To What Extent Can Individualisation in Terms of Different Types of Mode Improve Learning Outcomes and Learner Satisfaction? A Pre-study

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Abstract

With the latest technological developments and associated new possibilities in teaching, the personalisation of learning is gaining more and more importance. It assumes that individual learning experiences and results could generally be improved when personal learning preferences are considered. To do justice to the complexity of the personalisation possibilities of teaching and learning processes, we illustrate the components of learning and teaching in the digital environment and their interdependencies in an initial model. Furthermore, in a pre-study, we investigate the relationships between the learner's ability to (digital) self-organise, the learner's prior-knowledge learning in different variants of mode and learning outcomes as one part of this model. With this pre-study, we are taking the first step towards a holistic model of teaching and learning in digital environments.

Keywords: personalised learning, digital learning, digital teaching, teaching and learning model, experimental design, learning success

1. Introduction

Freedom of choice and individualisation describe a current trend in contemporary society (Hartley, 2007, 2008), accompanied by a shift from mass production and consumption to personalisation, diversity, and focus on specific values, such as creativity. This trend can also be observed in the field of learning, with changes in curricula and increased use of information and communication technology (ICT) reflecting the above developments (ibid.). ICT, in particular, creates multiple possibilities for teaching, learning, and assessment practices that can be more closely aligned with individual learner preferences (cf. Vainshtein et al., 2019, Becker et al., 2018).

Research shows that there is no universally beneficial learning design for different types of learners in different situations (cf. Koć-Januchta, 2016, Koper, 2006). Learner characteristics, such as self-regulation - the ability to reflect on the own thinking, set appropriate goals and plan for learning, monitor progress, and adjust or regulate the thinking, motivation, and study habits (e.g., Dent and Koenka, 2016), are pointed out as essential to achieving academic success. Besides the learners' characteristics, the content, the instructional methods, as well as learning materials and the learning environment, which includes the technology in use, must be considered (Khadimally, 2017). Research, e.g., shows that the level of learner control, as well as prompt facilitating reflection on information, are increasing online learning performance (Kauffman, 2015). Also, resources that are more difficult for students to access or dependent on stronger teacher guidance might not be a good fit for independent online learning (Gros, Garcia, Escofet, 2012). Khadimally (2017) recommends creating learning environments that are not only based on dialogic learning but also adapt to students' needs and support their self-directedness through student-driven learning and teaching optimally supported by

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technology. Cho et al. (2021) discuss the importance of high-quality study materials and sufficient support and feedback from teachers. At the same time, they also emphasise the need for student participation in interactive group tasks. Kitsantas et al. (2015) show in their research that students generally achieve more when technologies (e.g., for feedback) are used to support their self-regulation, motivation, and engagement.
These examples exemplify the components that should be considered when developing digital teaching and learning environments and working within and the complexity of their interdependencies. In this paper, we present a model focusing on the components: teacher (and teaching style), learner, outcomes, content, mode, assessment and environments, and their interdependencies. We then go one step further and focus on "mode", "outcome", and "learner" as selected model components. We empirically explore personalisation in terms of different types of mode and investigate how individual learning outcomes can be influenced by the types of visualisations (audio, video, and text), task structure and feedback forms. Therefore, we address the following research questions:

RQ 1: What is the relationship between various aspects of the mode, selected characteristics of the learner and learning success in the digital space?
RQ 2: How do different variations of the learning mode affect the learning process depending on the learner's characteristics?

To approach these questions, we conducted a pre-study with 73 students in an introductory course in the Business Information Systems program at the University of Potsdam (Germany) in January 2022. We chose an experimental design for this study because, under the control of certain factors, it allows insights into cause-effect relationships and, on this basis, makes it possible to explain social phenomena such as teaching and learning processes (cf. Eifler, 2014).
In the following, we present the theoretical-conceptual basis for the study, the experimental design, and the findings. After this, we discuss the results, limitations of our empirical investigation, and paths for future research.

2. Theoretical-conceptual foundation

The increasing availability of information and communication technology (ICT) allows for a more self-directed, individualised, and flexible learning experience (Rashid et al., 2016, Rodriguez, 2018). The learning process and its outcomes can be easily adapted to the existing knowledge and pre-experiences of the learner through a careful organisation of learning task, structure, medium, and so forth (cf. Kerr 2016, Mödritscher, 2004). The study by Simonds and Brock (2014) shows the interrelation between learner and mode preferences in digital environments. They found that older students prefer asynchronous learning formats such as pre-recorded video lectures. In contrast, younger students prefer interactive learning opportunities such as live chats or group work. In addition, in the experiment of Santally and Senteni (2013) with students in the second year of university, they found out that there was no performance improvement when redesigning learning units according to different learning styles. The authors argued that it would be a better approach to working towards more flexibility and adaptability of the e-learning environment and the use of multimedia (Santally and Senteni, 2013).

In their contribution, Waldrip et al. (2016) show that the personalisation of learning and well-being depends on a combination of factors and that not just one aspect is correct. Much more, a coherent and collaborative approach is needed to address the preference needs of learners with different backgrounds of experience (Waldrip et al., 2016). The increasing application possibilities of ICT in the educational context, e.g., via feedback apps, allow for targeted control of individual learning paths, preference needs and a specific definition of learning times and objectives (Torres-Madroñero et al., 2020). Thus, a greater scope has been enabled for teachers and learners to design their classes (Peters and Britez, 2019). Nonetheless, a unified understanding of the components used in creating and investigating personalised teaching and learning processes is lacking (cf. Vandewaetere, 2011). An approach is needed that considers the different design components of digital learning systems (Kem, 2022). This research gap will be addressed in this paper. We investigate to what extent the different mode variations as an independent variable impact the learning outcome while considering the learner's characteristics (prior knowledge, ability to (digital) self-organise). With our model and the pre-study based on it, we want to approach a holistic process model in which we explore the interdependencies between the different design components of teaching and learning in a digital environment.

Our considerations here build on preliminary work by Dees et al. (2017) and Biggs (1996). The Teaching/Learning Transactional Model (T/LT), according to Dees et al. (2017), provides a framework to encourage reflection on different parts of teaching (Dees et al., 2007). Thus, it offers a holistic view of teaching and learning units. The model consists of seven components: teacher, learner, content, assessment, environment, mode of teaching and teaching style. This

model and the corresponding questionnaire can be used as a pre-, in-the-moment, and post-teaching event reflection guide (cf. Dees et al., 2007). In addition, we consider Biggs' didactic concept 'constructive alignment' (CA) as it underlines the meaning of learning outcomes. Learning outcomes are not only a means of assessment but also of the general orientation of teaching and learning (Hussey and Smith, 2003). Biggs's didactic concept of "constructive alignment" (CA) has been applied and quoted worldwide and is used by universities for the course and program design (Kandbinder, 2014, Loughlin et al., 2021). The CA consists of three components: learning outcomes, methods, and examination forms. The core idea is that not only the learning objectives and methods but also the corresponding form of examination should be coordinated with each other. The distinctive feature of this model is the fusion of, on the one hand, constructivist approaches that focus on the learner's activities and, on the other hand, an instructional design that is more closely aligned with the goals of a course (Biggs, 1996). Instruction and construction are consequently thought of together.

3. Teaching and learning in the digital environment: A model of components and their interdependencies

Based on the preliminary work of Dees et al. (2007) and Biggs (1996), we present a model of components for teaching and learning in the digital environment in this section. We use the seven components of the Dees T/LT model as a basis. Further, we integrated 'teacher' and 'teaching style' into one component, as they are very much interrelated based on personal characteristics. Both Dees et al. (2007) and Biggs (1996) cite mode (method) and form of assessment as essential components of teaching and learning. Biggs additionally mentions learning outcomes. We integrate learning outcomes in our model (cf. Cavanagh et al., 2020) and distinguish more precisely between intended and emergent learning outcomes (cf. Hussey and Smith, 2003). Intended learning outcomes or learning objectives are set at the beginning, which may or may not is realised at the end of the teaching and learning unit. In this context, we would like to further develop the T/LT model according to Dees et al. (2007) by emphasising the processualism between teachers and learners and the different possibilities of influencing the learning outcome. We understand and describe teaching and learning as an instructive and constructive process in which the teacher plays a decisive role in preparing the content, intended learning outcomes and the mode, environment and assessment, and the learner is an active participant, too, giving feedback.

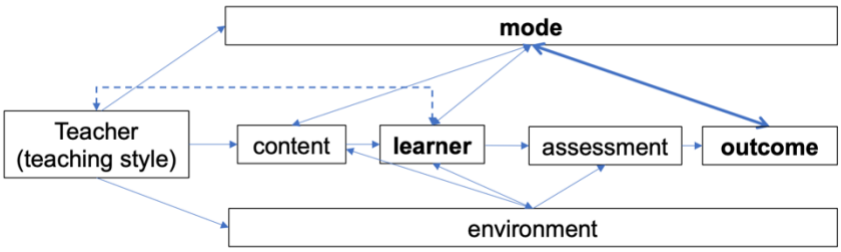

Figure 1. Teaching and learning in the digital environment - model of the components and their interdependencies.

Our model consists of the following components: teacher and teaching style, learner, mode, content, environment, outcome, and assessment. Further, our model underlines that the mode is designed according to the learning outcomes and content. For instance, deductive methods such as lectures are more suitable when declarative knowledge is to be acquired. In contrast, inductive methods such as problem- and project-based learning are more suitable for acquiring procedural knowledge (Prince et al., 2006, Alavi and Leidner, 2001).

The components in Dees et al.'s (2007) T/LT model and Biggs' concept of CA provide the basis for examining the teaching-learning interaction. We start with these components but consider teaching a communicative process (cf. Shannon and Weaver, 1949), in which knowledge is transferred from teacher to learner in a particular environment through a specific channel and in which teacher and learner are in constant exchange with each other. This is necessary because we want to investigate the mutual influence of all these components step by step. Fig 1 visualises the relationships between the components in the course of a learning process. The relationships that are the focus of this paper are marked in bold.

As a first step to capturing the complex interdependencies between the model components, we focus on one concrete part of the model. More precisely, we investigate the impact of different modes on emergent learning outcomes. The mode, at its core, describes how the learning content is transmitted to the learner. It includes the levels of visualisation (video, text, podcast), structuring and feedback. To get a more differentiated picture of the outcomes, we have divided them into two different types of knowledge (declarative and procedural) and learner satisfaction. The distinction between declarative and procedural knowledge helps us to specify the kind of

knowledge (facts and factual information vs how to do a specific task) (cf. Salaberry, 2018). Learner satisfaction gives us additional information about learners' perceptions of the content and process of the learning unit. Fig. 2 illustrates the variants of mode and outcomes.

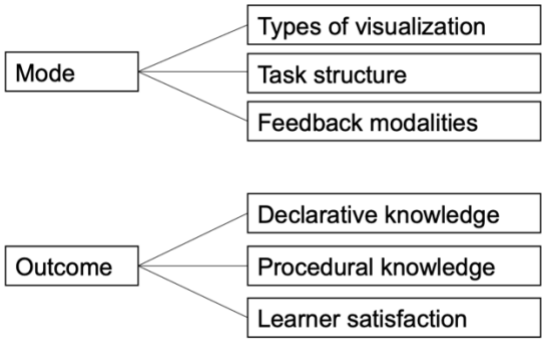

Figure 2. Variants of mode and outcomes.

4. Methodology

A mixed-method research approach was chosen and implemented as an experimental design. First, a randomised experiment was conducted with a 3x3x2 between-subject design. The research design included a quantitative survey at the beginning and the end. Before the experiment, the questionnaire assessed students' knowledge and ability to self-organise (SO). After the experiment, the second questionnaire assessed students' knowledge and satisfaction with the learning course. In the end, a qualitative part complemented the quantitative data assessment. With the qualitative survey, we assessed more information on students' motivation and behaviour during the learning phase. Overall, this experimental set-up is a pre-study to ensure a clean scientific procedure.

4.1. Procedure

All parts of the experiment were designed online. The experiment was integrated into an introductory course in the Business Information Systems program at the University of Potsdam in Germany. Seventy-three students, 39 male students (53,4%) and 34 female students (46,6%), participated in the experiment. The data acquisition took place for three weeks, starting in January 2022. Participation in the experiment was voluntary but allowed students to receive five to ten points, which they could count as extra points on their exam grades. The students were acquired in a lecture in the first bachelor's semester of the Business Information Systems program. A separate area for the experiment was set up in the learning environment *moodle*. All students were familiar with the online environment since the learning software is used at the University in regular courses. The students got access to individualised learning content and tasks in the learning environment.

To participate in the experiment, the students had to enrol in the environment. Afterwards, they received information about the experiment's procedure, tasks, and dates. In the beginning, all students had to complete an online questionnaire. The first questionnaire assessed students' knowledge before learning and their ability to (digital) self-organise. On average, students started with a score of 11.5 out of 18 possible points in the knowledge test. Students scored a medium level of SO in general (M=2.3) but a higher level of SO for digital learning (M= 3.0).

In the next step, they were randomly assigned to different experimental groups. From that point, the students received the learning content, depending on their group assignment. Before we started further calculations, we tested whether the experimental groups differed systematically in pre-survey characteristics (knowledge, SO digital, and SO general). The analysis of an ANOVA showed that the groups did not differ

Table 1. Experimental design.

		Factor A: Visualization					
		Podcast		*Video*		*Text*	
		Factor B: Structure					
		Structure	*No Structure*	*Structure*	*No Structure*	*Structure*	*No Structure*
Factor C: Feedback	*Always possible*	Group 1	Group 4	Group 7	Group 10	Group 13	Group 16
	Once possible	Group 2	Group 5	Group 8	Group 11	Group 14	Group 17
	Not possible	Group 3	Group 6	Group 9	Group 12	Group 15	Group 18

systematically in prior knowledge (Welch-Test $F(17, 72)=.72$, $p=.77$), SO digital ($F(17,72)=1.25$, $p=.26$) or SO general ($F(17,72)=.68$, $p=.81$). This justifies further calculations.
All participants had the same amount of time to complete the task. During the seven days learning period, students of two conditions could ask questions. Option for feedback was given via mail or video (zoom call) depending on their assignment to the experimental group (*Table 1).* After seven days, all students had to hand in the results of the final task. Half of the participants had already submitted an intermediate task after four days, depending on their experimental group. The final submission was followed by filling out an online questionnaire again. In the questionnaire after the experiment, the students had to fill out the knowledge test again and answer a validated questionnaire on their satisfaction with the learning course. Participants received their rewards, determined by the correctness of the task.

4.2. The mode variation

The mode varied on the levels of visualisation of the learning content, the structuring of the learning process and the possibility of interaction through feedback from the teacher. The three factors forming the mode are as follows:
Factor A-Visualisation: The students received the learning content on Business Process Management and Process Modelling and Description Language (PMDL). The information and examples explaining the learning content were the same for all three conditions. However, the visualisation of the learning content differed between the three conditions: video, podcast, and text.
Factor B-Structure: The learning period was either pre-structured or not structured. In the pre-structured condition, the students had to hand in small tasks that split the content into smaller pieces and were aimed at facilitating learning. In the not-structured condition, students had to structure the processing of the task on their own.
F*actor C-Feedback*: This third factor was divided into three conditions. Students in the first condition were always allowed to ask questions and receive teachers' feedback. Students in the second condition could ask questions once at a set time. Feedback options were given via e-mail and zoom-call. In the third condition, students did not have the opportunity to ask questions.

4.3. The learner

Two questionnaires were conducted at the experiment's beginning and the end. In the beginning, students' knowledge before the learning and students' ability to (digital) self-organise were assessed. The questionnaire after the experiment presented satisfaction with the learning course and the same knowledge test as in the beginning. The questionnaires consist of three parts: Students' ability to self-organise in general and digital environments was assessed with a validated questionnaire according to Klein et al.(2021). This was extended by measuring students' satisfaction on three subscales based on a validated questionnaire from Strachota (2006). Satisfaction was further divided into the subscales (i) student satisfaction with the learning content, (ii) student satisfaction with the instructor interaction and (iii) student general satisfaction. The knowledge test was included to assess students' knowledge of the topic before and after the learning period. It consisted of eighteen questions on business process management and process modelling and description language (PMDL), which the student had to answer as correct or wrong (e.g. *When creating the process model, the modeller has freedom as to which components are included and which are not; A task is a set of activities that represent a coherent set of facts in the process; Process interfaces indicate which other processes serve as input or output for the represented process.)*
The qualitative data was assessed after the questionnaire. The students were asked questions about their motivation and the experiment set-up (e.g. *Did you use other media? If yes, which ones? Did you exchange information with others? If yes, why? Did you find the learning input sufficient to complete the task? Did the work on the task arouse your interest? Were you able to use your prior knowledge to complete the task?*).

4.4. The learning outcome

First, learning success was measured with quantitative measurements on three levels: theoretical knowledge (knowledge test), procedural knowledge (PMDL-task) and students' satisfaction (*see Fig.2*). In the final PMDL task, the students had to modulate a textual process description in PMDL notation. The task evaluation was standardised to prevent bias from different observers. The task was evaluated on three criteria: *a) Were all the objects included? b) Were all the objects arranged correctly? c) Were all the objects labelled correctly?*

4.5. Data analysis

The data were analysed with *IBM SPSS Statistics* (Version 28). To investigate the two research questions, we used descriptive analysis to describe the sample and the results and to report the answers to the open questions. *Pearson's correlation coefficient* was used to answer the first research question. To address the second

research question, we calculated moderator analyses for each level of learning success and integrated the three aspects of the mode (visualisation, feedback and structure) into the model. To cover the interaction between the mode variation and the learner, we integrated the learner's characteristics (knowledge, self-organisation) as moderator variables into the regression model.

5. Findings

5.1. Descriptive results

We first look at the learning outcomes based on the score on the knowledge test after the learning period, and the grade on the PMDL-task. In the knowledge test after the learning period, the students scored about 13.0 out of 16 possible points (SD=1.6). Students of the group that once had the option to ask for feedback showed the highest scores on the knowledge test after the learning process (M=13.9 points). Looking at the grade of the final PMDL-task, the students achieved 3.6 of 5 points on average. The students reported that they invested 3.1 hours in submitting the final task.

Table 2. Descriptive results on learning outcomes and learner satisfaction.

	Overall	Visualization			Structure		Feedback		
Learning outcome		*Video*	*Podcast*	*Text*	*Structure*	*No structure*	*Always possible*	*Once possible*	*Not possible*
Knowledge test	13.0 (1.6)	12.6 (1.8)	13.0 (1.7)	13.3 (1.3)	12.8 (1.7)	13.1 (1.6)	12.3 (1.6)	13.9 (1.1)	12.7 (1.6)
PMDL task	3.6 (.6)	3.8 (.6)	3.4 (.7)	3.5 (.6)	3.6 (.7)	3.6 (.6)	3.6 (.6)	3.5 (.7)	3.6 (.6)
Satisfaction: i) Content - Satisfaction	15.7 (2.5)	16.1 (2.6)	15.5 (2.8)	16.0 (1.8)	16.5 (2.0)	15.2 (2.9)	15.3 (1.9)	15.3 (2.5)	17.0 (2.6)
ii) Instructor Satisfaction	10.7 (2.5)	10.2 (2.3)	10.9 (2.1)	11.0 (3.2)	11.2 (2.9)	10.2 (1.9)	10.5 (2.6)	10.3 (2.1)	11.2 (2.7)
iii) General Satisfaction	14.4 (2.6)	14.7 (2.4)	14.1 (2.9)	14.3 (2.5)	14.7 (2.7)	14.1 (2.5)	14.5 (2.9)	14.2 (1.9)	14.4 (2.9)
Learning time (hours)	3.1 (1.8)	3.2 (1.7)	3.2 (2.7)	2.8 (1.3)	3.2 (1.7)	3.0 (1.9)	2.7 (1.1)	3.0 (1.7)	3.5 (2.3)

Table description: M (SD)

5.2. Associations between the variables

To answer RQ1, we looked at the variables at the level of correlations (*Pearson, alpha .95*). We restrict the reporting to significant correlations. *Table 3* presents the correlation coefficients. We find that two of three measurements of learning outcomes do not show a significant association with any of the learner characteristics or the mode variations. The same applies to learners' satisfaction in general or for learners' satisfaction with the instructor interaction (feedback). However, we find positive correlations between variables and learners' satisfaction with the content. We find negative associations between (digital) SO and learners' satisfaction with the content (-.24*). We do not find significant associations between SO general and one of the satisfaction subscales. Furthermore, we found that no option for feedback is positively associated with the learner's satisfaction with the content (.29*). Furthermore, the structuring of the content is positively associated with learners' satisfaction with the content (.26*).

In the second step, we investigated how different variations of the learning mode affect the learning process depending on the learner's characteristics. To answer RQ2, we calculated a regression model and integrated the three aspects of the mode as well as characteristics of the learner as moderator variables. Our results show no significant influence of the variable's visualisation, structuring and option for feedback in combination with the learner's self-organisation or prior knowledge. Thus, the variables we integrated into the model do not contribute significantly to the variance analysis of learning output in the digital space. To investigate whether the examined learner characteristics shape the effect of mode variation on one of the three measures of learner success, we calculate a moderation analysis for each outcome variable. We find no significant results for all three regression models (knowledge test post ($F(12,72)=1.4$, $p=.19$), final

Table 3. Significant correlation between mode variations, learner's satisfaction, and learner's characteristics.

Variable	1	2	3	4	5	6
(7) Satisfaction: Learner-Content-Interaction			-.24*		.29*	-.26*
(1) Knowledge Test (T1)	1		.30*			
(2) Self-organisation general		1	.37**			
(3) Self-organisation digital			1			
(4) Visualisation				1		
(5) Feedback					1	
(6) Structuring						1

Table description: * $p < .01$, ** $p < .05$

submission F(12,72)=.636, *p*=.80), satisfaction F(12,72)=.887, *p*=.85)).

5.3 Critical reflection on the learning process

The questionnaire included several questions to better understand the learner's approach. Some of the questions addressed the students' approach to completing the task. Students were asked whether they used additional material or needed to exchange it with others. Twenty-five students (34%) reported that they used supplementary material. The utilisation of supplemental materials was limited to the use of *YouTube* (5 students), the internet in general (17 students), lecture slides (4 students), and the modelling tool *Modelangelo* (4 students). Multiple naming was possible. The next point was to ask why the students used additional material. Mainly, the students named comprehension problems regarding the material (5 students), a lack of clarity in the task (5 students), or interest in the learning content (1 student). 11 students (15%) indicated that they had exchanged information with others. Moreover, in the qualitative part, students' satisfaction with the learning material was surveyed. Questions on satisfaction with the learning material had to be answered on a 5-point Likert scale ranging from *strongly disagree (1)* to *strongly agree (5)*. The question *"I found the learning input sufficient to complete the task"* was rated with a medium score (M=2.6). Interestingly, the groups differ significantly from each other in their evaluation (*F*(15,57)=1.9, *p*=.04). Thus, students from the video group (M=3.3) rated the learning input better than students in the podcast group (M=2.4). The evaluation was mainly based on the fact that the video group had visualised modelling examples, which were missing in the podcast. Finally, the extent to which prior knowledge could be used to complete the task was also rated with a medium score of 2.7. Finally, the students answered whether the work on the task had stimulated their interest in the topic. The students rated their interest with 3.1 (SD=4.0).

6. Discussion and limitations

This study examines how different variations of the learning mode on the levels of visualisation, structuring, and feedback affect the learning outcome in the digital learning environment depending on the selected characteristics of the learner (prior knowledge, self-organisation). We use experimental design and could find significant associations between students' ability to digital self-organise and their satisfaction with the learning content. Similar relations between self-organisation and learning content were pointed out in other studies on digital learning: Digital learning does not take place at the university but almost exclusively from home, so self-organisation skills are strongly required. Learners are often interrupted or exposed to many distractions or simply unable to concentrate, which impairs efficient learning and correct understanding of the learning content (Owusu-Fordjour et al., 2020). In the same line of arguments, it seems less surprising that a given structure of the learning process increased the satisfaction of the learning content in our study. Therefore, our results highlight structural elements' role when designing digital learning environments. In the experimental study, we added components for structuring the learning time and content. The results show that this helped the students to divide the final goal into several sub-goals. Structuring

was furthermore positively associated with satisfaction. Research shows that digital learning requires high motivation, time management, and concentration from students (Hameed et al., 2008; Scheel et al., 2022). Students seem to have serious difficulties, especially with time management (Muresan & Gogu, 2013; Uzun et al., 2013). Thus, further research on design possibilities in the didactic structuring of digital learning spaces is needed.

We furthermore found that students who never got the option for feedback showed more satisfaction with the learning content. This is surprising because feedback is considered one of the most potent factors influencing learning in various instructional contexts, including digital learning environments. On the other hand, feedback is particularly challenging in digital environments without opportunities for direct exchange (Narciss, 2013). For this reason, in the research and practice of digital teaching, special attention should be paid to feedback from both intelligent tutoring systems and human tutors.

Regarding our findings on how different variations of the learning mode affect the learning process depending on the learner's characteristics, we could not find a significant correlation. Here we see an alternative argument that conflicts with the evidence of significant influences of the mode in combination with individual learner characteristics that should be investigated in a new experiment.

Our pre-study also shows some limitations. Our approach is to take a holistic perspective on teaching in the digital environment. Thus, the results of our experiment are limited since we used only a student sample. In the subsequent empirical investigation, we will increase the number of participants and target groups.

7. Conclusion and future research

Investigating learning in digital environments involves methodological challenges. One main challenge is taking learners' preconditions and preferences and the complex environment into account in analyses. For this reason, we developed an initial model of teaching and learning in a digital environment, including different components taken from the literature and their interdependencies. We propose a qualitative and quantitative empirical method to investigate the interdependencies between the components and apply this to the components “mode”, “outcome”, and “learner satisfaction”. Our goal is to lay the first foundation to investigate the dynamic relations between the individual and environmental dimensions in digital learning environments and contribute to the research on personalised learning experiences. Our pre-study focuses on the methodological challenges of researching learning in a digital environment.

Further research will integrate other mode variants, such as group-based work vs self-determined individual learning. Step by step, the interdependencies between learners' knowledge and ability to (digital) self-organise, different mode variants, and learning outcomes will be explored. By this, the model will be further evaluated. The aim is always to modify one dimension of teaching and learning to emphasise the effects on the other components more strongly. We aim to develop a holistic model using the findings, which explains the dynamic relations between the individual and environmental components. By integrating other variables on the part of the learner and by investigating different conditions from the learning process model, we want to contribute to successful individual digital learning.

The study's main goal was to address the demand for empirical validation on the topic and explicitly address the complexity and interdependencies between different aspects of mode, learner, and learning outcome. That is why a mixed-method research approach was chosen and implemented as an experimental design, which we consider a significant strength of this study. The extension of quantitative data with a qualitative survey gave insights into students' motivation and behaviour during the experiment. Furthermore, with the first results, we can extend our model further with more subcategories, such as the three forms of outcomes and modes.

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