number of disciplines and cases in total, some of the disciplines are represented only by very few cases. As a result, only the estimates for the 'large' disciplines can be considered reliable, while no meaningful interpretations are possible for those disciplines with low representation in the data. In future studies, more data should therefore be collected for these disciplines. Additionally, the final model still indicates a high amount of un-modelled variance (see variance components in Table 6.3). It must therefore be assumed that there are other relevant factors for study-related technology use that should be identified in future studies. Based on our framework of TML (Bower, 2019), both factors on the meso-level, such as teaching practices or technology integration in study programmes, and student level characteristics, for example, knowledge and skills, and personal experiences concerning technology, could lead to further insights in this context.

Overall, the results of the present study contribute knowledge in the field of student technology use in HE. To our knowledge, it is the first study to comprehensively address the interaction between micro- and meso-level factors regarding students' technology use. In addition to these empirical insights, the conceptual and methodical models can serve as a theoretical and empirical basis for future studies that further examine explanatory factors for technology use

at different levels. Especially in view of the rapid digitalisation processes in HE induced by the COVID-19 pandemic, a focus on student technology use alone does not appear meaningful, since discipline-related and institutional standards and differences are of particular relevance as well.

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7 Overall Discussion

The trend towards digitalisation in higher education (HE) has not been sufficiently addressed in the evaluation of student performance and academic success thus far. The main reason for this is that research on media use was rarely combined with more comprehensive – for example, psychological or sociological – (theoretical) models for academic success. Although there has been research on how HE students use digital media for learning and, in general, during their studies (e.g. Dolch & Zawacki-Richter, 2018; Grosch & Gidion, 2011; Müßig-Trapp & Willige, 2006; Persike & Friedrich, 2016), a large part of the HE research is still focused on 'classical' factors for academic success, such as motivation, self-regulation, and emotional aspects (e.g. Honicke & Broadbent, 2016; Hsieh, Sullivan, Sass, & Guerra, 2012; Pekrun, 2006). Furthermore, this research might not be entirely transferable to the German HE context since it is often located outside of Europe and based on small and rather homogeneous samples: for example, only psychology students (e.g. Bartimote-Aufflick, Bridgeman, Walker, Sharma, & Smith, 2016; Honicke & Broadbent, 2016).

To fill this research gap, four studies were carried out in the context of this dissertation. The overarching goal was to investigate the use and importance of digital media in contemporary German HE (programmes). An interdisciplinary theoretical approach, based on constructs from educational and social psychology as well as sociology, allowed for an analysis of individual characteristics, social background factors, and contextual influences at the same time. The aim was to comprehensively capture the factors that determine students' success in today's academic studies, while simultaneously identifying potentially disadvantaged groups and highlighting possible points of intervention and future research. In this chapter, the results are summarised and discussed in terms of limitations, implications, and overall contribution to research and practice.

7.1 Summary and Discussion of the Findings

Regarding the overall objective, firstly, a questionnaire instrument was developed, with which the relevant characteristics in terms of media use and academic achievement, based on the theoretical assumptions, could be measured and analysed. The comprehensive survey instrument consisted of established scales for study-related motivation, attitudes and other aspects in the general HE context (e.g. Brahm & Jenert, 2015; Leichsenring, 2011); students' media use and attitudes (Grosch & Gidion, 2011; Kothgassner et al., 2012); and a newly constructed scale for digital media self-efficacy, based on the general self-efficacy scale by Schwarzer and Jerusalem (2010). Psychometric analyses for the pre-test data as well as the main-study data, from one Swiss and six German higher education institutions (HEIs), indicated valid and reliable scales. Except for the scales for social integration (Leichsenring, 2011) and the TUI (Kothgassner et al., 2012), all analyses led to the expected results, thus replicating the results of prior research. In addition to the evaluation of the survey instrument and a partial replication of previous instruments, first descriptive insights into students' media use were provided. For example, the results indicate a further increase in the dissemination of smartphones, laptops, and tablets, in comparison to the findings based on a survey in 2012 and 2015 (e.g. Grosch & Gidion, 2012; Zawacki-Richter, Dolch, & Müskens, 2017), with 96 % of the present student sample owning a smartphone, 94 % owning a laptop, and 45 % owning a tablet. In 2012, only 56% owned a smartphone, 86 % owned a laptop and 9 % owned a tablet (Zawacki-Richter, 2015). By 2015, 91 % of students owned a smartphone, 92 % owned a laptop and 40 % owned a tablet (Zawacki-Richter et al., 2017). Additionally, the prevalent use of digital media for study purposes was confirmed in the present study. This frequent use and the further increase in the dissemination of mobile devices again further emphasise the relevance of digital media at universities and thereby of research on the digital media behaviour of university students. In summary, it seems necessary to extend existing instruments on teaching and learning in HE (e.g. Lemos, Queirós, Teixeira, & Menezes, 2011) to further investigate the usage of digital media as well as self-efficacy beliefs concerning digital media.

Secondly, in this respect, digital media usage behaviour and its relation to digital media self-efficacy, gender and study subject were analysed using an explorative approach. By using a latent profile analysis on items measuring usage frequency, self-rated skills and attitudes towards digital media applications, six media-user types were identified: marginal users, medium users, frequent users, inexperienced sceptics, experienced sceptics and study users. Most of the students belonged to the marginal-users category – i.e. there is only a low interest in digital media tools, they rate the accessibility low and they consider their skills regarding media technology and programming to be poor. While this was especially true for female students, male students

were more often considered frequent users, characterised by higher assessments of skills and higher interest in digital media tools. In addition, more males than females belonged to the group of inexperienced sceptics: They find digital media tools quite useful but at the same time are very sceptical and have a rather low assessment of their abilities. These results are in line with the results of prior research on gender differences in terms of digital media use and the associated self-assessment of skills (e.g. Busch, 1995; Durndell & Haag, 2002; W.-H. D. Huang, Hood, & Yoo, 2013). However, the identified user types also varied greatly depending on the subject: For example, more than half of the humanities students belonged to the marginal-users group, while the same proportion of engineering students were either considered frequent users or inexperienced sceptics. Compared to the other subjects, a relatively high proportion of the economics and social sciences students belonged to the experienced sceptics-group, which is characterised by high scepticism but also high interest and a high assessment of skills regarding media technology and programming. These differences between genders and subjects remained significant for most of the differentiated user types, even when analysed simultaneously in an additional multinomial regression model. This analysis also revealed significant differences in digital media self-efficacy with regard to media-user types: marginal users, especially, showed lower values for digital media self-efficacy compared to all others, and the largest difference occurred in comparison to frequent users. This result, again, confirms the value of considering the construct of digital media self-efficacy in research within the current university context. Overall, this study directly builds on and extends the previous studies on media use in HE (e.g. Grosch & Gidion, 2012; Zawacki-Richter, Müskens, Krause, Alturki, & Aldraiweesh, 2015), based on a more current and diverse student sample. At the same time, it also provides the basis for further analyses that include additional features, such as motivation, social background, and academic achievement.

This in-depth analysis of potential predictors for academic achievement was the focus of the third study. In a multi-stage analysis, mastery and performance goal orientation, anxiety in studying, academic and digital media self-efficacy, media-user types, gender, and socioeconomic background were examined with regard to the relationship with academic performance and, in some cases, with each other. In line with previous research findings (e.g. Bledsoe & Baskin, 2014; Honicke & Broadbent, 2016; Komarraju & Dial, 2014; Pekrun, 2006), the results of structural equation modelling indicate a direct relationship of performance goal orientation, anxiety about not meeting the demands of studying, digital media self-efficacy, socioeconomic background, and gender with academic performance. In line with, for example, Brahm, Jenert, and Wagner (2017); Hsieh, Sullivan, and Guerra (2007); and Hsieh et al. (2012), the relationship between academic self-efficacy and academic performance may be mediated by goal orientation and anxiety. Furthermore, based on the theoretical assumptions in line with SCT, the relationship

between socioeconomic background and academic performance might be mediated by academic self-efficacy (see e.g. Bandura, 1997; Gecas, 1989; Weiser & Riggio, 2010). However, as these results are only correlational in nature, longitudinal research is necessary to further investigate potential causal relations. Nevertheless, students with higher socioeconomic backgrounds appeared to feel slightly more competent, perceived their academic abilities as higher, and displayed better academic performance, which is in line with research by, for example, Pintrich (2004); Zimmerman (2000); Zimmerman, Bandura, and Martinez-Pons (1992). Additionally, this research indicates that both academic and digital media self-efficacy are affected by gender, with females showing lower self-efficacy in both dimensions, thus confirming the results of previous research (see e.g. Diseth, Meland, & Breidablik, 2014; C. Huang, 2013; W.-H. D. Huang et al., 2013; Vekiri & Chronaki, 2008). This means, female students show higher academic performance on average but at the same time show lower values of academic self-efficacy and are therefore benefiting less from the positive relationship between academic self-efficacy and academic performance. Although the results imply that students with higher digital media self-efficacy show slightly lower academic performance, the analyses at hand could not reliably identify the reasons for this relationship. While all six included media-user types appear to be related with digital media self-efficacy, only the experienced users, relative to the marginal users, showed significantly different effects in academic performance. Beyond that, it is noteworthy that the relationship between digital media self-efficacy and academic performance does not seem to be affected by socioeconomic background. For the first time, this study integrated students' media use and digital media self-efficacy in a comprehensive analysis of the relevant determinants of study performance. Based on the findings and limitations, this analysis can be further developed and supplemented in future studies. One important aspect that was not considered in this study is subject-related differences, whose relevance was underlined by the findings of the second study.

Lastly, these subject-related differences were closely examined in a multilevel assessment of the students' study-related technology use. Based on 105 disciplines and in line with the theoretical framework of discipline culture (e.g. Collins, Bulger, & Meyer, 2012; Lin & Ha, 2009; Tierney, 1988, 1997), differences in the frequency of use of study-related technology were found. However, study-related technology use seems to be independent of the progress of study; in other words, for the present cross-sectional data, no significant relation with the semester of study was found, which indicates that a socialisation process might be irrelevant to the technology use of the undergraduate students considered here. At the same time, however, an orientation towards fellow students seemed to occur, which indicates that peers may be of greater importance for the students' behaviour regarding technology use than, for example, lecturers. While digital media self-efficacy positively affects technology use for all disciplines in the same way, a more

differentiated effect was found for perceived usefulness of study-related technology. In this case, the relationship between perceived usefulness and study-related technology use differed for the disciplines. Therefore, digital media self-efficacy seems to be rather based on personal experiences and preconditions, whereas perceived usefulness could, for example, depend more on shared beliefs and teaching practices or the curricula. Still, the differences in the disciplines with regard to student technology behaviour may be partly attributed to existing preferences before beginning a course of study, that lead students to select a major that best suits these preferences (see e.g. Bardi, Buchanan, Goodwin, Slabu, & Robinson, 2014; Windolf, 1995). Here, further research using process data and, for example, monitoring students beginning at the end of high school and during their course of studies could lead to greater insights. Nevertheless, this study contributes to expanding our knowledge in the area of digital media use in HE and further identifies the relevance of digital media self-efficacy for media-use behaviour and its analysis.

The theoretical foundation of all investigations was SCT (e.g. Bandura, 1986), integrated in a technology mediated learning (TML) theory (Bower, 2019), and partially extended (e.g. by cultural reproduction assumptions, see, e.g., Chapter 5) due to the specific research questions. The broader theoretical framework of SCT was chosen for several reasons: Firstly, because self-efficacy influences behaviour (e.g. Bandura, 1997), it can be applied to digital media behaviour as well. Secondly, SCT has often been applied in educational contexts and this has led to mostly consistent results regarding the relevance of self-efficacy for academic motivation and outcome (e.g. Honicke & Broadbent, 2016). Finally, SCT combines personal and social environmental factors and thus allows for an analysis of (media) behaviour in an academic context that goes beyond an isolated consideration of individual dispositions. In this way, digital media use was integrated into a model linking students' personal background, the study context, self-efficacy beliefs and behaviour, and academic outcome. While this model is already well established for 'classical' determinants of academic achievement, such as goal orientation, emotion, or academic self-efficacy (e.g. Bartimote-Aufflick et al., 2016; Honicke & Broadbent, 2016; Hsieh et al., 2007; Zimmerman, 2000), an integration of digital media use was previously lacking. Therefore, the present dissertation contributes to theory development for research based on SCT, by assessing a suitable scale for digital media self-efficacy, that allows for such an integration, and by presenting the empirical results concerning relationships with academic outcome, digital media behaviour, and socioeconomic background. The scale was developed analogously to the scale for academic self-efficacy (Schwarzer, 1999) but can, due to its focus on digital media, be clearly distinguished from it and thus allows for a parallel consideration of both aspects in more complex explanatory models (as, for example, in Study 3). Based on the psychometric criteria, this seven-item scale seems promising for future research in HE. The empirical results

regarding the connection between digital media self-efficacy and academic achievement, as well as the potential influence of certain media-use patterns on academic success, clearly indicate that digital media can represent an important and meaningful addition to models of academic success, as based on SCT. As was demonstrated in Chapter 2.1.3, there is also an intersection of the present approach based on SCT with TML. The focus here was on learners and their beliefs, knowledge, and practices with regard to digital media, thus covering this part of the TML model. However, this theory also allows one to analyse the role of educators and the design and implementation of technology. This provides an opportunity for further investigation of digital media use in HE, placing a stronger emphasis on a mediational function of technology for more specific learning contexts. Digital media self-efficacy can be integrated very well in these analyses, in the form of learners' and educators' beliefs . Furthermore, the TML model enables, in principle, a more detailed outline of digital media and their use. The present approach could provide general insights into students' digital media use, but, due to this broad focus, left this media use rather unspecific. Nevertheless, for the theoretical perspective of SCT, new insights were gained. Whether this also applies to other theoretical strands, such as those briefly described in the theoretical overview in Chapter 2.2, remains to be investigated. As these were covered in large parts by the developed instrument, possibilities for further insights from different theoretical perspectives are provided.

Overall, within the framework of the four studies, digital media use was integrated into the measurement and analysis of the predictors of academic achievement. New insights were gained into media-related attitudes, beliefs, and behaviour – also with regard to relevance for academic performance and, finally, in terms of subject-related differences. This outlines the use and significance of digital media in contemporary German university programmes for an up-to-date and comparatively large database. However, there are of course limitations to this research, which are discussed below along with suggestions for possible future steps to be taken.

7.2 Limitations and Possibilities for Future Research

One major limitation of the presented studies is the data base: it is a non-randomised convenience sample that is therefore not representative of the general population of students in German HE. This limits the generalisability of the findings due to, for example, an over-representation of female students. However, the fact that the data is based on an online survey, among other things also asks for preferences in connection with online applications, may weigh somewhat more heavily. A bias of the sample, regarding those persons who tend to be more digital-media affine

and are therefore more likely to have taken part in this survey cannot be completely ruled out. However, the study environment of the four universities considered requires the use of online systems for enrolment, course booking, exam administration, and, in general, the retrieval of learning materials. This means that, in the context of this study, such students without appropriate equipment, e.g. an internet connection and a computer, were excluded by principle, but these students are unlikely to be present at the examined universities anyway as they would not be able to study. In addition, the results indicate a wide variation in media-related usage frequencies, attitudes, and beliefs, which does not suggest that the sample was strongly biased with regard to people with a strong and homogeneous affinity to digital media. Apart from this, the sample covers many different subjects, which therefore overcomes some of the limitations of samples used in previous studies, such as those based on low subject diversity (e.g. Zawacki-Richter et al., 2017) or those based on small samples of psychology students only (see e.g. Bartimote-Aufflick et al., 2016; Honicke & Broadbent, 2016).

While the size of the data set for the main study is relatively large (> 2000), the pre-test consisted of fewer than 200 cases. Therefore, the first psychometric analysis of the instrument was based on a rather small sample. However, the results of these analyses were almost entirely replicated for the larger full-scale data. Nevertheless, validity and reliability, especially of the newly developed scale for digital media self-efficacy, should be examined in future research. Because both studies used different samples – the 200 cases of the pre-test survey were not included in the full-scale data collection – test-retest reliability could not be analysed here and should also be included in the further evaluation of the survey instrument. A longitudinal study design would additionally allow for an analysis of criterion-related validity. This would be a valuable extension of the convergent and discriminant validity, which have been established. Furthermore, the instrument itself offers potential for revision. All scales in the questionnaire are based on self-assessment and self-report, which could lead to a bias in the information provided, for example, in relation to academic performance, which is presumably more reliable for well-performing students (Kuncel, Credé, & Thomas, 2005). Regarding academic performance, it would, therefore, be desirable to include actual grades. This was not possible with this large scale and anonymous survey, but this could possibly be overcome on a smaller scale, for example, in a course context (insofar as this is possible for reasons of data protection laws). Moreover, the self-assessment scales could be supplemented or partly replaced by competence measures, e.g. for digital media literacy (see e.g. Schmidt-Hertha & Rott, 2014). Beyond that, the presented results of both the psychometric analyses and the hypothesis testing are only based on data from four German universities, which are, except for the Technical University Kaiserslautern, full universities (i.e. they have no particular specialisation and offer a wide range of study programmes). Therefore, in future research the survey instrument should be applied in different contexts, such as with

another set of universities, with universities of applied sciences, with colleges and – using a translated version – outside the German HE context.

A further limitation is the cross-sectional nature of the data set. In future research, it would therefore be appropriate to carry out a longitudinal study. Many of the theoretically assumed relationships imply causality, which could not be adequately investigated by using the present cross-sectional design. Mediation analyses are needed to verify the theoretically assumed relationships that have only been tested based on correlation analyses so far, and, this is another important extension, these could better represent the presumed reciprocity. It was assumed that self-efficacy beliefs determine motivation and behaviour, for example, with regard to digital media, and a specific outcome – e.g. academic performance – but based on SCT (Bandura, 1986), reciprocal mechanisms lead to a subsequent adjustment of self-efficacy beliefs depending on prior experience. While, in this thesis, only one direction was presumed, often this direction is unclear and this assumption can only be validly examined for data with a temporal structure. This would, for example, allow one to more closely examine the bi-directional relationship of self-efficacy and academic performance. This longitudinal data-base is also necessary to further examine the relationship between digital media self-efficacy, media-user type, and academic performance. The result found in the analysis might not be reliable and needs to be interpreted with caution. Additionally, the media-user types distinguished here could not satisfactorily explain the possible influence of digital media self-efficacy on academic performance. In this respect, a different operationalisation of media-user types could be promising: for example, one based on a distinction between media behaviour oriented towards leisure or social networking in addition to the more study-related media usage examined here.

7.3 Further Implications for Research and Practice

The found prevalence of digital media in the university context has direct implications for research and practice. Both the developed instrument and the established theoretical and empirical models offer various possibilities for further research. Regarding the instrument used in this research, the first test has already indicated promising psychometric properties. Thus, it can be used in future research to examine students' digital media use, self-efficacy, and study behaviour. The instrument in general was built in a modular way, i.e. it can be extended by other scales or used in parts. It could, therefore, be used to accompany intervention studies, that test, for example, the integration of specific technology in teaching and learning contexts or initiatives to promote academic and digital media self-efficacy. Given the relationship identified with socioeconomic

backgrounds and gender, measures to promote academic self-efficacy could be a suitable starting point to further reduce the on-going inequality in the HE context (see also Lörz, Quast, & Roloff, 2015; McKay & Devlin, 2014; Stoessel, Ihme, Barbarino, Fisseler, & Stürmer, 2015; Weiser & Riggio, 2010). In this context, future studies could also more closely examine the presumed links between socioeconomic background, academic self-efficacy, academic achievement, and student retention.

To develop interventions for supporting self-efficacy beliefs it seems sensible to consider the sources of self-efficacy discussed in Chapter 2.3. The strongest influences are based on personal experiences (enactive attainment) and observations of others (vicarious experience), provided that these others are perceived as similar to oneself. Promoting positive personal experience – for example, in (guided) solving of specific tasks or positive examples of behaviour or problem-solving in the form of student tutors – therefore seems especially promising. This could usefully supplement verbal encouragement by educators (verbal persuasion), as this often seems insufficient because the component of one's own experience (whether through one's own practice or observation of others) is lacking. Regarding emotional barriers (physiological states), such as test anxiety, there are often already institutional services that can help, which can be further highlighted (for a detailed discussion of intervention potentials see e.g. Brahm & Pumptow, 2020; Schunk, 1991; Schunk & Pajares, 2002; Zimmerman, 2000).

Digital media self-efficacy is a good starting point for intervention studies, because it is related to the level of perceived expertise and affinity in conjunction with digital media (see e.g. Brahm & Pumptow, 2020). The results concerning digital media user types and discipline-related use and perceptions of study-related technology suggest that lecturers are confronted with a wide variety of different conditions in their (digital) teaching context. The promotion of digital media self-efficacy could potentially reduce these larger differences between students in their use of media and, thus, create more similar prerequisites for successful digitally accompanied learning among students. Besides this potential for interventions, adapting the curricula to these identified differences and types of media-use therefore represents a direct practical implication for HE lecturers and practitioners. Additionally, the instrument can be used to conduct studies on the current, COVID-19-related, (at least partially) digitalised teaching in universities all over the world, leading to further valuable insights into acceptance, use, successes, and failures of digital learning formats.

7.4 Overall Conclusion

The results of this dissertation provide an insight into student (media) behaviour in a modern HE context, potential determinants of academic performance, and group-specific differences (e.g. regarding gender, subject, or socioeconomic background). The findings are integrated into a theoretical framework for digital media use in the HE context that in parts corresponds to TML and is based on SCT, an approach often used in higher education research. Therefore, the findings theoretically and empirically extend previous research and models and adapt these to the contemporary HE environment. The presented empirical results indicate that this environment – in this case consisting of four German universities – is characterised by a wide distribution of mobile devices and the overall frequent use of media applications for study purposes. Furthermore, the results provide initial indications that certain patterns of media use – for example, characterised by a high level of scepticism accompanied by a high level of interest and (self-rated) ability – can have a beneficial effect on academic performance. Digital media self-efficacy, on the other hand, showed a negative correlation with academic performance. Though, due to its statistically weak nature, this finding should be further examined, at least when it comes to its relevance regarding direct influences on academic performance. However, digital media self-efficacy is undoubtedly highly relevant when it comes to analysing digital media-related behaviour and attitudes, as indicated by the consistent results in this respect. In this regard, the theoretically founded and newly developed scale for digital media self-efficacy provides an easy-to-implement measurement of the construct, which can, if necessary, be supplemented by other potentially study-relevant factors, such as usage behaviour and attitudes.

With regard to inequality processes, the results suggest that socioeconomic differences in terms of academic self-efficacy, the associated goal orientations and academic performance still exist, i.e. there is still a need for improvement if a further reduction of inequality in the HE context is to be achieved. Although not analysed in the present dissertation, a link between academic achievement and student retention can be assumed, leading to a higher dropout rate of those students with lower performance, which often goes along with lower socioeconomic backgrounds and is potentially mediated by, for example, academic self-efficacy. An influence of social backgrounds is not evident, however, in the case of digital media self-efficacy. In this case, although, gender-related differences were apparent, like also in academic self-efficacy and media-user type. This knowledge on the existence of media-user types and differences in study-related technology use (and perceived usefulness) that depend on subject, gender and self-efficacy beliefs is of high practical value: for example, in curriculum planning and for identifying opportunities and barriers to integrating technology in the study context – particularly in the case of a transition to digital teaching formats, as, for example, was the case in 2020 due to the COVID-19 pandemic.

Besides their practical value, the results indicate that digital media self-efficacy and digital media behaviour are a potentially useful and contemporary complement to theoretical models of student behaviour and success in HE. Thus, the presented model for analysing digital media use in HE contributes to the further development of theory within SCT framework. Altogether, the studies carried out for this dissertation and the results presented lead to a significant gain in knowledge for research in the field of HE and offer various possibilities for further research and practice at universities.

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A Scale for Digital Media Self-Efficacy

Original (German) scale for DMSE:

Wie sehr treffen die folgenden Aussagen auf Sie zu? Es geht um digitale Medien, d.h. PC- und Internetanwendungen, die sowohl mit dem Computer als auch mobil, z. B. mit Handy, Smartphone, Tablet oder Notebook, genutzt werden können

Bitte wählen Sie die zutreffende Antwort für jeden Punkt aus:

	Trifft gar nicht zu						**Trifft voll und ganz zu**
Wenn beim Umgang mit digitalen Medien etwas nicht klappt, finde ich Mittel und Wege damit es trotzdem klappt	○	○	○	○	○	○	○
Wenn ein Problem mit einer Medienanwendung auftaucht, kann ich es aus eigener Kraft meistern	○	○	○	○	○	○	○
Auch bei überraschenden Ereignissen bei einer Anwendung glaube ich, dass ich gut mit Ihnen zurechtkommen kann	○	○	○	○	○	○	○
Schwierigkeiten beim Umgang mit digitalen Medien sehe ich gelassen entgegen, weil ich meinen Fähigkeiten immer vertrauen kann	○	○	○	○	○	○	○
Was auch immer beim Umgang mit digitalen Medien passiert, ich komme damit klar	○	○	○	○	○	○	○
Für jedes Problem in Verbindung mit digitalen Medien kann ich eine Lösung finden	○	○	○	○	○	○	○
Wenn ich mit einer neuen Medienanwendung zu tun habe, weiß ich, wie ich damit umgehen kann	○	○	○	○	○	○	○

Translated[30] (English) scale for DMSE:

To what extent do you agree to the following statements? We are talking about digital media, i.e. PC and Internet applications that can be used both with a computer and mobile, e.g. with a smartphone, tablet or notebook.

Please select the appropriate answer for each item:

	totally disagree						totally agree
If something doesn't work with the use of digital media, I find ways and means to make it work	○	○	○	○	○	○	○
I have no difficulty in realising my intentions and goals in connection with a media application	○	○	○	○	○	○	○
I am relaxed about difficulties when dealing with digital media, because I can always trust my abilities	○	○	○	○	○	○	○
Whatever happens when dealing with digital media, I can handle it	○	○	○	○	○	○	○
For every problem in connection with digital media I can find a solution	○	○	○	○	○	○	○
When I am dealing with a new media application, I know how to handle it	○	○	○	○	○	○	○
If a problem arises concerning a media application, I can handle it on my own	○	○	○	○	○	○	○

[30] This translated version has not been psychometrically tested.

B Supplement Study 1

Table B.1: Internal consistency measure by Cronbach's Alpha of the used scales for the pre-test data.

Scale	No. Items	Cronbach's Alpha	Item-Scale cor. (min/max)	No. Items excl.
Identification with the University	3	0.88	0.75/0.82	1
Subjective Norm	3	0.71	0.57/0.72	1
Enjoyment (in studying)	3	0.79	0.59/0.70	-
Anxiety (in studying)	3	0.86	0.73/0.84	-
Active participation	3	0.88	0.79/0.88	1
Wish for active participation	3	0.88	0.71/0.80	1
Motivation	3	0.80	0.67/0.76	-
Extrinsic goal-orientation	3	0.71	0.47/0.62	-
Task value	3	0.87	0.75/0.86	1
Social integration	4	0.86	0.65/0.88	1
Academic integration	2	0.70	0.64/0.64	-
ASE	7	0.95	0.71/0.89	3
DMSE	8	0.94	0.75/0.92	3

```
lavaan 0.6-2 ended normally after 164 iterations
  Optimization method                           NLMINB
  Number of free parameters                        178
                                                  Used       Total
  Number of observations                          2001        2039
  Number of missing patterns                       245

  Estimator                                         ML
  Model Fit Test Statistic                    2503.121
  Degrees of freedom                               724
  P-value (Chi-square)                           0.000

Model test baseline model:
  Minimum Function Test Statistic            44982.787
  Degrees of freedom                               820
  P-value                                        0.000

User model versus baseline model:
  Comparative Fit Index (CFI)                    0.960
  Tucker-Lewis Index (TLI)                       0.954

Loglikelihood and Information Criteria:
  Loglikelihood user model (H0)            -122369.395
  Loglikelihood unrestricted model (H1)    -121117.835

  Number of free parameters                        178
  Akaike (AIC)                              245094.790
  Bayesian (BIC)                            246091.840
  Sample-size adjusted Bayesian (BIC)       245526.324

Root Mean Square Error of Approximation:
  RMSEA                                          0.035
  90 Percent Confidence Interval          0.034  0.037
  P-value RMSEA <= 0.05                          1.000

Standardized Root Mean Square Residual:
  SRMR                                           0.035

Parameter Estimates:
  Information                                 Observed
  Observed information based on                Hessian
  Standard Errors                             Standard

Latent Variables:
                   Estimate  Std.Err  z-value  P(>|z|)
  Ident =~
    Ident_erstreb     1.000
    Ident_identif     1.140    0.032   35.440    0.000
    Ident_gerne       1.068    0.029   36.820    0.000
```

```
Unt =~
  Unt_mensch        1.000
  Unt_familie       0.794    0.033   24.391    0.000
  Unt_unterst       0.954    0.036   26.389    0.000
Sorge =~
  Sorge_bewael      1.000
  Sorge_lerne       0.694    0.025   28.059    0.000
  Sorge_pensum      0.883    0.024   37.011    0.000
Freude =~
  Freude_themen     1.000
  Freude_wissen     1.133    0.035   32.188    0.000
  Freude_lernst     1.306    0.038   34.412    0.000
Teilh =~
  Teilh_aktiv       1.000
  Teilh_ideen       1.081    0.034   32.197    0.000
  Teilh_mitge       0.661    0.027   24.940    0.000
Mot =~
  Mot_interes       1.000
  Mot_vergnue       1.067    0.024   44.943    0.000
  Mot_gutfue        0.815    0.024   34.565    0.000
ExZO =~
  ExZO_noten        1.000
  ExZO_besser       1.081    0.046   23.367    0.000
  ExZO_zeigen       0.935    0.041   22.964    0.000
AW =~
  AW_wichtig        1.000
  AW_nuetzl         0.913    0.031   29.190    0.000
  AW_versteh        0.779    0.023   33.958    0.000
Integr =~
  Integr_kontakt    1.000
  Integr_kollege    0.526    0.017   31.259    0.000
  Integr_privat     0.953    0.023   41.926    0.000
ASW =~
  ASW_widerst       1.000
  ASW_ueberra       1.117    0.028   40.339    0.000
  ASW_schwier       1.200    0.032   37.283    0.000
  ASW_klar          1.254    0.031   40.830    0.000
  ASW_loesung       1.134    0.030   38.131    0.000
  ASW_neues         1.004    0.028   35.723    0.000
  ASW_kraft         1.002    0.027   37.660    0.000
MSW =~
  MSW_wider         1.000
  MSW_ueber         1.010    0.026   39.134    0.000
  MSW_schwi         1.163    0.028   41.438    0.000
  MSW_loesu         1.227    0.030   40.645    0.000
  MSW_neues         0.950    0.028   34.458    0.000
  MSW_klar          1.011    0.029   34.436    0.000
  MSW_kraft         1.025    0.027   37.529    0.000
```

Software-Output B.1: R-Output for confirmatory factor analysis

C Supplement Study 2

```
----------------------------------------------------
Gaussian finite mixture model fitted by EM algorithm
----------------------------------------------------

Mclust VEV (ellipsoidal, equal shape) model with 6 components:

 log-likelihood   n  df       BIC      ICL
      -26666.39 1684 417 -56430.65 -56735.3

Clustering table:
  1  2  3   4   5   6
 81 321 84 349 706 143

Mixing probabilities:
      1          2          3          4          5          6
0.04821409 0.19511705 0.05097702 0.21223229 0.40464752 0.08881203

Means:
               [,1]     [,2]     [,3]     [,4]     [,5]     [,6]
TUI_Int      3.927630 3.853058 3.984246 4.974944 3.162991 4.184491
TUI_Nutz     5.482095 5.977895 5.381722 7.000000 5.881745 4.994198
TUI_Zug      4.139865 4.073389 3.992095 4.386658 3.605205 3.986902
TUI_Skep     3.732036 3.941799 3.899269 3.598285 3.817308 4.076390
Uni_Ang      3.821896 3.471117 3.769410 3.584832 3.467028 3.338925
Buecher      3.765340 3.290101 3.645791 3.776973 2.785411 3.010957
OT_studienb  2.988480 2.316358 3.473256 2.839840 2.195993 2.024644
SeKomp_Med   3.316076 2.900808 3.263264 3.596940 2.051275 3.317397
SeKomp_Lit   4.425470 3.817105 4.613696 4.783091 4.231678 4.485555
SeKomp_SoFo  3.047600 1.001513 3.062746 2.490167 1.364244 2.921549
SeKomp_Prog  2.799036 3.123082 4.289164 3.476161 1.000000 3.514039
```

Software-Output C.1: Final LPA solution.

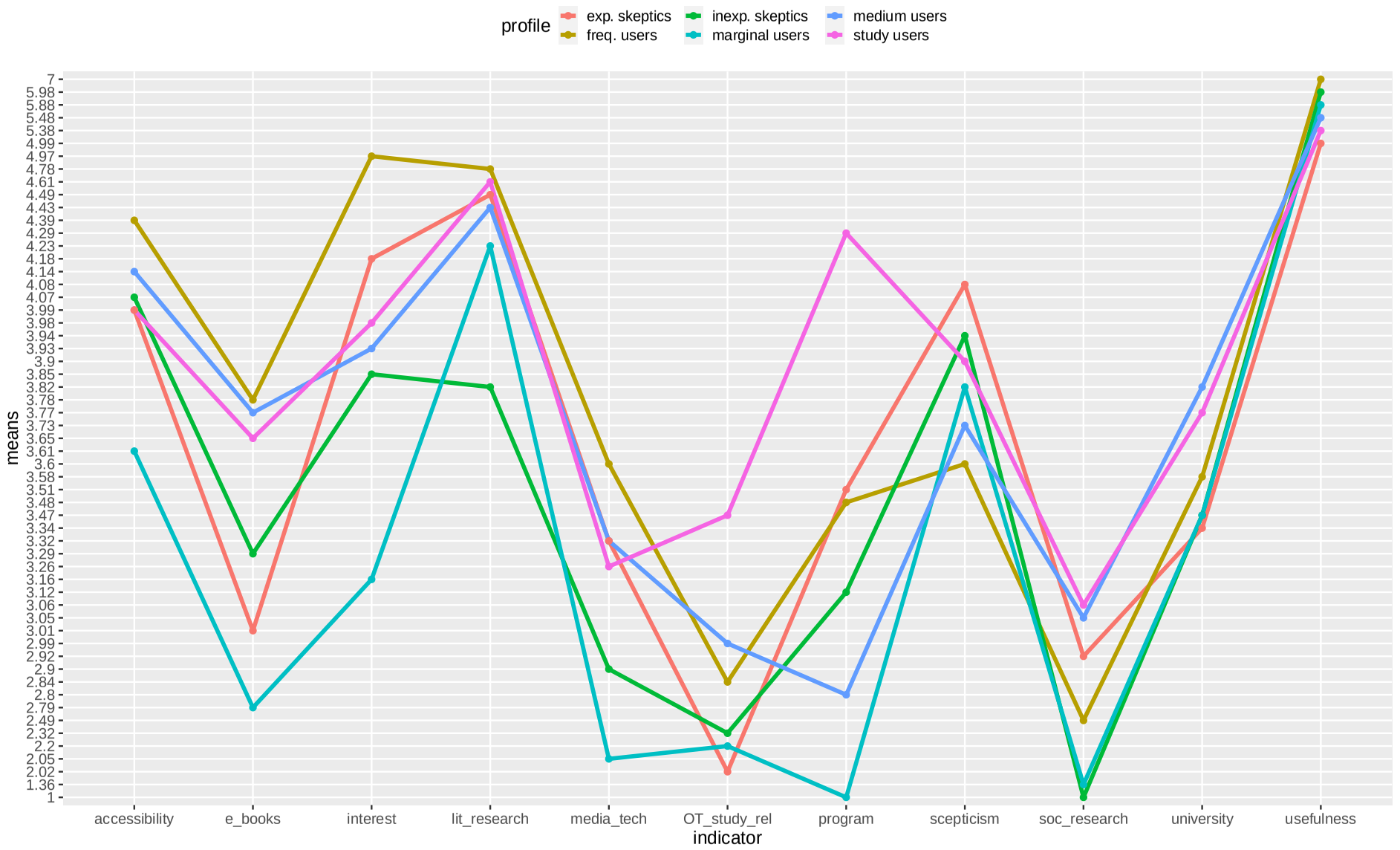

Figure C.1: Profile plot based on the estimated means for each scale and profile.

D Supplement Study 3

Table D.1: Absolute proportions, mean class probabilities and scale means for the six profiles of digital media usage behaviour and attitudes.

	medium users	inexp. sceptics	study users	frequent users	marginal users	exp. sceptics
absolute proportions	81	321	84	349	706	143
mean class probabilities	0,05	0,20	0,05	0,21	0,40	0,09
curiosity/interest	3,93	3,85	3,98	4,97	3,16	4,18
usefulness	5,48	5,98	5,38	7,00	5,88	4,99
accessibility	4,14	4,07	3,99	4,39	3,61	3,99
scepticism	3,73	3,94	3,90	3,60	3,82	4,08
university platforms	3,82	3,47	3,77	3,58	3,47	3,34
e-books	3,77	3,29	3,65	3,78	2,79	3,01
study related online tool	2,99	2,32	3,47	2,84	2,20	2,02
media technology	3,32	2,90	3,26	3,60	2,05	3,32
literature databases/research	4,43	3,82	4,61	4,78	4,23	4,49
soc. sciences research tools	3,05	1,00	3,06	2,49	1,36	2,92
programming	2,80	3,12	4,29	3,48	1,00	3,51

Table D.2: Bivariate Pearson Correlation of Factor Values for DMSE, ASE, anxiety, PGO and MGO as well as Academic Performance and ISEI (asterisks indicate significance levels).

	Academic Perf.	DMSE	ASE	ISEI	anxiety	PGO	MGO
Academic Perf.	1	-0.03	0.24***	0.1**	-0.26***	0.21***	0.17***
DMSE	-0.03	1	0.41***	0.01	-0.08*	0.06*	0.13***
ASE	0.24***	0.41***	1	0.05	-0.64***	0.26***	0.44***
ISEI	0.1**	0.01	0.05	1	-0.01	0.04	0.04
anxiety	-0.26***	-0.08*	-0.64***	-0.01	1	-0.07*	-0.29***
PGO	0.21***	0.06*	0.26***	0.04	-0.07*	1	0.37***
MGO	0.17***	0.13***	0.44***	0.04	-0.29***	0.37***	1

Significance codes: $***p < 0.001; **p < 0.01; *p < 0.05; .p < 0.1$.

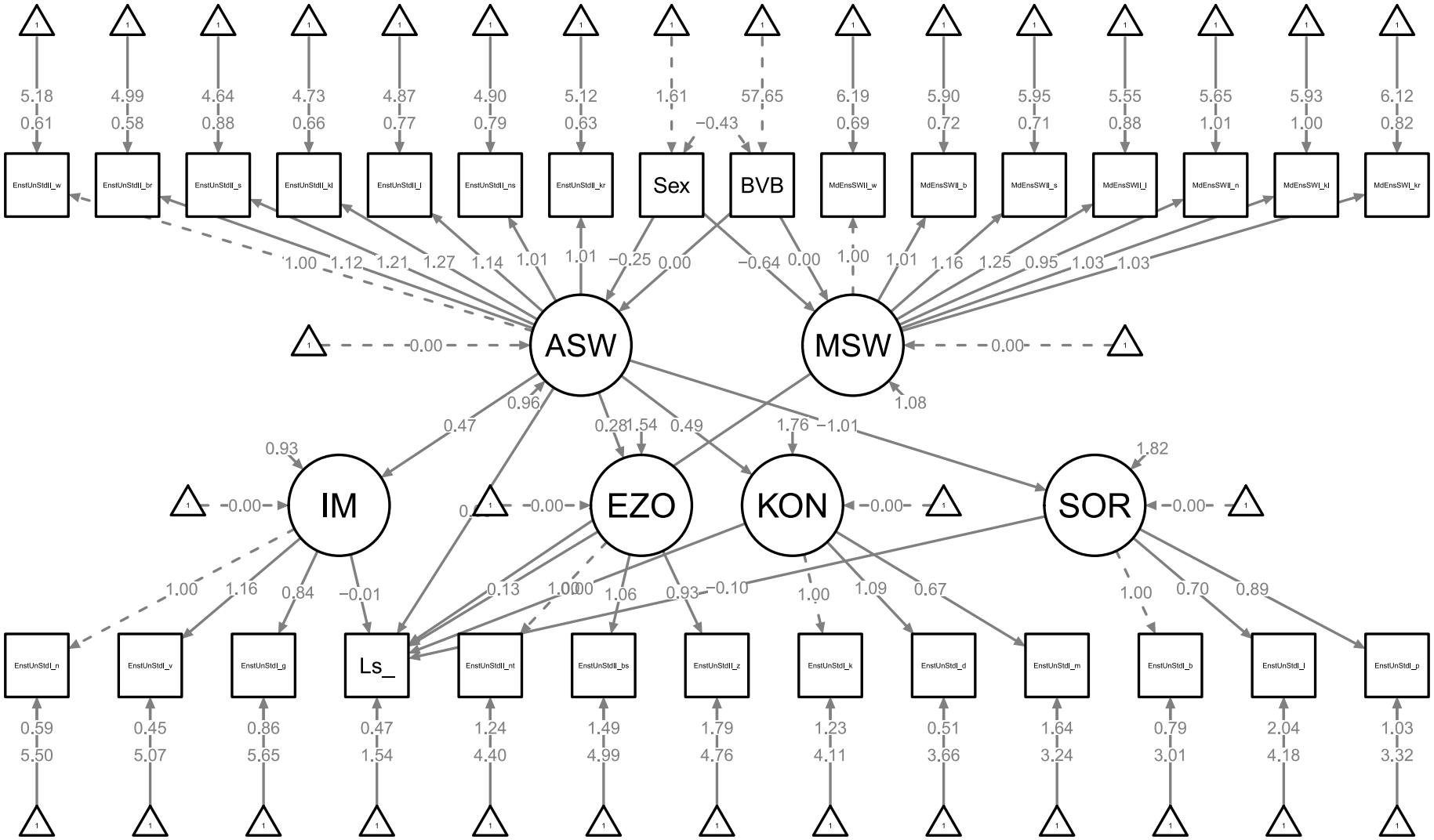

Figure D.1: Illustration of the full SEM including measurement models and residual variances.

Table D.3: Mean, standard deviation, and internal consistency measures Cronbach's Alpha, composite reliability and average variance extracted (AVE), of the used scales.

Constructs	Item	*M*	*SD*	Cronbach's α	Composite Reliability	AVE
Anxiety (in studying)	ANX_1	3.279	1.905	0.814	0.823	0.613
	ANX_2	4.251	1.855			
	ANX_3	3.562	1.805			
Mastery	MGO_1	5.394	1.311	0.836	0.842	0.642
Goal Orientation	MGO_2	4.940	1.404			
	MGO_3	5.552	1.282			
Extrinsic	PGO_1	4.323	1.686	0.755	0.756	0.510
Goal Orientation	PGO_2	4.912	1.819			
	PGO_3	4.672	1.782			
ASE	ASE_1	4.906	1.262	0.921	0.923	0.633
	ASE_2	4.694	1.343			
	ASE_3	4.323	1.529			
	ASE_4	4.403	1.490			
	ASE_5	4.566	1.428			
	ASE_6	4.627	1.325			
	ASE_7	4.843	1.278			
DMSE	DMSE_1	5.195	1.366	0.916	0.917	0.615
	DMSE_2	4.912	1.382			
	DMSE_3	4.801	1.520			
	DMSE_4	4.338	1.637			
	DMSE_5	4.726	1.431			
	DMSE_6	4.898	1.517			
	DMSE_7	5.088	1.449			
ISEI		63.44	18.670			
Academic Performance		1.549	0.761			

The measures are based on a number of cases of $n = 1753 - 1813$, depending on the number of missing values for each item.

E Supplement Study 4

Table E.1: Frequencies of participants for all 105 disciplines.

	abs. prop.	rel. prop
General Rhetoric	13	0.01
General Philology	1	0.001
English/American Studies	37	0.029
Archaeology	20	0.016
Construction Engineering	26	0.02
Business Administration	18	0.014
Bio- and Chemical Engineering	2	0.002
Biochemistry	13	0.01
Biodiversity	1	0.001
Bio Computer Science	11	0.009
Biology	56	0.044
Biophysics	2	0.002
Chemistry	24	0.019
Computational Engineering	1	0.001
Computer Linguistics	5	0.004
German as a second language	4	0.003
Economic Policy Consulting	1	0.001
Electrical Engineering and Information Technology	30	0.023
Empirical Educational Research	2	0.002
Empirical Cultural Science	2	0.002
Energy and Process Engineering	7	0.005
English Linguistics	2	0.002
Adult Education/ Further Training	5	0.004
Educational Science	49	0.038
Ethics - Economics, Law and Politics	1	0.001
Ethnology	4	0.003
European Culture and Economy (ECUE)	1	0.001
European Management	1	0.001
Facility Management	1	0.001
Automotive Engineering	26	0.02
Research and Development in Social Education/ Social Work	4	0.003
French	1	0.001
Early Intervention Studies	2	0.002

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	abs. prop.	rel. prop
Gender Studies - Culture, Communication, Society	1	0.001
Geography	24	0.019
Geoecology	3	0.002
Geoscience	13	0.01
German Studies	45	0.035
History	29	0.023
Health Economics	3	0.002
Human Geography/ Global Studies	3	0.002
Computer Science	65	0.051
Computer Science Courses	2	0.002
Information Systems	1	0.001
Intercultural German-French Studies	3	0.002
Intercultural Communication and Education	1	0.001
Intermedia	23	0.018
International Business Administration	17	0.013
IT Security	15	0.012
Japanese Studies	11	0.009
Clinical Psychology	2	0.002
Cognitive Science	12	0.009
Art History	10	0.008
Lasers and Photonics	1	0.001
Latin	2	0.002
Food Chemistry	7	0.005
Linguistics	8	0.006
Literary Studies	3	0.002
Other Literary Studies	7	0.005
Mechanical Engineering	53	0.041
Mathematics	29	0.023
Media and Communication Technology	1	0.001
Media Computer Science	2	0.002
Media Science	50	0.039
Medical Information Technology	1	0.001
Medical Radiation Science	1	0.001
Medical Technology	10	0.008
Molecular Medicine	2	0.002
Music Education	1	0.001
Musicology	3	0.002

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	abs. prop.	rel. prop
Nano-Sciences	9	0.007
Neurobiology	2	0.002
Neurosciences	3	0.002
Oriental Studies - Islamic Studies	2	0.002
East Asian Studies	14	0.011
Philosophy	10	0.008
Physics	34	0.026
Political Science	11	0.009
Product Development	5	0.004
Psychology	52	0.04
Spatial Planning	11	0.009
Religious Studies	3	0.002
Romance Studies	8	0.006
Russian Culture	1	0.001
Sales Engineering and Product Management	6	0.005
Sales Management	2	0.002
School Research and School Development	2	0.002
School Psychology	1	0.001
Slavic Studies	1	0.001
Software Engineering for Embedded Systems	2	0.002
Social Sciences	57	0.044
Socio-informatics	5	0.004
Sociology	11	0.009
Spanish	1	0.001
Sports Science	24	0.019
Speech Therapy	1	0.001
Urban and Regional Development	2	0.002
Theatre Studies	3	0.002
Theology	14	0.011
Environmental Sciences	15	0.012
Supply Science	3	0.002
Industrial Engineering	33	0.026
Business Mathematics	1	0.001
Economic Psychology	4	0.003
Business and Economics	94	0.073
$\sum$	1284	1

Table E.2: Correlation of DMSE, perceived usefulness of study-related technology (PU), social integration (INT), progress of study (PRO) and study-related technology use.

	TU	DMSE	PU	INT	PRO
TU					
DMSE	0.17				
PU	0.35	0.11			
INT	0.08	0.05	0.02		
PRO	0.02	0.06	0	-0.06	

Declaration on Authors' Contributions

This publication-based dissertation includes three manuscripts that were written together with another author. The manuscript titled 'A Typology of Higher Education Students' Media Usage Behaviour' (see Chapter 4; status in publication process: submitted) was written in single authorship. The proportional contributions to the other three manuscripts are presented in the subsequent tables.

Declaration on authors' contributions for 'Students' Digital Media Self-Efficacy and its Importance for Higher Education Institutions - Development and Validation of a Survey Instrument' (Chapter 3).

Author	Author position	Scientific ideas	Data generation	Analysis & interpretation	Paper writing
Marina Pumptow	first	70	80	90	70
Taiga Brahm	second	30	20	10	30

Status in publication process: published.

Declaration on authors' contributions for 'The Relevance of Digital Media Self-Efficacy and Media Usage for Achievement in Higher Education' (Chapter 5).

Author	Author position	Scientific ideas	Data generation	Analysis & interpretation	Paper writing
Marina Pumptow	first	80	80	90	70
Taiga Brahm	second	20	20	10	30

Status in publication process: under review.

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