Promoting Motivation in Higher Education:

Scalable Interventions based on Self-Determination Theory

Dissertation

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by

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Statutory declaration

I herewith formally declare that I have written the submitted dissertation independently. I did not use any outside support except for the quoted literature and other sources mentioned in the paper.

I clearly marked and separately listed all of the literature and all of the other sources which I employed when producing this academic work, either literally or in content.

I am aware that the violation of this regulation will lead to failure of the thesis.

Berlin, 27.04.22

Contributions of other persons to this work

I worked closely with Dr. Martin Schmidt-Daffy on my research and we published Article 1 together. His contribution was to help me develop the hypotheses and to work with me to adapt the instruments to the content. For study 2, Martin Schmidt-Daffy was responsible for the technical implementation of the individualized feedback in Excel. I wrote the two articles myself and analyzed all data independently.

Preface

When we think about our experiences in our academic education, we can probably all recall an instance when we learned about an interesting theory, practical tool, or simple concept that we found fascinating. We then talked about it with classmates or the instructor, attempting to find out more and better understand what it meant and how it related to other ideas or areas of our lives. Driven by the joy of discovery and knowledge, or the satisfaction of feeling that knowledge brings us closer to an important goal, we may even engage with the idea outside of the regular academic setting and end up using it in another context, such as our future profession. Personally, I felt this excitement when I was introduced to a motivational theory in my psychology studies that helped me better understand myself and the world around me. When I was first exposed to the self-determination theory of motivation, I felt that I could make more sense of the things I had already experienced in my life. I felt that I wanted to understand this idea even better in order to motivate and support those around me in their healthy development, which has always been a concern of mine. This enthusiasm, and the reflection of my values and beliefs about human functioning that I found in this theory, led me to apply for a doctoral position and dedicate my dissertation to the goal of applying a theory of motivation to higher education that I believe will benefit students' well-being, academic achievement, and development into more holistic human beings.

Before I begin to present my work, I would like to thank several individuals who contributed to the creation of this thesis and the research and personal development behind it. First and foremost, of course, a big thank you to my wonderful parents, Niels and Petra, who have shaped me from a very young age with much love and trust into an autonomous person striving for self-determination. You are the most important thing in the world to me. Regarding

my research and what I could learn in the last years, I am grateful for the great support of Dr. Martin Schmidt-Daffy and Prof. Bettina Hannover. Thank you, Martin, for your shared enthusiasm for Deci and Ryan and your sincere commitment to promoting self-determined learning. Your soothing way of listening and encouraging others' idea development in an unobtrusive way will be a role model for me. I would like to extend a special thank you to Prof. Bettina Hannover. When it comes to promoting self-determined motivation, nothing encourages as much as a supervisor who is so appreciative of the needs of her protégés and at the same time conveys a high standard with a great deal of trust. Thank you Bettina for your professional and human support, you have set the great standard by which I will measure managers in the future. I am very grateful for the wonderful time I had in the department and the many interesting colleagues I was able to meet. In particular, the invaluable support of Malte, who helped me with many organizational aspects of my research, the inspiring feedback and kind support of Karo, and the many creative office conversations, be it on topic or mundane, with Marina and Madeleine helped me a lot in writing this thesis. Thanks for the wonderful time also to all the others who accompanied me on my way and made my time at the university with their exciting characters pleasant and interesting. I look forward to staying in touch.

Danke!

Abstract (German)

Studierende in der Hochschullehre nachhaltig zu motivieren und zu selbstreguliertem Lernen zu befähigen ist insbesondere bei weniger interessanten, aber dennoch wichtigen Inhalten eine Herausforderung. Das ist der Fall, wenn Lehramtsstudierende lernen sollen, quantitative Daten in ihre pädagogischen Entscheidungen mit einzubeziehen. Im Kurs des Lehramtsstudiums zu evidenzbasiertem Handeln lernen Studierende oft eher mit wenig lernförderlichen, fremdbestimmten Formen der Motivation. Die Anwendung der erlernten Inhalte als zukünftige Lehrkraft obliegt aber weitestgehend ihnen selbst und erfordert positive Einstellungen zum Lerninhalt. Um die Motivation von Studierenden zu fördern, solche Lerninhalte zu erlernen und auch später in ihrem pädagogischen Handeln anzuwenden, wurden im Rahmen dieser Dissertation zwei theoriegestützte Interventionen in mehreren Studien entwickelt und erprobt, die auf der Selbstbestimmungstheorie der Motivation (SDT; Ryan & Deci, 2000, 2017) aufbauen. Die Interventionen wurden dabei in Einklang mit bestehenden Kurskomponenten zu Förderung selbstregulierten Lernens, in dem Falle mehrere formative Assessments, im Lehramtsstudium eingebaut. Die beiden Interventionen wurden in zwei experimentellen Feldstudien und einer dritten Vignettenstudie direkt in der Lehre implementiert und evaluiert. Übergeordnetes Ziel war es, Studierende nachhaltig (Selbstbestimmte Motivation) zum selbstregulierten Lernen anzuregen, so dass positive Einstellung zu den Inhalten (persönliche Relevanz) gefördert und eine zukünftige Anwendung in der Praxis unterstützt wird (Intentionen und Selbstwirksamkeit).

In einer ersten experimentellen Feldstudie in der Hochschullehre konnte eine Relevanzintervention bei Studierenden nicht nur selbstbestimmtere Motivation positiv beeinflussen, sondern unter anderem auch die Intention der Studierenden erhöhen, das Erlernte

später als Lehrkraft anwenden zu wollen. In einer zweiten experimentellen Feldstudie wurde diese Relevanzintervention durch eine Feedback-Intervention ergänzt. Diese baute auf einem automatisch individualisierten Feedback auf, das die Studierenden als formatives Assessment im Kurs in Bezug auf ihr Lernverhalten erhielten. Im Rahmen der Intervention wurde die Formulierung des Feedbacks experimentell variiert (autonomiefördernd vs. kontrollierend), um die Annahme überprüfen zu können, ob ein autonomieförderndes Feedback besser selbstreguliertes Lernen fördern kann als ein kontrollierend formuliertes Feedback. Die beiden Interventionen (Relevanzintervention und Feedback-Intervention) wurde in einem 2x2 Design gekreuzt, um herauszufinden ob positive Effekte der Relevanzintervention durch eine weitere autonomiefördernde Intervention verstärkt werden können. In Bezug auf das selbstregulierte Lernen zeigten sich vor allem positive Effekte der Relevanzintervention. Zudem fand sich eine positive Interaktion von Relevanzreflektion und der autonomieunterstützenden Formulierung des Feedbacks. Entgegen meiner Hypothesen zeigte sich jedoch auch das als kontrollierend formulierte Feedback als ähnlich wirksam in Bezug auf einige Variablen des selbstregulierten Lernens für die Studierenden, die nicht über die Relevanz der gelernten Inhalte reflektierten. Wider Erwarten wurden keine Effekte der beiden Interventionen auf motivationale Variablen beobachtet.

Um besser zu verstehen, wie Studierende die verschiedenen Feedbackformulierungen wahrgenommen haben, wurde Studierenden in einer dritten Studie (Vignettenstudie) prototypisches Feedback vorgelegt, das von den Studierenden in einem Zwischensubjekt-Design hinsichtlich verschiedener motivationaler Eigenschaften eingeschätzt werden sollte. Es zeigte sich, dass das autonomiefördernd formulierte Feedback im Vergleich zu kontrollierend formuliertem Feedback von Studierenden als stärker bedürfnisbefriedigend wahrgenommen

wurde und die Studierenden angaben, stärker selbstbestimmt mit diesem Feedback zu lernen. Allerdings gaben Studierende ebenfalls an, dass das kontrollierend formulierte Feedback mehr Klarheit besäße und sie sich eher Zeit nehmen würde, dass kontrollierende Feedback zu lesen. In einer abschließenden Diskussion wurden die Ergebnisse der drei Studien zusammengeführt, verglichen und daraus Erkenntnisse für die Hochschullehre sowie zukünftige Forschung abgeleitet.

Abstract (English)

Motivating students in higher education in a sustainable way and enabling them to engage in self-determined learning is a challenge, especially when it comes to less interesting but still important content. This is the case when student teachers are to learn to incorporate quantitative data into their pedagogical decisions. In the student teacher's course on evidence-based practice, students are often more likely to learn with forms of motivation that are not very conducive to learning and are externally determined. However, applying the content they learn as future teachers is largely up to them and requires positive attitudes toward the learning content. In order to promote students' motivation to learn such learning content and also to apply it later in their pedagogical actions, this dissertation developed and tested two theory-based interventions in several studies that build on the self-determination theory of motivation (SDT; Ryan & Deci, 2000, 2017). For this purpose, the interventions were incorporated in teacher training courses in line with existing course components designed to promote self-determined learning, in this case, multiple formative assessments. The two interventions were implemented and evaluated directly in courses through two experimental field studies and a third vignette study. The overarching goal was to stimulate students to engage in self-regulated learning in a sustainable manner (self-

determined motivation) so that positive attitudes toward the content (personal relevance) are fostered and future application in practice is supported (intentions and self-efficacy).

In a first experimental field study in higher education, a relevance intervention not only positively influenced students' self-determined motivation, but also, among other things, increased students' intentions to later apply what they had learned as teachers. In a second experimental field study, this relevance intervention was complemented by a feedback framing intervention. This built on automatic individualized feedback that students received as a formative assessment in the course regarding their learning behavior. Within the intervention, the framing of the feedback was varied experimentally (autonomy-supportive vs. controlling) in order to be able to test the assumption whether autonomy-supportive feedback is better able to promote self-determined learning than controlling feedback. The two interventions (relevance intervention and feedback framing intervention) were crossed in a 2x2 design to find out whether positive effects of the relevance intervention could be enhanced by another autonomy-supportive intervention. With regard to self-determined learning, positive effects of the relevance intervention were found above all. In addition, there was a positive interaction of the relevance intervention and the autonomy-supporting framing of the feedback. However, contrary to my hypotheses, feedback framed as controlling was also found to have similar effects on some variables of self-determined learning for students who did not reflect on the relevance of the content learned. Contrary to expectations, no effects of either intervention on motivational variables were observed.

To better understand how students perceived the different feedback formulations, students in a third study (vignette study) were presented with prototypical feedback to be assessed by students in a between-subjects design with respect to various motivational properties. It was found that

feedback framed in an autonomy-supportive manner was perceived by students as more need-satisfying compared to feedback framed in a controlling manner, and students indicated more self-determined learning with this feedback. However, students also indicated that the feedback framed in a controlling manner possessed more clarity and that they were more likely to take time to read the feedback framed in a controlling manner. In a final discussion, the results of the three studies were synthesized, compared, and insights for higher education teaching and future research were derived.

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Abbreviations

The following abbreviations appear throughout the text frequently. The abbreviations are written out in the text if they did not occur for a while.

DBDM – Data-based decision-making

SRL – Self-regulated learning

SDT – Self-Determination Theory

EVT – Expectancy-Value Theory

CET – Cognitive Evaluation Theory

OIT – Organismic Integration Theory

BPNT – Basic Psychological Needs Theory

EPLOC – External perceived locus of causality

IPLOC – Internal perceived locus of causality

RAI – Relative autonomy index

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1. INTRODUCTION

1.1. The need for self-determined motivation in education

In our educational system, we want to enable students to be self-regulated learners within our classes but also above and beyond. Students should be motivated to take active control of their own academic development and consciously engage in the acquisition of skills and knowledge. This particularly applies to higher education, which not only requires students to self-manage their learning more strongly but also to prepare for the application and transfer of professional knowledge to their future profession (Wang et al., 2020; M. C. White & DiBenedetto, 2017). Academic studies are supposed to prepare students for a life in society and a professional work field that require students to learn with a focus on future application of acquired skills and knowledge instead of merely conserving enough knowledge for the next exam (Wang et al., 2020). Consider for example a teacher learning about the principles of giving high quality feedback in his studies. What is it worth if that teacher is able to answer the questions about feedback in the final exam correctly, but when it comes to their[1] future profession, this teacher rather relies on the automatisms that they still kept from their own experience of feedback in school? Higher education should teach in a way that transmits a motivation to engage with important topics also when the supporting context of educational institution is not there anymore, thus equipping students with a motivation to continue learning throughout their whole lifespan (Liu et al., 2016). High quality motivation has also been shown to be a strong predictor of academic achievement, especially because motivated students are more likely to engage in activities beneficial to learning (Pintrich & Schunk, 2002; Richardson et

[1] In this dissertation, the singular *they* is used to equally address people of each gender

al., 2012). In higher education teaching, docents can positively support students' motivation, e.g. by attuning to students' interests making contents more relevant to students or providing motivating feedback (e.g., Leenknecht et al., 2017). Motivating students in higher education is a challenging endeavor though, as higher education teachers are often responsible for many students at the same time, leaving little room for personal interactions to individually support motivation (Henderson et al., 2019). Further, even though students have often chosen a study that corresponds to their interests, there are topics and courses in higher education that are less interesting for some students but nonetheless important for their studies and future professions (e.g., Sizemore & Lewandowski, 2009).

To conclude, it is important to find cost-effective ways to motivate students in higher education, even for courses that are not initially received with high interest. As discussed, this motivation should not merely bring students to deal with contents. It should rather energize them to take control over their learning progress and develop positive attitudes towards learning contents making it more probable that students will use and apply what was learned in the future. The next paragraph will describe such a content taught at university which was the target of the studies presented in this dissertation.

1.2. **Data-based decision-making for teachers**

An example for such a topic in education that is rather uninteresting but nonetheless important is a course about data-based decision-making (DBDM) for teaching students. In this course teaching students learn the basics of statistics and research methods. This knowledge is important for teacher professionalization, for example by enabling them to consult findings of scientific studies when planning their pedagogical practices as future teachers or use data and standardized assessments (including large scale assessments) to improve their teaching

(Schildkamp et al., 2012). DBDM is seen by experts as highly impactful for high quality teaching as well as teacher development (Brown & Zhang, 2016; Schildkamp et al., 2012) and is implemented in national policies and teacher curricula worldwide (European Commission [EC], 2007; Gogolin et al., 2020; Kultusministerkonferenz [KMK], 2014; Organisation for Economic Cooperation and Development [OECD], 2005).

However, teaching students often struggle with research and method courses and show lower interest and negative attitudes (Batanero et al., 2011; Murtonen et al., 2008). The course thus often does not match students interest and it might also elicit resistance by perceiving that the adoption of an evidence-based, data-driven professionalism means the devaluation of practice experience (Rousseau & Gunia, 2016). Often, the only value that teaching students see in method and statistics courses is for writing their thesis, but they fail to see the potential it has for their goals as a future teacher and their professional practice (Haberfellner & Fenzl, 2017). Whether student teachers will engage with scientific evidence and attempt to incorporate DBDM into their practice as teachers, however, depends heavily on their own initiative and high-quality motivation for the topic (Gorozidis & Papaioannou, 2014; Prenger & Schildkamp, 2018).

Therefore, the way these contents are being taught and the motivation and attitudes this teaching elicits in teaching students is of high importance (Dunn et al., 2019; Schildkamp et al., 2017). Thus, scalable interventions based in solid motivational theories are needed to promote the right motivation in students. When it comes to theory-based interventions, the Self-Determination Theory of Motivation (SDT, Deci et al., 2017; Ryan & Deci, 2000) has been shown to be one of the most powerful theoretical basis for interventions in education (Lazowski & Hulleman, 2016).

1.3. **Purpose of my work**

In my doctoral studies, the goal was to develop, implement and evaluate different scalable motivational interventions that support high quality motivation in students and enable them to become self-regulated learners and to be willing to use and apply course knowledge in their future profession. The interventions target a course in teacher training on DBDM for student teachers, which is important for professional work of teachers but often perceived as rather uninteresting. To achieve high ecological validity and maximize the practical implications of my studies, the interventions were tested by implementing them in the regular curriculum over an entire semester. Both the design of the intervention and the measurement instruments were adapted to the context of the target group based on expert opinion and using the existing teaching design. In the first part of the dissertation the theoretical foundation of the interventions which are based in the Self-Determination Theory (SDT) will be described. Thus, the following paragraph will outline how SDT describes different forms of motivation, which consequences these motivations have in education and how an academic environment can support these desired forms of motivation. After reviewing the current state of research and identifying remaining gaps, the first part concludes with a brief description of the interventions that were applied in the three studies that make up this dissertation and the respective hypothesis that were attempted to answer. The theoretical introduction is then followed by two articles. The thesis is in the form of a monography with the article reporting the first study being already published and the second article containing the second and third study that will be published after the publication of this dissertation. In the discussion of this thesis, the results of the three studies will be evaluated. To conclude, certain limitations of my works, the implications of my work for future research and for higher education teaching will be discussed.

2. THEORETICAL BACKGROUND

2.1. Motivational theories in education

Motivational theories attempt to explain the process that energizes human behavior and results in individual engagement. Understanding motivational processes enables educators to understand how and in which facets student motivation manifests itself, which situational or environmental factors affect these motivational states and how motivation relates to students' academic behaviors. Ultimately, this knowledge allows for interventions aiming to positively influence students' motivation, learning, professionalization and well-being. Several theories have been developed to explain motivation and its underlying processes, with each theory focusing on one or more particular aspects while giving less priority to other aspects. Even though theories have different foci and often use different vocabulary, some themes are common (e.g., the concepts of competence, value and attribution) and contemporary theories often describe the cognitive processes involved in motivation as well as an interaction with the social environment (Cook & Artino, 2016). Many theories include the idea of Wigfield and Eccles' (2000) Expectancy-Value Theory (EVT), which denotes motivation as a product of the perceived chances of success and the perceived value of a task. Social-cognitive theories such as Bandura' (1977) theory of Self-Efficacy are comparable to the expectancy component of EVTs. However, they are more specific about how the task or the situation influence an individuals' perceptions of ability to enact a behavior successfully. Other theories, such as Attribution Theory (Weiner, 1985) or theories of Goal Orientation (Ames, 1992; E. S. Elliot & Dweck, 1988) focus on the causal explanations individuals come up after an event and how this relates to their orientation towards different goals. Finally, the SDT represents another prominent motivational theory that is unique because of its conceptualization of motivation in qualitative rather than quantitative

terms and its focus on autonomy (Deci & Ryan, 1980). Whereas in aforementioned theories the resulting motivation is provided in terms of magnitude (having more or less motivation), SDT describes different qualities of motivation, providing information about why a person perceives to enact a behavior, with different consequences depending on the degree of self-determination (Ryan & Deci, 2017). As the degree of self-determination differs between more autonomous and more controlled forms of motivation, SDT places a unique focus on autonomy as a crucial ingredient for high quality motivation, next to competence and relatedness (Cook & Artino, 2016). SDT describes motivation in a unique way allowing for an important differentiation between reasons why someone is enacting a behavior, which have been found to relate very differently to outcomes like engagement, perseverance or intentions. Further, SDT also provides theoretical explanations and highlight pathways about how adaptive motivation can be promoted by the social environment (Ryan et al., 2021). Therefore, by providing clear theoretical guidelines that can be implemented in practical interventions, SDT-informed interventions have been found in numerous empirical studies to be one of the most effective approaches in promoting student motivation and adaptive outcomes in education (Cheon et al., 2018; Lazowski & Hulleman, 2016).

2.2. **Self-Determination Theory**

The Self-Determination Theory (SDT; Deci & Ryan, 1980; Ryan & Deci, 2017), is a macro-theory of human motivation and development that builds upon forty years of empirical research in various different fields, including organizations, health promotion, psychotherapy, sport and also in education. To understand how humans flourish and develop to their full potential, SDT adopts a need-based approach looking at human motivation from an organismic perspective happening within social contexts and describes under which conditions humans are

able to thrive. Human motivation, the energy that drives us, is not seen as a mere question of more or less, but SDT uniquely describes motivation in different qualities, that matter when researching and supporting human motivation. To give a first overview over this complex theory before going into more detail, the following section briefly describes six mini-theories that have been refined over the years. Each mini-theory focuses on a certain aspect of motivational processes within individuals and their interactions with the environment. The following chapters will then go into more detail with three mini-theories which describe the processes that informed the interventions that were applied in this work. Figure 1 provides a first overview of all relevant constructs in SDT and their relationships.

The *Cognitive Evaluation Theory* (CET) describes the core idea of SDT, that humans possess and innate drive for exploration and curiosity. This drive can fuel behavior by an innate satisfaction taken just from engaging in a behavior itself, a characteristic feature of humans called intrinsic motivation. Next to describing this motivational state of intrinsic motivation, CET also theorizes that external events, such as rewards or feedback can impact intrinsic motivation in different ways, depending on the functional significance an individual attributes to them. Thus if the external event is perceived as being controlling it can diminish intrinsic motivation. However, external events such as feedback or rewards were found to potentially also support intrinsic motivation when being perceived as informational (Ryan & Deci, 2017).

The concept of intrinsic motivation is complemented in *Organismic Integration Theory* (OIT) by the concept of extrinsic motivation, i.e., a behavior that is enacted because of its consequences instead of the pleasure of the behavior itself. In this mini-theory, extrinsic motivation is further differentiated into different motivational qualities, i.e., different reasons why a person feels that they are engaging in a certain behavior. The important distinction

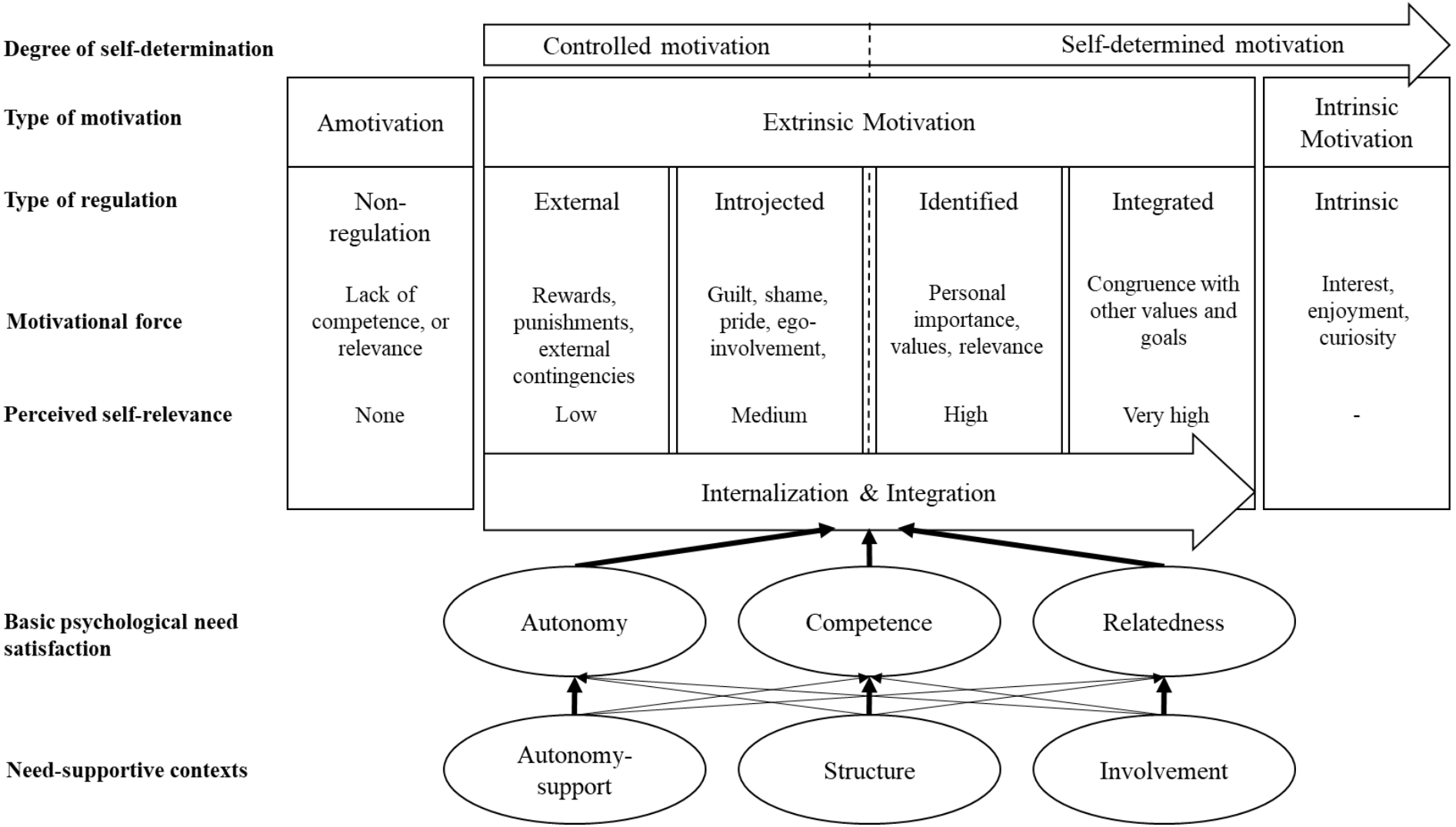
regarding these motivational qualities is that some behaviors feeling more like they are engaged in because of forces alien to oneself representing low self-determination (“I act, because I have to.”) while others are perceived more autonomous or self-determined (“I act, because I want to.”).

In OIT a continuum of motivational qualities describes how these different reasons for engaging in a behavior can be ordered regarding their level of self-determination and described on a fine-grained level, the including different cognitive, emotional and affective propensities related to them. Meta-analyses in the educational domain find that students learning with more self-determined qualities (“want-to” motivation), show more adaptive educational outcomes (e.g. positive affect, improved performance and learning), compared to students that learn because of rather controlled reasons (“have-to” motivation; Howard et al., 2021; Richardson et al., 2012; Vasconcellos et al., 2020). Further, the process of internalization is described, i.e., allowing individuals to adopt a “want-to” motivation, by supporting experiences of need-satisfaction.

The *Basic Psychological Needs Theory* (BPNT) describes these needs that are viewed as innate and universal psychological needs. Across cultures, SDT predicts that human functioning depends on the satisfaction of their needs for autonomy, competence and relatedness. BPNT describes what these needs entail and how they can be satisfied or frustrated by environmental factors and interactions with social agents. The description of need-supportive behaviors or external influences described the important processes that are used in interventions to support more self-determined qualities of motivation.

Figure 1

An overview of the most important constructs in SDT and their relationship



While the aforementioned mini-theories described mostly how different forms of motivation arise in relation to environmental influences, the *Causality Orientations Theory* (COT) describes how individuals differ regarding their causality orientations, i.e., their general tendency to interpret events. Whereas Cognitive Evaluation Theory described how external events are attributed a functional significance by a person, COT predicts that some people have an autonomous causality orientation focusing more on possibilities for self-determination and choice and attributing more informational functionality to external events. A controlling causality orientation of a person is expressed as focusing more on controlling aspects of the environment and interpreting external events as rather controlling in nature. A third orientation is an impersonal one where situations are perceived as less controllable and amotivating.

When analyzing human behavior, SDT is not only differentiating why humans engage in a behavior but also what they engage with, i.e., the goals that human choose to pursue and how the content of these goals affects their behavior and well-being. In the *Goal Contents Theory* (GCT) it is described how goals can be separated into goals with a more extrinsic content (e.g., material possessing, status) and goals with a more intrinsic content (e.g., personal development, connections to others). GCT predicts that intrinsic goals are more strongly related to basic psychological need satisfaction and autonomous motivation and relate positively to well-being compared to the pursuit of goals with an extrinsic content.

In a sixth mini-theory, the Relationship Motivation Theory (RMT), it is described how need-fulfillment in close relationships to other people is crucial to feel autonomous, securely attached and satisfied with those interpersonal connections.

To summarize, SDT does not only describe human's capabilities for intrinsic motivation and different forms of extrinsic motivation in a qualitative way on a continuum of self-

determination but also how the interaction of contextual factors and human propensities in the form of basic psychological needs relate to motivation. SDT thereby provides the necessary theoretical underpinnings to create practical interventions. As the SDT is the theoretical basis for the works presented, three of the six mini-theories that were used to develop the interventions in the studies will be explained in more detail in the following. Namely the Cognitive Evaluation Theory, the Organismic Integration Theory and the Basic Psychological Needs Theory.

2.2.1. ***Cognitive evaluation theory***

A basic tenet of SDT is that humans possess a natural tendency to explore and grow. It is by being active that humans develop, which can be observed best at how young children discover the world - through play (Csikszentmihalyi, 1975). This idea is expressed in *intrinsic motivation*, a state where an individual engages in an activity just because the enacting of the activity itself is perceived as rewarding (Deci & Ryan, 1985). What is easy to observe in young children also is present when we find pleasure in running through the woods or reading an unknown book and feeling excitement just by doing so, without the need of getting something out of it, like better fitness or superior knowledge. A focus of the Cognitive Evaluation Theory (CET) is on how the social environment and its interactions with the individual influence the experience of intrinsic motivation. Surprising at the time were early experiments that showed how tangible external rewards decreased intrinsic motivation in laboratory experiments (e.g., Deci, 1971). What followed from these finding was, that the individual's perception of where their behavior originated seemed to matter. The basis for this insight was Heider's (1958) naïve psychology, claiming that human behavior is strongly determined by perceptions of personal causation, thus if an observed behavior is perceived as being intended and caused by a person. DeCharms (1968) refined this thought, speaking of a perceived locus of causality. Thus, it

mattered if a person feels that the motivation for a certain behavior originates within that person (internal perceived locus of causality, IPLOC) or rather outside of that person (external perceived locus of causality, EPLOC). When engaging in an activity out of pleasure derived from enacting the activity itself, thus fueled by intrinsic motivation, the individuals' perception will correspond to an IPLOC. When being rewarded for an intrinsically motivated behavior, perceived causality can change from and IPLOC to an EPLOC, making the behavior feel less volitional or autonomous but rather externally controlled. Experiments with intrinsic motivation and rewards confirmed this with participants showing a target behavior less in a free choice period when they were knowingly rewarded for the same behavior during an experiment before, compared to participants that did not receive external rewards or only unexpected rewards during the experiment (Joussemet et al., 2004; Lepper et al., 1973). Intrinsic motivation is typically found to correlate positively with behavioral engagement in free choice periods, thus when the person is not required to enact the behavior, but is free to do so if they want to, perceived the behavior as originating from within. On the contrary, when engaging mostly for an external reward, participants usually stop engaging with the behavior as soon as the reward contingency stops (e.g., Deci et al., 1999). When looking at the field of education, there are plenty of other modes of interaction next to rewards that can potentially influence the perceived locus of causality of an individual, like evaluations or feedback. According to SDT the impact on motivation of those external events is dependent on the *functional significance* the individual attributes to them, i.e., how the individual interprets an external influence. Every event can be perceived as having a rather controlling, informational or amotivational character, corresponding somewhat to the intention the agent responsible for this event is assumed to have. Feedback from a teacher can be perceived by the student as rather informational, supporting the student with their personal

development by providing helpful information about their learning. The feedback from a teacher could also be perceived as controlling, when the perceived intention was to steer the student to an imposed direction or behavior. The latter would then be expected to influence the perceived locus of causality (PLOC) to a more external one. Thus, external influences like feedback can per se hamper intrinsic motivation if it is perceived as controlling but similarly have the potential to support intrinsic motivation, particularly when conveying positive information about one's competence (*positive feedback*). This is exemplified by a study of Ryan et al. (1983) where participants received positive feedback praising their performance on a task ("you have well done") reported higher intrinsic motivation compared to another group the same feedback with a connotation making it potentially being perceive as more controlling ("you have well done, just as you should"). What differs between the two ways of providing feedback is referred to as the interpersonal style, meaning how interactions are framed, which often determines the functional significance that individuals attribute to them. Thus, even when feedback is not positive but conveys information about aspects that are not satisfactory to certain standards and need to be changed or adapted (*negative feedback)* it could potentially be transmitted in ways that decrease its interpretation as being functionally controlling. The intervention of the second study builds on this finding, attempting to influence what functional significance the learners attributed to the feedback by framing feedback on self-determined learning.

However, CET has so far only dealt with intrinsic motivation and its relation to external events. It was discussed that intrinsic motivation is not only a motivational state that is perceived as rewarding and pleasurable by itself, but has also been shown to relate to higher engagement, increased interest and better conceptual (not rote) learning (Benware & Deci, 1984; Grolnick & Ryan, 1987). It is thus a lofty goal to draw on students' interest in education enabling learning to

be driven by intrinsic motivation, but educators eventually will need to also teach contents that do not elicit intrinsic motivation. How SDT describes the motivation for those contents that is not intrinsic, thus due to pleasure that comes from the learning itself, but rather driven by expected outcomes separable to the task is further elaborated in the following mini-theory.

2.2.3. ***Organismic integration theory***

With intrinsic motivation we find human's natural tendency for exploration, growth and challenge expressed. When motivated intrinsically, humans seek out new things out of curiosity, creatively explore new perspectives and often enjoy challenging themselves (Froiland, 2011; Heyman & Dweck, 1992). However, in our daily life, living as social beings in a society, we engage in many activities that are not all intrinsically motivated, but nonetheless worthwhile or necessary. Any behavior that is not intrinsically motivated, is per definition driven by *extrinsic motivation*, meaning that the behavior possesses an instrumental value that energizes the behavior, separable from the task itself. Similar to the concept of intrinsic motivation being an expression of the natural human tendency for growth and exploration, humans possess the tendency for *organismic integration*. When confronted with values, beliefs, expectations or behavioral regulations from others, humans strive to internalize and make them their own. Humans thereby strive to grow towards greater autonomy and to integrate their doing into their identity (Ryan & Deci, 2017). The more successful the process of internalization is, the more internal the PLOC will be (Ryan & Connell, 1989). This happens on a continuum of internalization, as will be evident from the following overview of different forms of behavioral regulation that gradually become more internalized (see also Figure 1). These more or less internalized forms of extrinsic motivation are described in Organismic Integration Theory (OIT) by different regulatory styles, specifying what an individual perceives as regulating their

behavior. Each description will be illustrated by an example how a student learning with this regulatory style would feel and think.

External regulation: A student who's learning mainly because they want to pass the exam at the end of the course. Maybe this student is engaging in repeating the contents of a lecture in this course, because they are afraid that they would fail the course otherwise and receive the course credits. As can be seen in this example, we speak of external regulation when a person engages in a certain behavior mainly because of external rewards or negative consequences. This corresponds to the predominant behavioral influence that behaviorist theories focused on (e.g., B. F. Skinner, 1953). As the behavior is contingent on external consequences it goes along with an EPLOC and represents non-internalized motivation. Even though humans can be motivated by external contingencies, externally regulated behavior is often coming at the price of poor maintenance and transfer, especially when the rewards or punishments are not salient or in effect anymore (Ryan & Deci, 2008). Behaviors motivated primarily by this controlled form of motivation are often enacted with lower quality and effort as the focus is more on the outcome, but not the value of the behavior itself (e.g., Cerasoli et al., 2014).

Introjected regulation: A student that engages in class because they feel that it is expected from their environment, e.g., they believe to be a proper student it is required to learn sufficiently for every course. When studying course material this student might be energized by the thought of proving to themselves and others that they are capable and smart, or avoiding feeling unworthy and disproved by important others. When behaviors are regulated by introjection, external contingencies are not necessary as they have already been internalized. Instead of external forces controlling the behavior, an individual feels an internally controlling force. The feeling that one "should" or "must" do something comes from an involvement of the

ego in the regulation of behavior. Driving emotions are often pride when trying to prove one's worth or guilt when attempting to avoid not being good enough to one's internal standards. A student that is regulated by introjection becomes their own internal judge as their self-worth is becoming dependent on them complying to their own internal standards (Deci & Ryan, 1995). This reflects the projection of a person's own self-approval to others, i.e. their self-worth is linked to how they believe their behavior would satisfy the expectations from peers, teachers or docents. Theoretically, introjected regulation works similarly to conditional regard in parental education, when parents only provide affection to a child that behaves according to their expectations (Roth & Assor, 2012). When looking at the effects introjected regulation has for the motivated behavior, somewhat more enduring effects than with external regulation can be observed. Regulation by introjection is an intrapersonal regulation, not necessarily requiring external input. Even though it might lead to somewhat more behavioral perseverance, it comes at an emotional cost with self-esteem being more unstable as its related to achievement and performance and one's internal evaluation (Paradise & Kernis, 2002; Ryan & Brown, 2006). Even though introjection is a somewhat more internalized forms of motivation, it represents a less volitional motivation than the following autonomous forms of regulation as it is perceived by the person as an internal control (Ryan & Deci, 2008). It represents self-control but not true self-regulation, e.g., goals, values or behaviors introjected from others might be adopted as one's own but without truly identifying with it and reflecting how it fits with one's own values and goals, thereby leading to inner conflict and reflecting only partial internalization. Introjected thus may lead to increased engagement but comes with emotional costs (van der Kaap-Deeder et al., 2016).

Identified regulation: A student that learns because they recognized how important it is to know the class content for their personal life at the moment or in the future. Even though it might not be fun to engage with this content, it is the conviction that it possesses an importance for a personally valued goal, e.g., one's future profession. When a person manages to consciously endorse and adopt the value of a behavior, they are driven by identified regulation. Acting out of the conviction that the outcome of a behavior entails personal relevance corresponds to an internal PLOC. Identified regulation is still considered extrinsic though, as the motivation does not derive from pleasure of learning itself but from concurring with the reasons for the behavior. But as one consciously understands the importance of the behavior and its results and therefore endorses the reasons for acting, it is considered a highly internalized form of extrinsic motivation (Vansteenkiste et al., 2018). Therefore, actions feel more volitional compared to less autonomous forms of motivation where one merely complies with external demands or internal pressures. Identified regulation is associated with increased behavioral persistence, vitality, engagement and positive emotions. It becomes especially relevant when behavior is not motivated by pleasure and excitement of the activity itself, but the behavior is still worthwhile and important for personal goals (Ryan & Deci, 2020; Vansteenkiste et al., 2018). However, also when identifying with "why" a student engages in a certain course it does not necessarily mean that the endorsed behavior is fully compatible with other needs, values or goals.

Integrated regulation: A student that has a strong conviction that learning about a topic that is currently covered is personally important and congruent with other goals that the students holds. The student manages to align their important values, like maintaining close relationships, with the learning behavior, for example by making sure that they spent enough time with important others. A further step in the internalization of behavioral regulations, now on a more

horizontal level, is the conscious embedding of the values and goals driving the behavior within one's identity. A behavior driven by integrated regulation represents the most internalized form of extrinsic motivation as it allows for the feeling of full integration. It means that the why of a behavior has not only been endorsed or identified with, but self-reflection and adaption of goals and values led to an integrated self, where a behavior is enacted wholeheartedly. Resulting in no inner conflict because needs, values and goals are aligned and the example student engaging in learning feels fully authentic (Ryan & Deci, 2006). Accordingly, integrated regulation and its associated self-compatibility of behavior is associated with improved self-regulation (Legault et al., 2007).

For a full picture of behavioral regulation, there is also the possibility of non-regulation, which is called *Amotivation* in SDT. A student that would not engage with the content, at least not with intentionality, represents an amotivated student. In other motivational theories the question is often if motivation is there or not and if so, how strong is the motivation. In other motivational theories that describe motivation as a quantitative construct Amotivation would thus represent the negative extreme, the lack of motivation. Through the lens of SDT it is possible though, that non-regulation, i.e., not engaging in a certain behavior, is a conscious choice (Vansteenkiste, Lens, et al., 2004). When a student sees important reasons not to engage in a certain behavior, not becoming active might even be autonomously motivated (Ryan & Deci, 2006). Commonly though, amotivation from an SDT perspective has two possible sources: lack of perceived competence or lack of autonomy (Pelletier et al., 1999). When a person believes that either the behavior has no consequences for a desired goal or the person feels incapable of performing the behavior effectively, the person will probably be amotivated due to a lack of

perceived competence. Similarly, when a person sees no value in the behavior or no meaningful outcome, amotivation will be the result as perceived autonomy is lacking.

When it comes to the regulation of human behavior we can thus conclude that besides non-regulation, extrinsic motivation forms a continuum from more controlled or external regulations towards more internal and autonomous regulations. A behavior is driven by external regulation when behavior depends on controlling external influences, introjected regulation describes regulation based on internal controls involving the ego and self-esteem contingencies, identified regulation means enacting a behavior because of recognition of its personal value and integrated regulation steers the behavior when the driving values are well integrated in one's other goals and values. Intrinsic motivation forms the end pole as a form of regulation that is autonomous entirely. The different forms of regulation are depicted along the continuum of self-determination in Figure 1.

This self-determination continuum is empirically testable with a quasi-simplex structure, predicting that regulations closer to each other correlate more strongly than regulations further apart (Guttman, 1954). These different regulations co-occur in complex behaviors but regulate the behavior to a different degree. A student could for example feel that they are learning to some extent because there is an exam in the end that needs to be passed, but also because they understand how some contents will help them in the future with personal goals. Thus when self-determined motivation of a person is assessed, all behavioral regulations for certain behavior are measured. To predict outcomes from these multiple forms of motivation occurring at the same time, an individual's relative autonomy index (RAI) can be calculated (Grolnick & Ryan, 1987). The RAI is calculated by subtracting the more controlled forms of motivation from the more autonomous forms of motivation, resulting in an individual score of relative autonomy that has

been shown to be very predictive of adaptive educational outcomes (Sheldon et al., 2017). Following this distinction of motivational qualities that vary from more to less self-determined, SDT also provides a description of universal psychological needs that need to be satisfied to allow for self-determined motivation. We therefore consider another mini-theory of SDT, the basic psychological needs theory, clarifying what the basic psychological needs for competence, relatedness and autonomy entail and how they can be supported by the environment.

2.2.3. ***Basic psychological needs theory***

In SDT, needs are not seen as acquired through socialization but as innate and universal for individuals of all ages and cultures and their satisfaction is predicted to be necessary for optimal human functioning and development (Ryan & Deci, 2017). It is also an assumption that the thwarting or frustration of these basic psychological needs for competence, relatedness and autonomy, in turn lead to ill-being and impaired functioning (Bartholomew et al., 2011). In the following the three needs will be briefly described.

Competence - The need for competence is based on the work of R. H. White (1959), who defined competence as the ability of a person to effectively influence their environment. With his idea of *effectance motivation* he proposed that humans have an innate tendency to be active and aim to have an effect on the world around them; to feel that they can produce effects. This includes an intrinsic satisfaction derived from feeling efficacious which stands in difference to the rather extrinsic satisfaction derived by the outcome one's actions produced as proclaimed in Bandura's (1977) notion of self-efficacy. The feeling of competence in SDT is somewhat dependent on feelings of ownership for a certain behavior, thus externally imposed behavior might only create a limited feeling of competence, even when effectively enacted (Ryan & Moller, 2017). The need for competence is thus satisfied when a person feels able to achieve

what they aim for, eliciting feelings of effectiveness (Chen et al., 2015). When a person feels incapable and rather experiences failure than being efficacious, the need for competence is frustrated.

Relatedness - The idea that humans possess a need for relatedness that makes them behave in a way will be accepted by others and makes them feel that they belong is based on the work of Baumeister and Leary (1995). As social beings, humans want to belong to groups they value and to matter to significant others (Ryan & Deci, 2017). Therefore, humans strive to avoid rejection and feel respected and appreciated by important others, which would be other students and the teaching personnel in higher education (Fedesco et al., 2019). However, being liked by other's for one's behavior does not necessarily satisfy the need for relatedness, it requires the perception of acceptance, care and mutual respect (Ryan & Deci, 2017). Similar to the need for competence, the care for others and being cared for needs to be unconditionally and happen autonomously to fully benefit human flourishing (Ryan & Deci, 2017). The satisfaction of the need for relatedness is thus expressed by feeling a close and honest connection to others that is mutual whereas the frustration of the need for relatedness is characterized by feelings of exclusion and loneliness (Ryan, 1995).

Autonomy - The need for autonomy is a central construct in SDT. It is based on work by DeCharms (1968) who proposed that intentional behavior is not always volitional. The perception of a behavior as willingly chosen correlates with the perceived locus of causality (PLOC), thus the degree to which a behavior is perceived as being regulated by the self. Autonomy reflects the feeling of being in control oneself, to own one's behavior and endorse it, instead of feeling pressured, coerced or externally controlled to behave in a certain way (Ryan & Deci, 2017). A behavior is perceived as autonomous when a person can fully identify with it

instead of merely executing what others impose. The acting person thus perceives themselves as the source of the behavioral intention. Possessing a need for autonomy does not mean that humans strive for the independence of others but rather that it matters if a behavior is perceived as originating within oneself, with volitional endorsement or if it, or if it rather feels like complying with external control. It is thus possible to follow the instructions of another person, e.g., the instructor in one's university course, with a feeling of volition and self-determination when understanding and accepting the reasons for the instructed behavior. The need for autonomy is thus satisfied when a person feels that they are "owning" their behavior, acting in a way that is congruent to their self and feeling that they have choice and options. Feeling coerced and being told what to do on the other hand comes with frustration of the need for autonomy, e.g., when the instructor in one's university course enforces compliance by threats or induction of guilt.

The satisfaction of those three basic psychological needs for competence, relatedness and autonomy contributes to the internalization of behavioral regulations and therefore provides a possibility for social agents to promote self-determined motivation by supporting need satisfaction. How the social context in education can satisfy these basic psychological needs and why the support for autonomy plays a special role in the process of internalization will be discussed in the following paragraph.

2.2.2.1. **Autonomy-support and internalization**

The internalization of behavioral regulation towards more self-determined forms of motivation can be facilitated by the social context in education, i.e., how a course and a class are designed as well as by the interaction with social agents that can support basic psychological need satisfaction. Teachers or docents that provide *structure* (e.g., formulate clear expectations,

provide helpful feedback) support students' competence satisfaction (e.g., Mouratidis et al., 2013; Niemiec & Ryan, 2009). When being *involved* (e.g., allocating time or resources for students, show a caring attitude) teachers support students' need for relatedness (e.g., Niemiec & Ryan, 2009; Sparks et al., 2016). Teacher's *autonomy-supportive* behaviors (e.g., prioritize students' perspectives instead of enforcing the teacher's view, minimize control and offer choice and options instead) will support students' satisfaction of their need for autonomy (Niemiec & Ryan, 2009; Reeve, 2016). When feeling not competent enough, students will not engage in a behavior. As was discussed earlier, lack of competence is a possible reason for amotivation. Similarly, a connection with others is important and a student will rather engage with input from teachers or docent they feel close to or cared for by (Fedesco et al., 2019). However, for internalized forms of motivation, autonomy is an indispensable condition (Ryan & Deci, 2017). Students that experience satisfaction of their needs for competence and relatedness might still only engage in a course to show others or themselves that they are good enough, or try to not disappoint others expectations. For true self-regulation to happen, a satisfaction of the need for autonomy is crucial, students need to "own" and endorse the learning behavior (Vansteenkiste et al., 2018). As autonomy-supportive behaviors include adopting the student's perspective and as the beneficial effects of relatedness and competence satisfaction do rely on at least some degree of autonomy, support for the need of autonomy is expected to go hand in hand with increased satisfaction of all three basic psychological needs (Ryan & Deci, 2017). Regarding the interventions that were applied in the studies presented, the focus therefore was on supporting student's need for autonomy to foster their internalization towards more self-determined motivation. In the following, the characteristics of autonomy-supportive teaching will be shortly discussed and the importance of personal relevance for the internalization process highlighted.

Ryan & Connell (1989) found first empirical support that teacher's autonomy-supportive behavior, led students to report more internalized forms of motivation, especially to more identified regulation. An autonomy-supportive teaching style is mostly empathic, attuning to the student including matching the pace of the learning to students' capabilities but also aiming to connect learning content to the student's interests (Reeve & Cheon, 2021). Autonomy-supportive teaching means thus adopting a student's frame of reference, allowing the student to be themselves by acknowledging their feelings and caveats and offering them choice and options (Katz & Assor, 2007; Patall et al., 2008; Reeve, 2016). Even when no choices can be offered and the learning content might not elicit students' interest, students can feel autonomous and volitional: Teachers and docents can support student's autonomy by accepting and acknowledging potential negative feelings and by providing them reasons for the behavior adopting the student's frame of reference while relying on non-controlling language when communicating (Assor et al., 2002; Reeve et al., 2002). In an early experiment Deci et al. (1994) found that student's better internalized their behavioral regulations for engaging in a boring task when their negative feelings where acknowledged, they were provided choice and they received a rationale that gave them an idea of how the task could be meaningful to them. Providing rationales explaining to students explaining why a certain content is important to learn constitutes a common ingredient of autonomy-supportive teaching and it possesses a special importance for the process of internalization, as will be discussed in the following paragraph.

2.2.2.2.**The role of personal relevance**

When a student does not see any personal value in a behavior, that student would probably not willingly engage with this behavior at all (Legault et al., 2006). For internalization to happen, it needs to be clear to the learner which value the activity holds for them and why it is

important to a current or future goal, especially when the content does not possess an intrinsic appeal (Jang, 2008). When aiming to support internalization, i.e. the active process of transforming behaviors, values and goals into one's own, personal relevance represents a crucial ingredient for internalization (Vansteenkiste et al., 2018). Even though relevance is often described and operationalized slightly differently, a common denominator is it's description as *meaningful connectivity* (Hartwell & Kaplan, 2018). Priniski et al. (2018) advocate to differentiate relevance on a continuum of personal meaningfulness, with personal association; personal usefulness and identification. When a content can be related to an interest, experience or memory that one has, the relevance relationship would be described by personal association. If the content is perceived to help with attaining a personal goal, the relationship would be described by personal usefulness, whereas for identification, the engagement with the content needs to be perceived as an expression of one's identity. Similarly, Hartwell and Kaplan (2018) state that a mere logical connection between two contents does not lead to personal meaningfulness but that a link to some aspect of the self is necessary. In education, this form of personal meaningfulness can potentially change the focus of a learner from checking if they understood to investigating how they relate to the content, allowing for agency and self-reflection (Cooper, 2014; Kaplan et al., 2014). Self-relevance in learning opens up reflections about how learning contents relate to a future self and provides an impulse for self-exploration and therefore an important precursor for internalization, as identification and integration in SDT are characterized by connections to and harmonization of one's values and goals (Flum & Kaplan, 2006; Kaplan et al., 2014; Vansteenkiste et al., 2018). College students concur with other stakeholders in the educational system about the relevance of academic institutions to prepare for future careers (Langer Research Associates, 2022), however when asked about how

their learning contents are relevant, different relevance-connections emerged (Pisarik & Whelchel, 2018). Relevance statements regarding how a content or course is necessary or required for a future career was equated to external regulation in SDT terms and came along with a perceived lack of autonomy as well as negative affect when learning. However, when students felt that knowledge or skills acquired were not relevant because they would help to get a job, but rather because they help doing a job better and be more effective in one's future profession, this was seen as internalization by identification (Pisarik & Whelchel, 2018). These findings corresponds to the claim of SDT that relevance connections between a learning content and a future goal promote internalization mainly when the goal content is intrinsic (personal growth, helping others) rather than extrinsic (materialistic goals, striving for power; Sierens et al., 2009).

The provision of rationales explaining the relevance of learning contents for students' personal life or future academic or professional career is therefore a typical component of autonomy-supportive teaching and as discussed before, is of special importance when dealing with courses or contents that may not elicit students' immediate interests (Assor et al., 2002). In an extensive meta-analysis, Steingut et al. (2017) found that rationale provision led to autonomy satisfaction, increased task value and engagement and was especially effective with uninteresting topics or activities. However, they also concluded that only few studies tested the effects of rationales in isolation. Further, they proposed that not all rationales provided by teachers or docents are necessarily accepted by students, or match what they perceive as being useful or personally relevant for them. An externally provided rationale may even be interpreted with a different functional significance (Deci & Ryan, 1985), carrying the possibility to be perceived as controlling when a student feels that its intention is to steer them in a certain direction (Vansteenkiste et al., 2018). Instead of being provided with a rationale that potentially misses the

students view on how contents are important for their personally held goals, students can also generate connections between taught content and their lives themselves (Hulleman et al., 2010) which might represent a more autonomy-supportive way to create relevance connections (Yeager et al., 2014).

To conclude, when developing interventions with the aim to support self-determined motivation by fostering student's internalization, it is crucial to ensure students perceive the contents to be self-relevant. Before translating these theoretical foundations into practical measures, the next section highlights the role that self-determined motivation plays in higher education and the goal of interventions designed to strengthen student motivation.

2.3. **Self-determined motivation in higher education**

When learners in (higher) education learn with intrinsic motivation, i.e., without external incentive but from the joy of learning, this is associated with positive emotions, better learning outcomes, and voluntary engagement (e.g., Gottfried et al., 2017; Howard et al., 2021). The autonomous engagement of young children in play and discovery that is intrinsically motivated seems to decrease in educational institutions where levels of intrinsic motivation drop, the more children and young adolescents progress (Gnambs & Hanfstingl, 2016; Otis et al., 2005). It is clear, that in education, not all topics or subjects will meet the individual interests of each student. As many of those topics still possess a relevance for the participation in society or the professional activity one is studying for, extrinsic forms of motivation will need to regulate the behavior at least to some extent (Ryan & Deci, 2020). This extrinsic motivation can vary regarding its degree of internalization and the corresponding degree of self-determination, leading to more or less adaptive learning outcomes (Howard et al., 2021). Recently, Kukita et al. (2022) found in an experience sampling study that regardless of what type of activity humans

engaged in (study, work, leisure), it is the degree of self-determination, i.e., the feeling of wanting to do the activity rather than having to do it, that is most important in determining whether positive affect, engagement, and meaningfulness are experienced. As described in the following, depending on the quality of motivation with varying degrees of self-determination that motivates learning, different consequences can be expected. In a comprehensive meta-analysis, learning for an external condition such as an exam was found not to be related to performance, but to lower student well-being (Howard et al., 2021). When ego is at play and students want to avoid disappointing the expectations placed on them by others, or when they want to prove to themselves that they are capable, they are more likely to take on performance goals and show more persistence, but at the expense of ill-being (Howard et al., 2021). Thus, it is possible to encourage students to learn through external incentives (e.g., course credit tied to attendance and passing an exam) or through internal pressures (e.g., creating internal pressure by tying positive esteem to meeting expectations). However, more internalized and self-determined forms of motivation are needed if the skills and knowledge taught are to be transferred to other contexts and the behavior learned is to be maintained (Chan et al., 2015; Ryan & Deci, 2008). Accordingly, if the goal is to have self-determined students who willingly engage with a subject, other forms of motivation are needed in higher education (Vansteenkiste et al., 2012).

More self-determined motivation has been found to lead to increased vitality and effort in students as well as improved learning with a focus on deep learning strategies (Legault & Inzlicht, 2013; León et al., 2015; Orsini et al., 2018). Legault and Inzlicht (2013) even showed that autonomous motivation led to improved self-regulation by increasing the brain’s sensitivity to situations where self-regulation failed. Other studies found that more autonomous motivation in language learning students was related to better planning of study time and decreased risk of

dropout (Vansteenkiste, Zhou, et al., 2005); in mathematics more self-determined motivation led to deep learning and increased engagement and perseverance (León et al., 2015). Especially important: self-determined motivation predicted the development of self-determined motivation to engage with the content or behavior outside of the learning context and the intentions to do so (Chan et al., 2015; Hagger & Chatzisarantis, 2016; Wang et al., 2020). It becomes clear that even though intrinsic motivation is highly desirable, internalized and thereby self-determined forms of extrinsic motivation play an important role in educational motivation. When students in high school suddenly had to work in a self-regulated manner due to school closures because of the Covid-19 pandemic, it was the degree to which they saw value for their future life in their mathematic homework that predicted the time they spent working on it (Combette et al., 2021). Underscoring this finding, Howard et al. (2021) found that the unique contribution of identified regulation, i.e., learning because it is personally important, to adaptive educational outcomes was particularly high. The extent to which our natural tendency to internalize and integrate the reasons for our behavior into our personality is successful is the result of an interaction between our own personality and influences from the environment, including those from important socialization agents (Deci et al., 1994). These socialization instances, in higher education this would be the instructor or course coordinator, can support students' natural tendency to internalize why they are studying for a course that initially holds little interest. The instructor promotes internalization by supporting the satisfaction of students' basic psychological needs for competence, relatedness, and autonomy (Vansteenkiste et al., 2018). Learning in higher education, even when learning due to external influences such as an exam or attendance obligations, always requires a minimum level of competence. For example, if a learner does not see any possibility of mastering the challenges of the study program with his own abilities, this

would be a possible source of *Amotivation* (Legault et al., 2006). In order for introjected regulation, i.e., internal pressure because, for example, one wants to prove to one's fellow students that one is smart enough, one must feel connected to others in addition to a minimal level of competence. So that their expectations and thoughts are important enough to lead to this form of internal control. (Ryan & Deci, 2017). The step toward fuller internalization through identification or integration requires the learner to actively reflect on and endorse the reasons for and value of the content and skills being acquired, depending on the contextual supports the need for autonomy (Vansteenkiste et al., 2018). Thus, it is need-supportive behavior by teachers or instructors, such as rationale for action or offering choices, that promotes need satisfaction in their students and enables self-determined motivation, which in turn is associated with positive learning outcomes (Gilbert et al., 2021; Jeno et al., 2021; Leenknecht et al., 2017). This process describing the sequential and consecutive influence of need-support, need satisfaction and self-determined motivation, as depicted in Figure 1, was recently corroborated in a large study with more than 30.000 students (Yu & Levesque-Bristol, 2020). Within this doctoral thesis I want to apply interventions that draw on these finding, enabling students to adopt self-determined motivation by recognizing how contents possess self-relevance and further by creating a more need-supportive course environment.

3. INTERVENTIONS FOR DBDM

When having the course about data-based decision-making (DBDM) in mind, knowing that it does not match the interest of some students the question arises: with which motivation will students learn and how can they still be motivated in a way that allows them to self-regulate their learning and prepare them to take the initiative when needed in their future profession?

Students often show lower interest and negative attitudes towards research and method courses in general (Murtonen et al., 2008), making learning out of intrinsic motivation less probable. Teaching students often see little value in the course contents of methods and statistics courses like the target course about DBDM, not recognizing the importance of educational research or knowledge and skills about scientific methods and statistics for their practice (Haberfellner & Fenzl, 2017; Thomm et al., 2021), which also decreases the probability of identified or integrated regulation to learn. The motivation for the learning in these courses will thus probably be less autonomous and rather dominated by controlled forms of behavioral regulations, as students learn because they need to get a pass for the course or are maybe ego-driven, attempting to prove themselves or others that they are good students. When being regulated by external contingencies, like an exam, continuous learning or application of DBDM will probably not be shown without external influenced present. Further, autonomous motivation for DBDM in other contexts like the future job of teaching students in school is unlikely and the implementation in one's future practice as a teacher, is improbable (Hagger & Chatzisarantis, 2016; Wang et al., 2020).

Even though intrinsic motivation might not be easily achievable under these circumstances, the course does contain a value to student's goals as teachers and students might be supported with internalizing their behavioral regulations, identifying with the value that learning for this course can have (Vansteenkiste et al., 2018). A motivational intervention should therefore aim to clarify the value that the knowledge of course contents has for students, similar to a rationale that is part of an autonomy-supportive teaching approach. A rationale supports internalization when the goal content connected to is an intrinsic one (e.g., personal growth, helping others, doing a job better) rather than an extrinsic one (materialistic goals, striving for

power; Sierens et al., 2009). An intrinsic goal when learning for DBDM could be to provide high-quality teaching to future students, a core benefit and argument for the international incorporation of DBDM into teacher curricula (e.g., EC, 2007; OECD, 2005). Thus, an intervention is needed to ensure that students have a first important prerequisite for the internalization process toward more self-determined motivation: recognition of the personal relevance.

A second important prerequisite to allow for internalization is a need-satisfying learning environment (Vansteenkiste et al., 2018). As discussed with the Organismic Integration Theory before, psychological need satisfaction is an important facilitator of internalization and SDT predicts that reflection about the personal relevance of a behavior will facilitate internalization more effectively when accompanied by basic psychological need satisfaction (Vansteenkiste et al., 2018). The impact of an intervention targeting students' relevance beliefs could thus be strengthened by another need-supportive intervention embedded in the course environment. In the course about DBDM, students are provided regularly with written feedback regarding their learning progress and their self-regulated learning measured with a *formative assessment* (Black & Wiliam, 2009; Clark, 2012). This student-docent interaction, if designed to meet students' basic psychological needs, offers another way to promote self-determined motivation. Additional to creating a supportive climate for the intervention targeting student's relevance beliefs, this second intervention is attempting to support student's SRL with need-supportive feedback. In the following paragraphs I will briefly elaborate on these two interventions, prior research in the field and unaddressed gaps in the research that I attempt to close.

3.1. **Relevance intervention**

The idea of targeting the perceived connections between learning contents and personal goals to motivate learners has already left its mark on intervention research within different approaches to motivation. When these interventions are based on solid psychological theories and attempt to change the way individuals make sense of situations they find themselves in, they can be considered “wise interventions” (Walton & Wilson, 2018). Especially when tasks are perceived as less interesting per se, increasing their personal meaningfulness seems to be a promising approach potentially leading to long-lasting changes in personal and psychological constructs (Priniski et al., 2018; Walton & Wilson, 2018). Researchers have applied this idea in intervention research with different names and operationalization, depending on the underlying theoretical understanding (e.g., “utility-value interventions”, Hulleman et al., 2010; “purpose interventions” Yeager et al., 2014; or “rationale provision”, Reeve et al., 2002). The following paragraphs provide a brief summary of prior research with relevance interventions stemming from different motivational theories, highlight research done so far with interventions targeting relevance from the lens of SDT and ends by identifying gaps that this work attempts to fill.

3.1.1. ***Relevance in different paradigms***

Next to SDT, much of this research has happened within the framework of Expectancy-Value Theory (EVT, Wigfield & Eccles, 2000). EVT conceptualizes motivation as a rather quantitative concept, i.e., people differ in how much motivation they develop. According to EVT, the extent of motivation results from the product of the expectation of success with regard to a desired outcome and the value that this outcome has for the person acting. In this paradigm, the utility-value is targeted as a part of the value component with utility-value interventions (UVI, Hulleman & Harackiewicz, 2020). These interventions aim at increasing motivation by increasing the perceived instrumental value the outcome of a certain behavior has. EVT thus

conceptualizes relevance as perceived instrumentality, i.e., the perception that a behavior is helpful in achieving personal goals (Eccles, 2009). These utility-value interventions are often writing assignments in which students reflect on the utility of a learning content to their personal lives in the form of an essay or letter to another person (e.g., Hulleman et al., 2017).

In an illustrative experimental study, Hulleman et al. (2010) asked students in an introductory psychology course to write two essays during the semester. The experimental group was asked to explain in a letter to a person close to them how a self-selected content from the course related to that person's life; the control group summarized the content. By the end of the course, the experimental group showed increased interest in the course topic, improved performance, and were more likely to choose the course topic as their major. Similar utility-value interventions have been used in various school and university settings, with different formats, such as students reading and reflecting on other-generated information about utility, students rating various statements about the utility of a topic, generating their own information about utility, or a combination of these (Canning et al., 2017; Canning & Harackiewicz, 2015; Hulleman & Harackiewicz, 2020).

Another example of an applied intervention from education that attempts to enhance learners' academic performance by changing the meaning they ascribe to the learning content is the purpose for learning intervention (Yeager & Bundick, 2009). Theoretically the purpose intervention is based on work on identity (e.g., Arnett, 2000; Erikson, 1968) and life purpose (e.g., Damon, 2009a, 2009b). The purpose intervention is considered a wise intervention, similar to utility interventions, in that it seeks to change the way social situations, in this case learning situations, are interpreted and thus constructed by students. In an experimental study with first-year psychology students, Yeager et al. (2014) asked students to write an essay on a self-

transcending topic and induced a perceived norm of self-transcending attitudes among students with feigned survey results. Finally, he asked students to make their own connections between what they learn in a course and how it can serve a self-transcending purpose in a testimonial for future students. The purpose intervention improved college students' deep learning compared to a control group, however, the intervention was rather time-consuming, lasting around 25 minutes. These brief interventions, which aim to change psychological processes and support adaptive construal of reality, are considered to be highly context-dependent (Walton & Yeager, 2020). When designing targeted psychological interventions, it is important to identify relevant psychological processes and influencing factors in learning situations and consciously modify them based on theoretical knowledge (Walton & Yeager, 2020). In our case, previous research with student teachers confirms that students often do not recognize the value hidden in the content of DBDM which is perceived as a rather tedious task. SDT provides an adequate theoretical framework that describes how, through the process of internalization, students can be assisted in changing their "have-to motivation" to a "want-to motivation" by recognizing their "purpose of learning".

3.1.2. ***Relevance interventions in SDT***

In the EVT paradigm utility-value corresponds to the concept of usefulness, i.e., the extent to which the activity is a means to an end, similar to the concept of extrinsic motivation in SDT (Eccles & Wigfield, 2002; Wigfield et al., 2009). From the perspective of SDT, however, not every useful activity is necessarily self-relevant, meaning that a utility intervention does not necessarily promote self-determined motivation. For example, a behavior may be seen as useful to achieve an externally imposed or introjected goal (e.g., learning about research and statistics in a course on DBDM because it is helpful for the thesis or because it is important to be an

exemplary teacher), which is more likely to support external or introjected regulation (Vansteenkiste et al., 2018). For true internalization, it is important that the activity is not only useful but personally meaningful for the learner. Therefore, only rationales that are autonomous, because they allow personal identification with the behavior, will lead to internalization (Steingut et al., 2017; Vansteenkiste et al., 2018), making it important to look at relevance interventions from an SDT perspective. This is exemplified by a study from Vansteenkiste, Simons, Lens, Soenens, et al. (2004), who found that learning about recycling strategies was better promoted when the content was linked only to an intrinsic goal (e.g., support of the community) than when it was linked to an intrinsic goal and an additional extrinsic goal (e.g., monetary reward). Some other studies underscore the role of relevance perception in the process of internalization. An early experimental study by Deci et al. (1994) showed that college students engaged more in a boring activity during a free-choice period after the experiment when they performed that boring activity in the previous laboratory study under autonomy-promoting factors, including the provision of a rationale. However, only few studies have examined the provision of rationales and their effects in isolation, and Steingut et al. (2017) found no clear effects on autonomous motivation in their meta-analysis. However, the observed effects on subjective task value, engagement, and autonomy satisfaction seem promising, and the provision of rationales seems to have a more powerful effect on uninteresting tasks. In one of the few studies to test the potential of a rationale in isolation to promote internalization, Reeve et al. (2002) created a lesson in "conversational Chinese" in an uninteresting format and asked students to participate in it. Piloting revealed that the lesson was perceived as having little relevance to the students' lives and as being rather boring. All students received the same lesson, but either no information about how the lesson might be useful in the control group, or a rationale that

emphasized the benefits to the students' future work as teachers in the experimental group by explaining that they would be most likely to have a Chinese-speaking child in their future class. The rationale was framed in a way that supported student autonomy by using language that was non-controlling or inviting (e.g., "you can" instead of "you should") and acknowledged and accepted possible negative feelings that the task might evoke in students. Students who received the rationale reported that they ended up seeing more relevance in the task, showing more self-determined motivation, and putting forth more effort. In another study, Jang (2008) observed that student teachers who were presented with rationales in an autonomy-supportive way prior to a lesson on correlations presented in an uninteresting way showed greater conceptual learning and were observed to invest more effort. In this study, it was identification with the uninteresting learning content in particular that mediated the effects of the rationale on student behavior, underscoring the relevance of supporting student internalization and the potential of drawing on internalized forms of extrinsic motivation when dealing with uninteresting topics.

Thus, it can be summarized that the provision of relevance plays an important role in self-determination theory and its account of supportive teacher behavior. So far, only a few findings on the effect of relevance in isolation exist, which on the one hand are very promising, but on the other hand still warrant longitudinal testing in real learning contexts, as will be further elaborated in the following section.

3.1.3. ***Research gaps***

Research with SDT has thus already provided initial evidence of how rationales that convey information about the personal relevance of a rather uninteresting activity can support the internalization of students' motivation. Although there is some experimental evidence, it is of lower ecological validity due to the lesson lasting only a few hours and being set up only for the

experiment. Therefore, the question remains as to what effect a rationale implemented in the actual university curriculum would have. The first study was designed to fill this gap and also to test the potential of a relevance intervention in which students themselves make the personal connections between learning content and an important future goal, rather than having an external agent provide the rationale. Further, even though the lesson about correlations used by Jang (2008) was embedded in the regular curriculum, increasing ecological validity compared to experimental studies outside the regular educational context, the effect of a relevance intervention has yet to be tested in a longitudinal field experiment in higher education. With the relevance intervention, a promising and short instrument for promoting students' self-determined motivation was tested and applied. The next step was to improve the motivational impact of the relevance intervention on student learning by supporting students' self-determined learning (SRL) in an autonomy-supportive way. Study 2 therefore focused on the written feedback framing that students received during the course.

3.2. **Feedback framing intervention**

To further support the internalization that the relevance intervention aimed for and its impact on student learning, I developed a second intervention based on the principles of SDT that would fit the setup of the course. Studies investigating the relationship between the quality of motivation and academic achievement in higher education found that improved SRL is an important mediating factor, meaning that more self-determined students are not only more engaged, but also more likely to self-regulate their learning (e.g., Kusurkar et al., 2013; Luo et al., 2021). The following, therefore, briefly describes the framework that the course design provided for students' self-regulated learning and then goes on to describe a possible role of feedback in this process and how SDT principles can help in making feedback effective. While

following the course about DBDM, students were offered several formative assessments in the form of learning progress tests that consisted of multiple-choice questions for students to monitor their learning progress and engage with SRL (Black & Wiliam, 2009; Clark, 2012). SRL means that a learner actively sets goals, decides on strategies to achieve those goals, and evaluates and adjusts their learning behavior accordingly (Zimmerman, 2000). Therefore, students were prompted throughout the course to set goals and plan for learning, including time allocation and learning strategy selection. To support this process, learners can receive feedback not only on their performance, but also on the way they learn, to help them better manage their own learning (Butler & Winne, 1995). Students would thus receive feedback on their SRL and could adjust their learning behavior accordingly. How could feedback be given in such a way that students' self-determined motivation is supported and they willingly engage with the feedback, even if it is often negative and they have to adjust their learning behavior?

3.2.1. ***Feedback and motivation***

Feedback is a common form of interaction between students and faculty in higher education and it is well known that feedback is not only highly valued by students but also has tremendous potential to positively impact learning (Kluger & DeNisi, 1996). However, meta-analyses on feedback show large variations in observable effects and even negative effects; indicating that how feedback is given matters. (Hattie & Timperley, 2007; Wisniewski et al., 2019). Previous research on the motivational effects of feedback has often distinguished feedback by valence, with positive feedback representing a favorable evaluation, while negative feedback, also referred to as change-oriented (Carpentier & Mageau, 2013) or corrective feedback (Mouratidis et al., 2010), informs that standards are not being met and that behavior may need to be adjusted (Askew & Askew, 2000; Kluger & DeNisi, 1996). This research on the

motivational implications of feedback suggested that positive feedback increases intrinsic motivation (Deci, 1971; Hagger et al., 2015; Mouratidis et al., 2008), but negative feedback, transmitting the information that things need to be changed, often does not (Fong et al., 2019; Mabbe et al., 2018). When providing feedback on students' SRL, however, the feedback often needs to be corrective and students need to engage with the negative feedback, i.e., adjust their learning behavior. Students must read it, take it seriously, and adjust their learning behavior accordingly (Winstone et al., 2017). So how can feedback that also gives students negative information about their learning process and prompts them to adjust their learning best be designed so that students don't just actively engage with it because of external control, but do so with more self-determined forms of motivation?

3.2.2. ***Autonomy-supportive framing***

From the point of view of SDT, feedback can have different motivational effects. As discussed in the context of cognitive evaluation theory (CET), actions of external agents, such as feedback given in response to learning behaviors, can be interpreted by the receiver with varying functional significance and thus determine motivational impact (Deci et al., 1994). Feedback can be interpreted as more controlling, for example, because it imposes a certain view on the recipient or commands certain actions. However, feedback could equally be interpreted as autonomy-supportive if it merely provides information and invites action, making the experience of an internal perceived locus of causality (IPLOC) more likely. Accordingly, the way a message is framed can affect how volitional people feel when they respond to it and how persistent this adaptive behavior will be shown (Pope et al., 2018). Under the SDT framework, messages framed in an autonomy-supportive rather than a controlling way are more likely to persuade the recipient and make them engage with the message while retaining a feeling of self-determination

(Bradshaw et al., 2021; Smit et al., 2019). In the educational context, interacting in an autonomy-supportive way means the “interpersonal sentiment and behaviors teachers provide during instruction to identify, nurture, and develop student’s inner motivation resources” (Reeve, 2009, p. 160). Thus, by providing rationales that refer more to the learner's intrinsic goals (e.g., learning, growing, helping others) and explaining how and why the information reported back is useful and personally relevant, feedback allows the recipient to embrace the feedback's content with a feeling of self-determination (Reeve et al., 2002). Adopting the perspective of the person receiving a message also means acknowledging what negative feelings the message might elicit (Reeve, 2009). To further support the self-determination of the receiver, non-controlling language (use of inviting words like “you can”, “you might”) is preferred to controlling language (use of prescribing language such as “you should”, “you need to”, “you have to”) in formulating the message (Reeve, 2009). Another importance aspect of autonomy-supportive message framing is the provision of choices and options and to encourage self-initiative and the making of one's own decisions (Katz & Assor, 2007). In contrast, controlling message framing involves the sender imposing his or her opinion or view on the receiver while getting the receiver to comply by evoking guilt and appealing to external expectations or threats (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). While relying on controlling language, rationales are either not provided or only rationales related to extrinsic goals (e.g., complying with external demands, satisfying the expectations of others) are used (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004).

These SDT principles have been applied and tested when framing health messages attempting to support patients' self-determined motivation to adhere to treatments (Altendorf et al., 2019; Martela et al., 2021; Smit et al., 2019) or to promote more autonomous adherence to

disease prevention guidelines during the recent Covid-19 pandemic (Bradshaw et al., 2021; Martela et al., 2021). In the educational setting, instructions have been formulated in an autonomy-supportive way leading to improved (conceptual) learning (Hooyman et al., 2014; Vansteenkiste, Simons, et al., 2005), less cheating (Pulfrey et al., 2019) and more self-determined motivation and satisfaction of undergraduate students' need for autonomy (Baker & Goodboy, 2019). When presenting students with a syllabus, outlining a potential higher university course in autonomy-supportive or controlling language, Young-Jones et al. (2019) found that students reading the course manual in autonomy-supportive language reported to value the course more, reported higher perceptions of autonomy and competence satisfactions and increased intentions to take this course compared to students who read a controlling syllabus. Similarly, Baker and Goodboy (2019) showed in an experimental study that a pre-recorded lecture taught in an autonomy-supportive way resulted in students reporting higher intrinsic motivation, greater effort, and higher intentions to take future courses with the instructor than students who attended a lecture without autonomy-supportive instruction. The lecture delivered in an autonomy-supportive way included the provision of rationales for why students needed to do certain things or the provision of choices in the use of materials.

Those studies, however, did not explicitly incorporate feedback, but applied autonomy-supportive framing to the language of instruction or the wording of a message. In one early experimental study that investigated feedback framing, Ryan (1982) showed that positive feedback, normally conducive to intrinsic motivation, can undermine students' intrinsic motivation when framed in a controlling manner. However, only few studies have tested the potential of autonomy-supportive framing for the acceptance and engagement with feedback, especially negative feedback. One such exception in the school context is the study by Mabbe et

al. (2018), who experimentally tested how positive and negative feedback affected young adults solving a puzzle task when the feedback was phrased in either an autonomy-supportive or a controlling way. Next to positive feedback, having the most favorable effect on learner motivation, it was an autonomy-supportive communication style of feedback that led to increases in interest, autonomy and competence satisfaction, and also intrinsic motivation, albeit to a lesser degree. A few other studies explicitly looking at communicating negative feedback in an autonomy-supportive way can be found in the sports context. In a diary study, Carpentier and Mageau (2016) found that the degree to which change-oriented feedback was autonomy-supportive positively correlated with athletes' autonomous motivation, self-confidence, and satisfaction of needs for autonomy and competence. Similarly, Muynck et al. (2017) experimentally tested the impact of feedback valence (positive or negative) and communication style (autonomy-supportive or controlling) and found that when coaches gave their athletes feedback in a sport context, it was the degree to which the feedback was given in an autonomy-supportive way that was critical, relating to increased task enjoyment and perseverance. In summary, there are exciting findings from a variety of fields on the potential of formulating negative feedback, but very few from the field of education.

3.2.3. ***Research gaps***

Although there is promising research on how positive feedback provided in an autonomy-supportive way can contribute to self-determined motivation and engagement, little is known about the potential of autonomy-supportive framing for negative feedback requiring the adaptation of behavior (see Muynck et al., 2017 for a study in the sport context or Mabbe et al., 2018 for a study in elementary school). To our knowledge, no experimental study has yet tested how feedback for SRL can be framed in an autonomy-supportive way. Similarly, none of the

previously mentioned studies have tested the effect of autonomy-supportive feedback in a higher education context or over the course of an entire semester. All of the aforementioned experimental studies on the delivery of negative feedback took place on a single day, albeit in school- or university-like settings. I aimed to fill this gap by testing the potential of autonomy-supportive feedback for SRL over an entire semester in a regular university course.

3.3. **The contribution of my research**

The overall goal of this research was to help students in higher education become more self-determined learners. This involved finding ways to promote a sustainable motivation to learn that goes hand-in-hand with a willingness to actively manage the learning process and learn content with a future application in mind. The research presented therefore focused on practical implications for higher education teaching and increased ecological validity through experiments in which the interventions were directly applied to higher education teaching. I chose the course on DBDM for teachers as an uninteresting but important content for students to learn, as this is where the risk of less sustainable motivation is highest. The purpose of this research direction was to develop and evaluate two simple, brief interventions that could be easily implemented in higher education teaching.

In the first study, I used a relevance intervention in the course on DBDM in which students were asked to regularly reflect on how knowledge of a recently covered content of their choice is relevant to them as future teachers. With this longitudinal field experiment, I wanted to test whether this relevance intervention alone could promote students' self-determined motivation and engagement. Therefore, I hypothesized that the relevance intervention would improve students' motivational outcomes (*hypothesis 1a*) and also lead to improved learning in resulting in better performance on knowledge tests (*hypothesis 1b*).

In a second study, I attempted to build on the effects of the relevance intervention, as the desired higher perception of relevance is an important prerequisite for further internalization of self-determined motivation and thus for additional autonomy-supportive interventions. Consequently, students should be helped to translate their higher-quality motivation into better self-directed learning (SRL) and performance. To further support the impact of the intervention on students' SRL and thus performance, another intervention was added to the relevance intervention that targeted the feedback students received on their SRL. It was already part of the regular coursework that students were asked to report their SRL (e.g., goal setting, learning strategies) in the course during the three formative assessments. Students then also already received feedback on each of these reported SRL behaviors and performance in the three formative assessments. With respect to this feedback, we aimed to test whether students' SRLs and the motivational effects of the relevance intervention could be best supported if the feedback was framed according to SDT, i.e., in an autonomy-supportive way. Therefore, in a second longitudinal field study, the framing of the feedback, which students received (autonomy-supportive framing or a controlling framing) was experimentally varied. In addition, the experimental variation of the feedback was combined with the relevance intervention in a 2x2 design to test what effects the interventions had individually, but also in combination. My hypotheses, additional to the one’s from study, were that also the feedback framing intervention would contribute separately to improved motivational outcomes (perceived relevance, self-determined motivation, satisfaction with autonomy; *hypothesis 2a*) and improved SRL (including goal setting, learning time and strategies, self-assessment accuracy, performance; *hypothesis 2b*). Further, I expected that the two interventions would also interact and lead to the most positive

motivational (*hypothesis 3a*) and SRL outcomes (*hypothesis 3b*) in combination, in line with the importance of relevance as a prerequisite for internalization.

A third study sought to investigate the precise mechanisms of action of feedback with autonomy-supportive framing and its potential when studied in isolation. In the previous study, feedback was automatically individualized based on students' learning behaviors using pre-formulated text elements, resulting in each student receiving a unique combination of feedback. In order to look exclusively at the effects of different framing, feedback was adjusted to learning behavior data equally for everyone rather than at the individual level. Using the average data on student SRL behavior from the previous study, two versions of prototypical feedback were created, one in autonomy-supportive framing and one in controlling framing. In a vignette experiment with between-subjects design, student teachers were asked to rate the feedback in terms of its motivational effects and characteristics (including feedback perception, perceived need support, self-determined motivation). My hypothesis was that feedback phrased in an autonomy-supportive way would be perceived as more autonomy-supportive and would elicit more self-determined motivation (*hypothesis 4*). With regard to other need-supportive characteristics, an exploratory approach was taken and no hypothesis was formulated.

In the next chapters there will first be two articles that include the studies just mentioned. Subsequently, the findings resulting from the studies are discussed and the strengths and limitations of the research presented are elaborated. Finally, there are some important implications for future research with similar interventions and for application in higher education teaching including some suggestions for promoting self-determined motivation in teaching.

4. MY EMPIRICAL WORKS

4.1. Article 1

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Self-determined motivation for data-based decision-making: A relevance intervention in teacher training

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Self-determined motivation for data-based decision-making: A relevance intervention in teacher training

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Abstract: While teachers' core responsibility is to provide high-quality instruction, they are also expected to engage in data-based decision-making (DBDM), e.g., to analyse and use data to improve instruction. We developed a relevance intervention to promote student teachers' self-determined motivation and application intentions for DBDM and implemented it into a large compulsory university course. In a randomized controlled trial, participating students were either repeatedly prompted to reflect about the relevance of DBDM contents (relevance-condition) or asked to summarize DBDM contents (summary-condition). Students in the relevance-condition reported more self-determined forms of motivation, more autonomy-satisfaction, were more willing and self-confident to apply DBDM as teachers than students in the summary-condition. The intervention's effect on application intentions was fully mediated by an increase in self-determined motivation. Students' knowledge of DBDM could not be increased by the intervention. Implications for improving university educational training for student teachers are discussed.

Subjects: Teaching & Learning; Initial Teacher Training; Teacher Training; Teachers & Teacher Education

Keywords: Data-Based decision-making; self-determination theory; relevance intervention; teacher training; application intentions; field experiment

University students who aspire to become classroom teachers are often highly motivated to engage with the content of their teaching subjects and to learn how to act pedagogically, to effectively support student learning (e.g., Rutsch et al., 2020). However, student teachers are typically less motivated to engage with learning content that is the basis for data-based decision-making (DBDM, Heitink et al., 2016; Murtonen et al., 2008). DBDM means the systematic gathering, analysis, and evaluation of empirical data, with the goal of examining one's own

PUBLIC INTEREST STATEMENT

Data-based decision-making (DBDM) for teachers means that teachers use systematically collected information for controlling pedagogical processes when making important pedagogical decision. Acquiring the skills required for DBDM does not seem appealing to every student but is nonetheless important. To strengthen a motivation that originates within the learner, we asked teaching students in a regular university course about DBDM several times during the course to select a content taught in the course and reflect about how and why it might be relevant for their future teaching. Compared to a control group, students who had been encouraged to reflect on the content's relevance were more convinced that DBDM was relevant to their future profession, they described their learning motivation as more intrinsic and autonomous, and reported a stronger willingness to use and apply their skills for DBDM later as a teacher.

pedagogical practice, as well as the improvement of instruction and school effectiveness (Mandinach, 2012). DBDM has become an essential part of the teacher education curriculum to the extent that evidence-based school practice and teacher accountability have been called for by educational policy (e.g., Gogolin et al., 2020, for Germany where our study was conducted; Mandinach & Gummer, 2016, for the U.S.; Schildkamp et al., 2014, for Europe).

DBDM requires knowledge of empirical research methods and statistics, learning content that student teachers often experience as particularly difficult (Murtonen et al., 2008). Later in school, DBDM requires activities which are often not considered by teachers as part of their duties and require an extra time commitment, in addition to the core business of teaching, like for instance, the evaluation of their own teaching or the effectiveness of pedagogical interventions. For these reasons, students' motivation to engage in DBDM is often dominated by unfavourable, extrinsic, and non-self-directed forms, and their attitudes or intentions to incorporate DBDM into their own practice are often negative, too (Kippers et al., 2018; Murtonen et al., 2008; Sizemore & Lewandowski, 2009). With the goal of promoting more favourable forms of motivation and attitudes toward DBDM, we developed an intervention for students enrolled in a master program in teaching and implemented it into a course on DBDM, which is a compulsory part of the regular university curriculum for student teachers in Germany.

1. Promoting self-determined forms of motivation and positive attitudes towards DBDM

According to Self-Determination Theory (SDT, Deci & Ryan, 2000), students' motivation can vary in both, strength and quality. The theory postulates that human motivation varies regarding the degree of self-determination, with six forms of motivation being distinguished, depending on what is regulating the person's behaviour, or in other words, why a person is doing the behaviour. The varying types of behavioural regulations can be ordered on a continuum of self-determination, with a feeling of a complete lack of self-determination on the one hand, and a feeling of full self-determination on the other. The prototype of self-determined motivation is when the activity itself is experienced as rewarding. In our example this would be a student who learns about DBDM just because it satisfies their curiosity and the learning itself gives them pleasure (*intrinsic regulation*). The extreme on the lower end of the self-determination continuum, *amotivation*, can be illustrated by a student who perceives no intention and no reason to learn about DBDM at all. In between these two extreme forms of motivation lie four forms of extrinsic motivation (see Figure 1). Here, behaviour is driven by some outside influence or goal. For the two least self-determined forms of extrinsic motivation, *external regulation* and *introjected regulation*, outside forces need to be

The Self-Determination Continuum

Degree of Self-Determination	Less Self-Determined			More Self-Determined		
Type of Motivation	Amotivation	Extrinsic Motivation				Intrinsic Motivation
Type of regulation	Non-regulation	External regulation	Introjected regulation	Identified regulation	Integrated regulation	Intrinsic regulation
Internalization	Lack of internalization		Partial	Full	Full	Not required
Perceived self-relevance	None	Low	Medium	High	Very High	-

Figure 1. The self-determination continuum
***Note.* (Adapted from: Vansteenkiste et al., 2018)**

present for the behaviour to be executed, as is illustrated by a student who learns about DBDM mainly because they are afraid not to pass the final test (external regulation) or by a student who feels that it is what is expected from them by others, without truly identifying with the value of DBDM (introjected regulation). The two forms of relatively self-determined forms of extrinsic motivation, *identified regulation* and *integrated regulation*, refer to behaviours that originate more strongly within the person. For instance, a student may experience learning about DBDM as not inherently rewarding but still feel autonomously motivated as they identify with its personal importance, i.e., that DBDM can help improve their future teaching *(identified regulation)*. When brought into harmony with other personal values, e.g., an idea of how they want to work as a future teacher, the behaviour may even be perceived as an integrated expression of their identity and core values (*integrated regulation*). Hence, identified and integrated regulation together are considered as self-determined forms of motivation, despite their partly extrinsic qualities.

Self-determined motivation has been shown to be related to deep-learning strategies (Bailey & Phillips, 2016; Orsini et al., 2018), increased emotional engagement (Van der Kaap-Deeder et al., 2016), more self-regulated learning (León et al., 2015), and thereby also better academic performance (Bailey & Phillips, 2016; Cerasoli et al., 2014; Orsini et al., 2018; Ratelle et al., 2007). Self-determined forms of motivation have also been shown to be positively related to higher intentions to make use of newly acquired skills outside of the context they were learned in (Chan et al., 2015; Hagger & Chatzisarantis, 2016) and, more specifically, to correlate positively with teachers' willingness to implement innovations (Gorozidis & Papaioannou, 2014). In contrast, less self-determined forms of motivation were found to be associated with low perseverance, low effort expenditure, weaker performance (Bailey & Phillips, 2016; Cerasoli et al., 2014), and weaker intentions for application (Hagger & Chatzisarantis, 2016; Rump et al., 2017).

2. Strengthening the personal relevance of DBDM

As self-determined forms of motivation have been found to be related to more adaptive student outcomes, it is concerning that students show little interest in the topic of DBDM (Murtonen, 2005; Murtonen et al., 2008) and do not recognize its value for their later professional activity as a teacher (Haberfellner, 2017). According to SDT, a crucial precondition for internalization, i.e., for students to internalize a certain behaviour thus moving towards more self-determined forms of motivation, is that the behaviour possesses relevance for an intrinsic personal goal (Vansteenkiste et al., 2018). After identification with the personal value of a task for an intrinsic future goal, students adapt more self-determined forms of motivation (Deci et al., 1994; Reeve et al., 2002) and effort expenditure happens more autonomously, compared to effort expenditure driven by external pressure (Ryan & Deci, 2017; Vansteenkiste et al., 2018). Provision of a rationale, a statement that conveys information about the meaning and relevance of a learning content for one's personal life or intrinsic goals, is therefore a typical component of autonomy-supportive teaching practices aiming to support internalization (Ryan & Deci, 2017).

Since DBDM learning content is often experienced as difficult by students (Murtonen et al., 2008), we did not expect that providing a rationale for DBDM would necessarily promote the experience of learning out of pleasure (intrinsic motivation). However, the two extrinsic forms of self-determined motivation, namely identified and integrated regulation, should be promoted by reflecting on the relevance of the learning content: Students will mentally work out the relevance of DBDM for their later professional activity as a teacher, thus recognizing a personal value in it (identified regulation), and integrate this value with other values that make up their identity (integrated regulation; Reeve, 2016; Reeve et al., 2002). The strengthening of these two types of internalized extrinsic motivation might then lead students to develop intentions to apply DBDM, although engagement with the learning content is not driven by experiencing pleasure.

3. Relevance interventions

Interventions where a rationale is provided have already been successfully applied within the expectancy-value framework of motivation (Harackiewicz & Priniski, 2018; Wigfield et al., 2000).

Here, making information about the usefulness of course content for students' personal lives available was shown to strengthen utility-values, thus increasing students' motivation to engage in the course content, as measured by time or effort invested (e.g., Canning et al., 2017). Expectancy-value theory assumes that utility-values increase motivation as they are instrumental for the attainment of a future goal, irrespective of whether the content of this goal is extrinsic (e.g., helps me pass the exam) or intrinsic (e.g., helps me support students' learning in my class) and irrespective of whether the rationale is externally provided or self-generated. In contrast, in the SDT framework strengthening motivation is not understood as an increase in quantity, but as a shift to qualitatively different, more self-determined forms. Studies within the SDT-framework have provided evidence that only utility-values relating to an intrinsic, personally important goal promote self-determined forms of motivation (Vansteenkiste et al., 2004, 2018) and that self-determined forms of motivation in turn ensure that learning contents are used outside the context in which they were acquired (Chan et al., 2015; Hagger & Chatzisarantis, 2016). From an SDT perspective, it should also matter whether students can satisfy their basic psychological needs for autonomy, competence, and relatedness, with the satisfaction of the need for autonomy being especially critical for a person to "take ownership" (Ryan & Deci, 2017). Generating rationales oneself should be more autonomy-supportive than providing reasons for a behaviour by an external agent (Steingut et al., 2017). We therefore designed the intervention in such a way that students, while they could freely choose a course content recently covered within the course, were led (a) to reflect about a personally significant goal, namely their professional teaching job, and (b) to self-generate connections to their future professional activity.

Going beyond research conducted within the expectancy-value framework showing effects of utility-value interventions on the strength of motivation, we predicted our intervention to foster self-determined qualities of motivation. As students freely chose the target content and come up themselves with arguments for the relevance of an intrinsic goal, SDT predicts that these motivational effects go along with an increased satisfaction of the need for autonomy. Regarding student's performance in the course, we expected those who received the intervention to learn more, compared to students from a control group. We further predicted that our intervention would impact students' intentions to apply course contents as a future teacher. More specifically, we predicted that the two internalized forms of extrinsic motivation would mediate the effect. To the extent that reflecting on the relevance of DBDM strengthens identification with (identified regulation) and integration of reasons (integrated regulation), students' application intentions should increase, too.

As earlier studies were unclear about a possible effect of rationale provision on students' self-efficacy we decided to include it in our analyses with no directed hypothesis (e.g., Steingut et al., 2017). We further explored the two other basic psychological needs specified in SDT, competence and relatedness (Ryan & Deci, 2017), checking for possible side effects of our intervention.

4. Research hypotheses

We expected that prompting students to reflect on the relevance of DBDM course contents for an intrinsic personal goal will

- increase the perceived relevance of the course contents (*hypothesis 1*),
- foster self-determined forms of motivation (*hypothesis 2*),
- strengthen the satisfaction of autonomy in the course (*hypothesis* 3),
- increase performance in a knowledge test on the course contents (*hypothesis 4*),
- strengthen intentions to apply course contents in one's future job as a teacher (*hypothesis 5*), mediated by internalized extrinsic motivation (identified and integrated regulation; *hypothesis 6)*

5. Method

5.1. Procedure, experimental treatment, and participants

5.1.1. Procedure

We conducted a randomized controlled experiment embedded in the regular curriculum of a university course about DBDM for students enrolled in a large university's master program in teaching. The experimental manipulation was provided via the instruction students received at the beginning of the learning tests. At the beginning of the course, all enrolled students were allocated to either the relevance intervention (relevance-condition) or to a control group (summary-condition) by simple randomization on class level. The course lasted for 12 weeks in total and consisted of four course units (topics: probabilities, diagnostics, intervention and evaluation) which lasted for three weeks each. Each course unit consisted of two lectures and a practical session that were all held by the same lecturer for all students. At the end of each course unit students were offered an online knowledge test, which consisted of multiple-choice questions that covered all the content that had been taught until that time in the course. The first three knowledge tests were voluntary (but participation was recommended). The fourth knowledge test, covering the contents of all course units, was the only obligatory course component and took place at the university. Students needed to answer 50% of the multiple-choice questions correctly to pass the exam. Students could lower their pass mark to 40% when they showed an increase in absolute answers correct from one knowledge test to the next one. This served as an incentive for students to participate in all knowledge tests. At the end of the term, a link to our questionnaire was distributed via email. The questionnaire assessed demographical (age, gender, study program, and track) and psychological variables (perceived relevance of course contents, satisfaction of basic psychological needs, self-determined motivation to learn, self-efficacy for application, application intentions). Students were told that their answers were recorded anonymously and would not affect the evaluation of their coursework, that participation in the survey was voluntary, that they could discontinue the survey at any time, and that neither non-participation nor discontinuation would have negative consequences for them. Participants consented at the beginning of the survey to the scientific use of their data, including their scores on the knowledge tests.

Data collection lasted four weeks with three reminders sent after one, two, and three weeks of the initial invitation, respectively. Participants received a full debrief including preliminary results two months after data collection was finished.

5.1.2. Experimental treatment

Our goal was to develop an intervention that could be integrated into the regular teacher education curriculum. Therefore, reading the rationale and answering the question should take as little time as possible. At the beginning of each knowledge test, students received the following instructions (the topic of the course unit was adapted every week) depending on their group allocation:

Relevance-condition: "*The last two lecture sessions dealt with the planning and interpretation of evaluations. Choose a content (topic, concept, or insight) from your memory of these sessions. Below, write why it may be helpful for your future work as a teacher to know this lecture content. Write approx. four sentences.*"

Summary-condition: "*The last two lecture sessions dealt with the planning and interpretation of evaluations. Choose a content (topic, concept, or insight) from your memory of these sessions. Below, write a summary of the selected lecture content. Write approx. four sentences*."

The original instructions in German, as well as excerpts from answers that students produced can be found in the online supplement.

5.1.3. Participants

In total, 385 student teachers participated in the course. The final sample consisted of n = 159 students who answered our questionnaire at the end of the course (41.3% response rate; n = 72 in the relevance-condition and n = 87 in the summary-condition). Participants were 71.5% female, 24.1% male and 7 participants identified as non-binary. The two experimental conditions did not differ significantly regarding the distribution of participant's gender ($\chi^2(2) = .442$, $p = .80$). Participants had a mean age of M = 27.96 years (SD = 5.66) and the two conditions did not differ significantly regarding participant's age ($t(154) = .243$, $p = .73$). The majority of participants were preparing to teach at secondary school (66.2%), the rest of them was following the track to become an elementary school teacher (33.8%). The two conditions did not differ significantly regarding the distribution of participants' study track ($\chi^2(1) = 1.869$, $p = .18$). As the intervention was embedded in the knowledge tests and the first three knowledge tests were voluntary, participants received different dosages of the intervention. The majority of the 159 participants included into our final sample had taken part in all four knowledge tests (n = 123; 77.4%), while some participants took part only three times (n = 19, 11.9%), two times (n = 6, 3.8%) or only once (n = 11, 6.9%) and thereby were exposed to lower doses of the intervention. However, there was no significant difference in mean intervention dosage between the two conditions ($t(157) = -.182$, $p = .86$). We decided to include all participants who received the intervention prompt at least once, in line with other studies who applied writing interventions (e.g., Hulleman & Harackiewicz, 2009) and who found no dosage effects of such an intervention (Canning et al., 2017)

6. Measures

For all psychological variables, respondents answered on seven-point Likert scales ranging from 1 (does not apply at all) to 7 (fully applies). Students' course performance score was calculated as the percentage of correct answers on each of the four knowledge tests. A complete overview of all items can be found in the online supplement.

6.1. Perceived relevance

We assessed how relevant students perceived the course contents to be for their future job as a teacher with six items. Two items were more generic (e.g.: "*The contents of the lecture are useful for my professional activity as a teacher*") and four items explicitly covered specific application scenarios. These examples had been identified as particularly significant for teachers with experts in the field of DBDM prior to our main study (e.g.: "*As a teacher I need theories and methods of pedagogical diagnostic to appropriately evaluate my students*."). Internal consistency was good with Cronbach's α = .80.

6.2. Self-determined motivation to learn

To develop items that assessed the six different motivational qualities from a SDT perspective, we adapted existing scales (AMS, Vallerand et al., 1993; SIMS, Guay et al., 2000; SRQ-L; Black & Deci, 2000) to the specific setting of a lecture-based university course and to the specific course content, DBDM. To that end, we asked the teaching personnel organizing the course and experts in the field of DBDM to generated possible reasons to engage in DBDM and categorized them according to their degree of self-determination. For example, reasons referring to the exam were moulded into items measuring external regulation, as exams often represent a strong and salient external influence for university students. Or contents referring to DBDM being part of teachers' professional identity were moulded into items measuring integrated motivation. In this way, we generated two items four each of the six motivational qualities, resulting in six items representing more self-determined forms of motivation (e.g., *"I have learned because I will need these contents as a future teacher.")* and six items representing less self-determined forms of motivation (e.g., "*I have studied for the final knowledge test, so that I get the confirmation of active participation in the lecture.")*. Students were asked to indicate how strongly each of the 12 items applied to them in the course, with the six resulting scores being integrated into a common score, the so-called relative autonomy index (RAI; Grolnick & Ryan, 1987; Howard et al., 2017):

RAI = (intrinsic regulation + integrated regulation + identified regulation)—(introjected regulation + external regulation + amotivation)

This parsimonious and well validated measure allows to compare the differences in the degree of self-determination of learner's motivation with a single score, with higher scores indicating more self-determined motivation in relation to less self-determined motivation.

6.3. Combined score for internalized extrinsic motivation

To test our assumption that the effect of our intervention on application intentions would be mediated by internalized extrinsic motivation, we collapsed the two items for identified regulation (e.g.," *I learned for the course so that later I would be knowledgeable in this area*.") and the two items for integrated regulation (e.g.," *I learned because I am convinced that I need to act based on evidence as a teacher*.") to a subscale with four items, which proved to be strongly reliable with Cronbach's α = .91.

6.4. Satisfaction of the need for autonomy

Need satisfaction regarding competence and relatedness were also assessed with three items each. As we neither expected nor found an effect of the intervention on the two needs, only results regarding need for autonomy are included. Item content, reliability analyses, and results can be found in the online supplement.

Autonomy satisfaction was assessed with three items. We asked students to rate how much the statements were true, compared to a regular lecture (e.g., "*Compared to a typical lecture … I was able to make more of my own decisions regarding learning options*."), Cronbach's α = .80.

6.5. Knowledge tests

All tasks in the knowledge tests had a multiple-choice answering format, with students having to identify two correct answers out of five options. Each of the first three knowledge tests consisted of 12 multiple-choice questions covering the most recently discussed topic. Six additional questions on each of the course units already completed were added, such that the first test consisted of 12 questions, the second of 18 and the third test of 24 questions. The obligatory fourth knowledge test consisted of 6 questions from each of the four learning units (24 questions).

6.6. Application intentions

To measure students' willingness to apply course contents in their future work as a teacher we developed four items. We consulted experts in the field of DBDM in school contexts and the coordinator of the course about the most probable and useful ways of applying the acquired knowledge in teachers' practice. Four items were formulated, one referring to participation in school evaluations, one to the usage of standardized instruments, one to the consideration of scientific evidence about efficacy of pedagogical measure, and one to the evaluation of own teaching practice (e.g., "*As a teacher I intend to evaluate my own lessons with questionnaires*."). Internal consistency was good with Cronbach's α = .80.

6.7. Additional variables

With the final questionnaire, demographic information (gender, age, and study track) was assessed and a final question asked if students became aware of our experimental manipulation.

6.6.1. Self-efficacy regarding application

We asked students how confident they were regarding the implementation of the skills they acquired within the course when facing obstacles with five items (e.g., "*I am confident that as a teacher, I can familiarize myself with the current state of research, even when time is short*"). Internal consistency was acceptable with Cronbach's α = .70.

7. Results

Before we conducted our main analyses, we checked for any influences of gender and study program on our dependent variables. A group of *t*-tests indicated neither significant differences between male and female students nor between students preparing for secondary school compared to students preparing for elementary school. As a manipulation check, we asked two independent raters to classify all answers students had produced in response to the instructions as either a reflection about relevance or a summary of course contents, with raters being blind to experimental condition. Raters' classifications correlated with r = .91 and disagreement was resolved by discussion. In all four knowledge tests, answers to the intervention prompt in the relevance-condition were significantly more likely to be rated as a reflection about relevance than answers of participants in the summary-condition (knowledge test 1 χ^2 = 58.961, p < .001; knowledge test 2 χ^2 = 66.581, p < .001; knowledge test 3 χ^2 = 44.697, p < .001; knowledge test 4, χ^2 = 63.437, p < .001). When asked, only 5% of the participants indicated that they were aware that instructions differed somehow between students.

In our final dataset we had 0.3% of missing data on item level. We ran all analysis on a dataset where missing values were replaced with estimation maximization and as results did not differ we decided to exclude missing values analysis by analysis. To test the effects of the intervention on our dependent measures we used a posttest-only experimental research design (Campbell & Stanley, 1967). We investigated the predicted differences between the two conditions with one-sided independent samples *t*-tests. We checked homogeneity of variances with Levene's test and adjusted results if the assumption was violated. To conduct mediation analysis, we used Hayes (2018) PROCESS package version 3.3. We report Cohen's *d* with pooled standard deviations as a measure of effect size.

7.1 Validity analyses

To assess validity of our instruments we applied confirmatory factor analysis with maximum likelihood estimation for all our dependent measurements. All models representing the factorial structure of the scales showed indication for acceptable fit (analysis results can be found in the online supplement). We further tested the continuum assumption for motivation to learn, stating that the order of the subtypes of motivation along the continuum of self-determination should be reflected in correlational patterns, with correlations being stronger between neighbouring subtypes and weaker or even negative between subtypes of motivation which are more distant from each other on the continuum (Howard et al., 2017). As can be seen in Table 1, the correlational patterns reflected the continuum structure. Furthermore, in line with SDT, the satisfaction of the psychological need for autonomy as well other adaptive learning outcomes (application intentions and self-efficacy) correlated with the subtypes of motivation, with correlations becoming less negative and then more positive along the continuum.

7.2 Main analyses

Descriptive statistics including means, standard deviations, mean differences, and effect sizes for the six dependent variables are displayed in Table 2.

7.2.1 Student teachers' motivation

We found support for our first three hypothesis. Students in the relevance-condition reported perceiving course contents as more useful to their future job, compared to students in the summary-condition, $t(157) = -3.53$, p < .001, d = 0.56; BCa 95% CI [0.24, 0.88] (*hypothesis 1*). Participants who were repeatedly asked to reflect on the personal relevance of course contents reported a higher score on the RAI, compared to participants in the summary group, $t(157) = -1.93$, p = .028, d = 0.31; BCa 95% CI [0.01, 0.62] (*hypothesis 2*). When looking at internalized extrinsic motivation, thus a combined score of identified regulation and integrated regulation,2A comparison of the intervention effects on all subtypes of motivation with a MANOVA can be found in the online supplement. Students in the relevance-condition endorsed them to a stronger extent than students in the summary-condition, $t(157) = 2.35$, p = .02, d = 0.37; BCa 95% CI [0.06, 0.69].

Table 1. Correlations between different forms of motivation and other dependent variables (n = 159)

		1	2	3	4	5	6	*M*
1	Amotivation	1	.45**	-.35**	-.62**	-.62**	-.75**	3.90
2	External		1	-.19*	-.40**	-.45**	-.42**	5.25
3	Introjected			1	.58**	.54**	.40**	4.07
4	Identified				1	.83**	.69**	4.05
5	Integrated					1	.68**	4.50
6	Intrinsic						1	2.28
	Application Intentions	-.52**	-.34**	.38**	.64**	.67**	.53**	4.72
	Autonomy Satisfaction	-.36**	-.26**	.19*	.33**	.35**	.41**	4.44
	Self-Efficacy[a]	-.37**	-.26**	.30**	.47**	.47**	.37**	4.88

Note: [a] $n = 155$. * $p \leq .05$; ** $p \leq .01$.

Table 2. Means and standard deviations, mean differences and effect sizes broken down by experimental condition for all dependent variables

	Summary Condition		Relevance Condition			
Variable	*M*	*SD*	*M*	*SD*	Mean difference	*d*
Perceived Relevance	4.97	1.04	5.51	0.82	0.53**	0.56
RAI	-4.45	12.09	-0.74	12.09	-3.71*	0.31
Internalized Extrinsic Motivation	4.23	1.34	4.73	1.34	0.50*	0.37
Autonomy Satisfaction	4.11	1.49	4.69	1.39	0.58**	0.40
Test Performance (%)	75.91	15.03	77.32	14.18	1.41	0.10
Application Intentions	4.48	1.21	4.94	0.84	0.47**	0.44

Note. * $p \leq .05$. ** $p \leq .01$.

Regarding need satisfaction (*hypothesis 3*), participants in the relevance-condition reported a higher autonomy in the course compared to participants in the summary-condition, $t(157) = -2.52$, $p = .065$, $d = 0.40$; BCa 95% CI [0.09, 0.72]. We did not find any effects of the intervention on the satisfaction of the needs for competence and relatedness (analyses can be found in the online supplement). Other than expected, we did not find an effect of the intervention on students' test performance on LPT4, $t(157) = -.60$, $p = .548$, $d = .10$; BCa 95% CI [−.22, .41] (*hypothesis 4*).

7.2.2 Student teachers' application intentions

Corroborating hypothesis 5, students who repeatedly reflected about the personal relevance of course contents indicated higher intentions to apply acquired skills and knowledge in the future, compared to students in the summary-condition, $t(152.47) = 2.88$, $p = .003$, $d = 0.42$; BCa 95% CI [0.11, 0.74].

As depicted in Figure 2, mediation analysis indicated an indirect effect of the relevance reflection on application intentions through internalized extrinsic motivation (identified and integrated regulation), $b = 0.26$, as the bias-corrected 95% confidence interval did not include zero [0.04, 0.52]. The direct pathway between intervention and application intentions was not significant, $b =$

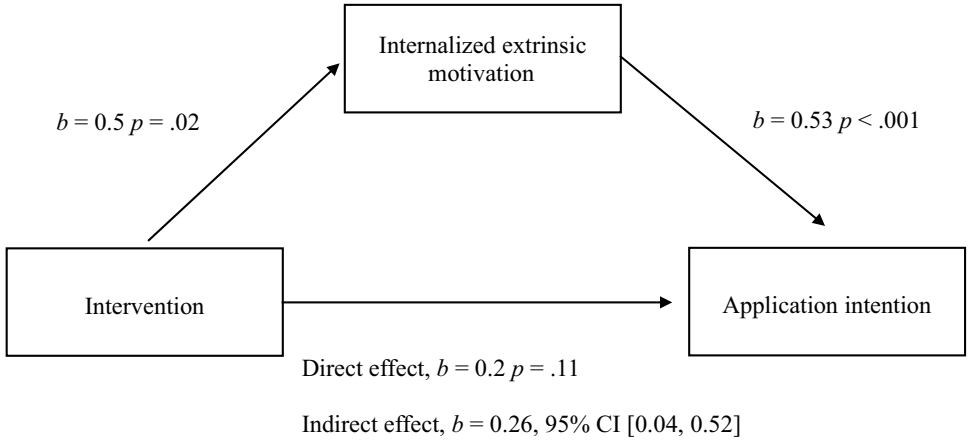

Figure 2. Mediation model of the intervention effect on application intention via internalized extrinsic motivation

0.2, p = .11, which indicates a full mediation, meaning that as expected (*hypothesis 6*), the effects of the intervention on application intentions was fully explained by the indirect path via internalized extrinsic motivation.

7.3 Additional analyses

7.3.1 Self-efficacy for application

Students in the relevance-condition reported more confidence in being able to apply course contents against obstacles and challenges, compared to students in the summary-condition, t (157) = −2.19, p = .013, d = 0.35, BCa 95% CI [0.03, 0.67].

8. Discussion

In our study, we applied a brief motivational intervention prompting students enrolled in a master program in teaching to reflect on the relevance of Data-Based Decision-Making (DBDM) for their future professional activity as a teacher. While many countries have embedded DBDM into their teacher preparation programmes, it often is challenging to engage students in the learning contents, as they experience them as particularly difficult and not intrinsically appealing (e.g., Batanero et al., 2011; Heitink et al., 2016; Murtonen, 2005; Murtonen et al., 2008). Also, it is crucial to encourage students to later make use of DBDM in their professional practice, i.e., to systematically gather, analyse and evaluate empirical data with the goal of examining their pedagogical practice, improving instruction in the classroom and evaluating the effectiveness of pedagogical interventions.

As expected, students who had reflected on the relevance of DBDM reported more favourable qualities of motivation, endorsed the relevance of DBDM for their future job to a stronger extent, and felt more autonomous in learning. While they did not improve their knowledge of DBDM, their intentions to engage in DBDM as a future teacher were strengthened. Altogether, results suggest that this short intervention can be implemented in a regular university curriculum without the need of many resources and adaptions and still unfold important motivational effects.

8.1 Promoting motivation to learn

Most students who want to become teachers probably aim to provide high-quality instruction and thereby promote the social and intellectual development of each of their individual future students. However, many teacher students are unaware that basic knowledge of research methods and statistics, the contents of courses about DBDM, might help them achieving these goals. As positive attitudes about the practicability and usefulness of DBDM methods for improving teaching is a crucial factor when it comes to applying them as a teacher, courses about DBDM should convey the content's importance. Results of the present study suggest that our relevance intervention is a promising tool for this purpose: At the end of the semester students found DBDM to be more relevant for their future teaching if they were regularly prompted to think about the content's relevance for their future professional activities. This finding is in line with research within the expectancy-value framework (Harackiewicz & Priniski, 2018). The present study complements this line of research by providing evidence that the *quality* of students' motivation can be improved by our relevance intervention implemented into a regular university course over an entire semester.

Students who were asked to reflect on the relevance of the course content reported more self-determined motivation to learn, evident in more positive scores on the relative autonomy index (RAI). This suggests that these learners aligned the reasons for learning about DBDM with their own goals as a future teacher and were therefore more sustainably motivated than the students who regularly wrote summaries of the same content. Vansteenkiste et al. (2018) proposed that for a rationale to support internalization, it needs to be attuned to the learner's perspective. As we asked students to pick the content that they wanted to reflect on and to come up with their own rationale regarding the relevance of the contents, they could attune their arguments to their own values and preferences.

This may explain why we found a strong effect of our relevance intervention—in contrast to the findings of the meta-analysis by Steingut et al. (2017) who reported no overall effect of external rationale provision on self-determined motivation.

The effect of our intervention on autonomy satisfaction indicates that students in the relevance condition felt more self-determined within the course. Although the learning conditions and requirements concerning the knowledge tests were identical for students in the two experimental conditions, those who participated in the relevance intervention experienced themselves as more autonomous. This suggests that feelings of autonomy can be enhanced simply by asking learners to find their own rational why the subject matter is important. The effect was comparable in size to what other studies have found. However, so far, most studies have only examined the effect of relevance interventions combined with other autonomy-supportive practices (Steingut et al., 2017).

The effect of our relevance intervention was particularly evident in a subgroup of self-determined forms of motivation, namely internalized extrinsic motivation, the combination of identified and integrated motivation. Students in the relevance condition were more likely to report that they learned because they needed the knowledge later as a teacher and it was part of who they wanted to be as a teacher.

Contrary to our expectation, students having reflected on the relevance of course contents did not perform better in the knowledge test. This might be due to the pathway from motivation to achievement being constrained by the learners' inability to translate high quality motivation into high quality learning or by the fact that students had to meet external requirements (pass the exam, meet the deadlines) such that differences in the quality of their motivation did not play out in differences in test performance (Vu et al., 2021). Apparently, then, the intervention had no effect on students working and learning behaviour. One possible explanation is that performance in the last knowledge test was the criterion for passing the course. This external incentive could have resulted in students from the summary-condition being highly motivated to learn as well—albeit for the test. The learning motivation of the two groups therefore differed more in terms of quality than in terms of intensity, with the motivation of the relevance intervention group being more sustainable.

8.2 Promoting application intentions

The application of DBDM skills in school enables teachers to adapt and to develop their instruction and to continuously align their professional activities with the advancing scientific knowledge—but it is also associated with an additional amount of work. Administrative measures to encourage teachers to undertake this effort, e.g., performance-based pay, do not always have the desired effects (United Nations Educational, Scientific and Cultural Organization, 2020). It is therefore even more important that teachers develop a self-determined motivation to use DBDM. The current study suggests that the foundations for this motivation can already be laid during teacher training. As predicted, students who thought about why DBDM was relevant for their future job reported higher intentions to apply DBDM (e.g., evaluate own lessons, participate in school evaluations) later, compared to students who wrote summaries. We found that this difference was fully mediated by internalized extrinsic motivation. This suggests that the increase in application intentions was caused by students in the relevance condition having aligned the learning objectives of the course with their own goals and values. This finding is in accordance with Hagger and Chatzisarantis (2016) who found that self-determined motivation in class predicted out-of-class behavioural intentions. In our study, we only measured the intention to use the course content (DBDM) and not the actual application. However, Hagger and Chatzisarantis (2016) found a substantial effect of intentions on actual behaviour.

Our relevance intervention not only strengthened students' application intentions for DBDM but also their self-efficacy regarding their implementation. Students who were asked to think about the relevance of DBDM saw themselves as more able to apply their knowledge even in the face of

obstacles and difficulties (e.g., time pressure, complex situations). Assuming that this effect is due to the autonomy-supportive character of the intervention, the effect size is in line with results of Hagger and Chatzisarantis (2016) on perceived behaviour control. Similarly, Ross et al. (2016) found that self-determined motivation to learn was positively related to university students' self-efficacy regarding information literacy.

8.3 Limitations and future directions

The present study tested a relevance intervention in a teacher training course on DBDM. Even though we applied a randomized controlled design, it would be possible to rule out any potential baseline differences between groups in upcoming experiments.

Future research might investigate whether comparable effects can also be found with other course content and in other disciplines and test if the promising effects last and also translate to difference in application behavior.

In our study students had to pass an exam at the end of the semester. Accordingly, the motivational effects of the relevance intervention were observed within a setting in which there was also an external incentive to learn. It remains to be tested what motivational effects a relevance reflection has without the concurring influence of external incentives and whether it may elicit sufficient motivation and knowledge acquisition to even avoid mandatory tests.

Future studies could combine the relevance intervention with other autonomy-supportive practices, e.g., the use of non-controlling language, to explore whether the effects are amplified and also become visible in learning behaviour and performance. The effects of our intervention were observed on self-report data only. Behavioural data, e.g., the use of DBDM skills in schools, would further substantiate the effectiveness of the intervention.

We will gladly provide our research materials, like the intervention instructions and the motivation scales tailored to the DBDM-content, to others who wish to research these or related questions.

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Ethical approval
This study received approval by the ethical committee of Freie Universität Berlin (032/2019).

Conflicts of interest/Competing interests
The authors have no relevant financial or non-financial interests to disclose.

Short summary of key research activities
We aim at fostering more self-determined qualities of motivation and self-regulated learning in courses on data-based decision-making (DBDM) which does not appeal attractive to many teacher students but is nevertheless of essential importance in their future profession. In an experimental study, we had students reflect about the relevance of DBDM and succeeded in strengthening their motivation to apply it in their future profession as a teacher. We further conducting experiments regarding the language of formative feedback to support self-determined motivation and self-regulated learning in students.

Correction
This article has been republished with minor changes. These changes do not impact the academic content of the article.

Supplementry material
Supplemental data for this article can be accessed here.

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4.2. **Article 2**

The effect of autonomy-supportive feedback and a relevance intervention on students' self-regulated learning and motivation

In higher education, students are required to manage their learning autonomously to a great deal, often organizing learning for multiple courses at the same time, creating weekly plans incorporating many different events, setting goals, monitoring their progress, choosing their approach on how to learn, and many more facets of self-regulated learning (SRL). This is a demanding process that requires time and effort and can be especially demanding, when students are required to engage in course contents that do not seem inherently interesting to them, but are nonetheless important.

Students in higher education need to have high quality, motivation when it comes to the self-regulation of their learning. A crucial condition is that students see personal relevance in the learning. However, students might need helpful learning environments that assist them in transferring their high-quality motivation to more and better self-regulated learning. Educators can structure student's SRL by supporting them with prompting SRL behavior and providing feedback about how to learn best. Student's success, however, depends on their active engagement with this support. We therefore investigated if the combination of a relevance intervention and autonomy-supportive feedback to optimally support student's motivation and self-regulated learning.

Motivation in higher education

In higher education, all students need to self-regulate their learning, which means to plan, monitor and evaluate their learning process (Zimmerman, 2000). Students might engage in self-regulated learning for different reasons though, which have been found in research with Self-

Determination Theory (SDT, Ryan & Deci, 2017), to correlate with different, more or less adaptive, outcomes. The reason for engaging in a behavior are ordered on a continuum of self-determination representing the degree to which a person's motivation is originating rather within the person or if reason for enacting a behavior are rather alien to the person. Therefore, when learning at a university, students can take control of their learning progress and engage in self-regulated learning because they know that they need to pass an exam to get course credits (external regulation, i.e., behavior driven by external rewards or threats). They might also feel pressured by the expectations of their docents making them feel as bad students if they do not perform well (introjected regulation, i.e., behavior driven by avoidance of guilt or seeking pride). This would reflect low self-determination, as students engage in the behavior more due to external contingencies, even if their motivation might be partially internalized (e.g., motivated by avoidance of guilt). More self-determined students would engage in self-regulated learning because they perceive the act of learning as meaningful for their lives and their future goals (identified regulation, i.e., behavior that is driven by recognition of its personal relevance). A student that integrates the behavior well with other goals and values they have might manifest an even more self-determined form of motivation (integrated regulation, i.e., behavior that is driven by personal important reasons that are well aligned with one's values and goals). Finally, students might also simply enjoy the process of regulating their own learning and working on good ways how to learn best (intrinsic regulation, behavior driven by the inherent reward it provides). Research has shown that these different forms of motivation correlate with learning outcomes, with more self-determined students feeling more autonomous in their learning (i.e., they feel like their behavior originates within their conscious will and reflects what they really want), showing more adaptive learning behavior compared to students that are less self-

determined (i.e., they feel that their behavior is the result of external influence or pressure; Ryan & Deci, 2017). These adaptive outcomes not only often include improved (self-regulated) learning, but also motivation outside of the learning context to engage with the learning contents as well as stronger intentions to use and apply what was learned and self-efficacy to do so (see Dübbers & Schmidt-Daffy, 2021; Hagger & Chatzisarantis, 2016). It is therefore advisable to support students SRL in a way that will allow them to be motivated in a self-determined manner to regulate their learning. What do students need to develop self-determined motivation for SRL?

Supporting self-determined motivation

Following SDT, the development of more self-determined motivation depends on the satisfaction of basic psychological needs. The need for autonomy is crucial for self-determined motivation as its satisfaction allows students to see their learning behavior as an expression of their own will. Autonomy in the paradigm of SDT means to feel psychological freedom or ownership over one's actions instead of feeling externally controlled. The satisfaction of this need can be facilitated by the social context, which in the educational domain is often designed and strongly influenced by the docent or teacher and the respective teaching behavior (e.g., Leenknecht et al., 2017). An educator aiming at supporting students' self-determined motivation might offer students choices and options in a non-controlling way while acknowledging the student's perspective and potential reservations and providing rationales (e.g., Ryan & Deci, 2017; Sierens et al., 2009). When focusing on the central aspects of autonomy, the notion of personal relevance sticks out as another crucial component, especially when the target behavior is not necessarily interesting and rewarding by itself.

The importance of relevance

The idea that students are always motivated because they intrinsically enjoy their learning is aspirational but probably not realistic, especially not for some courses like research methods and statistics, that are often mandatory as students are supposed to be able to deal with scientific evidence. These courses, even though not inherently interesting for most students, possess a relevance for students' university studies and future professions. Intervention studies within the framework of Expectancy-Value Theory (EVT, Wigfield & Eccles, 2000) have shown that subjective usefulness of course contents promotes students' performance and interest (e.g., Canning et al., 2017; Kosovich et al., 2019). In one study, Canning et al. (2017) asked students in an introductory biology course to pick a recently covered topic and describe how knowledge of this content was relevant to their own life, leading students to show improved performance and more likely stay in STEM (science, technology, engineering, mathematics) courses. Looking through the lens of SDT, instead of bringing students to engage in their studies with external pressure (e.g., exams, grades), they might be motivated by helping them recognize the personal relevance that they see in the course. The provision of rationales, i.e., information about why a certain topic or behavior possesses a personal relevance for the actor, is a typical component of autonomy-supportive teaching behavior. It has nevertheless only rarely been examined in isolation, where it showed mixed effects, with small or none effects on performance and self-determined motivation (Dübbers & Schmidt-Daffy, 2021; Steingut et al., 2017). Results were most promising for uninteresting tasks and in higher education though (Steingut et al., 2017). Supporting students with the formation of personal relevance connections with the learning content is therefore a promising tool to support students' self-determined motivation, especially for rather uninteresting course contents. Additionally, to the recognition of the course content's relevance, students then need to actively engage in SRL activities. Therefore, the educational

context needs to provide the right support that helps students not only to clarify the personal relevance but also supports their SRL activities in an autonomy-supportive way.

Feedback for self-regulated learning

The three phases of self-regulated learning (i.e., planning, monitoring, evaluating) are supported by a course framework that provides students with some sort of formative assessment. Further, the learner should be prompted to regularly set goals, plan when and how to learn and to continuously evaluate how goals are met and if the strategy needs to be adapted (Wong et al., 2019). To optimally support students in adapting their behavior in a way that is beneficial for their learning, students benefit from feedback on their self-regulated learning behavior and on individual learning outcomes (Hattie & Timperley, 2007; Lipnevich & Smith, 2018). Feedback for SRL is scaffolding the planning, monitoring and evaluation of learning behavior by contrasting goals with performance, showing the progress towards goals and putting goals in relation to the overall learning progress. The feedback also makes the time spent visible and helps evaluating the current progress to point out possibilities for adaption of behavior, e.g., the choice of future strategies. The continuous monitoring and adopting of one's learning behaviors is an effortful task and it requires the student to act on the feedback and to stay motivated to do so. When providing feedback to learners in higher education, it is assumed that they understand that feedback is supposed to support them with their learning (e.g. Bailey & Garner, 2010). But students often fail to see the need for their own active engagement with the feedback (Price et al., 2011). The potential of feedback in education is extensive, however, meta-analyses often report very heterogeneous effects, ranging from strongly positive effects to even negative effects on students' performance (Kluger & DeNisi, 1996; Wisniewski et al., 2019). Feedback only unfolds its effect though, if learners act on it (Boud & Molloy, 2013). Learners often focus mostly on

grades and dismiss the instructional feedback that comes with them (Bailey & Garner, 2010). Students need to actively engage in this feedback process, take responsibility and use the feedback to improve their learning process. What characteristics does a feedback need to have, to ensure students' motivation and active engagement with it?

When evaluating the motivating role of feedback, feedback valence is often considered. Positive feedback, informing the recipient about a positive evaluation, is considered to support self-determined motivation, whereas negative feedback may have demotivating effects (Fong et al., 2019; Mabbe et al., 2018). However, when supporting students with SRL, negative feedback is important in form of bringing gaps between goals, standards and the actual behavior to students' awareness. For the motivating effect, the language of feedback might be important (Winstone et al., 2017). The feedback needs to be designed in a way that does not elicit the feeling in student that they are being forced or controlled to learn in a certain way but rather that their feeling of self-determination regarding their learning is strengthened (Cate, 2013). Sierens et al. (2009) found that the provision of structure by teachers (e.g., scaffolding the learning process with clear expectations and helpful advice) only had a positive influence if there was at least some support of the learner's autonomy. Also, the choices and actions that students need to undertake in self-regulated learning are less effortful and ego-depleting when students act with more self-determined motivation (Moller et al., 2006; Werner & Milyavskaya, 2018). In order to allow students to be motivated in a self-determined manner to take up the feedback and work with it, the goal should be to find an autonomy-supportive way to frame feedback students receive regarding their SRL.

Autonomy-supportive feedback

Scholars working with SDT have used the principles of autonomy-supportive communication or instruction in many different fields, like health behavior, sports coaching, motor learning and education (e.g., Altendorf et al., 2019; Bradshaw et al., 2021; Carpentier & Mageau, 2016; Hooyman et al., 2014; Young-Jones et al., 2019. When looking at message framing, communication or feedback style, the overarching idea of making them autonomy-supportive is that receivers will feel that their need for autonomy is satisfied. This can be achieved by the message being formulated in non-controlling language (inviting language e.g., “would”, instead of controlling language, e.g., “should”), referring more to intrinsic reasons than external contingencies or providing rationales in general instead of omitting them. The receiver’s autonomy is further supported by acknowledging potential negative affect and by providing the receiver choices instead of enforcing the sender’s perspective. Studies on autonomy-supportive communication in different areas have shown mixed results, with sometimes null effects (e.g., Altendorf et al., 2019; Bradshaw et al., 2021) and sometimes positive effects on the receiver’s motivation (e.g., Carpentier & Mageau, 2016; Hooyman et al., 2014). In the field of education, framing a learning activity in an autonomy-supportive way led to increases in conceptual learning in 11-12-year-old students (Vansteenkiste et al., 2005). Young-Jones et al. (2019) found that describing a syllabus for students in higher education framed in an autonomy-supportive way led to increased liking and intention to take the course but showed no effects on students' motivation for the course. A few studies have worked explicitly with autonomy-supportive feedback, mostly in the context of sports and physical education (e.g., Carpentier & Mageau, 2016; Mouratidis et al., 2010; Muynck et al., 2017). In cross-sectional and diary studies, autonomy-supportive feedback showed to be positively related to autonomous motivation in athletes (Carpentier & Mageau, 2016; Mouratidis et al., 2010), and performance feedback led

athletes to report higher levels of autonomy-satisfaction (Muynck et al., 2017). When looking at autonomy-supportive feedback in education, research is still limited. Mabbe et al. (2018) tested the effect of feedback valence and communication style with middle school students in a short-term experiment and found that autonomy-supportive feedback had the potential to support students' needs for competence and autonomy as well as their intrinsic motivation. However, the need for competence was mainly supported by feedback that provided the learner a positive evaluation of their progress towards goal attainment. As feedback for SRL often aims at shifting students' attention to gaps between their behavior and optimal learning behavior, the effect it has on the satisfaction of the need for competence is unclear. Theoretically, the provision of structure, i.e., formulating clear expectations and providing information on how to improve constitutes a separate dimension from autonomy-support. It needs to be taken into account that formulating feedback in an autonomy-supportive way might sometimes alter the amount of structure that it provides, e.g., when offering students to choose if they want to adopt a higher goal or not. Therefore, we conclude that allowing students to adopt and effectuate feedback and respective adaptions to their learning behavior with a feeling of ownership and self-determination instead of coercion and control with a helpful and supportive feedback with clear autonomy-supportive characteristics constitutes a promising way to support students SRL. A relevance intervention assisting students in identifying with the contents' personal relevance might create the necessary motivational precondition for this feedback to encourage students to engage. There is, to our current knowledge, no study that tests the potential of a relevance intervention and an autonomy-supportive feedback to support students' SRL in higher education. We want to fill this gap with a long-term field experiment, testing the effect of an autonomy-supportive feedback on students' SRL behavior and their self-determined motivation.

The present study

In our first study, we wanted to test an autonomy-supportive feedback provided in a regular university course and see how it effects students learning and motivation combined with a relevance intervention. The course was dealing with Data-Based Decision-Making (DBDM), a course that aims to transmit basic knowledge in research and statistics to future teachers. In a 2 x 2 field experiment we combined a relevance intervention with autonomy-supportive feedback over the course of an entire university term. We expected that students receiving a relevance intervention will show improved self-regulated learning compared to students from a control condition (*hypothesis 1*) and also expected a positive main effect of individualized feedback framed in an autonomy-supportive way compared to individualized feedback framed in a controlling way on students self-regulated learning (*hypothesis 2*). Improved self-regulated learning includes investing more time in one's learning, setting higher goals, reducing the difference between goal and performance and showing improved performance. Similarly, we expected that students receiving the relevance intervention (*hypothesis 3*) and the autonomy-supportive feedback (*hypothesis 4*) will report more adaptive motivational outcomes, in particular more satisfaction of their need for autonomy, more self-determined motivation, more perceived relevance of contents and higher intentions and self-efficacy for application of course contents in the future. We further expected a statistical interaction between both interventions leading to improved self-regulation (*hypothesis 5*) and more adaptive motivational outcomes (*hypothesis 6*) for students that received a combination of the relevance intervention and the autonomy-supportive feedback compared to students receiving only one of the interventions or only the control conditions. As we wanted to test the effect of an autonomy-supportive feedback,

but also expected that autonomy-supportive feedback provides less structure than a controlling feedback, we controlled in all analyses for structure.

Method

Participants

Our participants were students enrolled in a course about data-based decision-making as part of their master's program in teacher training at a large German university (N = 444). Our data was collected on with questionnaires at the beginning and at the end of the course. We recorded 169 responses of students that answered both questionnaires and provided informed consent for scientific use of their data. As our interventions took place in four consecutive sessions of a seminar, we excluded 12 students that did not participate in all four sessions as they would have received lower doses of the intervention, leaving us with a final sample of 157 students (35%). There was no significant difference between conditions regarding the percentage of students filling in the two questionnaires, (t1) X^2 (3) = 2.31, p = .511, (t2) X^2 (3) = 3.94, p = .268. The final sample consisted of 71 % female students, students were on average 28.5 years old (SD = 7.56) and were studying to teach in either high school (51.9 %), primary education (36.4 %) or other school tracks (e.g., special education, 11.7 %). We tested for any differences regarding demographic variables between the four experimental groups resulting from the combination of the two interventions (feedback, relevance) with chi-square tests (gender and study track) and an ANOVA (age). No significant difference emerged regarding participants age between the conditions, F(1,137) = 0.03, p = .866 and only a marginally significant difference between the feedback framing conditions, F(1,137) = 3.51, p = .063, with students in the non-controlling feedback condition being somewhat older on average (M = 29.8, SE = .91) compared to students in the controlling feedback condition (M = 27.4, SE = .88). We found no difference

between conditions regarding participants gender, X^2 (3) = 1.99, p = .574, or study track, X^2 (15) = 10.14, p = .811. As participants were studying different and often several school subjects (e.g., math, biology), we tested if students' school subjects were randomly divided. Participants in the different groups did not differ regarding the subjects they were studying except for a significant difference regarding the division of students studying foreign and old languages X^2 (3) = 9.07, p = .028. The percentage of students studying the subject of foreign and old languages was highest in students receiving both experimental conditions (46%), followed by students receiving both control conditions (29%) and lowest in students receiving either one experimental and one controlling condition (18% and 20%).

Procedure

The course in which our experiment took place was composed of four main topics each of which were taught in a separate course unit: probabilities, diagnostics, intervention and evaluation. The first questionnaire assessing the motivational variables was assessed before the start of the course (t1), a second one followed at the end of the course (t2). Each of the four units was taught over three weeks, including two lectures and a practical session with *Excel* in smaller groups of students. All course components were taught by the same instructor. Students were provided with a formative assessment at the end of every course unit in form of online learning progress tests (LPT). Each of the four LPT consisted of a test with 12-24 multiple choice questions assessing students’ knowledge of all contents covered until that point. All course components were voluntary, except the fourth LPT, covering all course contents. This last LPT served as an obligatory competence check where a 50% pass mark was conditional to receive the course credits. No grades were given though. Within the test, students received immediate corrective feedback. Further, students’ learning behavior was assessed with every LPT (e.g., time spent

learning, goal for the next test, etc.). In order to support students SRL, students received a written feedback after each LPT, providing information about the performance on the LPT together with recommendations regarding their SRL behavior. The feedback was individualized with an algorithm using the data about students' learning behavior that they reported in the LPTs.

Figure 1

Overview of Course Topics, the Two Questionnaires, LPTs and Feedback

We applied a 2x2 randomized, controlled, between-subjects, pre-post study design. Students were randomly allocated to one of the two experimental conditions of each factor manipulated at the beginning of the course, resulting in four possible conditions. The algorithm applied by the survey tool we used for our data collection and randomization resulted in a somewhat unequal allocation to the four experimental conditions (see Table 1), which was not affected by dropout.

Table 1

The Experimental Conditions

Nr.	Experimental Conditions			*n*
1	Relevance	&	Autonomy-Supportive Feedback	39
2	Relevance	&	Controlling Feedback	38
3	Summary	&	Autonomy-Supportive Feedback	35
4	Summary	&	Controlling Feedback	45

Our interventions were both taking place around the LPTs: the LPTs started with the relevance intervention, students then answered questions about their learning behavior and the multiple choice questions to assess their knowledge; the second intervention was the written feedback that students received after each LPT which was framed in two different ways (autonomy-supportive or controlling).

Experimental manipulations

Relevance Intervention

The relevance intervention was presented at the beginning of each LPT, thus four times for every student. Students received either the relevance or the summary condition, depending on their allocation to an experimental condition at the beginning of the course.

In the relevance condition, we presented students a prompt to reflect about the relevance of a self-chosen, recently covered course content for their future professional activity as a teacher in four sentences (cf. Dübbers & Schmidt-Daffy, 2021):

> Relevance-condition: '*The last two lecture sessions dealt with the planning and interpretation of evaluations. Choose a content (topic, concept, or insight) from your memory of these sessions. Below, write why it may be helpful for your future work as a teacher to know this lecture content. Write approx. four sentences.'*

Students in the summary condition were also asked to select a recently covered course content but then to merely summarize it, as well in four sentences:

> Summary-condition: '*The last two lecture sessions dealt with the planning and interpretation of evaluations. Choose a content (topic, concept, or insight) from your memory of these sessions. Below, write a summary of the selected lecture content. Write approx. four sentences*.'

Feedback framing intervention

Automated, individualized feedback for self-regulated learning. As a regular part of the course, students received written feedback in response to each LPT, providing them information and guidance regarding their SRL. We assessed students' SRL with questions and prompts, asking students about how they learned (e.g., time invested, strategies applied) but also prompting them to engage in other SRL behavior (e.g., set a goal for the next LPT, plan time to learn). This self-reported data about students' SRL (see Table 2) was used in the feedback together with students' scores on the learning progress test to automatically create an individual feedback.

Table 2

Student Data Regarding their SRL Behavior

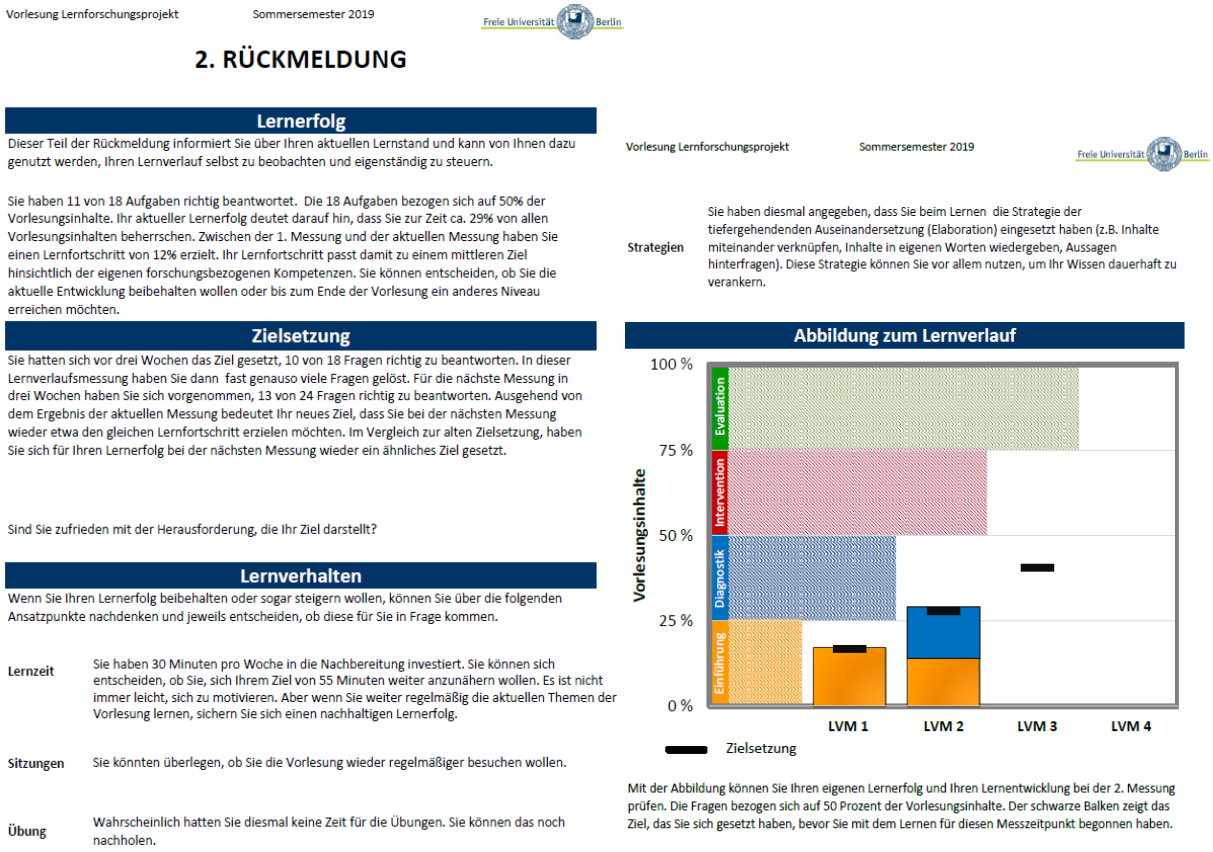
	Measuring Point				
Variable	Pre	LPT 1	LPT 2	LPT 3	LPT4
Being present in course events		X	X	X	X
Time planned learning	X	X	X	X	
Time spent learning		X	X	X	X
Goal set for LPT	X	X	X	X	
Self-assessment for LPT		X	X	X	X
LPT performance		X	X	X	X
Personally useful learning strategies	X				
Use of learning strategies		X	X	X	X
Use of learning aids		X	X	X	

In the following, it is first explained how the individual feedback was created from data students provided about their SRL, then the experimental manipulation regarding the framing of the feedback is explained. The written feedback was presented in three blocks. First students received information about the results of their last learning progress test (LPT). The second

block gave information about the goals students set themselves. The third block provided information about the learning behavior students reported. In all of the three parts, students received informational feedback combined with suggestions on how to improve. At the end of the feedback, a graph supported the written information showing the scores obtained, the different LPTs and the respective goals, if data was available (see Figure 2).

Figure 2

An exemplary written Feedback for LPT2



Vorlesung Lernforschungsprojekt Sommersemester 2019 Freie Universität Berlin

2. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie über Ihren aktuellen Lernstand und kann von Ihnen dazu genutzt werden, Ihren Lernverlauf selbst zu beobachten und eigenständig zu steuern.

Sie haben 11 von 18 Aufgaben richtig beantwortet. Die 18 Aufgaben bezogen sich auf 50% der Vorlesungsinhalte. Ihr aktueller Lernerfolg deutet darauf hin, dass Sie zur Zeit ca. 29% von allen Vorlesungsinhalten beherrschen. Zwischen der 1. Messung und der aktuellen Messung haben Sie einen Lernfortschritt von 12% erzielt. Ihr Lernfortschritt passt damit zu einem mittleren Ziel hinsichtlich der eigenen forschungsbezogenen Kompetenzen. Sie können entscheiden, ob Sie die aktuelle Entwicklung beibehalten wollen oder bis zum Ende der Vorlesung ein anderes Niveau erreichen möchten.

Zielsetzung

Sie hatten sich vor drei Wochen das Ziel gesetzt, 10 von 18 Fragen richtig zu beantworten. In dieser Lernverlaufsmessung haben Sie dann fast genauso viele Fragen gelöst. Für die nächste Messung in drei Wochen haben Sie sich vorgenommen, 13 von 24 Fragen richtig zu beantworten. Ausgehend von dem Ergebnis der aktuellen Messung bedeutet Ihr neues Ziel, dass Sie bei der nächsten Messung wieder etwa den gleichen Lernfortschritt erzielen möchten. Im Vergleich zur alten Zielsetzung, haben Sie sich für Ihren Lernerfolg bei der nächsten Messung wieder ein ähnliches Ziel gesetzt.

Sind Sie zufrieden mit der Herausforderung, die Ihr Ziel darstellt?

Lernverhalten

Wenn Sie Ihren Lernerfolg beibehalten oder sogar steigern wollen, können Sie über die folgenden Ansatzpunkte nachdenken und jeweils entscheiden, ob diese für Sie in Frage kommen.

Lernzeit Sie haben 30 Minuten pro Woche in die Nachbereitung investiert. Sie können sich entscheiden, ob Sie, sich Ihrem Ziel von 55 Minuten weiter anzunähern wollen. Es ist nicht immer leicht, sich zu motivieren. Aber wenn Sie weiter regelmäßig die aktuellen Themen der Vorlesung lernen, sichern Sie sich einen nachhaltigen Lernerfolg.

Sitzungen Sie könnten überlegen, ob Sie die Vorlesung wieder regelmäßiger besuchen wollen.

Übung Wahrscheinlich hatten Sie diesmal keine Zeit für die Übungen. Sie können das noch nachholen.

Vorlesung Lernforschungsprojekt Sommersemester 2019 Freie Universität Berlin

Strategien Sie haben diesmal angegeben, dass Sie beim Lernen die Strategie der tiefergehendenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Diese Strategie können Sie vor allem nutzen, um Ihr Wissen dauerhaft zu verankern.

Abbildung zum Lernverlauf

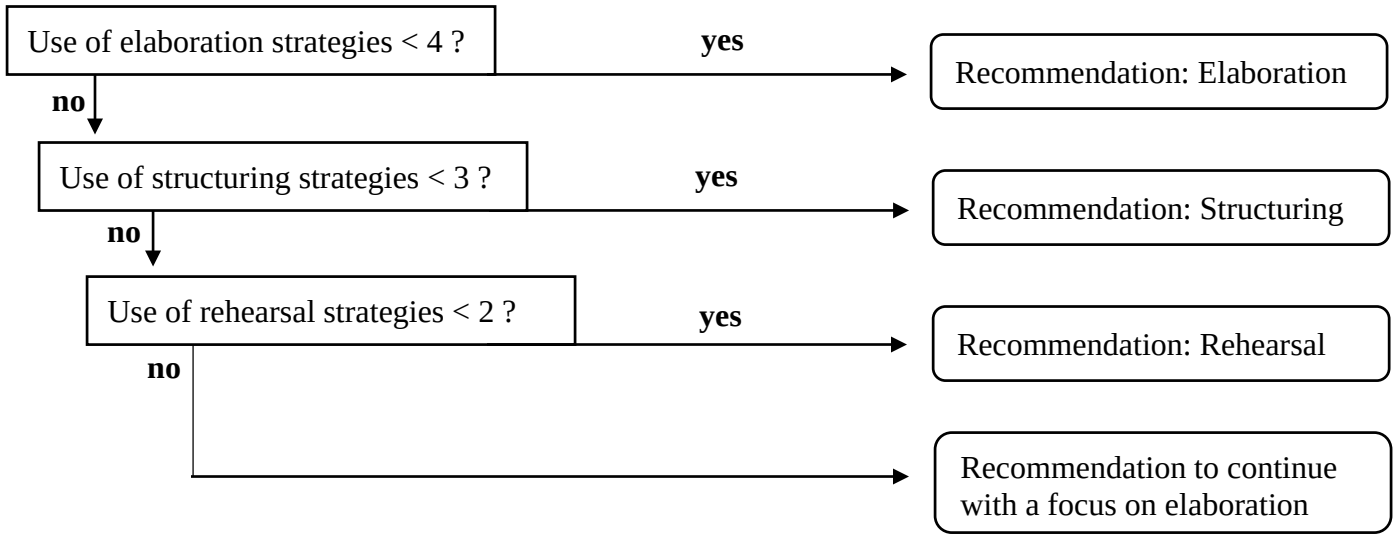
Mit der Abbildung können Sie Ihren eigenen Lernerfolg und Ihren Lernentwicklung bei der 2. Messung prüfen. Die Fragen bezogen sich auf 50 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt das Ziel, das Sie sich gesetzt haben, bevor Sie mit dem Lernen für diesen Messzeitpunkt begonnen haben.

Together with the teaching personnel of the course, we developed standards and benchmarks regarding optimal SRL behavior and learning outcomes in the course. Based on these standards and benchmarks we created text elements that could be used to create automated, individualized feedback with an *Excel* algorithm. The feedback was generated based on the

information we had obtained on students' prior SRL behavior during the LPTs. The construction principle is displayed in Figure 1. The information each person had provided on the scales to describe their own learning behavior together with their scores on the LPT was used to feed back that the desired SLR behavior was already being demonstrated or that it was not yet being sufficiently demonstrated. Recommendations on how to improve were also included. Each student received the feedback via their student mail after they had participated in a LPT. That way we could regularly provide an individual feedback for SRL to more than 400 students. In the following, our procedure to produce the individualized feedback will be described using learning strategies students reported as an example. We wanted students to prioritize deep learning strategies (i.e., elaboration) but also use organization strategies (i.e., to structure contents) and finally also to some extent to merely rehearse. We therefore always emphasized the importance of elaboration strategies (“to anchor new knowledge in existing knowledge”), unless students reported to use them already sufficiently. If students reported to apply elaboration at least fairly often (4 or 5 on a scale from 1 to 5), we recommended to also structure the learning content (“to create yourself an overview over all contents”), in case students did not report at least medium agreement (3 on a scale from 1 to 5) to using this strategy. If also this condition was fulfilled, we recommended students to also rehearse contents (“to refresh knowledge of former lessons”) if students reported to not rehearse at all. In case students reported to have used all learning strategies above the respective benchmarks that were set, they received the recommendation to continue using all strategies with a focus on elaboration (see Figure 3).

Figure 3

Decision Tree for Automated Feedback Regarding the Recommendation for Learning Strategies



Feedback Framing. What differed between the two experimental conditions was the way in which the feedback was designed. We created two conditions, one with an autonomy-supportive and one with a more controlling feedback. In the autonomy-supportive condition, the degrees of freedom were emphasized and non-controlling language was used (i.e., “should” or “could” and “might”). The autonomy-supportive feedback always framed information with an emphasis on choice, e.g., students were asked to reflect if goals were challenging enough instead of merely instructing them to set a higher goal. Furthermore, one goal of the course was described as supporting self-regulated learning and the acquisition of competence. We also made sure to acknowledge potential difficulties that students might experience (e.g., “sometimes it might be difficult to do…”) and gave a rationale for adoptions of learning behavior that we proposed (e.g., „it still might be useful to do [X] as it will lead to deepened understanding”).

In contrast, in the controlling condition, there was no emphasis on students’ choice but they were rather pressured to adopt a certain behavior by referring to external (threat of failing an

exam) or internal constraints (shame of not fulfilling expectations). The controlling character was further enforced by the use of imperatives and words like “should”, “must”, or “have to”. The controlling feedback thus expressed that a certain behavior and performance was demanded and expected from a student teacher in this course. Students received direct instruction on what to change instead of prompting that they make their own decisions. When evaluating their self-set goals and their learning progress, passing the final exam was the benchmark instead of the acquisition of a satisfying level of competence. Potential difficulties were not acknowledged, as happened in the autonomy-supportive feedback condition and rationales provided emphasized the importance for the final exam. Excerpts can be found in Table 3, with the respective explanation above. The full texts of the feedback can be found in the appendix.

Table 3

Autonomy-Supportive and Controlling Characteristics of Example Text Elements

Autonomy-Supportive Framing	Controlling Framing
Reference to one’s own learning goals and standards	Reference to external performance goals / requirements
“This part of the feedback informs you about your current learning progress and can be used by you to observe your learning progress yourself and to control it independently.” *“Your learning progress thus fits to an intermediate goal regarding your own research-related competencies.”*	*“This part of the feedback will inform you about how well you are currently meeting the requirements set in this course for student teachers.”* *“Your learning is thus largely in line with what is expected of a student teacher.”*
Use of non-controlling language (e.g., “want to”, “could”, “might”)	Use of controlling language (e.g., “should”, “must”, “need to”)
*“Based on the result of the current test, your new goal means that you **want to** achieve a*	*“Based on the result of the current test, your new goal means that you **need to** make a*

higher learning progress in the next assessment." *"To learn you **could** further use the different learning strategies."*	*higher learning progress in the next assessment."* *"You **should** continue to use the different learning strategies."*
Prompts to reflect and decide oneself – guiding questions	Provision of directives and instructions
How much time do you want to spend on learning until the next test? *If you also want to repeat old topics, it might make sense to schedule more time than last time because new topics will be added.* *What do you want to do to achieve your goal?*	*Do not forget that with each of the tests new topics are added.* *Because you also have to repeat the old topics, you should plan more time for studying for the next test than the last time.* *Make an effort to reach your goal!*
Emphasis on choice and options	No choices are provided or emphasized
"You can decide whether you want to maintain the current progression or if you want to reach a different level by the end of the course."	*"If your performance continues to develop like this, you will probably pass the learning outcome assessment at the end of the lecture."*
Acknowledgement of students' perspective and feelings	Students' perspective and feelings are not addressed
"It is not always easy to motivate yourself. But if you decide to regularly study the current topics of the course, you will ensure sustainable learning success." *"You probably didn't have time to work on the exercises."*	*"Study the current topics of the course on a regular basis. You should not only start learning at the end of the course shortly before the learning success check."* *"You have not yet worked on the exercises."*

Measures

All items were assessed on an equidistant, fully verbalized 7-point Likert-scale (1 = Does not apply at all; 7 = Fully applies). Items were presented in German.

Self-regulated learning behavior

Performance LPT. We assessed students' performance on the MC questions of the LPTs. The number of questions increased with course progression, as questions were always asked for recent but also for former course contents (number of questions: 1st LPT = 12, 2nd LPT = 18, 3rd and 4th LPTs = 24). All questions were testing conceptual knowledge and students had to select two correct answers from five answer options to receive a point.

Goals. We asked students at the end of each LPT to set themselves a goal for the next LPT, corresponding to the number of questions they aimed to answer correct.

Self-assessment accuracy. Before starting a LPT students were asked how many questions they expected to answer correctly on this LPT. We then calculated the accuracy of the self-assessment by subtracting the self-assessment from their actual score.

Time planned to learn. After each LPT, just after students were asked to set themselves a goal for the next LPT, we asked them how many hours per week they plan to invest into studying the course material.

Time spent learning. At the beginning of each LPT we asked students how much time they actually spent studying the past three weeks (since the last LPT).

Use of learning strategies. We asked students to what extent they used learning strategies of rehearsal, organization, elaboration and thinking about application. Students could answer for each learning strategy on a 5-point Likert scale from 1 (not at all) to 5 (extremely).

Use and perception of feedback. We asked students if they had fully read the feedback and if they had used the feedback to adapt their learning process. We assessed this for the first three feedbacks. Students could answer for both items on a 5-point Likert scale from 1 (not at all) to 5 (extremely).

Perceived relevance

We assessed how relevant students perceived the course content to be with seven items. One item was more generic “The contents of the course are useful for my professional activity as a teacher.” In contrast, the other six items were more specific to the course contents of DBDM (e.g., “As a teacher, I make better pedagogical decisions when I review the current state of research beforehand.”. The scale showed high reliability with Cronbach’s α = .83 (t1) and Cronbach’s α = .88 (t2).

Motivation to learn

To assess the different qualities of students’ motivation to learn we used the structure of existing scales like the AMS (Vallerand et al., 1993) and the SRQ-A (Ryan & Connell, 1989) and tailored items to the specific context of a higher university course (e.g. replacing “school” with “this course”) about DBDM for teachers. We also created items to account for the specific circumstances of the course and topic together with the teaching personnel and DBDM experts. Additional to the subscales of amotivation, external regulation, introjected regulation, identified regulation and intrinsic motivation, we decided to also include items tapping into integrated regulation, as we believe student teachers in their master already developed a more complex identity with goals and values that a new concept like DBDM might be integrated into. To limit the length of the questionnaire at the beginning of the course we omitted on of the three items of each subscale at t1, assessing each subscale with 2 items. Motivation to learn was thus assessed with 12 items on t1 and with 18 items on t2. The full list of items can be found in the appendix.

Amotivation was assessed with three items, all including statements of students that do not possess any motivation to learn (e.g., “Honestly, I don't know; I really feel that I am wasting my time in this course”). External regulation was assessed with three items that represented

students learning mainly to pass the final LPTs (e.g., “I learned in order to pass the learning progress test and thus the course.”). Introjected regulation was assessed with three items that represented students that mainly learning because it is expected of them and they would feel bad if they didn’t (e.g. “I learned because I would feel bad about myself otherwise”). Identified regulation was assessed with three items representing students learning because they recognize the personal importance of the contents (e.g., “I learned because I will need this content as a future teacher.”). Integrated regulation was assessed with three items representing students learning because the contents fit with the way they want to be as a teacher (e.g., “I have learned because I am convinced that as a teacher I must act evidence-based.”). Intrinsic motivation was assessed with three items representing students learning mostly out of pleasure of interest (e.g., “I learned because I enjoy studying this content.”). The subscales showed unacceptable (introjected regulation on t1) to excellent reliability with Spearman-Brown ρ = .42 - .86 (t1) and Cronbach’s α = .65 - .94 (t2).

Basic psychological needs

We assessed how students’ basic psychological needs satisfaction and frustration for autonomy, competence and relatedness. As we deemed questions for need satisfaction impossible to answer before the course started, we only assessed these items at t2. Each construct was assessed with three items. We used items from the German version of the Balanced Measure of Psychological Needs Scale (BMPNS; Neubauer & Voss, 2016), but often adapted or changed item content to our higher university context (as has been done in Dübbers & Schmidt-Daffy, 2021). Autonomy satisfaction measured if students perceived that they could learn in their own way and felt like they had choice and options (e.g.,” In the course I can learn in my own way.”). Autonomy frustration assessed if students felt acting more controlled and out of outside pressure

(“In the course, other people tell me what to do.”). Competence satisfaction assessed if student felt mastery and success when working in the course (e.g., “In the course, I feel competent in terms of acquiring the learning content.”). Competence frustration assessed if students felt disappointed in or insecure about their competence and abilities (e.g., “In the course, I feel insecure about my abilities.”). Relatedness satisfaction assessed if students perceived that the docent had a caring attitude towards them (e.g., “In the course, I feel that the docent cares about my learning.”). Relatedness frustration assessed if the students perceived the relationship with the docent to be cold and distant (e.g., “In the course, the docent doesn't seem to like me very much.”). The subscales had unacceptable (relatedness frustration) to good reliabilities with Cronbach’s α = .54 – .84.

Intentions to apply

We assessed students’ intentions to use and apply DBDM in the future with specific items representing the most probable examples of application. This scale was already used in a former study (Dübbers & Schmidt-Daffy, 2021), where four items were developed together with the teaching personnel of the course and experts in the field of DBDM (e.g., “As a teacher, I plan to evaluate my teaching regularly using questionnaires.”). The scale showed acceptable to good reliability with Cronbach’s α = .74 (t1) and Cronbach’s α = .81 (t2).

Self-efficacy for application

We assessed the self-efficacy of students regarding the application of DBDM with four items asking how confident students feel about applying DBDM even given various obstacles (e.g.,” I have the confidence to research the current state of research on a pedagogical question, even if time is short.”). This scale was already used in a former study (Dübbers & Schmidt-

Daffy, 2021). The scale showed acceptable to good reliability with Cronbach's α = .72 (t1) and Cronbach's α = .85 (t2).

Structure

We wanted to test if students perceived any unintended differences between the two feedbacks regarding the provision of structure. Therefore, we assessed students' perceptions of how clear expectations were communicated (two items, e.g." In the context of learning progress test, expectations were not clearly communicated to me."), the ease of understanding (two items, e.g. "In the context of learning progress test, the feedback contained understandable information.") and amount of support provided (e.g., "In the context of the learning progress test, I did not feel that I received sufficient support.") at t2. The six items showed acceptable reliability with Cronbach's α = .78.

Demographics

We assessed students' gender, age, study track and subject studied.

Data analysis

For the psychological constructs that were assessed at t2 only, we applied factorial-two-way-ANCOVAs. For all other variables that were assessed on the baseline measurement and after the course had ended as well as for students' SRL data, we compared groups with mixed-ANCOVAs. We tested the assumptions of normality of residuals for each variable. Variables that showed a positive skew were log-transformed. We decided to winsorize outliers in extreme cases ($z > 3.29$), replacing them with the next highest value that is not an outlier, to not violate test assumptions. Results before and after outlier removal were always compared and no significant difference emerged. To test for sphericity, we applied Mauchly's test and if significant we report Greenhouse-Geisser-corrected values. As participants who studied the school subject of old

languages were not evenly distributed across conditions, we controlled for it in all analyses. We further used perceived structure as a control variable for all analyses to check for possible differences in the amount of clarity, directiveness and ease of understanding that might exist between the many different text elements of the automated feedback and the two different feedback framing conditions. Both variables were added as covariates to the analyses.

Results

Preliminary analysis

Fidelity analyses & manipulation check

To test if students adhered to the intervention instructions of the relevance intervention we asked two independent raters to categorize students' responses as either a summary or a reflection about the personal relevance of the course. Ratings correlated on average by $r = .76$ and diverging classifications were discussed and resolved. There was a significant effect of the relevance intervention on the amount of students' reflections that were categorized as relevance reflections, $F = (1,153) = 165.23$, $p < .001$, with students in the relevance condition producing more relevance reflections ($M = 2.28$, SE = .11) compared to students in the summary condition ($M = 0.3$, SE = .11).

Regarding our feedback manipulation, we wanted to know if students actually read the feedback. We asked students in LPT 2, 3 and 4 if they had fully read the feedback regarding their recent LPT. When we compared how much students reported to have read the feedback on average, we found no significant difference between the conditions of feedback framing, $F(1,153) = 1.5$, $p = .223$, but a marginally significant difference between the conditions of the relevance intervention, $F(1,153) = 3.31$, $p = .071$, with participants in the relevance condition

reporting to have read the feedback more fully (M = 4.4, SE = 0.08) compared to participants in the summary condition (M = 4.2, SE = 0.07).

As a manipulation check for the autonomy-supportive and controlling framing of the feedback we asked students if they felt controlled by the feedback ("In the feedback my docent was prescribing me how to design my learning process"), to make sure that the controlling feedback was perceived as more controlling compared to the autonomy-supportive feedback. Contrary to our expectations, we did not find a significant difference between the autonomy-supportive and the controlling feedback condition, $F(1,142) = 1.09$, $p = .299$.

Learning behavior

Table 4

Results of Mixed ANCOVAs on Learning Behavior Data. Main Effects for Relevance Condition, and Framing Condition and Statistical Interaction between Relevance and Framing Condition

	Relevance		Feedback framing		Interaction	
Variable	*F*	*p*	*F*	*p*	*F*	*p*
Performance	2.51	**.072**	0.01	.994	0.91	.420
Goal setting	0.48	.654	0.23	.836	3.06	**.039**
Self-assessment accuracy	2.44	**.072**	1.29	.279	0.15	.911
Time planned to learn	0.14	.922	2.66	**.053**	1.87	.139
Time spent learning	0.07	.854	0.33	.628	6.86	**.005**
Rehearsal	1.66	.182	1.17	.319	0.63	.573
Organization	4.01	**.009**	0.55	.638	0.67	.562
Elaboration	2.67	**.051**	0.28	.824	0.11	.944
Application	3.21	**.026**	0.48	.687	0.27	.833
Usefulness feedback	1.75	.180	1.88	.160	0.30	.717
Adoption of learning behavior	0.41	.650	0.80	.441	0.60	.539

Performance

We evaluated the learning progress of students over all four LPTs. Supporting *hypothesis 1*, the results showed a marginally significant effect of the relevance intervention on learning progression over time, F (2.39, 354.23) = 2.51, p = .072, η^2 = .017. Contrasts revealed that students in the relevance condition showed significantly higher performance in LPT3 (M = 14.8, SE = 0.59) compared to the students in the summary condition (M = 13.2, SE = 0.60), F (1,148) = 4.48, p = .036, η^2 = .029. We found no effect of the feedback intervention.

Goal setting

Regarding the goals students set themselves, we tested if students set themselves higher goals over time, between the different conditions. When comparing the goals students set themselves during the course, we found no main effects of the two interventions. However, a significant interaction on the progression of goal setting emerged, F(2.41,356.05) = 3.06, p = .039, η^2 = .02. Pairwise comparisons revealed that the highest increase in goal setting over time was observed for students receiving the relevance prompt and autonomy-supportive feedback (M = 7.14, SE = .66) or a summary prompt and controlling feedback (M = 7.88, SE = .68). These two groups showed a significantly higher increase in goal setting from LPT1 to LPT4 compared to students who were in the summary condition and received autonomy-supportive feedback (M = 6.13, SE = .87) or in the relevance condition and received controlling feedback (M = 5.88, SE = .86). The results only partially confirm *hypothesis 5*, as we predicted the combination of the relevance condition and autonomy-supportive feedback to support students' SRL the best, but the increase in goal setting for students participating in the summary condition and receiving controlling feedback is contrary to *hypothesis 5*.

Self-assessment accuracy

We evaluated students' self-assessment accuracy over all four LPTs. In line with *hypothesis 1*, we found a significant effect of the relevance intervention on students' self-assessment accuracy when asked to judge their current competence level and compared it to their actual score, $F(2.65,400.03) = 2.44$, $p = .072$, $\eta^2 = .016$. As the number of MC-questions became more with the first three LPTs, the differences between self-assessment and score increased over time on average. Students in the relevance condition showed a less pronounced increase in the differences between self-assessment and scores over time ($M = 2.21$, SE = .40) compared to students in the summary condition ($M = 2.61$, SE = .40). Students receiving the relevance condition were thus more accurate over time when estimating the score, they will obtain on the next LPT. No effect of the feedback intervention emerged.

Time planned to learn

We evaluated the time students planned to learn over all four LPTs. We found no main effect of the relevance intervention, but a marginally significant main effect of the feedback intervention, $F(2.75,414.95) = 2.47$, $p = .067$, $\eta^2 = .016$. This finding contradicts our *hypothesis 2*, as students in the controlling feedback condition increased the time they planned to invest in learning from LPT1 to LPT4 (M = 23.94, SE = 9.12), whereas the time students receiving the autonomy-supportive feedback planned to invest in learning slightly decreased (M = -3.83, SE = 9.63).

Time spent learning

We found main effects of the two interventions on time spent learning. Also, a significant interaction emerged. Students receiving the relevance condition together with autonomy-supportive feedback ($M = 95.48$, SE = 19.82) or students receiving the summary condition and

controlling feedback (*M* = 99.89, SE = 18.07) showed significantly higher increases over time in the time they spent learning. Accordingly, students in either relevance and controlling feedback conditions (*M* = 55.02, SE =19.79) or summary and autonomy-supportive feedback conditions (*M* = 37.84, SE = 20.65) reported to have spent significantly less time, $F(1.33,200.39) = 6.85$, $p = .005$, $\eta^2 = .056$. Again, this interaction partially confirms the prediction of *hypothesis 5*, predicting that students receiving both experimental conditions with show most adaptive SRL outcomes, with the high values of students in the summary condition receiving controlling feedback contradicting the prediction.

Use of learning strategies

We evaluated if the use of learning strategies differed between conditions and over time. We found no difference between conditions regarding the use of rehearsal strategies over time. However, students in the relevance condition showed a significantly stronger increase (M = 1.18, SE = .19) in the use of the strategy of organization compared to students in the summary condition (*M* = 0.50, SE = .17), $F(2.78,417.07) = 4.01$, $p = .009$, $\eta^2 = .026$. Similarly, students in the relevance condition also showed a stronger increase that was marginally significant in the reported use of elaboration (*M* = 1.29, SE = .17), compared to students in the summary condition (*M* = 0.69, SE = .17), $F(2.78,406.69) = 2.67$, $p = .051$, $\eta^2 = .018$. Finally, the amount that students reported to have thought about ways to apply the knowledge increased significantly more strongly for students in the relevance condition (*M* = 1.30, SE = .19), compared to students in the summary condition (*M* = 0.56, SE = .19), $F(2.83,416.26) = 3.21$, $p = .026$, $\eta^2 = .021$. Overall, we find support for *hypothesis 1,* as the relevance intervention seems to positively affect the use of deep learning strategies. The feedback intervention did not show any effect on the use of learning strategies.

Use and perception of feedback

We found no difference regarding how students rated the feedback's usefulness or in how they had used it to adapt their learning process.

Motivational variables

Table 5

Results of Mixed ANCOVAs on Motivational Variables Main Effects for Relevance and Framing Condition and Statistical Interaction between Relevance and Framing Condition.

	Feedback					
	Relevance		Framing		Interaction	
Variable	*F*	*p*	*F*	*p*	*F*	*p*
Perceived relevance	0.06	,815	1.16	.284	0.55	.460
Motivation to learn	0.25	.617	0.80	.374	.024	.876
Autonomy satisfaction	0.01	.908	0.26	.608	0.64	.426
Autonomy frustration	0.15	.700	0.20	.653	0.27	.607
Competence satisfaction	0.15	.696	0.68	.411	<0.01	.966
Competence frustration	2.41	.123	0.46	.499	1.45	.230
Relatedness satisfaction	0.64	.426	0.76	.385	0.34	.563
Relatedness frustration	0.03	.869	0.96	.329	0.09	.764
Application intentions	0.49	.486	0.09	.761	0.16	.693
Self-efficacy	< 0.01	.977	0.73	.395	1.32	.253

We analyzed effects of our intervention on motivational variables comparing scores from pre and post measures. Against our predictions we did not find significant effects of neither the relevance intervention (*hypothesis 3*) nor the feedback framing intervention (*hypothesis 4*), nor an interaction of the two interventions (*hypothesis 6*) on any of the motivational variables. As depicted in Table X, students did not differ regarding perceptions of relevance of course contents, they did not differ regarding the development of motivation to learn and they did not differ in their satisfaction or frustration of basic psychological needs for autonomy, competence

and relatedness. We further did not find a difference between conditions regarding intentions to use and apply course contents in the future or self-efficacy regarding their application.

Brief discussion

We attempted for the first time to combine a relevance intervention and a feedback framing intervention in a long-term field experiment, to test its potentially synergistic effect on students' SRL and motivation. We expected that having students reflect about the personal relevance of self-chosen concepts and receiving autonomy-supportive feedback throughout a university course would benefit their learning, both in isolation and, in addition, when combined.

Learning behavior

Our *first hypothesis* was that the relevance intervention, compared to merely summarizing course contents, would lead to improved SRL learning. We found support for this claim, students reflecting regularly about the personal relevance they see in the course contents also became better over time to assess their current competence level, reflected in improved self-assessment accuracy. When looking at learning strategies that students applied, we found that students did not differ regarding the amount of rehearsing they did, but students in the relevance condition engaged significantly more deeply in learning strategies (organization, elaboration, and application). Finally, students also showed improved performance over time when they repeatedly received a prompt for relevance reflection, evident in their achievement test scores in the third performance test. This is probably because the test was not novel anymore, students were maybe losing interest somewhat and acted on the motivation that learning the contents was personally relevant. Regarding the final performance test, also students who were not convinced of the personal relevance again had an external incentive, passing the course with 50% correct

answers, which might have evened out the positive effects of the intervention. We do overall conclude, that the relevance intervention helped to improve students' SRL.

Regarding *hypothesis 2*, we also expected that students receiving feedback in autonomy-supportive language show improved self-regulated learning compared to students receiving the individualized feedback in controlling language. However, we found no effect of language alone on SRL variables, with the exception of time students planned to learn. Contrary to our expectation, students receiving the controlling feedback reported to have increasingly invested more learning time throughout the course, whereas for students in the autonomy-supportive feedback condition the time they invested actually decreased. We did not find any other effect of the feedback framing alone.

Finally, we expected the two interventions to lead to an additional positive effect on self-regulated learning when combined, as both were supposed to satisfy students' needs for autonomy. We found partial confirmation of our *hypothesis 5* for goal setting and the time students spent learning. For those two variables, students that received both treatment conditions showed most adaptive SRL behaviors with highest goals set and most time spent learning over the course. Students receiving only one of the two treatments showed decreased goal setting and time spent learning. However, students receiving both control treatments were as effective as students receiving both treatments, which contradicts our initial *hypothesis 5*.

Motivation

Regarding our motivational variables, we had expected that both treatments would unfold a separate effect as well as an interactive effect on need satisfaction, self-determined motivation, and intention to apply, as well as on self-efficacy. However, contrary to our expectations, none of the expected effects emerged.

To conclude, we found some evidence for the beneficial effect of a relevance intervention on students' SRL, but effects on motivational variables were absent. Further, our feedback framing intervention did not trigger the effects we expected. The null effects of the relevance intervention on motivational variables might be due to an insufficient sample size reducing the power to detect effects, but probably also due to the brevity of the intervention. In other studies, applying interventions, students typically produced rationales about the personal usefulness or relevance of the contexts by writing one to two pages. In our study, we asked students to only write about four sentences, as our intervention should not interrupt the coursework too much.

The autonomy-supportive feedback framing did not show any intended effect either, which might be due to, as the manipulation check suggest, the control condition not being experienced as controlling enough. When creating the text elements for the two conditions, a balance had to be found to write feedback in a controlling language that still includes the same amount of information and provides similar recommendations as the autonomy-supportive feedback. It is possible, as the failed manipulation check indicates, that the controlling feedback language was not framed rigidly enough. Furthermore, even though we aimed to control for a potential difference in structure, we are unclear if some text elements gave students more clear direction than others. We therefore decided to investigate the actual differences between controlling and autonomy-supportive feedback in more detail.

Study 2: The effect of autonomy-supportive feedback alone

In our second study, we wanted to test if our manipulation of the feedback text elements to be autonomy-supportive or controlling worked as intended. From an SDT perspective a feedback can possess characteristics that support each of the basic psychological needs for autonomy, competence and relatedness. The respective behaviors supporting the needs are

autonomy-supportive behavior for autonomy, the provision of structure supporting feelings of competence and involvement which supports the need for relatedness. We were interested if students perceived our autonomy-supportive feedback indeed as more autonomy-supportive and if this feedback had the potential to affect their motivation to learn in the course. In a vignette-based experiment, we used the average student data from Study 1 to create a prototypical feedback using the same algorithm applied in Study 1. We designed the study as an experiment with the same difference in feedback framing: autonomy-supportive vs. controlling. We then asked students to put themselves in the situation of a student receiving this feedback and evaluate the feedback. We expected that the autonomy-supportive feedback would be rated as higher on autonomy-support (*hypothesis 1*) and would lead students to report more self-determined motivation to learn than the controlling feedback (*hypothesis 2*). No hypothesis was specified as to whether the provision of structure would differ between the two feedback conditions (*hypothesis 3*): While in the autonomy-supportive feedback students were offered to make their own choices, the controlling feedback could be perceived as providing more direction or clear instructions regarding what to do compared to the autonomy-supportive feedback. Regarding involvement, we wanted to test if there was a difference between the two feedback conditions, as autonomy-supportive interventions often go along with support for the other basic needs (Ryan & Deci, 2017; *hypothesis 4*).

Method

Participants

Participants were student teachers enrolled at a large university in Germany. The experiment was conducted in one lesson of a regular course that deals with pedagogical psychology for teaching students as obligatory part of their master's program teacher training.

The course was taught in 17 different classes. Overall, 444 students participated in the lesson of whom 417 gave their informed consent (94% response rate) to the use of their answers for scientific purposes. Participants in the final sample were mostly female (79.3%), on average 26.3 years old and were either preparing to become a teacher at a high school (44.7%), an elementary school, (43.9%) or were following other study tracks (e.g., special education; 11.4 %). Participants were randomly allocated to one of the two experimental conditions (controlling feedback condition = 210 participants; autonomy-supportive feedback condition = 207 participants) and participants in the two conditions did not differ regarding the distribution of gender $X^2(1) = 0.15$, $p = 1.00$, age $t(408) = 1.30$, $p = .19$, and study track $X^2(6) = 10.21$, $p = .12$.

Experimental manipulation

Irrespective of experimental condition, the feedback that students saw was based on the exact same SRL data, i.e., the goals the fictitious students had set themselves, the time they had invested, the learning strategies they had used and the same graph was used to illustrate students' learning progress.

Procedure

We incorporated our experiment as an individual task of one lesson in the course, which was about feedback. The study was designed as a randomized, controlled, between-subjects vignette experiment. Students were randomly assigned on individual level to either the autonomy-supportive feedback group or the controlling feedback group, with a stratification on class level making sure that in each class a similar number of students was allocated to each of the two conditions. At the end of the lesson students were provided a link to an online questionnaire, which they were told presented them a new perspective on feedback. The students had not learned about the concept of autonomy-support, the factor that was experimentally

manipulated, yet, as it was the content of a lesson to come, neither were they aware that this would be manipulated. At the beginning of the questionnaire we presented students the vignette. Students were asked to imagine they were taking a class about DBDM, a compulsory course in the upcoming university term and that we would ask them to evaluate feedback that they received in the course to support their SRL. The vignette represented the original course setup. We began by briefly describing to the students how the course was set up:

> "Imagine you are taking a course at the university on research-based competencies for teachers. The course concludes with a learning progress test that must be passed in order to receive credit for the course. During this course, you complete three learning progress tests are not included in the evaluation of your performance in the course, but are designed to help you monitor your progress. Before each test, you were asked to set a goal in terms of points, how much time you wanted to invest in preparation and, immediately before the measurement, how well you think your current level of competence was. "

The feedback that students were presented and asked to evaluate was the individualized feedback that they would have received after each of the first three LPTs in the course that we presented in the vignette. Students thus saw three feedbacks, each based on average student data for LPT 1, 2 and 3 and formulated in either an autonomy-supportive or a controlling way, depending on their experimental group. The values that we used to create the feedback were the mean values of students that actually participated in the target course about DBDM one year before (e.g. scores, goals, time planned, time invested, learning strategies used) and were identical for all students, also across conditions. We decided to alternate feedback and blocks of dependent variables. After student had read a feedback, a set of dependent variables was presented on a new page and participants could not go back to a previous page, so they would

rely on their overall impression of the feedback to answer items. We then showed the next feedback that mainly entailed the same autonomy-supportive or controlling characteristics but differed from the feedback before merely regarding the data about learning behavior as the students progressed through the hypothetical course (e.g., higher goals and scores). We did not present all three feedbacks after each other as we assumed that it would be repetitive (see Table 6 for an overview). At the end of the questionnaire, students were informed about the purpose of the study and the experimental manipulation and we asked students for their informed consent to use their data for scientific purposes.

Measures

All of the scales except for the semantic differential were answered on a fully verbalized 7-point likert scale (1 = fully disagree, 7 = fully agree). The semantic differential was answered on a 5-point scale were the two bipolar adjective pairs presented the two extremes (e.g., 1 = interesting, 5 = boring). Items were presented in German. Reliability scores can be found in Table 6.

Semantic differential

We wanted to learn about how students perceived the two differently framed feedbacks, to see where controlling and autonomy-supportive feedback make a difference. We therefore used a semantic differential (Osgood et al., 1957). We selected pairs of adjectives that described aspects of the feedback like its clarity, structure, justification and interestingness, as we suspected all those facets to be influenced by autonomy-supportive practices incorporated in the feedback framing. Further we also assessed the perceived style of interaction of leadership and the perceived motivational effect it might have. In total, students were presented with 21 items of bipolar adjective pairs describing different characteristics of a feedback.

Need-supportiveness

In order to assess how need-supportive students perceived the feedback to be, we used the Teacher as a Social Context Questionnaire (TASQ; Skinner & Belmont, 1993), which is commonly used to analyze need-supportive teaching in SDT (e.g., Vermote et al., 2020). We wanted to assess if students perceived the differently framed feedbacks to provide different amounts of structure, autonomy-support and involvement. Following the structure of the TASQ, we adapted existing items to the higher education context or formulated items similar to the items of the TASQ, tapping more into the support of SRL.

Structure. To assess the amount of structure student perceived the feedback to provide we assessed two aspects, namely if students perceived that expectations were clearly communicated and to what extent the feedback provided specific help or support for students' learning progress.

Expectations. We assessed if the feedback communicated clear expectations with four items. Three of these items were items from the TASQ, adapted to the context of a university ("in school" was replaced with "in this course" and "clarity of instructions" with "clarity of expectations"). Another item was created in addition, asking more specifically about clarity of learning goals and requirements (e.g., "My docent made sure that I really understood the goals of the course and what I needed to do to achieve them.").

Help/Support. We newly created four items to assess if students perceived that the feedback provided helpful advice for their learning (e.g., "I get helpful hints from my docent on how to study for this course."). This was necessary as the subscale of the TASQ regarding help/support from the teacher assesses in general if the teacher helps the students when it is needed (e.g., "Even when I run into problems, my teacher doesn't help me."). We wanted to ask

more specifically if students perceived getting from the docent regarding their self-regulated learning.

The two subscales of expectations and help/support showed good reliability and were collapsed for reasons of sparsity to an overall scale for structure with eight items which showed good reliability as well.

Autonomy-support. To determine the autonomy-supportive characteristics of the feedback we assessed three aspects: the provision of choice, the perceptions of being controlled and communication of relevance.

Choice. We assessed how much students perceived that the feedback provided them choice and options with three adapted items from the TASQ ("schoolwork" became either "learning", „course" or "organize my studies"). We created two additional items capturing if the docent was encouraging students to make their own choices in the course (e.g.," My docent encourages me to make my own decisions about learning in this course.").

Control. We assessed with three items if the students perceived the docent as trying to exert control over them. Additional to one item from the TASQ ("It seems like my docent always tells me what to do."), we created two items that asked specifically if the docent was perceived as attempting to control students' learning behavior (e.g., "My docent tells me exactly how to learn.").

Relevance. The items tapping to the provision of rationales of the TASQ focused on a teacher providing rationales explaining why the learning content was relevant. We wanted to know if students perceived the docent to give reasons for the way that he recommended students to learn. We therefore adapted the items. We assessed if students perceived that the docent

provided rationales and explained their feedback regarding students' learning process with four items (e.g., “My docent talks about why I should learn a certain way.”).

The three subscales showed medium to good reliability and were collapsed to a scale of autonomy-support with 12 items which showed good reliability.

Involvement. We assessed how involved students perceived the docent to be (e.g., “My docent is very good with other people's emotions.”) with four items, adapting the items to the context of higher education. In higher education, the docent often does not communicate with students personally, but rather in the format of a lecture or in our case, personalized feedback sent via Email. We decided to discard item 4 of the involvement scale, “I don't feel very good about the way my docent talks to me”, in the analysis, as it substantially improved scale reliability of the remaining three items.

Motivation to learn

We wanted to see if students that read through the vignette-feedback framed in an autonomy-supportive way expected themselves to be more self-determined in their motivation to learn compared to students that read through the vignette with controlling feedback. We assessed student's self-determined motivation to learn in the course with the *Skalen zur motivationalen Regulation beim Lernen* (SMR-L), a validated measure to assess motivational regulation for learning in German (Thomas & Müller, 2016). The scale is based on the Academic Motivation Scale (AMS; Vallerand et al., 1993), while avoiding the empirically unproven tripartite subdivision of intrinsic motivation (Howard et al., 2017). We adapted the scale to the course content by changing the stem to “I am learning in the course about Data-Based Decision-Making...”. We further adapted the items for external regulations to the university context by changing “because I’ll get into trouble at home.” into “because I’ll get into trouble.” and the item

“because my parents demand it of me.” into “because others demand it of me.”. The SMR-L consists of 14 items in total and assesses four subscales, namely intrinsic regulation (e.g., “because otherwise I will get in trouble with my instructor.”, identified regulation (e.g., “because I want to understand the content.”), introjected regulation (e.g., “because it is embarrassing not to know anything.”) and external regulation (e.g., “because otherwise I will get in trouble with my docent.”). All subscales showed acceptable to good reliability. In order to combine the information on the different subscales representing different regulatory styles, a relative autonomy index (RAI) is usually computed. By subtracting the values of the less self-determined forms of motivation (external regulation and intrinsic regulation) from the more self-determined forms of motivation (identified and intrinsic regulation), we obtained a score that indicates the individuals’ degree of self-determination (Sheldon & Hilpert, 2012).

General feedback evaluation

We asked students how extensively they would study the feedback (“I would spend time to read this feedback.”) and if they would use it to adapt their learning behavior (“I would adjust my learning behavior based on the feedback.”).

Data analysis

We analyzed reliability by calculating Cronbach’s α. Further, as a preliminary analysis of the semantic differential, we conducted a principal axis factor analysis on the 21 items with oblique rotation (direct oblimin). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .93 (“marvelous” according to Hutcheson & Sofroniou, 1999). An initial analysis was run to obtain eigenvalues for each factor in the data. We applied the criterion of an eigenvalue of 0.7, as proposed by Jolliffe (1986). Five factors had eigenvalues over the criterion of 0.7 and in combination explained 67.17% of the variance. The items that

clustered on the same factor suggested that factor 1 represents the appeal of the feedback (e.g., interesting - boring, varied -monotonous), factor 2 represents the emotional effect of the feedback (calming - frightening, relieving - stressful), factor 3 represents the justification of the feedback (reasoned - unjustified, comprehensible - ungrounded), factor 4 represents the tone of interaction (recommending -commanding, guiding - prescriptive,) and factor 5 represents clarity of the feedback (structured - chaotic, clear - blurred). An overview including reliability scores can be found in Table 6. We tested our hypotheses with separate univariate ANOVAs using IBM SPSS version 25.

Table 6

Presentation Order of Feedback and Scales; Subscales and Reliability Scores

Presented feedback	Scale	Subscale	Nr. of items	Cronbach's α
Feedback LPT1				
	General feedback Evaluation			
		Appeal	6	.87
		Affect	5	.82
	Semantic differential	Justification	3	.84
		Tone of interaction	4	.78
		Clarity	3	.74
Feedback LPT2				
	Structure		8	.81
		Expectations	4	.70
		Help/Support	4	.81
	Autonomy-support		12	.87
		Choice	5	.83
		Control	3	.82
		Relevance	4	.68

	Involvement		3	.78
Feedback LPT3				
	Motivation (RAI)		13	
		External regulation	3	.71
		Introjected regulation	4	.81
		Identified regulation	3	.90
		Intrinsic regulation	3	.89

Results

We report separate univariate ANOVAs on the outcome variables in the following. In Table 8, descriptive statistics including means, standard deviations, mean differences and effect size are displayed for all dependent variables. The correlations between dependent variables can be found in Table 7.

Table 7

Correlations between Dependent Variables

	1	2	3	4	5	6	7	8	9	10	11
1 - Read	1										
2 - Adapt	.49**	1									
3 – Appeal	.47**	.61**	1								
4 – Affect	.37**	.46*	.63**	1							
5 – Justific.	.31**	.37**	.59**	.49**	1						
6 – Tone	.22**	.32**	.48**	.59**	.41**	1					
7 – Clarity	.39**	.30**	.56**	.48**	.60**	.34**	1				
8 – Structure	.26**	.38**	.41**	.31**	.37**	.28*	.27**	1			
9 – AS	.12*	.34**	.37**	.36**	.28**	.51**	.18**	.63**	1		
10 – Involv.	.15*	.34**	.39**	.41**	.27**	.40**	.21**	.64**	.77*	1	
11 – RAI	n.s.	.16**	.18**	.22**	.16**	.30**	n.s.	.27**	.42**	.34**	1

Note. * $p < .05$. ** $p < .001$

Justific. = Justification, AS = Autonomy-support, Involv. = Involvement, RAI = Relative autononmy index (Motivation to learn)

General feedback evaluation

Students who received the controlling feedback reported more willingness to read the feedback than students who received the autonomy-supportive feedback, with a marginally significant effect, $F(1,415) = 3.77$, $p = .053$. No significant difference emerged between the two experimental groups regarding the willingness to adapt their learning behavior after reading the feedback, $F(1,415) = 0.81$, $p = .37$.

Table 8

Means and Standard Deviations, Mean Differences and Effect Sizes Broken down by Experimental Condition for all Dependent Variables

Variable		Controlling		Autonomy-supportive		Mean difference	*d*
		M	*SD*	*M*	*SD*		
Read feedback		5.71	1.35	5.45	1.39	-0.26[a]	**0.19**
Adapt learning behavior		4.73	1.30	4.85	1.25	0.12	0.09
Semantic differential	Appeal	3.51	0.86	3.47	0.73	-0.04	0.05
	Affect	3.19	0.70	3.27	0.57	0.08	0.11
	Justification	3.99	0.85	3.92	0.77	-0.07	0.09
	Tone	3.31	0.88	3.72	0.71	0.41**	**0.52**
	Clarity	4.11	0.77	3.92	0.75	-0.19*	**0.24**

Need supportiveness							
Structure		4.34	1.02	4.56	0.92	0.22*	**0.23**
	Expectations	4.47	1.10	4.37	1.07	-0.1	0.10
	Help/Support	4.21	1.22	4.76	1.05	0.55**	**0.48**
Autonomy-support		3.83	1.00	4.67	0.78	0.84**	**0.93**
	Choice	3.71	1.23	4.92	1.06	1.21**	**1.06**
	Control	4.19	1.44	3.04	1.14	-1.15**	**0.89**
	Relevance	3.97	1.11	4.39	1.00	0.42**	**0.40**
Involvement		3.72	1.27	4.30	1.09	0.58**	**0.49**
Motivation to learn	RAI	0.45	4.09	2.32	3.18	1.87**	**0.51**
	External	4.30	1.41	3.61	1.18	-0.69**	**0.54**
	Introjected	3.19	1.36	3.05	1.20	-0.14	0.11
	Identified	4.47	1.46	5.09	1.20	0.62**	**0.47**
	Intrinsic	3.48	1.39	3.89	1.22	0.41*	**0.31**

Note. * $p \leq .05$. ** $p \leq .01$. [a] marginally significant with $p \leq .06$

Semantic differential

No significant difference emerged between the two experimental groups regarding the appeal of the feedback, $F(1,415) = 0.28$, $p = .59$, the affect it elicited, $F(1,415) = 1.36$, $p = .24$, nor the degree to which the feedback seemed justified, $F(1,415) = 0.77$, $p = .381$. The autonomy-supportive feedback group reported the tone of the feedback to be more facilitative (vs. commanding), compared to the controlling feedback group, $F(1,415) = 27.80$, $p < .001$. At the

same time, the controlling feedback was rated higher regarding its clarity compared to the autonomy-supportive feedback, $F(1,415) = 5.97$, $p = 02$.

Need-supportiveness

Structure

Overall, students in the autonomy-supportive group rated the feedback as possessing more structure than the students in the controlling feedback group, $F(1,415) = 5.29$, $p = .02$.

Looking at the subscales of structure, there was no significant difference between the two groups regarding the clear communication of expectations, $F(1,415) = 0.94$, $p = .33$. However, the students in the autonomy-supportive feedback group rated the feedback to provide more help and support compared to the students receiving the controlling feedback, $F(1,415) = 23.49$, $p < .001$.

Autonomy-support

Similarly, the autonomy-supportive group reported the feedback to be more autonomy-supportive compared to the group receiving a controlling feedback, $F(1,415) = 89.68$, $p < .001$.

In particular, the autonomy-supportive group perceived the feedback to provide more choice and options, $F(1,415) = 116.07$, $p < .001$, to be less controlling $F(1,415) = 137.91$, $p < .001$ and to include more rationales and reasons, $F(1,415) = 16.31$, $p < .001$, compared to the group who received a controlling feedback.

Involvement

The autonomy-supportive feedback group also rated the feedback higher regarding the instructor involvement, compared to the group with controlling feedback, $F(1,415) = 24.75$, $p < .001$.

Motivation to learn

Students in the autonomy-supportive feedback group reported more self-determined motivation indicated by a higher RAI compared to students in the controlling feedback group, $F(1,415) = 27.07$, $p < .001$. Looking at the four subscales of motivation, students in the controlling feedback condition agreed more strongly to the statements representing external regulation of their learning, $F(1,415) = 29.95$, $p < .001$, no difference emerged between groups regarding introjected regulation though, $F(1,415) = 1.30$, $p = .25$. Students in the autonomy-supportive feedback group reported that they would learn in the course more strongly because of identified regulation, $F(1,415) = 22.58$, $p < .001$, and intrinsic regulation, $F(1,415) = 10.12$, $p = .002$, compared to students in the controlling feedback group.

Brief discussion

In our second study we wanted to investigate how strongly the autonomy-supportive compared to the controlling feedback was perceived as need-supportive and could thus affect students' motivation. We therefore generated prototypical feedback based on average student data from Study 1 and asked students to rate it regarding its need support. We found strong support for our *first hypothesis*: students rated the autonomy-supportive feedback as providing them with more choice and exerting less control than the controlling feedback. Students also considered the autonomy-supportive feedback to more strongly provide reasons for the recommendations given in the feedback. The results regarding the semantic differential further supported the autonomy-supportive effect, as the tone of the autonomy-supportive feedback was perceived as being more guiding and recommending than the tone used in the controlling feedback. Also our *second hypothesis* was confirmed: Students who read the autonomy-supportive feedback reported a higher relative autonomy index, reflecting more self-determined motivation to learn compared to students who read through the controlling feedback condition.

Regarding our *third hypothesis* we found a less clear result. Overall, the autonomy-supportive feedback was perceived as providing more structure than the controlling feedback. Students rated the autonomy-supportive feedback as providing more help and support for the adaption of their learning behavior, however, regarding clear communication, no significant difference emerged. Further, the controlling feedback was perceived as transporting information more clearly and understandable. Students receiving the controlling feedback predicted that they would invest more time to read this feedback compared to students in the autonomy-supportive feedback condition. We also tested if the involvement that students perceived in the feedback was different between groups and students who read the autonomy-supportive feedback indeed reported higher levels of involvement.

General Discussion

In this research we investigated the effect of a relevance intervention and individualized feedback framed in an autonomy-supportive way on students' SRL and motivation. The first study aimed to combine two interventions to optimally support students SRL and motivation, grounded in SDT. A relevance intervention together with individualized feedback that was framed in either an autonomy-supportive or a controlling way were applied in a field experiment implemented in a regular university course. As several results that we expected were absent and some even different than expected we set up a follow-up study to investigate how well our manipulation of feedback framing had worked. In the second study we presented students either three autonomy-supportive or three controlling feedbacks based on average student data from our first study in a vignette experiment. Students rated the feedback regarding its need supportiveness and the motivation it would elicit. We found strong effects supporting the

successful manipulation of the feedback framing. In the following, results from the two studies are explained together in more detail and conclusions and implications are discussed.

Relevance intervention

We applied a brief relevance intervention in our first field study which had already shown promising results regarding motivational variables in a previous experimental study in the context of teacher education. We wanted to test the interventions' potential to support students with their SRL. The relevance intervention seemed to have positively influenced students' SRL behavior. Forging a connection between learning about data-based decision-making for teachers and its' relevance for students' future goal to optimally support student development as a teacher increased students' engagement in learning. As can be seen from the following example, students identified the relevance of course contents for their future work:

"As a future teacher it is part of the task to evaluate own lessons. Since sampling plays a relevant role in this, it is important to be informed about sampling. It is especially important to know that an optimal sample size does not guarantee a representative sample. As a teacher, this is important in order to always consider both sample size and representativeness in any samples that are collected and to include this in the evaluation."

Recognizing the learning contents' importance for the personally valued goal of being a good teacher thus led to improved performance and a stronger use of deep learning strategies. Similar results have been found in past research with utility-value or relevance interventions. In our study, the relevance intervention did, however, not show any effects on motivational variables. This is in contrast to previous research using similar interventions, (e.g., research with utility-value interventions, Canning & Harackiewicz, 2015) and a former study of ourselves (Dübbers & Schmidt-Daffy, 2021), which found effects on interest, intentions, and self-efficacy

similar contexts with similar populations. Possibly the value of the feedback interfered with the effect of the relevance intervention, as students received very diverse feedbacks depending on their performance and SRL behavior. Thus, independent to the intended language manipulation framing the feedback in an autonomy-supportive or controlling feedback students could have received feedback that was either conveying positive or negative feedback, not necessarily corresponding to the experimentally but probably affecting students self-determined motivation (Mabbe et al., 2018). Students receiving the relevance intervention could be especially sensitive to this difference as a neurobiological study suggests, showing that individuals brains were more sensitive to feedback valence after a motivational manipulation supporting internalization (DePasque & Tricomi, 2015).

Feedback framing intervention

Regarding the feedback framing we had expected that the autonomy-supportive feedback would allow students to learn with a more self-determined motivation enabling them to better self-regulate their learning. However, we only found a main effect on the time students planned to learn. That effect was contrary to our expectation, as students reported to have planned to learn more when receiving the controlling feedback. It is possible that the more demanding tone of the controlling feedback led students to merely report higher values or maybe even plan more time. External pressure can lead to engagement, even though it is mostly at the cost of well-being and often not related to deep learning (Ryan & Deci, 2017).

As we found no effects of the feedback framing manipulation on any motivational variable, we need to ask whether the feedback framing manipulation had actually worked as intended. In our second study we therefore tested the two feedback framing conditions in a separate but similar sample, to find out how students perceive the two feedback framing

conditions. We found strong effects of the treatment on perceived autonomy-support and on students' self-determined motivation, suggesting that our manipulation of the feedback framing has been successful. Even though the autonomy-supportive feedback was perceived as having a more guiding and recommending tone, it was also perceived as vaguer and less clear. The controlling feedback on the other hand was perceived as having a more commanding and directing tone but also as more clear and understandable. Students expect that a feedback gives them clear information regarding how well their performance satisfies to assessment criteria and expectations (Ferguson, 2011), an information that was probably more strongly transported in the controlling feedback. This might also explain why students reported they would spend more time reading the feedback when they saw the controlling feedback. Further, we provided a quite extensive feedback, which students might have deemed too long to read so that they rather screened text instead of thoroughly reading every sentence. Information relevant to students (apart from the recommendations we gave) could have been extracted by checking scores and mainly also by the graph in the end, showing the development of goals and scores. If students refrained from carefully reading the feedback, the ability of the intervention to work was drastically reduced, as the formulation of sentences carried the message. Hence, the same feedback delivered in person instead of written feedback might have led to increased effects.

Interaction of relevance and feedback framing

Additional to our expectations that the two interventions would both individually support students' autonomy, self-determined motivation, and self-regulated learning, we especially expected that students who recognize the learning contents' personal relevance would benefit most from autonomy-supportive feedback. The interaction between the relevance intervention and feedback framing on goal setting and time spent learning partly confirmed or hypothesis that

relevance was an important prerequisite in order for other need-supportive influences to motivate behavior. Students that reflected about how the content was relevant for them and also received autonomy-supportive feedback set higher goals and reported to have spent more time learning compared to students that were in the control conditions.

However, students who did not reflect about the contents' relevance and also received the controlling feedback did just as well regarding goal setting and time spent learning. This deviates from our expectation that the group of students merely summarizing contents and receiving a controlling feedback would show the least adaptive results.

Potentially, without recognizing the relevance of course contents (research skills for teachers), students were not very interested to self-regulate their behavior due to a lack of personal connection to the course contents. Thus, they did not engage with the autonomy-supportive feedback which more strongly offers choice and room for self-initiative, thus requires more engagement by the student. Instead, students that did not see the contents as relevant might have been more engaged with the feedback if its tone was controlling and provided clear commands and directives. When students are supported to recognize the relevance of course contents, they are more ready and willing to make decisions themselves and expect and embrace the room for self-initiative and decision-making about standards and goals.

To summarize, we aimed to show the benefits for SRL and motivation of combining a relevance intervention with autonomy-supportive feedback that was individualized for each student. We found some support for the effects of the relevance intervention on students' SRL but most effects were absent. We found only limited effects of the feedback framing intervention, with some effects that differed from our expectations. Even though the second study supported the successful manipulation of the feedback framing, it also raised the question

if the controlling feedback potentially possessed other advantages, like more clarity and directiveness. A relevance intervention seems to be a useful tool to support students' SRL, but more light needs to be shed on which information is helpful to students in a feedback and how it is communicated best when attempting to frame it in an autonomy-supportive way.

Limitations and implications

We identified certain limitations in our study leading to implications for future research. In our first study we worked with a rather small sample due to dropout on six different measurement time points. Repeating the experiment with a larger sample and thereby a higher power might show more results. Future studies attempting to work with the relevance intervention could be to find ways how to improve fidelity with a relevance intervention and have students produce longer statements leading to deeper reflection and forging of relevance connections. Further, an analysis of the texts student produced would provide valuable information, as the relevance intervention might have been stronger in cases where students came up with more specific, more personal, or maybe even more prosocial (e.g., how the content will help me serve others better) relevance reflections. Regarding the autonomy-supportive feedback it would be important to test it also against a neutral control in future studies, with feedback merely transmitting information. Further, differences between experimental conditions might have been demonstrated if the controlling feedback had been even more controlling and failure to pass had been associated with sanctions and guilt. Furthermore, it would be interesting to test to what extent autonomy-supportive feedback might be more effective when delivered by the docent in person, compared to written feedback. We wondered if it was possible for students to extract the information they were interested in from the feedback without giving much attention to the language or framing used, making the intervention less effective. Also, it would

be interesting to experimentally test the benefits of automatically individualizing feedback. Finally, we showed a useful and scalable way to provide individualized feedback in higher education. We gladly share our materials and the procedure we applied in Excel.

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5. DISCUSSION

It is a challenging educational endeavor to impart knowledge to students and get them to actively engage in learning-related activities without significantly driving them with external pressure, but rather letting them act autonomously and self-regulated. To do this, it is especially important not only to transfer knowledge, but also a positive attitude toward what is learned, especially an understanding of personal relevance. However, the fact that in higher education there are often many students per teacher makes individual persuasion difficult and requires scalable approaches. This conveyance of positive attitudes should enable students to engage with the content in a self-regulated manner and make application in their future careers more likely. This is particularly important for topics such as data-based decision-making (DBDM) for teachers, on the one hand, because teachers decide for themselves to a large extent how actively they implement evidence-based practices in their teaching. On the other hand, because it seems to be a challenge to inspire positive attitudes and high motivation for this topic, as students struggle with the content and often see little point in it, even though DBDM has enormous potential for teacher development and quality instruction. The studies conducted for this dissertation were therefore dedicated to a practical goal: to derive practical interventions from sound motivational theories that, in concert with instructional design, promote student teachers' self-determined motivation for DBDM. Thus, the overarching goal of the studies I present in this paper was to support university teaching. Therefore, scalable interventions to promote student motivation, learning, and positive attitudes were tested and evaluated in practice. Because such interventions are particularly effective when well matched to context, two principles should tailor interventions and evaluation more closely. One is the interaction with and integration into a course format that is already designed to encourage students to engage in self-determined

learning. Namely, the target courses always revolved around a formative assessment that allowed learners to monitor and better manage their own skill development. Moreover, the course did not end with a graded exam; rather, the goal was to demonstrate one's competence in a final competency assessment for which the previous formative assessments had prepared. In addition, learners provided regular information about their learning behavior as part of the formative assessment and received personalized feedback with recommendations for their learning behavior and information about their competence development. Based on these preconditions of the course, the two interventions should support the goal of the course format to make learners self-determined and self-regulated learners. The first intervention (relevance intervention) at the beginning of each formative assessment was designed to convince learners of the personal relevance of the learning objectives in order to create the appropriate motivation. To help learners work on their own initiative with the feedback from formative assessment and effectively adapt their own learning during the course, the second intervention sought to optimize the framing of this feedback according to the principles of the self-determination theory of motivation.

In addition to this attempt to create a clear link between course design, learning objectives, and intervention design, there was a second point to make the present studies more relevant to the actual context. To account for the specific circumstances of university teaching and the particular challenge of DBDM for teachers in capturing key psychological constructs, the main measurement tools were adapted with the help of experts in the field. For example, to assess prospective teachers' willingness to use DBDM in the future, we described real-world use scenarios that specifically depict evidence-based actions taken by a teacher, as well as the challenges that can be expected. This adaptation to specific circumstances, as well as the direct

testing of the interventions in university teaching, gives the studies presented high ecological validity. Based on the theoretical foundation of SDT and practical orientation to the circumstances of the course on DBDM, I developed and implemented two interventions: a relevance intervention and a feedback framing intervention.

The results of study 1 suggest that a relevance intervention has the potential to support students' internalization toward more self-determined motivation and even to increase intentions for future application and implementation of the acquired knowledge (*hypothesis 1.1*). At the same time, no clear effect on student learning performance was evident (*hypothesis 1.2*). Because we hypothesized that higher self-determined motivation would lead to better performance by improving the quality of students' self-regulated learning, a second intervention should specifically support students in translating their motivation into adaptive learning behaviors. Thus, in a second study, a feedback framing intervention was used to test whether feedback framed in an autonomy-supportive way could better support students' SRL, especially when combined with the relevance intervention from Study 1. The results of Study 2 showed some promising results regarding the effects of the relevance intervention on students' SRL (*hypothesis 1.2*). However, the effects of both interventions on motivational variables were absent (*hypothesis 1.1, 2.1* and *3.1*). The feedback framing intervention showed little effect on student SRL by itself (hypothesis 2.2), but in combination with the relevance intervention had an effect on several variables of student SRL (*hypothesis 3.2*), including some unexpected results. These mixed findings, particularly with respect to the effects of the feedback framing intervention, did not allow for a clear conclusion about the potential of autonomy-supportive framing. The third study therefore examined the potential of autonomy-supportive compared to control feedback framing in isolation and assessed the perceived motivational characteristics in detail. The results

showed that the prototypical feedback framed in an autonomy-supportive way was rated by students as more need-supportive and promoting self-determined motivation compared to the feedback framed in a controlling way (*hypothesis 4*), underscoring its potential for use in feedback in higher education.

The following section discusses in more detail the interpretation of the results of the two interventions across studies, the limitations of this work, and the potential for future research and implications for higher education teaching.

5.1. **Supporting self-determined motivation with a relevance intervention**

In a first study, the learners should be supported in developing a more positive attitude and motivation towards the learning contents of the DBDM and thus to learn and use the offers of the formative assessment in a more self-determined way. For this purpose, students were given a short reflection task at the beginning of each formative assessment on the relevance of the content to their future work as teachers. For experimental comparison, the control group summarized the contents at the same time. According to SDT, recognizing a relevant personal connection to a learning content is a prerequisite for internalization towards more self-determined motivation. However, the effects of relevant interventions have rarely been tested in isolation (Steingut et al., 2017) and in experimental field studies (for exceptions see Jang, 2008; Reeve et al., 2002). Thus, to support student motivation, I implemented a brief relevance intervention in the regular curriculum that was designed to help students recognize the personal relevance of the course content to their profession as future teachers.

Students who were asked to regularly relate course content to its relevance for their future teaching careers rated the content as more relevant. Although this may seem trivial, unlike many interventions designed to improve perceptions of relevance, our students were not provided with

any additional information about how the content was relevant. Students were simply asked to reflect on their existing knowledge and relate it to their future careers. Consistent with the "saying-is-believing" paradigm, this indicates that by simply reproducing information they may have encountered during the course in a lecture or seminar about the relevance of content, students tend to adopt these attitudes (Higgins, 1999).

The intervention possibly stimulated learners not only to reproduce arguments from teaching for usefulness, but also to critically engage with them and relate them to themselves and their own goals as future teachers. For these students, therefore, the future time perspective was brought more into their awareness, meaning that even new information was more likely to be considered from the perspective of (personal) relevance and with a focus on application in a professional context (Simons et al., 2004)

Even though the intervention only asked students to write a few sentences instead of an entire essay, as has been the case with similar interventions (Canning et al., 2017; Hulleman et al., 2010) powerful motivational effects emerged. Reflection on the relevance of the content led students to report that their need for autonomy was more fully satisfied in the course. Students' need for autonomy is typically satisfied in teaching by giving students the opportunity to make important choices or to have a say in certain decisions. Such an approach often requires course customization and sovereignty on the part of the instructor to account for student choices. However, these findings confirm that students can also feel more autonomy satisfaction simply by better understanding how things they are asked to do are personally relevant to them, so that they can willingly comply with course structures and learn more voluntarily (Assor et al., 2002).

In line with SDT, which states that relevance is an important factor in the internalization process, students also reported more self-determined forms of motivation, as evidenced by a less

negative index of relative autonomy. The RAI was negative as more controlled forms of motivation, such as learning because of the exam at the end of the course, still had the strongest influence on learning behavior. This finding reflects that student teachers are primarily concerned with the content on DBDM because they are driven by outside influences such as passing the course or the expectations of faculty or their future employers. The results confirm the problematic motivational baseline regarding DBDM of earlier research and is likely symptomatic of university teaching where students are often motivated by exam pressure emphasizing the need for such interventions. Although less self-determined forms most strongly regulated students' learning for DBDM, reflecting on the relevance of the content increased internalized forms of motivation in the relevance condition compared to the summary condition. That it is significant to promote self-determined motivation despite dominant controlled forms of motivation is evident from the following finding. Namely, it appears that students who received our intervention had stronger intentions than their peers in the control group to use DBDM as future instruction when asked about specific use cases, such as examining the state of research to make pedagogical decisions. These increased intentions were entirely mediated by internalized forms of extrinsic motivation, underscoring the importance of high quality motivation when it comes to not only imparting knowledge but also fostering students' willingness to apply it. These findings underscore the importance of internalized forms of extrinsic motivation, especially for more uninteresting but important content where fostering intrinsic motivation is likely to be more difficult. The significance of these findings are underscored by Hagger and Chatzisarantis (2016), who showed that autonomous motivation in learning is related to more autonomous motivation and intentions for the behavior or content even outside of the learning context. Combining these findings with the present results, it could be concluded that student teachers

who learn DBDM with more self-determined motivation are also likely to engage with it as teachers more autonomously and are more likely to apply it to their practice. As also observed by Hagger and Chatzisarantis (2016), students also reported feeling more efficient with the application of DBDM skills. This could be explained due to the feeling of efficacy being somewhat contingent on feeling ownership of a behavior: The more a person feels that the behavior originates within them, the more they take credit for their success (Ryan & Moller, 2017).

Finally, despite the differences in students' motivational quality, no significant differences were found regarding their learning performance. This could be due to the compulsory examination of minimum competency, which, although ungraded, was perceived by learners as if it were an exam, reflecting a strong external influence on learning, as indicated by high values of external regulation. For example, Cerasoli et al., (2014) found that external incentives, such as an exam, can have a strong impact on performance masking the effects of high-quality motivation. From previous studies, however, we knew that fostering self-determined motivation carries with it the potential for promoting self-regulated learning (e.g., Sierens et al., 2009). Therefore, in another experiment, students' self-determined learning (SRL) should be analyzed at a more fine-grained level to see if the interventions can support students' learning in the course.

5.2. **Combining a relevance intervention and feedback framing for SRL**

The promising change in student motivation towards more self-determined motivation thus did not manifest itself in improved learning outcomes. Therefore, the positive effect of the relevance intervention on self-determined motivation should be strengthened and the expected positive effects on students' self-regulated learning should be improved in a second study.

Because previous research had found a clear relationship between higher self-determined motivation and improved SRL (e.g., León et al., 2015; Vansteenkiste et al., 2012), the purpose was to examine students' SRL and the interventions' effects on it in more detail. As in Study 1, students received a relevance intervention with control group in an experimental design at the beginning of the formative assessment. So in addition to the relevance intervention, students should receive another intervention that supports their SRL learning in particular. This intervention should fit into the existing course design. In the course on DBDM, students received intensive feedback on each formative assessment by default, i.e., three times during the course. The feedback was automatically individualized based on data on learning performance and process that students had provided at the beginning of each formative assessment, e.g., goals, strategies, learning time. It was this individualized feedback that the second intervention was designed to address. In order to find out whether students can be supported particularly well in the reception and implementation of this feedback by a special framing intervention, this was tested experimentally. One half of the students received the individualized feedback in an autonomy-supportive framing and the other half got the feedback in a controlling framing. Predefined rules enabled automated generation of individualized feedback based on the students' learning behavior, which was compiled from preformulated text modules. In this process, each text module was formulated once in an autonomy-supportive framing (condition 1) and once in a controlling framing (condition 2). This was a novel approach to delivering needs-supportive feedback as the feedback was highly individualized based on data on student SRL behavior. The aim was to find out whether one of the formulations leads to students working better with the feedback, i.e. adapting their learning behavior. Secondly, whether the different framings of the feedback had different effects on self-determined motivation, especially since this often involved

negative feedback that drew attention to deviations from optimal learning behavior. Furthermore, the question to what extent one or the other framing had a different effect on the learners depending on whether they were stimulated to think about the relevance of the content. Therefore, both interventions were crossed in a longitudinal 2x2 design. It was found that students' self-determined learning was supported in multiple ways by the combination of our two interventions, but students' motivational outcomes were not. In what follows, I will first discuss the effects of each intervention individually and then the interactions between them. Finally, I will discuss the lack of effects on motivational outcomes.

Relevance intervention

The relevance intervention considered alone already showed some positive effects on as SRL of the students in Study 2. Students who participated in the relevance intervention were more accurate in estimating their competencies immediately before the knowledge test than students in the summary condition. Thus, students appeared to be either better motivated to estimate their current level of competence or had better metacognitive strategies in learning, which has also been linked to more self-determined motivation by findings of recent studies (e.g., Cho et al., 2021). As the intervention brought students to connect their current behavior to themselves in future situations, it might have benefit the self-regulation of learning by activating a future time perspective more strongly, which has been found to be beneficial for SRL and related to more internalized forms of extrinsic motivation (Bilde et al., 2011). In addition, students in the relevance condition reported using more deep learning strategies during learning, which supports the importance of self-determined motivation for effective learning as have previous studies like Ulstad et al. (2018) suggested. No difference was found regarding the use of surface learning strategies. In addition, there was a significant difference between students'

performance on the relevance and summary conditions across all four formative assessments, which was mainly due to better performance on the relevance condition on the third learning progress test. A similar pattern was observed in the first study, suggesting that more self-determined motivation affects performance primarily when external conditions are less salient. This is in line with Cerasoli et al. (2014) who suggested that the link between self-determined motivation and performance is weaker when performance is tied to external contingencies, like final exams. Accordingly, when the external pressure to pass the final test is the primary focus in the fourth learning assessment, students learn with less self-determined motivation, although likely with less optimal learning strategies. Recent research combining Achievement Goal Theory (e.g., E. S. Elliot & Dweck, 1988) and SDT links teaching styles to learners' adoption of mastery goals (Benita & Matos, 2020; Deci & Ryan, 2016). Thus, learners who are more convinced of relevance are more likely to adopt a mastery goal orientation and therefore perform better on voluntary formative tests. The need to pass the final measurement, albeit without a grade, may then still act as a controlling influence, leading all learners to adopt a stronger performance goal orientation.

Feedback framing intervention

With regard to the framing of feedback, it was expected that an autonomy-supportive framing intervention would lead to improved SRL. Contrary to this hypothesis, only one effect of framing emerged, and it was different than expected. Students who received feedback on their SRL with a controlling framing intervention reported allocating more time to learning than students in the autonomy-supportive condition. It is possible that students felt more pressure to report learning times that would meet external expectations with the controlling framing, as more controlled motivation has been shown to be positively related to cheating (Pulfrey et al., 2019).

In the following paragraphs, some more interaction effects of feedback framing intervention with the relevance intervention are reported. Subsequently, possible explanations for the absence of some expected effects of the feedback framing intervention are discussed.

Interaction of relevance and feedback framing

Regarding the interaction of the two interventions, it was theorized that relevance is crucial for internalization and could be supported by feedback framed in an autonomy-supportive way as another need-supportive intervention. Therefore, the most favorable results were expected from a combination of relevance condition and autonomy-supportive framing. Consistent with this expectation, students who received this combination set higher goals and reported spending more time learning than students who received only one of the two interventions. Surprisingly, students who only summarized content and received controlling feedback performed as well as students who reflected on relevance and received autonomy-supportive feedback. Although this pattern became significant for only two of the variables examined for SRL, I would like to present possible explanations.

Students who reflect on the relevance of content develop more self-determined motivation and want to take charge of the learning process, while also expecting to be able to take more control over decisions such as goal setting, planning learning, and choosing strategies. This represents a concept Reeve (2013) refers to as "agentic engagement," when students strive to take the initiative in shaping their learning to meet their needs. Therefore, the autonomy-supportive feedback that includes more degrees of freedom and often asks students to make their own decisions rather than instructing them on what to do could be beneficial to these students. The students in the summary conditions on the other hand may be less convinced of the relevance of the content and therefore possess more controlled forms of motivation. Their

expectations of feedback might then be to expend less energy, preferring feedback that gives clear instructions on what to do next.

Connected to this line of reasoning is the notion that students are guided toward different type of goals depending on the interplay between the feedback framing intervention and the relevance intervention. The controlling framing focuses students more on passing the final exam as a motivator, which may elicit a performance goal in students (E. S. Elliot & Dweck, 1988; Maehr & Zusho, 2009). The autonomy-supportive feedback, on the other hand, focuses on student competence growth as a goal, leading to an orientation toward mastery of the subject matter. However, it has been suggested that students internalize mastery goals better when they are suggested by an autonomy-supportive instructor. Accordingly, the relevance intervention as an autonomy-supportive element of the course fits better with the learning goal orientation offered in the autonomy-supportive feedback framing (Benita & Matos, 2020).

Even though the feedback was intended to vary only the degree of autonomy support between the two framing conditions, it was unclear whether the amount of structure provided also varied to some degree, which may also account for these unexpected results. Although autonomy-supportive framing allowed for more self-determination, making one's own decisions, or understanding why something was important, more structured feedback potentially conveyed clearer expectations and made it easier to know what a recommended behavior was and what next step to take. Although autonomy support and structure are not mutually exclusive, but rather are two separate dimensions that can both contribute to self-determined motivation (Sierens et al., 2009), our findings called for further investigation of the need-supportive properties of the two feedback framing conditions.

Lack of effects on motivational variables

Notwithstanding the second study's focus on SRL, it was hypothesized that both interventions would also positively affect the motivational constructs already used in study 1. Surprisingly, no significant effects emerged for any of the constructs examined, including perceived relevance, self-determined motivation, satisfaction of basic psychological needs, and frustration, intentions, and self-efficacy. It is possible that the study was underpowered because of two reasons. One, because the final sample of Study 2 was more than 10% smaller than that of Study 1. The smaller sample was due to the additional questionnaire that was added in the pre-post design. In addition, there were more dropouts in Study 2 because participants who did not participate in all three voluntary learning progress tests had to be excluded, as this would have exposed them to a lower dose of both interventions. A second reason for lack of power is that the study was significantly more complex due to testing a 2x2 design with one covariate and interactions, and existing effects could not be uncovered (Brysbaert, 2019). In addition, the fact that Study 2 included only participants who had taken part in all three formative assessments may have resulted in positive selection of the most motivated students. A sample consisting of such positive selection makes it more difficult to achieve an effect on motivation with the interventions, as the sample may have already exhibited desirable motivational characteristics.

It should also be noted that in Study 1, formative assessment was already offered to students, a component of teaching that has been shown to have a positive impact on learner motivation (Cauley & McMillan, 2010; Yin et al., 2008). Most importantly, feedback was intensified in Study 2, which in Study 1 consisted only of feedback on results and learning progress. In Study 2, all students, regardless of their experimental assignment, received individualized feedback on their learning behavior, which has also been shown to have a positive

effect on learning motivation in past studies (Koenka & Anderman, 2019; Lim et al., 2021). Thus, several components of the teaching already had a positive effect on the motivation of all students, which possibly limited the possibilities of an additional experimental intervention. In the following, a few more points are discussed that may have led to the two interventions, as well as their interaction, not yet being able to develop their motivational potential.

That Study 1 found a strong motivational impact of a relevance intervention and then Study 2 found no motivational impact is counterintuitive. However, other studies with similar interventions have also found effects of varying strength, e.g., in that students have difficulty coming up with relevance connections on their own and then do not show the expected effects (Canning et al., 2019). Students who have difficulty thinking of relevant connections may conclude that the topic is less relevant to them (Lindeman et al., 2018). In support of this argument, the number of relevance reflections produced by students in the relevance condition was about 5% lower in the second study than in the first. However, this difference was not tested for statistical significance. Yet, there are other reasons why the existing motivational effects of the intervention may not have manifested in the results.

In addition to the relevance intervention, the feedback framing intervention alone also showed no effect on motivation variables. A recent study that experimentally tested framing of health messages according to SDT principles also found no significant effect of message framing on motivational outcomes (Bradshaw et al., 2021). In this study, conducted in the context of the Covid-19 pandemic, the authors explained that participants likely expected or were more accustomed to a more direct tone when health messages were communicated in the uncertainty of a critical public health situation. It could be argued that students are also accustomed to receiving feedback that is commanding or gives clear instructions rather than freedom to make

their own decisions (Cate, 2013; Ferguson, 2011), and therefore feedback framed in a controlling way is more likely to meet students' expectations for feedback. This is especially true when students are uncertain about what learning behaviors are required to pass a final exam.

Thus, it was ultimately unclear whether feedback in the different frameworks actually differed primarily in terms of perceived support for autonomy, or whether there may also have been differences in terms of the structure that the feedback offered. In addition, the question arose as to the extent to which students may have expected their feedback to be commanding rather than supportive of their own decision making. To learn more about the potential of autonomy-supportive feedback, a further study should rule out possible confounding factors such as individualizing feedback and combining it with other interventions to learn more about the modes of action and potential of feedback framing.

5.3. **The effects of feedback framing on students' motivation**

Since the feedback framing intervention in the field experiment of Study 2 had few and partly unexpected effects on students' SRL and, contrary to expectations, none on their motivation, a third study was designed to investigate the potential of feedback framing and its motivational properties in more detail. The third study, unlike the previous studies, was not a field experiment but a vignette experiment in which participants were asked to put themselves in the situation of following the course on DBDM. However, the subjects were also student teachers who would take the course on DBDM in the following semester. Furthermore, the learning situation in which the feedback presented had been used was described in detail, and students were asked to put themselves in that situation when evaluating the feedback. Based on the average student data from Study 2, vignettes of prototypical feedback were created and students read the feedback with either autonomy-supportive or controlling framing. The

perceived tone of the feedback was evaluated, as well as the need-satisfying characteristics of structure, autonomy support, and involvement. In addition, it was ascertained what motivation the respective feedback framing would elicit in the students. The hypothesis was that the autonomy-supportive feedback framing would be perceived accordingly (e.g. higher in autonomy-support, more guiding tone) and would therefore lead to more self-determined motivation.

The autonomy-supportive framing was rated by students as hypothesized, with a more guiding tone and more autonomy-supportive features. While no directed hypothesis was formulated about other need-supportive features, the autonomy-supportive framing of the feedback was also rated as entailing more structure and involvement, as suggested theoretically by SDT (Deci et al., 2017). Students who read the autonomy-supportive framing feedback intervention even reported learning with significantly higher self-determined motivation than students who read the controlling framing feedback, as evidenced by a more positive RAI.

These clear results, which underline the potential of autonomy-supportive feedback, at the same time raise the question why the effects did not manifest in the field experiment in study 2. The differences between the two studies could possibly be explained by the different perspectives, first the evaluation of feedback in a vignette study and then the actual feedback to be used. In the vignette study, student teachers may then evaluate feedback more according to the criteria they know for feedback that is conducive to learning, or which feedback they find more comfortable. So they are more likely to evaluate the feedback from the perspective of a future teacher. However, when they actually have to work with the feedback and the feedback gives them information about their personal performance, learners may still want different

feedback, with more structure and guidance, for example. Here they view the feedback more from the perspective of a student who is actively engaged in the learning process.

Also, past studies of teaching behavior and student evaluation have found that students often confuse autonomy-supportive teaching with a lack of teaching skills or low standards (Boggiano et al., 1993; Flink et al., 1990), and that good evaluations of teaching can be attributed in part to low standards and lax grading (Stroebe, 2016).

Another difficulty in interpreting the differential effects on motivational variables between Study 2 and Study 3 lies in the variety of different combinations of feedback that students received in Study 2. Many different text modules were created, for all possible combinations of student learning behavior data. The text modules then each came in autonomy-supportive and controlling versions. However, which unique combination of these modules learners had now received depended on students' SRL learning behaviors. It could be that some text modules were more effective at satisfying learner autonomy, while others may have involved more structure. Study 3, on the other hand, allowed for a controlled comparison of the feedback framing which underscores the potential of autonomy-supportive feedback. In addition, as noted earlier, the sample of Study 2 was potentially more positively selected in terms of their motivation, as only students who participated in all voluntary formative assessments in the course were included in the study. In contrast, in Study 3, no restrictions other than consent led to exclusion.

Finally, there is another argument as to why the autonomy-supportive feedback framing was judged to be significantly more motivating in Study 3 and yet resulted in no effect on motivation in the field trial. Possibly, the applied framing of the feedback in an autonomy-supporting way resulted in a higher cognitive load for the students. Because students who

received the autonomy-supportive feedback were often asked to make decisions about how to set goals, what standards to use, or what strategies to choose, they may have had to invest more mental effort. The controlling feedback framing, on the other hand, often gave instructions or commands about what to do, limiting students' autonomy but placing less of a burden on them to reflect and make decisions about their SRL behavior. While recent studies have found that providing choices has the potential to reduce cognitive load, the tasks and choices examined in this study were less complex than the choices involved in self-regulating one's learning (Schneider et al., 2018). When choices are too complex or it is unclear what the best path is, this can reduce the autonomy-supportive effect of choices (Katz & Assor, 2007). Accordingly, in a qualitative study, student teachers also rated clarity and actionable advice as an important component of high-quality feedback (Ferguson, 2011). This is somewhat supported by the finding that although autonomy-supportive feedback was clearly rated as more beneficial in terms of supporting needs in Study 3, students were more willing to invest time in reading controlling feedback, which they rated as clearer.

In order to classify the findings discussed so far, some limitations of the studies are discussed in the following and resulting as well as additional learning for research in this area is drawn. Finally, implications for teaching resulting from this research series will also be discussed and an overall conclusion drawn.

5.2. **Limitations & research implications**

Before concluding with implications for higher education teaching, some limitations of the presented studies will be briefly discussed and a number of implications for future research will be formulated. First, particularly following the strong effects of the relevance intervention on students' intentions to use and apply data-based decision-making (DBDM) in their future

careers, future studies should aim to assess how well these intentions translate into behavioral measures. While the studies presented used extensive self-report, it might already be interesting to invite students to a workshop on DBDM or provide informational materials about DBDM and just see who signs up. This would already provide a low-effort measurement on actual behavioral readiness. Finally, it would be of great interest to investigate the extent to which students' positive attitudes toward DBDM persist once they reach practice.

Because we aimed not only to keep the intervention brief but also to integrate it into the regular curriculum as unobtrusively as possible without interfering with teaching, students sometimes did not adhere to the low-key intervention instructions. Future research could examine the extent of the intervention's impact by considering how well students followed the intervention instructions (Nagengast et al., 2018). To the extent that the effect is significantly amplified in such analyses that take into account how many individuals actually followed the intervention instructions, consideration should be given to how to increase fidelity. It would be possible to increase the likelihood that students actually respond to the intervention prompt with a reflection on relevance. This could be done by providing reasons for conducting this reflection, which we omitted because we did not want students to know the goal of the experiment. In addition, the reflection could be made more prominent by detaching it from the regular coursework and making it an additional, separate part of the course. For future research, it would also be possible to examine the written products of the relevance intervention in more detail, for example, in terms of students' focus on extrinsic or intrinsic goals, use of personal pronouns, and degree of personal references. If it turns out that the relevance intervention is more effective when students make it more personal, it would be conceivable to improve the intervention by

making specific suggestions. For example, students could be asked to think about their own values beforehand or to use more personal examples.

With respect to the feedback framing intervention, it remains unclear whether the many different text modules were successfully manipulated in terms of their degree of need support. In the vignette study, a prototypical feedback representing the average student was analyzed, whereas in the field experiment, students received various combinations of feedback elements with potentially different motivational effects. Students who deviated from the average and indicated more or less adaptive learning behaviors may have found the tone of the interaction or even the recommendations less useful or motivating. Although it would take a great deal of time to test the two aspects separately, hopefully this would deepen knowledge of how feedback can best be framed to effect behavior change. To further promote the acceptance and use of feedback, research should be conducted on what information students want and need in feedback for SRL. For example, it would be possible to give learners a choice of what information they would like to receive in their feedback. This will make the feedback more meaningful to students. The level of structure students need, i.e., what information and guidance they need to make informed decisions about adjusting their learning behavior, should also be explored. Furthermore, it would be interesting to consider the differences in ability and self-efficacy with respect to SRL of students and to examine which constellations of autonomy support and structure are most conducive for students with low levels of proficiency.

When assessing self-determined learning (SRL), we did not rely on common scales such as the MLSQ (Pintrich et al., 1991), in which students are asked about their learning behavior but instead asked students to describe their learning behavior in concrete terms, such as setting goals directly or indicating how much time they spent learning. Although this approach might suffer

from a lack of validity, on the other hand, some researchers claim that traditional questionnaires on SRL often measure knowledge about SRL rather than what is actually done (Foerst et al., 2017). Future studies could combine both validated SRL questionnaires and direct observations of SRL behavior and aim to gain more insight into what feedback information students actually use for SRL and how. It would also be conceivable to use the specific analysis of the effect of the feedback on the needs of the learners from study 3 in a field test as in study 2 to see if they then evaluate differently from the perspective of the learners. It would then also be interesting to examine whether the expectations of the feedback differ depending on how present the final competence measurement is as an external motivator.

Finally, since no conclusive statement could be made about the interplay between feedback framed in different ways and other need-supporting features of a course, future studies should aim at further investigating which constellations of need-supporting influences are most favorable and how they influence each other. It would be interesting to investigate whether learners' expectations of feedback differ depending on the degree of personal relevance they see in the content. In this context, the recording of learners' goal orientations seems promising.

5.3. **Implications for higher education teaching**

When designing courses in higher education, it is critical that students recognize the personal connection they have to what they are learning. When students understand why learning, especially of a potentially uninteresting content, is important, they can learn more from within themselves and with more self-determination. It also helps students take responsibility for their learning, use higher quality learning strategies, and ultimately increases students' readiness to apply the knowledge they learn in the future. While teaching relevance can and should be integrated into many other facets of instruction, a brief relevance intervention has proven to be a

simple but effective tool to support student reflection on and recognition of content relevance. Incorporating information about how content relates in various ways to aspects of their future careers that are personally important to students is likely to increase the impact of the intervention. Significant here, however, is that there is a way to align the arguments about the usefulness of a piece of content with the learners' personal values and goals and to trigger such reflections more often. Recently, it has been suggested in SDT research that discovering one's true values rooted in one's identity and being able to be guided by these inner values is strongly associated with feelings of autonomy and self-determination (Assor et al., 2019). Thus, a relevance intervention may be best presented not only with information about the usefulness of course content for future goals, but also by providing learners with opportunities to reflect on how specific goals or facets of their profession relate to their core values and identity. For example, learners might be asked to make a plea on a topic of their choice and explain how a topic is important to them personally. Reflecting on what kind of teacher they want to be and how their personal values and identity as a teacher are expressed can be another step in helping students become empowered teachers.

Another approach to bring the connections students make during the relevance intervention to a more personal level would be to either encourage the use of personal pronouns or also prescribe to relate more to personal experiences and values. However, it could also be supported by providing testimonials from former students or practitioners about how their beliefs about DBDM changed or in what situations they found these skills helpful.

If students are to be supported in self-regulating their learning, they need feedback on this process, and this feedback, of course, thrives on fitting the learner's individual situation. A task that is often extremely time-consuming in university teaching and the supervision ratio that

prevails there. In collaboration, an Excel-based tool was developed that automatically provides students with individualized feedback based on their SRL learning behaviors and outcomes. This feedback can contribute to students' self-determined motivation when framed according to guidelines for autonomy-supportive message framing. However, even though students benefit from freedom of choice, they need the appropriate support and structure to make the most of those choices. To help students deal with the freedoms of autonomy-supportive feedback framing, it can help to offer general rules on how to set a good learning goal, for example, or how to effectively plan learning time. To further tailor feedback to students' needs, students could be given choices about what information they would like and what information they are still missing. When students are able to voice their opinions and express concerns, they feel they can express themselves and their sense of autonomy is strengthened.

5.4. **Conclusion**

In this dissertation, I presented and evaluated two interventions for higher education teaching derived from self-determination theory in three studies. The interventions were adapted to the realities and challenges of teaching DBDM and evaluated under high ecological validity in vignette and field experiments. I was able to show that theory-based, practical interventions can be integrated into university teaching with little effort to support students in their self-determined motivation. In the short term, positive effects can be observed in terms of more self-regulated learning and higher autonomy, but also effects that can potentially influence behavior as a professional teacher, such as more self-determined motivation and increased intention to apply. For future research, some exciting open questions and starting points remain, especially regarding the effect of autonomy-supportive feedback in the context of self-regulated learning and its interplay with students' needs and expectations.

6. APPENDIX

6.1. **Supplemental material of study 1**

LIST OF ALL ITEMS

List of items used in the post intervention questionnaire (Items in German – English translation below)

Perceived relevance:

1. Die Inhalte der Vorlesung sind nützlich für meine berufliche Tätigkeit als Lehrkraft
2. Als Lehrkraft treffe ich bessere pädagogische Entscheidungen, wenn ich vorher den aktuellen Forschungsstand recherchiere.
3. Als Lehrkraft benötige ich Theorien und Methoden der pädagogischen Diagnostik, um meine Schülerinnen und Schüler angemessen zu bewerten.
4. Als Lehrkraft muss ich nicht verstehen, wie die Forschung im Bildungsbereich funktioniert. (*Recoded*)
5. Als Lehrkraft kann ich meine Schülerinnen und Schüler besser fördern, wenn ich standardisierte Tests und Fragebögen (z.B. VERA, Prüfungsangstfragebogen) einsetze.
6. Als Lehrkraft sind regelmäßige Evaluationen für mich wichtig, um meinen Unterricht und meine Schule weiterzuentwickeln.

Motivation to learn

Amotivation

- Ich hatte keine Lust, mich mit den Inhalten auseinander zu setzen.
- Ich war nicht motiviert, diese Inhalte zu lernen.

External regulation

- Ich habe für die abschließende Lernerfolgskontrolle gelernt, damit ich die aktive Teilnahme an der Vorlesung bestätigt bekomme.
- Ich habe für die Vorlesung nur so viel getan, wie von mir verlangt wurde.

Introjected regulation

- Ich habe mich mit den Inhalten der Vorlesung beschäftigt, weil es sich so für einen Studenten/eine Studentin gehört.
- Ich habe gelernt, weil die Kenntnis dieser Inhalte von mir als zukünftige Lehrkraft erwartet wird.

Identified regulation

- Ich habe für die Vorlesung gelernt, damit ich mich später in diesem Bereich auskenne.
- Ich habe gelernt, weil ich diese Inhalte als zukünftige Lehrkraft brauchen werde.

Integrated regulation

- Ich habe gelernt, weil ich überzeugt bin, dass ich als Lehrkraft evidenzbasiert handeln muss.
- Ich habe gelernt, weil die Kenntnis dieser Inhalte zu dem Bild gehört, das ich von mir selbst als zukünftige Lehrkraft habe.

Intrinsic motivation

- Ich habe gelernt, weil ich die behandelten Inhalte richtig spannend fand.
- Ich habe gelernt, weil mir die Beschäftigung mit diesen Inhalten Spaß macht.

Satisfaction of basic psychological needs:

Im Vergleich zu einer typischen Vorlesung…

Autonomy

1. ... gab es ein vielfältigeres Angebot von Möglichkeiten, sich mit den Vorlesungsinhalten zu beschäftigen.
2. ... konnte ich mehr eigene Entscheidungen in Bezug auf die Lernangebote treffen.
3. ... konnte ich stärker auf meine eigene Art und Weise lernen.

Competence

1. ... habe ich häufiger das Gefühl Aufgaben erfolgreich zu bearbeiten.
2. ... konnte ich neue Inhalte besser mit meinem Vorwissen verbinden.
3. ... fühlte ich mich kompetenter was den Erwerb der Lerninhalte angeht.

Relatedness

1. ...empfand ich die Stimmung unter den Studierenden als angenehmer.

2. ...hatte ich mehr Möglichkeiten, mit anderen Studenten /Studentinnen in Kontakt zu kommen.
3. ...hatte ich stärker das Gefühl, dass dem Dozenten mein Lernerfolg wichtig ist.

Application intentions

1. Als Lehrkraft habe ich vor, mich freiwillig zu melden, wenn Mitwirkende für die interne Schulevaluation gesucht werden.
2. Als Lehrkraft habe ich vor, auch standardisierte Messinstrumente einzusetzen.
3. Als Lehrkraft habe ich vor, meinen Unterricht regelmäßig anhand von Fragebögen zu evaluieren.
4. Als Lehrkraft habe ich vor, wissenschaftliche Erkenntnisse zur Wirksamkeit pädagogischer Maßnahmen zu recherchieren.

Self-efficacy with application

1. Als Lehrkraft traue ich mir zu, den aktuellen Forschungsstand zu recherchieren, selbst wenn die Zeit dafür knapp ist.
2. Als Lehrkraft bin ich mir sicher, dass ich den Einsatz standardisierter Tests und Fragebögen auch gegenüber kritischen Eltern oder anderen Lehrkräften gut begründen kann.
3. Auch wenn ich mich als Lehrkraft noch so sehr bemühe, kann ich die Zuverlässigkeit meiner Beurteilung der Schülerinnen und Schüler kaum verbessern. (*Recoded*)
4. Als Lehrkraft traue ich mir zu, eine Evaluation so zu gestalten, dass sich ungünstige Bedingungen für Schule und Unterricht verändern.
5. Ich glaube, dass ich als Lehrkraft auch in schwierigen Situationen wissenschaftliche Methoden und Erkenntnisse erfolgreich anwenden kann.

English translation

Perceived relevance

1. The contents of the lecture are useful for my professional work as a teacher.
2. As a teacher, I make better pedagogical decisions if I review the current state of research beforehand.
3. As a teacher I need theories and methods of pedagogical diagnostics to evaluate my students appropriately.
4. As a teacher, I do not need to understand how educational research works. (Recoded)
5. As a teacher, I can better support my students if I use standardized tests and questionnaires (e.g. VERA, test anxiety questionnaire).
6. As a teacher, regular evaluations are important for me to help develop my teaching and my school.

Motivation to learn

Amotivation

- I had no desire to deal with the content.
- I was not motivated to learn this content.

External regulation

- I had no desire to deal with the content.
- I was not motivated to learn this content.

External regulation

- I have studied for the final learning progress test so that I can get confirmation of active participation in the lecture.
- I only did as much for the lecture as was required of me

Introjected regulation

- I studied the contents of the lecture because that is what a student should do.
- I learned because knowledge of this content is expected of me as a future teacher.

Identified regulation

- I studied for the lecture so that I would later be knowledgeable in this area.
- I studied because I will need this content as a future teacher.

Integrated regulation

- I learned because I am convinced that I need to act based on evidence as a teacher.
- I learned because knowing this content is part of the image I have of myself as a future teacher.

Intrinsic motivation

- I learned because I found the content covered really exciting.
- I learned because I enjoy dealing with this content.

Satisfaction of basic psychological needs:

Compared to a typical lecture…

Autonomy

1. ... there was a more diverse range of opportunities to engage with the lecture content.
2. ... I was able to make more of my own decisions regarding the learning opportunities.
3. ... I was able to learn more in my own way.

Competence

1. ... I have more often the feeling to work on tasks successfully.
2. ... I could better connect new contents with my previous knowledge.
3. ... I felt more competent with regard to the acquisition of the learning content.

Relatedness

1. ...I found the atmosphere among the students more pleasant.
2. ...I had more opportunities to get in touch with other students.
3. ...I had a stronger feeling that my learning success was important to the lecturer.

Application intentions

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1. As a teacher, I intend to volunteer when contributors are sought for the internal school evaluation.
2. As a teacher, I plan to use standardized measurement tools. 3. as a teacher, I plan to evaluate my teaching regularly using questionnaires.
3. As a teacher, I plan to evaluate my teaching regularly using questionnaires.

4. As a teacher, I plan to research scientific evidence on the effectiveness of pedagogical interventions.

Self-efficacy with application

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1. As a teacher, I am confident that I can research the current state of research, even if time is short.
2. As a teacher, I am confident that I can justify the use of standardized tests and questionnaires to critical parents or other teachers.
3. No matter how hard I try as a teacher, I can hardly improve the reliability of my assessment of students. (Recoded)
4. As a teacher, I trust myself to design an evaluation to change unfavorable conditions for school and teaching.
5. I believe that as a teacher I can successfully apply scientific methods and findings even in difficult situations.

1. INTERVENTION INSTRUCTIONS & EXCERPTS

The intervention instructions (Original version in German – English translation below)

Relevance-condition:

In den letzten beiden Vorlesungssitzungen ging es um [Insert Current Topic]. Wählen Sie aus Ihrer Erinnerung an diese Sitzungen einen Inhalt aus (Thema, Konzept oder Erkenntnis). Schreiben Sie im Folgenden, warum es für Ihre zukünftige Tätigkeit als Lehrkraft hilfreich sein kann, diesen Vorlesungsinhalt zu kennen. Schreiben Sie ca. 4 Sätze.

Summary-condition:

In den letzten beiden Vorlesungssitzungen ging es um [Insert Current Topic]. Wählen Sie aus Ihrer Erinnerung an diese Sitzungen einen Inhalt aus (Thema, Konzept oder Erkenntnis). Schreiben Sie im Folgenden eine Zusammenfassung über den ausgewählten Vorlesungsinhalt. Schreiben Sie ca. 4 Sätze.

Excerpts from student answers to the intervention prompt (German)

Relevance-condition:

„Ich fand die subjektive Einschätzung von Wahrscheinlichkeiten interessant, die einerseits im Alltagsleben hilfreich, im Schulkontext jedoch fatale Ausmaße haben kann. So ist es für mich besonders wichtig, Zufallseinflüsse und subjektive Bewertungen zu reduzieren durch standardisierte Tests, um fairere Bewertungen von SchülerInnen zu ermöglichen."

Summary-condition:

„Normalverteilung: Ist eine Verteilung der großen Zahlen (bei kleinen Zahlen eher unwahrscheinlich), auch Gaußsche Glockenkurve genannt. NV mit Standardabweichung gibt wieder, wie stark Zufallseinflüsse wirken, insb. für Personenmerkmale (IQ-Test etc.) verwendet (SD klein = kleine Zufallseinflüsse, SD groß = große Zufallseinflüsse). Unter Angabe des Vertrauensintervalls können Wahrscheinlichkeitsaussagen getroffen werden (wie wahrscheinlich liegt Wert innerhalb eines Intervalls der NV)."

English translation

The intervention instructions:

Relevance-condition:

The last two lecture sessions were about [Insert Current Topic]. Choose one piece of content (topic, concept, or insight) from your memory of these sessions. Write below why knowing this lecture content may be helpful for your future teaching. Write approximately 4 sentences.

Summary-condition:

The last two lecture sessions were about [Insert Current Topic]. Choose one piece of content (topic, concept, or insight) from your memory of these sessions. Below, write a summary about the selected lecture content. Write approximately 4 sentences.

Excerpts from student answers to the intervention prompt (German)

Relevance-condition:

"I found the subjective assessment of probabilities interesting, which on the one hand is helpful in everyday life, but in the school context can be fatal. Thus, it is particularly important for me to reduce random influences and subjective assessments through standardized tests to enable fairer assessments of students."

Summary-condition:

"Normal distribution: Is a distribution of large numbers (unlikely for small numbers), also called Gaussian bell curve. NV with standard deviation reflects how strong random influences have an effect, used esp. for person characteristics (IQ test etc.) (SD small = small random influences, SD large = large random influences). By specifying the confidence interval, probability statements can be made (how likely is the value within an interval of the normal distribution)."

2. ADDITIONAL ANALYSES

Analyses for competence and relatedness

Participants in the relevance-condition also reported higher satisfaction in their need for competence compared to participants in the summary-condition, but the observed difference did not reach statistical significance, $t(157) = -1.02$, $p = .31$, $d = 0.16$; BCa 95% CI [-0.15, 0.48].

Similarly, the relatedness need satisfaction reported by student teachers in the relevance group was higher compared to the reported need satisfaction of student teachers in the summary-condition, but this difference did not reach statistical significance, $t(157) = -0.925$, $p = .357$, $d = 0.15$; BCa 95% CI [-0.17, 0.46].

Validity analyses

In order to test for factorial validity, we performed confirmatory factor analysis with IBM SPSS AMOS version 25, using full information maximum likelihood estimations for all five scales that were adapted to assess dependent variables (perceived relevance, application intentions, self-efficacy for application, basic psychological needs, motivation to learn). We first checked for model fit analyzing each scale in a separate model and then tested if our proposed factorial structure fit the data better than a less constraint model (with fewer latent variables) by comparing models. To identify our models, we used the marker indicator approach and always fixed one unstandardized factor loading of an observed measure to a value of one.

To check model fit we report the chi-square test results which corresponds to the traditional approach of model testing, that tests if the model differs significantly from one that fits the data exactly (Kline, 2016). Furthermore, we report a comparative fit index (CFI) and the Normative Fit Index (NFI). We consider values equal or above .90 as indicative of an acceptable fitting model (Whittaker, 2015). Additionally, we report the root mean-square error of approximation (RMSEA) as an absolute fit index with values up to .05 indicating a close-fitting model and values up to .10 indicating acceptable fit (Whittaker, 2015).

Even though for perceived relevance and basic psychological needs the traditional approach of chi-square test indicated a significant difference from a model exactly fitting the

data, the comparative fit indices (NFI,CFI) and the RMSEA indicated acceptable fitting model for all variables:

Model fit test and indices for all scales.

Scale	X^2	df	*p*	CFI	NFI	RMSEA
Perceived Relevance	23.98	9	.004	.95	.92	.10
Application Intentions	2.93	2	.231	1.0	.99	.05
Self-Efficacy	10.87	5	.054	.96	.93	.09
Basic Psychological Needs	65.12	24	>.001	.94	.91	.10
Motivation to learn	54.27	39	.053	.99	.96	.05

To test if our factorial structure is valid we inserted all observed items and compared models with increasing complexity against a model with just one general factor and against each other to test if the data would be better explained by less factors. To determine a better fit we applied the X^2-difference test, compared differences in CFI and RMSEA. According to Cheung and Rensvold (2002) criteria for determining a substantial change in fit is $\Delta CFI \leq .01$ and $\Delta RMSEA \leq .015$. The X^2-difference tests were significant for all model comparisons and differences in fit indices were above thresholds, supporting the factorial structure of our scales.

Model comparison

M1-M2 $\Delta X^2 = 120.15$, $\Delta df = 6$, $p < .001$ ($\Delta CFI = .038$, $\Delta RMSEA = -.006$)

M2-M3 $\Delta X^2 = 427.26$, $\Delta df = 15$, $p < .001$ ($\Delta CFI = .135$, $\Delta RMSEA = -.024$)

M3-M4 $\Delta X^2 = 195.11$, $\Delta df = 45$, $p < .001$ ($\Delta CFI = .049$, $\Delta RMSEA = -.01$)

Results of confirmatory factor analysis with different models.

Nr.	Variables	X^2	df	*p*	CFI	RMSEA	AIC
1	General factor	1623.72	594	>.001	.663	.105 [.099, .111]	1839.72
2	General factor, Relevance, Intentions, Self-efficacy	1503.12	588	>.001	.701	.099 [.093, .105]	1731.12
3	General factor, Relevance, Intentions, Self-efficacy, Basic Psychological Needs	1075.86	573	>.001	.836	.075 [.068, .081]	1333.86
4	Relevance, Intentions, Self-efficacy, Basic Psychological Needs, Self-Determined Motivation	880.75	528	>.001	.885	.065 [.057, .072]	1228.75

Results from MANOVA analysis including all subtypes of motivation

Using Pillai's trace there was a significant effect of the intervention on the subtypes of motivation, V = .99, $F(6,152) = 2405.12$, $p = .028$, $\eta^2 = .77$. Separate univariate ANOVAs on the outcome variables revealed significant intervention effects on amotivation $F(1,157) = 3.58$, $p = .30$, identified regulation, $F(1,157) = 6.47$, $p = 006$, integrated regulation, $F(1,157) = 3.76$, $p = .027$, and non-significant effects of the intervention on external regulation, $F(1,157) = 0.90$, $p =$

.173, introjected regulation, $F(1,157) = 0.01$, $p = .467$ and intrinsic regulation, $F(1,157) = 0.75$, $p = .144$.

Estimated marginal means, standard errors and mean differences for all subtypes of motivation.

	Control (I)		Experimental (II)		Mean difference (I-II)
Dependent variable	*M*	*SE*	*M*	*SE*	
Amotivation	4.10	.16	3.63	.18	- 0.47
External regulation	5.31	.13	5.13	.14	- 0.20
Introjected regulation	3.96	.15	3.97	.16	0.01
Identified regulation	4.20	.15	4.76	.16	0.56
Integrated regulation	4.26	.15	4.70	.17	0.44
Intrinsic regulation	3.21	.15	3.40	.16	0.19

6.2. **Supplemental material of study 2**

LIST OF ALL ITEMS

The supplemental material contains a list of items applied in the pre intervention questionnaire and during the formative assessments 1 – 3 that were used to individualize the feedback to students. The instructions of the relevance intervention and the instructions for the control condition. Further, items used in pre and post intervention questionnaires to assess student's psychological variables. (Original items in German – English translation below)

- GERMAN -

Pre intervention questionnaire

Zielsetzung für die Lernverlaufsmessung nach den ersten 3 Wochen.

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 - Mindestkompetenz

6 - Mindestkompetenz

7 - Regelkompetenz

8 - Regelkompetenz

9 - Regelkompetenz Plus

10 - Regelkompetenz Plus

11 - Optimalkompetenz

12 – Optimalkompetenz

Einschätzung der Lernstrategien

Welche der folgenden Lernstrategien halten Sie für lernwirksam: [Ja/Nein als Antwortformat]

- Ich besuche die Vorlesungs- und Übungssitzungen
- Ich nehme an den Lernverlaufsmessungen teil
- Ich beschäftige mich außerhalb der Vorlesungssitzungen wiederholt mit den Kursmaterialien (z.B. Vorlesungsfolien, Übungsdateien).

- Ich mache eine Liste mit Schlüsselbegriffen, die ich mir versuche zu merken.
- Ich versuche Kursinhalte miteinander zu verbinden.
- Ich fasse die Kursinhalte in eigenen Worten zusammen.
- Ich hinterfrage oft, ob ich Ideen oder Konzepte aus dem Kurs für überzeugend halte.
- Ich denke bei Annahmen oder Schlussfolgerungen, die mir präsentiert werden, über mögliche Alternativen nach.
- Ich überlege mir, wie die Inhalte für mich in der praktischen Anwendung von Nutzen sein können.
- Ich versuche mir vorzustellen, in welchen zukünftigen Situationen die Inhalte mir weiter helfen können.

Geplante Zeit Nachbereitung

Wie viel Zeit haben Sie vor, in die Nachbereitung der Vorlesung zu investieren? [Angabe in Minuten pro Woche]

Formative assessment

(including instructions of the relevance intervention)

Anwesenheit bei Präsenzveranstaltungen

Haben Sie die vorhergehenden Vorlesungssitzungen besucht bzw. die Übungsaufgaben bearbeitet? [VL1, VL2, Übung]

Investierte Lernzeit

Wie viel Zeit haben Sie im Schnitt pro Woche in den vergangenen 3 Wochen die Vorlesung nachbereitet? Wenn Sie die Vorlesung nicht nachbereitet haben, tragen Sie 0 ein. [offen]

Intervention

[Experimentalgruppe] *In den letzten beiden Vorlesungssitzungen ging es um das Handlungsschema und den Umgang mit Wahrscheinlichkeiten. Wählen Sie aus Ihrer Erinnerung an diese Sitzungen einen Inhalt aus (z.B.: Thema, Konzept oder Erkenntnis). Schreiben Sie im Folgenden, warum es für Ihre zukünftige Tätigkeit als Lehrkraft hilfreich sein kann, diesen Vorlesungsinhalt zu kennen. Schreiben Sie ca. 4 Sätze.*

oder

[Kontrollgruppe] *In den letzten beiden Vorlesungssitzungen ging es um das Handlungsschema und den Umgang mit Wahrscheinlichkeiten. Wählen Sie aus Ihrer Erinnerung an diese Sitzungen einen Inhalt aus (Thema, Konzept oder Erkenntnis). Schreiben Sie im Folgenden eine Zusammenfassung über den ausgewählten Vorlesungsinhalt. Schreiben Sie ca. 4 Sätze.*

Nutzung Lernstrategien

In welchem Ausmaß haben Sie die folgenden Strategien zum Lernen der aktuellen Vorlesungsinhalte verwendet (außerhalb der Vorlesung und Lernverlaufsmessung)?

- Ich habe mich wiederholt mit den Vorlesungsinhalten beschäftigt (z.B.: Folien gelesen, Übungen wiederholt, Schlüsselbegriffe gelernt).
- Ich habe die Kursinhalte strukturiert (z.B.: Übersicht angelegt, wichtigste Inhalte rausgeschrieben).
- Ich habe mich tiefergehend mit den Kursinhalten auseinandergesetzt (z.B.: Inhalte miteinander verknüpft, Inhalte in eigenen Worten wiedergegeben, Aussagen hinterfragt).
- Ich habe über die Anwendung der Kursinhalte nachgedacht (z.B.: Nutzen der Inhalte reflektiert, konkrete Anwendungssituationen ausgedacht).

Selbsteinschätzung Kompetenz

[LVM1]

Bitte versuchen Sie Ihren aktuellen Kompetenzstand bezüglich der bisherigen Vorlesungsinhalte einzuschätzen. Wie viele der 12 Fragen in der folgenden Lernverlaufsmessung können Sie wahrscheinlich richtig beantworten?

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 – Mindestkompetenz

6 –Mindestkompetenz

7 –Regelkompetenz

8 –Regelkompetenz

9 - Regelkompetenz Plus

10 - Regelkompetenz Plus

11 – Optimalkompetenz

12 – Optimalkompetenz

[LVM2]

Bitte versuchen Sie Ihren aktuellen Kompetenzstand bezüglich der bisherigen Vorlesungsinhalte einzuschätzen. Die folgende Lernverlaufsmessung enthält 6 Fragen zur Einleitung und 12

Fragen zur Diagnostik. Wie viele dieser 18 Fragen können Sie wahrscheinlich richtig beantworten?

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 – unter Mindestkompetenz

6 – unter Mindestkompetenz

7 – Mindestkompetenz

8 – Mindestkompetenz

9 - Mindestkompetenz Plus

10 - Regelkompetenz

11 – Regelkompetenz

12 – Regelkompetenz

13 – Regelkompetenz Plus

14 - Regelkompetenz Plus

15 - Regelkompetenz Plus

16 – Optimalkompetenz

17 – Optimalkompetenz

18 – Optimalkompetenz

Bitte versuchen Sie Ihren aktuellen Kompetenzstand bezüglich der bisherigen Vorlesungsinhalte einzuschätzen. Die folgende Lernverlaufsmessung enthält 6 Fragen zur Einleitung, 6 Fragen zur Diagnostik und 12 Fragen zur Intervention. Wie viele dieser 24 Fragen können Sie wahrscheinlich richtig beantworten

[LVM3]

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 – unter Mindestkompetenz

6 – unter Mindestkompetenz

7 – unter Mindestkompetenz

8 – unter Mindestkompetenz

9 - Mindestkompetenz

10 - Mindestkompetenz

11 – Mindestkompetenz

12 – Mindestkompetenz

13 – Regelkompetenz

14 - Regelkompetenz

15 - Regelkompetenz

16 – Regelkompetenz

17 – Regelkompetenz Plus

18 – Regelkompetenz Plus

19 – Regelkompetenz Plus

20 – Regelkompetenz Plus

21 – Optimalkompetenz

22 – Optimalkompetenz

23 – Optimalkompetenz

24 - Optimalkompetenz

Fragen zur Rückmeldung (ab LVM2)

Die folgenden Fragen beziehen sich auf die Rückmeldung, die Sie im Anschluss an die vorhergehende Lernverlaufsmessung erhalten haben. [5 Stufige Antwortskala: gar nicht-kaum-mittelmäßig-ziemlich-außerordentlich]

- Ich habe die Rückmeldung vollständig gelesen.
- Die Rückmeldung enthielt nützliche Informationen für meinen Lernprozess.
- Ich habe aufgrund der Rückmeldung mein Lernverhalten überdacht und angepasst.

[Hauptteil mit 12 / 18 oder 24 MC Fragen]

Zielsetzung

Bitte setzen Sie sich ausgehend von Ihrem ersten Eindruck zu Ihrer Kompetenz jetzt noch Ziele für die nächste Messung.

[LVM1]

Die nächste Lernverlaufsmessung enthält 18 Fragen. Sechs Fragen wiederholen die Themen der Einleitung und 12 Fragen beziehen sich auf den neuen Themenbereich Diagnostik. Welches Kompetenzziel wollen Sie bei dieser Messung erreichen?

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 – unter Mindestkompetenz

6 – unter Mindestkompetenz

7 – Mindestkompetenz

8 – Mindestkompetenz

9 - Mindestkompetenz Plus

10 - Regelkompetenz

11 – Regelkompetenz

12 – Regelkompetenz

13 – Regelkompetenz Plus

14 - Regelkompetenz Plus

15 - Regelkompetenz Plus

16 – Optimalkompetenz

17 – Optimalkompetenz

18 – Optimalkompetenz

[LVM2]

Die nächste Lernverlaufsmessung enthält 24 Fragen. Je sechs Fragen wiederholen die Themen der Einleitung und Diagnostik und 12 Fragen beziehen sich auf den neuen Themenbereich Intervention. Welches Kompetenzziel wollen Sie bei dieser Messung erreichen?

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 – unter Mindestkompetenz

6 – unter Mindestkompetenz

7 – unter Mindestkompetenz

8 – unter Mindestkompetenz

9 - Mindestkompetenz

10 - Mindestkompetenz

11 – Mindestkompetenz

12 – Mindestkompetenz

13 – Regelkompetenz

14 - Regelkompetenz

15 - Regelkompetenz

16 – Regelkompetenz

17 – Regelkompetenz Plus

18 – Regelkompetenz Plus

19 – Regelkompetenz Plus

20 – Regelkompetenz Plus

21 – Optimalkompetenz

22 – Optimalkompetenz

23 – Optimalkompetenz

24 - Optimalkompetenz

[LVM3]

Die nächste Lernverlaufsmessung enthält 24 Fragen. Je sechs Fragen wiederholen die Themen der Einleitung, Diagnostik und Intervention und sechs weitere Fragen beziehen sich auf den neuen Themenbereich Evaluation. Welches Kompetenzziel wollen Sie bei dieser Messung erreichen?

1 - unter Mindestkompetenz

2 - unter Mindestkompetenz

3 - unter Mindestkompetenz

4 - unter Mindestkompetenz

5 – unter Mindestkompetenz

6 – unter Mindestkompetenz

7 – unter Mindestkompetenz

8 – unter Mindestkompetenz

9 - Mindestkompetenz

10 - Mindestkompetenz

11 – Mindestkompetenz

12 – Mindestkompetenz

13 – Regelkompetenz

14 - Regelkompetenz

15 - Regelkompetenz

16 – Regelkompetenz

17 – Regelkompetenz Plus

18 – Regelkompetenz Plus

19 – Regelkompetenz Plus

20 – Regelkompetenz Plus

21 – Optimalkompetenz

22 – Optimalkompetenz

23 – Optimalkompetenz

24 - Optimalkompetenz

Ziel Zeit Nachbereitung

Wie viel Zeit wollen Sie in den folgenden drei Wochen zur Nachbereitung der Vorlesungsinhalte investieren, um Ihr Ziel zu erreichen? [offen]

Items assessing psychological constructs from the pre and post intervention questionnaire

Items or scales marked with an aterisk have only been assessed in the post intervention questionnaire.

Motivation zu lernen

Amotivation

- Ich war nicht motiviert diese Inhalte zu lernen.
- Ich hatte keine Lust, mich mit den Inhalten auseinanderzusetzen.

- Ehrlich gesagt weiß ich nicht, wieso ich gelernt habe; ich hatte das Gefühl ich verschwende meine Zeit in diesem Kurs.*

Externale Regulation

- Ich habe gelernt, damit ich die aktive Teilnahme an der Vorlesung bestätigt bekomme.
- Ich habe gelernt, um die Lernerfolgskontrolle und damit den Kurs zu bestehen.
- Ich habe gelernt, weil ich Angst hatte den Kurs nicht zu bestehen.*

Introjizierte Regulation

- Ich habe gelernt, weil es sich so für einen Studenten/eine Studentin gehört.
- Ich habe gelernt, weil die Kenntnisse von mir als zukünftige Lehrkraft erwartet werden.
- Ich habe gelernt, weil ich mich sonst schlecht fühlen würde.*

Identifizierte Regulation

- Ich habe gelernt, weil ich diese Inhalte als zukünftige Lehrkraft brauchen werde.
- Ich habe gelernt, damit ich mich später in diesem Bereich auskenne.
- Ich habe gelernt, weil es mir wichtig ist die Inhalte zu kennen.*

Integrierte Regulation

- Ich habe gelernt, weil ich überzeugt bin, dass ich als Lehrkraft evidenzbasiert handeln muss.
- Ich habe gelernt, weil die Kenntnis dieser Inhalte zu dem Bild gehört, dass ich von mir selbst als zukünftige Lehrkraft habe.
- Ich habe gelernt, weil die Kursinhalte gut dazu passen, wie ich als Lehrkraft arbeiten möchte.*

Intrinsische Motivation

- Ich habe gelernt, weil ich die behandelten Inhalte richtig spannend finde.
- Ich habe gelernt, weil mir die Beschäftigung mit diesen Inhalten Spaß macht.
- Ich habe gelernt, weil mich die Inhalte neugierig gemacht haben.*

Selbstwirksamkeit bezüglich der Anwendung

- Ich traue mir zu, den aktuellen Forschungsstand zu einer pädagogischen Fragestellung zu recherchieren, selbst wenn die Zeit dafür knapp ist.
- Ich bin mir sicher, dass ich den Einsatz standardisierter Tests und Fragebögen auch gegenüber kritischen Eltern oder anderen Lehrkräften gut begründen kann.

- Ich traue mir zu, eine Evaluation so zu gestalten, dass ungünstige Bedingungen für Schule und Unterricht erkannt und verändert werden können.
- Ich kann auch komplexe wissenschaftliche Methoden und Erkenntnisse anwenden, um Probleme im Unterricht zu lösen.

Wahrgenommene Relevanz

- Die Inhalte der Vorlesung sind nützlich für meine berufliche Tätigkeit als Lehrkraft.
- Als Lehrkraft treffe ich bessere pädagogische Entscheidungen, wenn ich vorher den aktuellen Forschungsstand recherchiere.
- Als Lehrkraft benötige ich Theorien und Methoden der pädagogischen Diagnostik, um meine Schülerinnen und Schüler angemessen zu bewerten.
- Als Lehrkraft hilft es mir zu verstehen, wie die Forschung im Bildungsbereich funktioniert.
- Als Lehrkraft kann ich meine Schülerinnen und Schüler besser fördern, wenn ich standardisierte Tests und Fragebögen (z.B. VERA, Prüfungsangstfragebogen) einsetze.
- Als Lehrkraft sind regelmäßige Evaluationen für mich wichtig, um meinen Unterricht und meine Schule weiterzuentwickeln.

Anwendungsintentionen

- Als Lehrkraft habe ich vor, mich freiwillig zu melden, wenn Mitwirkende für die interne Schulevaluation gesucht werden.
- Als Lehrkraft habe ich vor, auch standardisierte Messinstrumente einzusetzen.
- Als Lehrkraft habe ich vor, meinen Unterricht regelmäßig anhand von Fragebögen zu evaluieren.
- Als Lehrkraft habe ich vor, wissenschaftliche Erkenntnisse zur Wirksamkeit pädagogischer Maßnahmen zu recherchieren.

Befriedigung und Frustration der psychologischen Grundbedürfnisse*

Im Kurs…

Verbundenheit

Befriedigung

- … mag ich den Dozenten.
- ... kümmert sich der Dozent um mich.
- ... habe ich das Gefühl, dass dem Dozenten mein Lernerfolg wichtig ist.

Frustration

- … fühle ich mich dem Dozenten nicht sehr nahe.
- … scheint mich der Dozent nicht sehr zu mögen.

- ... bin ich dem Dozenten egal.

Autonomie

Befriedigung

- ... gibt es ein vielfältiges Angebot von Möglichkeiten, sich mit den Vorlesungsinhalten zu beschäftigen.
- ... kann ich eigene Entscheidungen in Bezug auf die Lernangebote treffen.
- ... kann ich auf meine eigene Art und Weise lernen.

Frustration

- … muss ich Dinge gegen meinen Willen tun.
- … schreiben andere Menschen mir vor, was ich tun soll.
- … verspüre ich viel Druck, auf den ich lieber verzichtet hätte.

Kompetenz

Befriedigung

- ... habe ich das Gefühl mich weiterentwickeln zu können.
- ... bin ich erfolgreich, selbst bei schwierigen Dingen.
- ... fühle ich mich kompetent, was den Erwerb der Lerninhalte angeht.

Frustration

- ... habe ich das Gefühl, bei irgendetwas versagt zu haben oder nicht gut in etwas zu sein.
- ... bin ich von vielen meiner Leistungen enttäuscht.
- ... fühle ich mich unsicher bezüglich meiner Fähigkeiten.

Einschätzungen zur Lernverlaufsmessung*

Im Zusammenhang mit der Lernverlaufsmessung…

Erwartungen

- … war mir klar, was von mir erwartet wurde.
- … wurden mir die Erwartungen nicht klar kommuniziert.

Unterstützung

- … habe ich mich beim Lernen für den Kurs nicht ausreichend unterstützt gefühlt.
- … habe ich hilfreiche Anregungen und Hinweise zur Gestaltung meines Lernprozesses bekommen.

Wahrgenommene autonomie-Unterstützung / Kontrolle

- … wurde mir vorgeschrieben, wie ich meinen Lernprozess gestalten soll.
- … wurde ich angeregt, selbst über meinen Lernprozess nachzudenken.

Verständlichkeit

- … hatte ich Schwierigkeiten die Informationen in der Rückmeldung zu verstehen.
- … enthielt die Rückmeldung verständliche Informationen.

Anstrengung

- … habe ich nicht sehr viel Mühe investiert.
- … habe ich mich sehr angestrengt.

Belastung

- … habe ich häufig Stress erlebt.
- … war der Arbeitsaufwand für mich eine große Belastung.

Selbstreguliertes Lernen

- ... habe ich die Inhalte regelmäßig nachgearbeitet bzw. über einen längeren Zeitraum verteilt gelernt.
- ... habe ich mir bewusst eigene Lernziele gesetzt und geprüft, ob ich diese erreiche.
- ... habe ich über die Vorgehensweise und Unterstützungsmöglichkeiten beim Lernen intensiv nachgedacht.

Wahrgenommener Lernerfolg

- … habe ich das Gefühl, viel gelernt zu haben.
- … habe ich nicht das Gefühl, die Inhalte gut verstanden zu haben.

- ENGLISH -

Items of the pre intervention questionnaire

Goal setting for formative assessment after the first 3 weeks

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 - Minimum competence

6 - Minimum competence

7 - Standard competence

8 - Standard competence

9 - Standard competence Plus

10 - Standard competence Plus

11 - Optimal competence

12 – Optimal competence

Learning strategies preference

Which of the following learning strategies do you consider effective for learning: [Yes/No as answer format].

1. I attend the lecture and tutorial sessions.
2. I participate in the learning progress measurements.
3. I repeatedly engage with course materials (e.g., lecture slides, exercise files) outside of lecture sessions.
4. I make a list of key terms that I try to remember.
5. I try to connect course content to each other.
6. I summarize course content in my own words.
7. I often question whether I think ideas or concepts from the course are persuasive.
8. I consider possible alternatives to assumptions or conclusions presented to me.
9. I think about how the content might be useful to me in practical applications.
10. I try to imagine future situations in which the content can help me.

Attendance at classroom events

How much time do you plan to invest in following up on the lecture? [Indication in minutes per week]

Items of the formative assessment (including instructions of the relevance intervention)

Preparation and review

Have you attended the previous lecture sessions and/or worked on the exercises? [lecture 1,2, tutorial session]

Time spent learning

On average, how much time per week did you spend following up on the lecture during the past 3 weeks? If you did not follow up the lecture, enter 0. [open]

Intervention

[experimental condition] *The last two lecture sessions were about the scheme of action and dealing with probabilities. Choose one piece of content from your memory of these sessions*

(e.g.: theme, concept, or insight). Write below why knowing this lecture content may be helpful for your future teaching. Write approximately 4 sentences.

or

[control group] *The last two lecture sessions were about the scheme of action and dealing with probabilities. From your memory of these sessions, select one piece of content (topic, concept, or insight). Below, write a summary about the selected lecture content. Write approximately 4 sentences.*

Use of learning strategies

To what extent did you use the following strategies to learn the current lecture content (outside of lecture and formative assessment)?

- I have repeatedly dealt with the lecture content (e.g.: read slides, repeated exercises, learned key terms).
- I have structured the course content (e.g.: created an overview, wrote out the most important content).
- I have dealt with the course content in more depth (e.g., I have linked content with each other: I have linked the contents, reproduced the contents in my own words, questioned statements).
- I have thought about the application of the course content (e.g., I have reflected on the use of the content: Reflected on the use of the content, thought up concrete application situations).

Self-assessment

[formative assessment 1]

Please try to assess your current level of competence with respect to the lecture content you have covered so far. How many of the 12 questions in the following learning progress measurement are you likely to be able to answer correctly?

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 – Minimum competence

6 –Minimum competence

7 –Standard competence

8 –Standard competence

9 - Standard competence Plus

10 - Standard competence Plus

11 – Optimal competence

12 – Optimal competence

[formative assessment 2]

Please try to assess your current level of competence with respect to the lecture content you have covered so far. The following learning progress measurement contains 6 introductory questions and 12 diagnostic questions. How many of these 18 questions are you likely to be able to answer correctly?

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 – below minimum competence

6 – below minimum competence

7 – Minimum competence

8 – Minimum competence

9 - Minimum competence Plus

10 - Standard competence

11 – Standard competence

12 – Standard competence

13 – Standard competence Plus

14 - Standard competence Plus

15 - Standard competence Plus

16 – Optimal competence

17 – Optimal competence

18 – Optimal competence

Please try to assess your current level of competence with respect to the previous lecture content. The following learning progress measure contains 6 questions on introduction, 6 questions on diagnosis, and 12 questions on intervention. How many of these 24 questions are you likely to be able to answer correctly

[formative assessment 3]

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 – below minimum competence

6 – below minimum competence

7 – below minimum competence

8 – below minimum competence

9 - Minimum competence

10 - Minimum competence

11 – Minimum competence

12 – Minimum competence

13 – Standard competence

14 - Standard competence

15 - Standard competence

16 – Standard competence

17 – Standard competence Plus

18 – Standard competence Plus

19 – Standard competence Plus

20 – Standard competence Plus

21 – Optimal competence

22 – Optimal competence

23 – Optimal competence

24 - Optimal competence

Use of feedback (from formative assessment 2)

The following questions refer to the feedback you received following the previous learning progress measurement. [5-point response scale: not at all-mildly-moderately-quite-exceedingly]

- I have read the feedback completely.
- The feedback contained useful information for my learning process.
- I have reconsidered and adjusted my learning behavior as a result of the feedback.

[Main section with 12 / 18 or 24 MC questions]

Goal setting

Based on your current impression of your competence, please set yourself a goal for the next measurement.

[formative assessment 1]

The next formative assessment contains 18 questions. Six questions repeat the topics of the introduction and 12 questions relate to the new topic area of diagnostics. What competency goal do you want to achieve in this measurement?

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 – below minimum competence

6 – below minimum competence

7 – Minimum competence

8 – Minimum competence

9 - Minimum competence Plus

10 - Standard competence

11 – Standard competence

12 – Standard competence

13 – Standard competence Plus

14 - Standard competence Plus

15 - Standard competence Plus

16 – Optimal competence

17 – Optimal competence

18 – Optimal competence

[formative assessment 2]

The next formative assessment contains 24 questions. Six questions each repeat the topics of Introduction and Diagnostics and 12 questions relate to the new topic Intervention. What competency goal do you want to achieve in this measurement?

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 – below minimum competence

6 – below minimum competence

7 – below minimum competence

8 – below minimum competence

9 - Minimum competence

10 - Minimum competence

11 – Minimum competence

12 – Minimum competence

13 – Standard competence

14 - Standard competence

15 - Standard competence

16 – Standard competence

17 – Standard competence plus

18 – Standard competence plus

19 – Standard competence plus

20 – Standard competence plus

21 – Optimal competence

22 – Optimal competence

23 – Optimal competence

24 - Optimal competence

[formative assessment 3]

The next formative assessment contains 24 questions. Six questions each repeat the topics of introduction, diagnostics, and intervention, and six more questions relate to the new topic area of evaluation. What competency goal do you want to achieve in this measurement?

1 - below minimum competence

2 - below minimum competence

3 - below minimum competence

4 - below minimum competence

5 – below minimum competence

6 – below minimum competence

7 – below minimum competence

8 – below minimum competence

9 - Minimum competence

10 - Minimum competence

11 – Minimum competence

12 – Minimum competence

13 – Standard competence

14 - Standard competence

15 - Standard competence

16 – Standard competence

17 – Standard competence Plus

18 – Standard competence Plus

19 – Standard competence Plus

20 – Standard competence Plus

21 – Optimal competence

22 – Optimal competence

23 – Optimal competence

24 - Optimal competence

Goal review time

How much time do you plan to invest in the following three weeks to review the lecture content in order to achieve your goal? [open]

Items assessing psychological constructs from the pre and post intervention questionnaire

Items or scales marked with an aterisk have only been assessed in the post intervention questionnaire.

Motivation to learn

Amotivation

- I was not motivated to learn this content.
- I had no desire to deal with the content.
- Honestly, I don't know why I studied; I felt like I was wasting my time in this course.

External regulation

- I have learned so that I can get confirmation of active participation in the lecture.
- I studied in order to pass the learning success test and thus pass the course.
- I studied because I was afraid of not passing the course.

Introjected regulation

- I learned because that is what a student is expected to do.
- I learned because the knowledge is expected of me as a future teacher.

- I learned because otherwise I would feel bad about myself.

Indentified regulation

- I learned because I will need this content as a future teacher.
- I have learned so that I will later be knowledgeable in this area.
- I have learned because it is important for me to know the contents

Integrated regulation

- I learned because I am convinced that I need to be evidence-based as a teacher.
- I learned because knowing this content is part of the image I have of myself as a future teacher.
- I learned because the course content fits well with how I want to work as a teacher.*

Intrinsic Motivation

- I have learned because I find the content covered really exciting.
- I have learned because I enjoy dealing with this content.
- I learned because the content made me curious.

Self-efficacy regarding application

- I have the confidence to research the current state of research on a pedagogical issue, even if time is short.
- I am confident that I can justify the use of standardized tests and questionnaires to critical parents or other teachers.
- I have the confidence to design an evaluation in such a way that unfavorable conditions for school and teaching can be identified and changed.
- I can also apply complex scientific methods and findings to solve problems in the classroom.

Perceived relevance

- The contents of the lecture are useful for my professional work as a teacher.
- As a teacher, I make better pedagogical decisions if I research the current state of research beforehand.
- As a teacher, I need theories and methods of educational diagnostics to appropriately assess my students.
- As a teacher, it helps me to understand how educational research works.
- As a teacher, I can better support my students when I use standardized tests and questionnaires (e.g., VERA, test anxiety questionnaire).
- As a teacher, regular evaluations are important for me to develop my teaching and my school.

Application intentions

- As a teacher, I plan to volunteer when contributors are sought for internal school evaluation.
- As a teacher, I also plan to use standardized measurement tools.
- As a teacher, I plan to evaluate my teaching regularly using questionnaires.
- As a teacher, I plan to research scientific findings on the effectiveness of pedagogical measures.

Basic psychological needs satisfaction and frustration*

In the course…

Relatedness

Satisfaction

- ... I like the lecturer.
- ... the lecturer takes care of me.
- ... I have the feeling that my learning success is important to the lecturer.

Frustration

- ... I don't feel very close to the lecturer.
- ... the lecturer does not seem to like me very much.
- ... the lecturer does not care about me.

Autonomy

Satisfaction

- ... there is a wide range of opportunities to engage with the lecture content.
- ... I can make my own decisions regarding the learning opportunities.
- ... I can learn in my own way.

Frustration

- ... I have to do things against my will.
- ... other people tell me what I should do.
- ... I feel a lot of pressure that I would rather have done without.

Competence

Satisfaction

- ... I have the feeling that I can develop further.
- ... I am successful, even with difficult things.
- ... I feel competent when it comes to acquiring the learning content.

Frustration

- ... I have the feeling that I have failed at something or that I am not good at something.
- ... I am disappointed in many of my accomplishments.
- ... I feel insecure about my abilities.

Evaluation of the formative assessment*

In the context of the formative assessment…

Expectations

- ... it was clear to me what was expected of me.
- ... the expectations were not clearly communicated to me.

Support

- ... I did not feel sufficiently supported in learning for the course.
- ... I received helpful suggestions and hints on how to organize my learning process.

Perceived autonomy-support / control

- ... I was told how to organize my learning process.
- ... I was encouraged to think about my learning process myself.

Comprehensibility

- ... I had difficulties understanding the information in the feedback.
- ... the feedback contained understandable information.

Effort

- ... I have not invested very much effort.
- ... I have put in a lot of effort.

Load

- ... I often experienced stress.
- ... the workload was a great burden for me.

Self-regulated learning

- ... I have regularly reworked the contents or learned them over a longer period of time.
- ... I have consciously set my own learning goals and checked whether I am achieving them.
- ... I have thought intensively about the procedure and support possibilities for learning.

Perceived Learning

- ... I have the feeling that I have learned a lot.
- ... I do not have the feeling that I have understood the contents well.

6.3. **Supplemental material of study 3**

The following are the three prototypical feedbacks, each first in autonomy-supportive and then in a controlling framing. Subsequently, the scales together with the instructions in the order presented can be found, first in German as used and then in English translation.

1. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie über Ihren aktuellen Lernstand und kann von Ihnen dazu genutzt werden, Ihren Lernverlauf selbst zu beobachten und eigenständig zu steuern.

Sie haben 8 von 12 Aufgaben richtig beantwortet. In Bezug auf die getesteten Inhalte können Sie jetzt prüfen, ob das Ergebnis dem Niveau entspricht, das Sie für diese Veranstaltung ansterben. Der Lernerfolg passt zu einem mittleren Ziel hinsichtlich der eigenen forschungsbezogenen Kompetenzen. Sie können entscheiden, ob Sie dieses Niveau beibehalten wollen oder bis zum Ende der Vorlesung ein anderes Niveau erreichen möchten.

Zielsetzung

Sie hatten sich das Ziel gesetzt, 8 von 12 Fragen richtig zu beantworten. In der Lernverlaufsmessung haben Sie genauso viele Fragen gelöst. Für die nächste Messung haben Sie sich vorgenommen, 10 von 18 Fragen richtig zu beantworten. Relativ betrachtet haben Sie sich damit wieder ein ähnliches Ziel gesetzt. Das neue Ziel bedeutet, dass Sie anteilsmäßig wieder etwa gleich viele Fragen richtig beantworten möchten, wie Sie beim letzten Mal beantworten konnten.

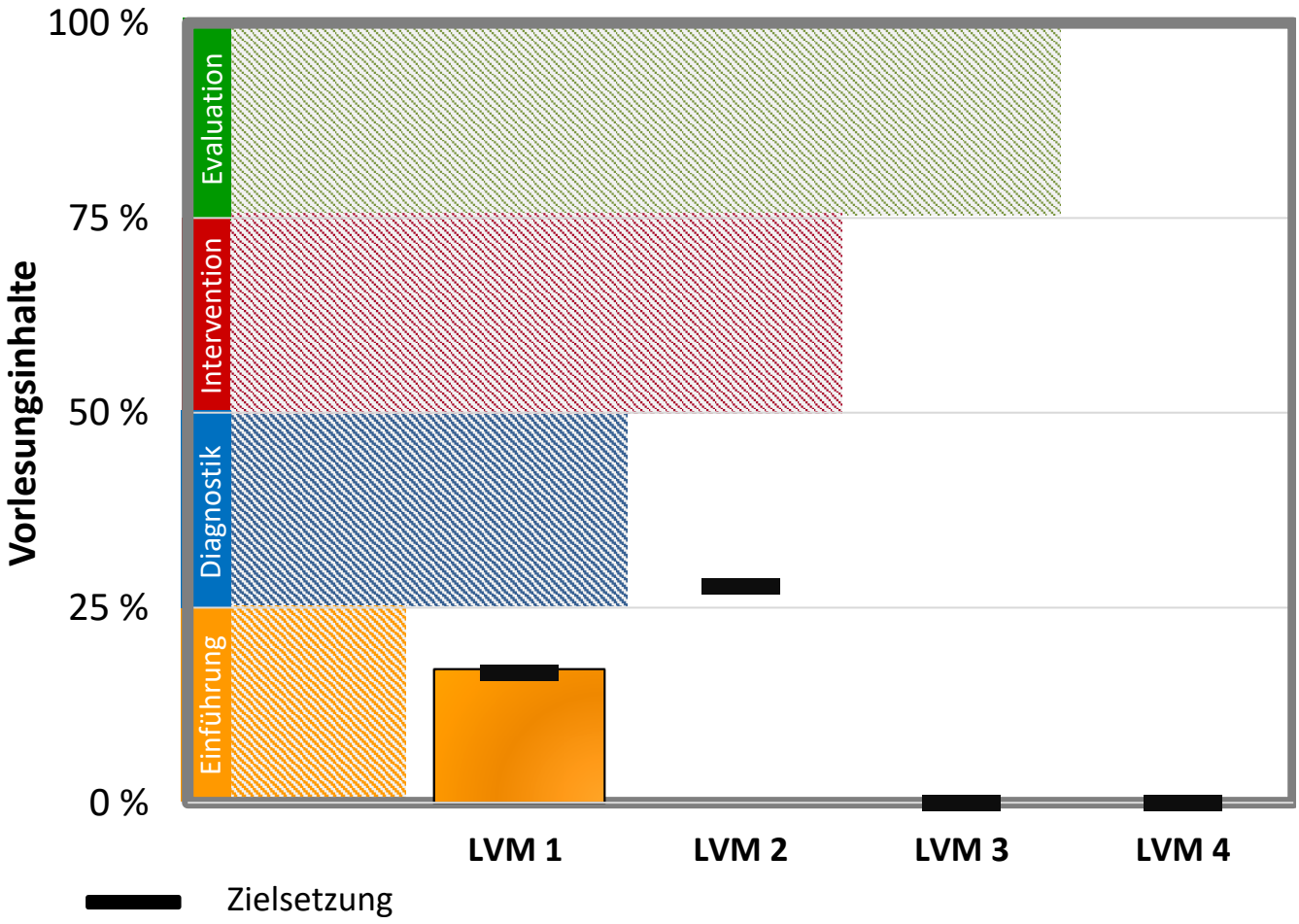
Sind Sie zufrieden mit der Herausforderung, die Ihr Ziel darstellt?

Lernverhalten

Wenn Sie Ihre Lernerfolg beibehalten oder sogar steigern wollen, können Sie über die folgenden Ansatzpunkte nachdenken und jeweils entscheiden, ob diese für Sie in Frage kommen.

Lernzeit	Sie haben 30 Minuten pro Woche in die Nachbereitung investiert. Sie können sich entscheiden, ob Sie, sich Ihrem Ziel von 65 Minuten weiter anzunähern wollen. Es ist nicht immer leicht, sich zu motivieren. Aber wenn Sie weiter regelmäßig die aktuellen Themen der Vorlesung lernen, sichern Sie sich einen nachhaltigen Lernerfolg.
Strategien	Sie haben angegeben, dass Sie beim Lernen nur mäßig die Strategie der tiefergehendenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Sie können diese Strategie vor allem nutzen, um Ihr Wissen dauerhaft zu verankern.

Abbildung zum Lernverlauf



Mit der Abbildung können Sie Ihren eigenen Lernerfolg bei der 1. Messung prüfen. Die Fragen bezogen sich auf 25 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt das Ziel, das Sie sich für diesen Messzeitpunkt gesetzt haben.

1. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie darüber, wie gut Sie aktuell die Anforderungen erfüllen, die in dieser Veranstaltung an die Lehramtsstudierenden gestellt werden.

Sie haben 8 von 12 Aufgaben richtig beantwortet. Bezogen auf die getesteten Inhalte deutet die Anzahl der korrekt beantworteten Fragen darauf hin, dass Ihre Leistung im Bereich forschungsbezogener Kompetenzen derzeit weitgehend den Erwartungen an eine /einen Lehramtsstudierenden entspricht. Wenn Sie dieses Niveau beibehalten, werden Sie die Lernerfolgskontrolle am Ende der Vorlesung wahrscheinlich bestehen.

Zielsetzung

Sie hatten sich das Ziel gesetzt, 8 von 12 Fragen richtig zu beantworten. In der Lernverlaufsmessung haben Sie genauso viele Fragen gelöst. In der nächsten Messung müssen Sie entsprechend Ihrem neuen Ziel 10 von 18 Fragen richtig beantworten. Relativ betrachtet gilt für Sie dann also wieder ein ähnliches Ziel. Das neue Ziel bedeutet, dass Sie anteilsmäßig wieder etwa gleich viele Fragen richtig beantworten müssen, wie Sie beim letzten Mal beantworten konnten.

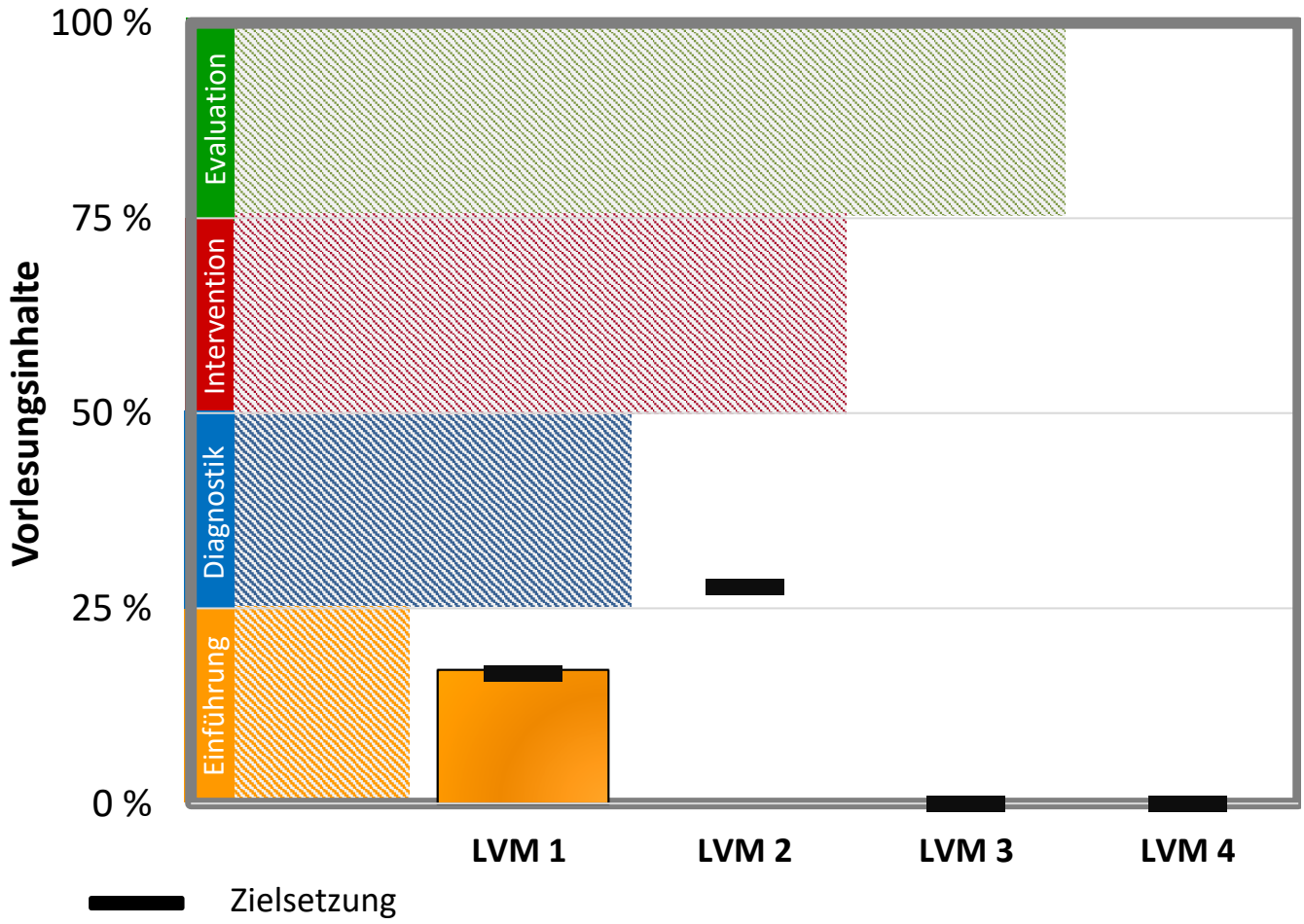
Setzen Sie sich ein Ziel, das eine größere Herausforderung darstellt!

Lernverhalten

Sie sollten versuchen, Ihre Leistung weiter zu steigern oder zumindest beizubehalten. Im Folgenden haben wir Ihnen Ansatzpunkte zusammengestellt, die Sie dabei nutzen sollten.

Lernzeit	Sie haben nur 30 Minuten pro Woche in die Nachbereitung investiert. Eigendlich hatten Sie doch das Ziel von 65 Minuten. Diesem Ziel sollten Sie sich weiter annähern. Lernen Sie weiter regelmäßig die aktuellen Themen der Vorlesung. Ansonsten müssten Sie alles am Ende der Veranstaltung kurz vor der Lernerfolgskontrolle lernen.
Strategien	Sie haben angegeben, dass Sie beim Lernen nur mäßig die Strategie der tiefergehendenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Sie sollten diese Strategie stärker nutzen, um Ihr Wissen besser zu verankern.

Abbildung zum Lernverlauf



Die Abbildung zeigt Ihren Leistungsstand bei der 1. Messung. Die Fragen bezogen sich auf 25 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt die vorher festgelegte Zielstellung für diesen Messzeitpunkt.

2. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie über Ihren aktuellen Lernstand und kann von Ihnen dazu genutzt werden, Ihren Lernverlauf selbst zu beobachten und eigenständig zu steuern.

Sie haben 11 von 18 Aufgaben richtig beantwortet. Die 18 Aufgaben bezogen sich auf 50% der Vorlesungsinhalte. Ihr aktueller Lernerfolg deutet darauf hin, dass Sie zur Zeit ca. 29% von allen Vorlesungsinhalten beherrschen. Zwischen der 1. Messung und der aktuellen Messung haben Sie einen Lernfortschritt von 12% erzielt. Ihr Lernfortschritt passt damit zu einem mittleren Ziel hinsichtlich der eigenen forschungsbezogenen Kompetenzen. Sie können entscheiden, ob Sie die aktuelle Entwicklung beibehalten wollen oder bis zum Ende der Vorlesung ein anderes Niveau erreichen möchten.

Zielsetzung

Sie hatten sich vor drei Wochen das Ziel gesetzt, 10 von 18 Fragen richtig zu beantworten. In dieser Lernverlaufsmessung haben Sie dann fast genauso viele Fragen gelöst. Für die nächste Messung in drei Wochen haben Sie sich vorgenommen, 13 von 24 Fragen richtig zu beantworten. Ausgehend von dem Ergebnis der aktuellen Messung bedeutet Ihr neues Ziel, dass Sie bei der nächsten Messung wieder etwa den gleichen Lernfortschritt erzielen möchten. Im Vergleich zur alten Zielsetzung, haben Sie sich für Ihren Lernerfolg bei der nächsten Messung wieder ein ähnliches Ziel gesetzt.

Sind Sie zufrieden mit der Herausforderung, die Ihr Ziel darstellt?

Lernverhalten

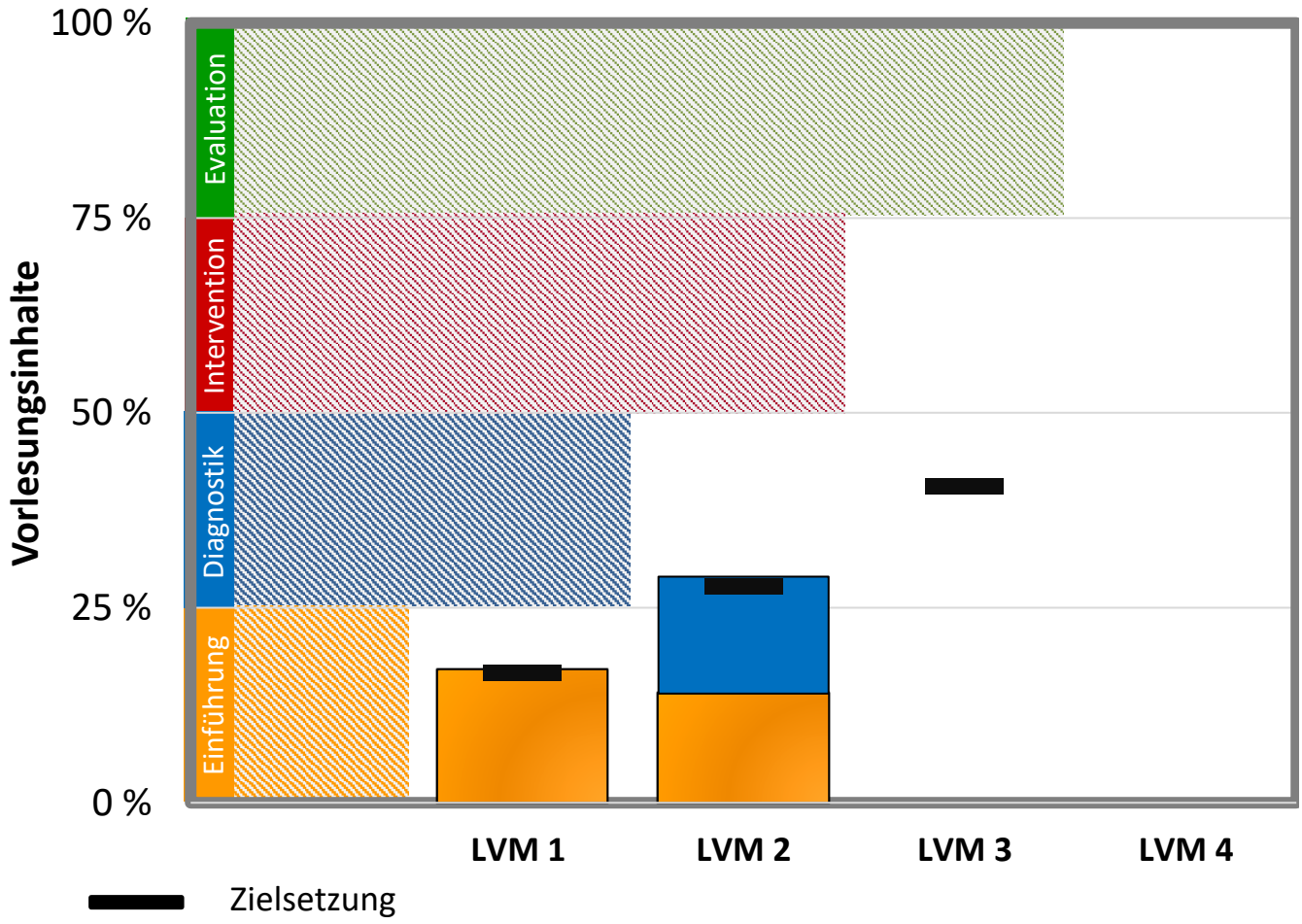
Wenn Sie Ihren Lernerfolg beibehalten oder sogar steigern wollen, können Sie über die folgenden Ansatzpunkte nachdenken und jeweils entscheiden, ob diese für Sie in Frage kommen.

Lernzeit	Sie haben 30 Minuten pro Woche in die Nachbereitung investiert. Sie können sich entscheiden, ob Sie, sich Ihrem Ziel von 55 Minuten weiter anzunähern wollen. Es ist nicht immer leicht, sich zu motivieren. Aber wenn Sie weiter regelmäßig die aktuellen Themen der Vorlesung lernen, sichern Sie sich einen nachhaltigen Lernerfolg.
Sitzungen	Sie könnten überlegen, ob Sie die Vorlesung wieder regelmäßiger besuchen wollen.
Übung	Wahrscheinlich hatten Sie diesmal keine Zeit für die Übungen. Sie können das noch nachholen.

Strategien

Sie haben diesmal angegeben, dass Sie beim Lernen die Strategie der tiefergehendenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Diese Strategie können Sie vor allem nutzen, um Ihr Wissen dauerhaft zu verankern.

Abbildung zum Lernverlauf



Mit der Abbildung können Sie Ihren eigenen Lernerfolg und Ihren Lernentwicklung bei der 2. Messung prüfen. Die Fragen bezogen sich auf 50 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt das Ziel, das Sie sich gesetzt haben, bevor Sie mit dem Lernen für diesen Messzeitpunkt begonnen haben.

2. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie darüber, wie gut Sie aktuell die Anforderungen erfüllen, die in dieser Veranstaltung an die Lehramtsstudierenden gestellt werden.

Sie haben 11 von 18 Aufgaben richtig beantwortet. Die 18 Aufgaben bezogen sich auf 50% der Vorlesungsinhalte. Ihre aktuelle Leistung deutet darauf hin, dass Sie zur Zeit ca. 29% von allen Vorlesungsinhalten beherrschen. Zwischen der 1. Messung und der aktuellen Messung haben Sie einen Lernfortschritt von 12% nachgewiesen. Ihr Lernfortschritt entspricht damit weitgehend den Erwartungen an eine /einen Lehramtsstudierenden. Wenn sich Ihre Leistung so weiter entwickelt, werden Sie die Lernerfolgskontrolle am Ende der Vorlesung wahrscheinlich bestehen.

Zielsetzung

Sie hatten sich vor drei Wochen das Ziel gesetzt, 10 von 18 Fragen richtig zu beantworten. In dieser Lernverlaufsmessung haben Sie dann fast genauso viele Fragen gelöst. In der nächsten Messung in drei Wochen müssen Sie entsprechend Ihrem neuen Ziel 13 von 24 Fragen richtig beantworten. Ausgehend von dem Ergebnis der aktuellen Messung bedeutet Ihr neues Ziel, dass Sie bei der nächsten Messung wieder etwa den gleichen Lernfortschritt erzielen müssen. Im Vergleich zur alten Zielsetzung ist die neue Zielsetzung für den Leistungsstand bei der nächsten Messung wieder ähnlich.

Setzen Sie sich ein Ziel, das eine größere Herausforderung darstellt!

Lernverhalten

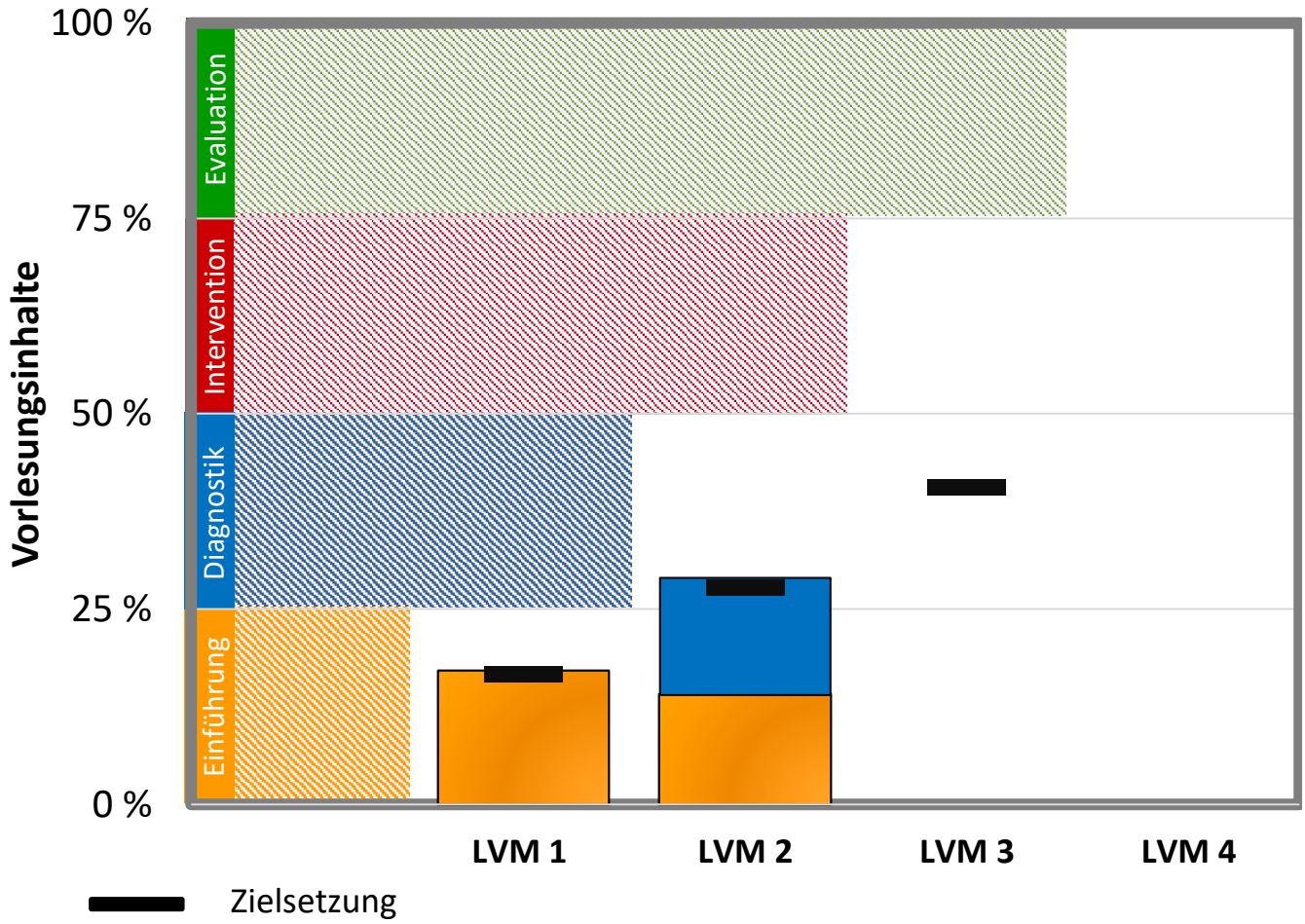
Sie sollten versuchen, Ihre Leistung weiter zu steigern oder zumindest beizubehalten. Im Folgenden haben wir Ihnen Ansatzpunkte zusammengestellt, die Sie dabei nutzen sollten.

Lernzeit	Sie haben 3л Minuten pro Woche in die Nachbereitung investiert. Eigentlich hatten Sie doch das Ziel von pp Minuten. Diesem Ziel sollten Sie sich weiter annähern. Lernen Sie weiter regelmäßig die aktuellen Themen der Vorlesung. Ansonsten müssten Sie alles am Ende der Veranstaltung kurz vor der Lernerfolgskontrolle lernen.
Sitzungen	Sie besuchen die Vorlesung nicht mehr regelmäßig. Sie sollten wieder regelmäßig kommen.
Übung	Anders als beim letzten Mal haben Sie die Übungen diesmal nicht bearbeitet. Holen Sie das nach.

Strategien

Sie haben diesmal angegeben, dass Sie beim Lernen die Strategie der tiefergehendenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Nutzen Sie diese Strategie, um Ihr Wissen besser zu verankern.

Abbildung zum Lernverlauf



Die Abbildung zeigt Ihren Leistungsstand und Ihre Leistungsentwicklung bei der 2. Messung. Die Fragen bezogen sich auf 50 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt die festgelegte Zielstellung, bevor Sie mit dem Lernen für diesen Messzeitpunkt begonnen haben.

3. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie über Ihren aktuellen Lernstand und kann von Ihnen dazu genutzt werden, Ihren Lernverlauf selbst zu beobachten und eigenständig zu steuern.

Sie haben 15 von 24 Aufgaben richtig beantwortet. Die 24 Aufgaben bezogen sich auf 75% der Vorlesungsinhalte. Ihr aktueller Lernerfolg deutet darauf hin, dass Sie zur Zeit ca. 45% von allen Vorlesungsinhalten beherrschen. Im Vergleich zu vorhergehenden Messungen haben Sie insgesamt einen Lernfortschritt von 55% erzielt. Bei der 4. Lernverlaufsmessung können Sie sich daher die Bestätigung der aktiven Teilnahme an der Vorlesung sichern, wenn Sie Fragen zu 40% der Vorlesungsinhalte richtig beantworten. Das entspricht 10 von 24 möglichen Punkten. Bei diesem Lernerfolg können Sie davon ausgehen, dass Ihre forschungsbezogenen Kompetenzen mindestens ausreichen, damit Sie im weiteren Studium darauf aufbauen können.

Zielsetzung

Sie hatten sich vor drei Wochen das Ziel gesetzt, 13 von 24 Fragen richtig zu beantworten. In dieser Lernverlaufsmessung haben Sie dann 2 Fragen mehr gelöst. Für die nächste Messung in drei Wochen haben Sie sich vorgenommen, 15 von 24 Fragen richtig zu beantworten. Ausgehend von dem Ergebnis der aktuellen Messung bedeutet Ihr neues Ziel, dass Sie bei der nächsten Messung wieder einen genauso großen Lernfortschritt erzielen möchten. Im Vergleich zur alten Zielsetzung, haben Sie sich für Ihren Lernerfolg bei der nächsten Messung wieder ein ähnliches Ziel gesetzt.

Sind Sie zufrieden mit der Herausforderung, die Ihr Ziel darstellt?

Lernverhalten

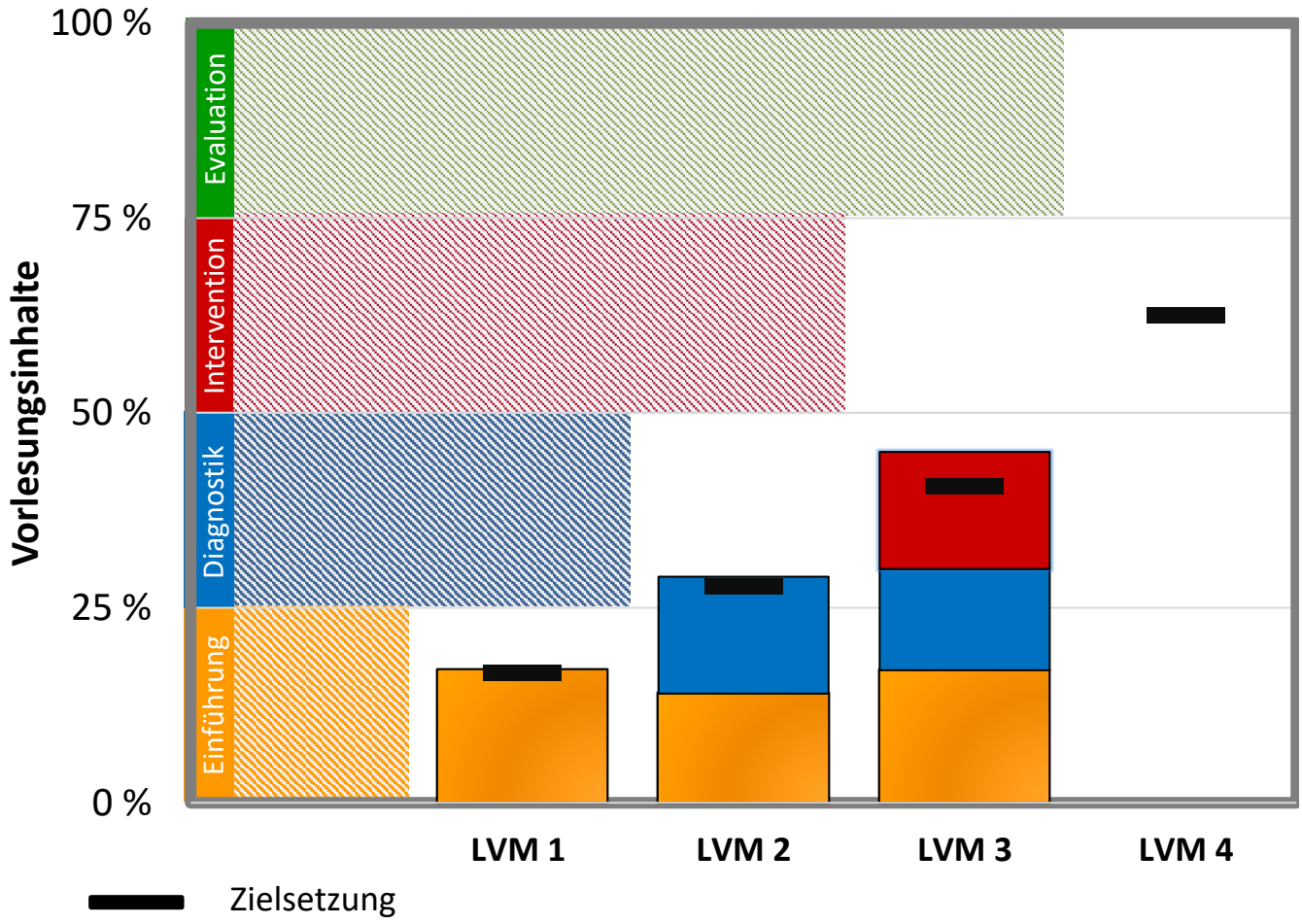
Wenn Sie Ihren Lernerfolg beibehalten oder sogar steigern wollen, können Sie über die folgenden Ansatzpunkte nachdenken und jeweils entscheiden, ob diese für Sie in Frage kommen.

Lernzeit	Sie haben 45 Minuten pro Woche in die Nachbereitung investiert. Sie können sich entscheiden, ob Sie, sich Ihrem Ziel von 70 Minuten weiter anzunähern wollen. Es ist nicht immer leicht, sich zu motivieren. Aber wenn Sie weiter regelmäßig die aktuellen Themen der Vorlesung lernen, sichern Sie sich einen nachhaltigen Lernerfolg.
Sitzungen	Sie könnten überlegen, ob Sie die Vorlesung wieder regelmäßiger besuchen wollen.
Übung	Sie haben weiterhin die Möglichkeit, die aktuellen und vorhergehenden Übungen nachzuholen.

Strategien

Sie haben diesmal angegeben, dass Sie beim Lernen nur mäßig die Strategie der tiefergehenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Diese Strategie können Sie vor allem nutzen, um Ihr Wissen dauerhaft zu verankern.

Abbildung zum Lernverlauf



Mit der Abbildung können Sie Ihren eigenen Lernerfolg und Ihren Lernentwicklung bei der 3. Messung prüfen. Die Fragen bezogen sich auf 75 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt das Ziel, das Sie sich gesetzt haben, bevor Sie mit dem Lernen für diesen Messzeitpunkt begonnen haben.

3. RÜCKMELDUNG

Lernerfolg

Dieser Teil der Rückmeldung informiert Sie darüber, wie gut Sie aktuell die Anforderungen erfüllen, die in dieser Veranstaltung an die Lehramtsstudierenden gestellt werden.

Sie haben 15 von 24 Aufgaben richtig beantwortet. Die 24 Aufgaben bezogen sich auf 75% der Vorlesungsinhalte. Ihre aktuelle Leistung deutet darauf hin, dass Sie zur Zeit ca. 45% von allen Vorlesungsinhalten beherrschen. Im Vergleich zu vorhergehenden Messungen haben Sie insgesamt einen Lernfortschritt von 28% nachgewiesen. Bei der 4. Lernverlaufsmessung müssen Sie daher nur Fragen zu 40% der Vorlesungsinhalte richtig beantworten, um die aktive Teilnahme an der Vorlesung bestätigt zu bekommen. Das entspricht 10 von 24 möglichen Punkten. Diese Leistung müssen Sie erreichen, um unter Beweis zu stellen, dass Ihre forschungsbezogenen Kompetenzen mindestens ausreichen, um erfolgreich weiter zu studieren.

Zielsetzung

Sie hatten sich vor drei Wochen das Ziel gesetzt, 13 von 24 Fragen richtig zu beantworten. In dieser Lernverlaufsmessung haben Sie dann 2 Fragen mehr gelöst. In der nächsten Messung in drei Wochen müssen Sie entsprechend Ihrem neuen Ziel 15 von 24 Fragen richtig beantworten. Ausgehend von dem Ergebnis der aktuellen Messung bedeutet Ihr neues Ziel, dass Sie bei der nächsten Messung wieder einen genauso großen Lernfortschritt erzielen müssen. Im Vergleich zur alten Zielsetzung ist die neue Zielsetzung für den Leistungsstand bei der nächsten Messung wieder ähnlich.

Setzen Sie sich ein Ziel, das eine größere Herausforderung darstellt!

Lernverhalten

Sie sollten versuchen, Ihre Leistung weiter zu steigern oder zumindest beizubehalten. Im Folgenden haben wir Ihnen Ansatzpunkte zusammengestellt, die Sie dabei nutzen sollten.

Lernzeit Sie haben 45 Minuten pro Woche in die Nachbereitung investiert. 9ƛƎŜyűŧƛŎK KI·űűŜyƴ{ƛŜ ŘƻŎK ŘI·ă ½ƛŜƒ Ǿƻyƴ70 Minutenɸ 5ƛŜăŜY ½ƛŜƒ ăƻŧŧűŜyƴ{ƛŜ ăƛŎK ǿŜƛűŜƝ I·ƴƴŅKŜƝyɸ Lernen Sie weiter regelmäßig die aktuellen Themen der Vorlesung. Ansonsten müssten Sie alles am Ende der Veranstaltung kurz vor der Lernerfolgskontrolle lernen.

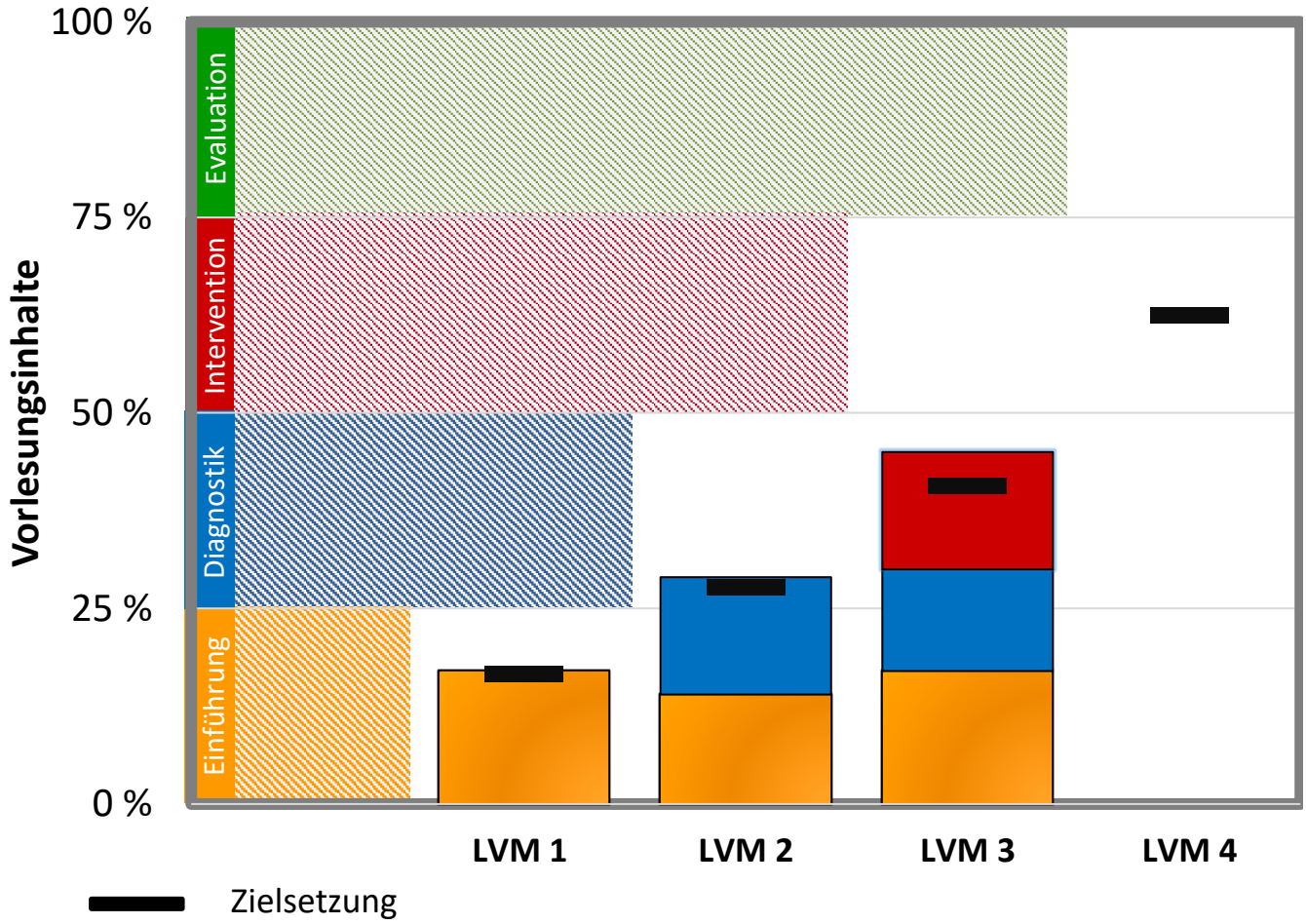
Sitzungen Sie besuchen die Vorlesung nicht mehr regelmäßig. Sie sollten wieder regelmäßig kommen.

Übung Auch diesmal haben Sie die Übungen nicht bearbeitet. Holen Sie das nach.

Strategien

Sie haben diesmal angegeben, dass Sie beim Lernen nur mäßig die Strategie der tiefergehenden Auseinandersetzung (Elaboration) eingesetzt haben (z.B. Inhalte miteinander verknüpfen, Inhalte in eigenen Worten wiedergeben, Aussagen hinterfragen). Nutzen Sie diese Strategie, um Ihr Wissen besser zu verankern.

Abbildung zum Lernverlauf



Die Abbildung zeigt Ihren Leistungsstand und Ihre Leistungsentwicklung bei der 3. Messung. Die Fragen bezogen sich auf 75 Prozent der Vorlesungsinhalte. Der schwarze Balken zeigt die festgelegte Zielstellung, bevor Sie mit dem Lernen für diesen Messzeitpunkt begonnen haben.

The following are the instructions and scales used in the order they were presented in the study.

- GERMAN -

Stellen Sie sich vor, Sie absolvieren einen Kurs an der Universität zu forschungsbezogenen Kompetenzen für Lehrkräfte. Der Kurs schließt mit einer Lernstandskontrolle ab die bestanden werden muss um die Teilnahme für den Kurs bestätigt zu bekommen. Während dieses Kurses absolvieren Sie drei Lernverlaufsmessungen, die nicht in die Bewertung ihrer Leistung im Kurs mit eingehen, sondern Ihnen beim Überwachen Ihres Lernfortschritts helfen sollen. Drei Wochen vor jedem Tests wurden Sie aufgefordert, sich ein Ziel zu setzen. Sie wurden gefragt, wieviel Zeit Sie in die Vorbereitung investieren wollen und welchen Kompetenzstand Sie erreichen möchten. Stellen Sie sich vor, die folgenden Rückmeldungen haben Sie jeweils nach dem Absolvieren der drei Lernverlaufsmessungen erhalten. Lesen Sie die Rückmeldungen aufmerksam durch. Versuchen Sie anhand der Fragen einzuschätzen, wie Sie die Rückmeldung und den Dozierenden wahrnehmen. Versetzen Sie sich dabei am besten in die Situation eines Studenten/einer Studentin in diesem Kurs.

[Präsentation Feedback zu Lernverlaufsmessung 1]

*Sie haben die Rückmeldungen zu Ihren Lernverlaufsmessungen gelesen. Versuchen Sie nun anhand der folgenden Fragen die Rückmeldung durch den Dozent und die Wirkung auf Sie als Teilnehmer*in des Kurses einzuschätzen.*

Evaluation des Feedbacks

*Zunächst einige allgemeine Fragen, wie Sie, als Student*in in dem Kurs das vorliegende Feedback einschätzen würden:*

- Ich würde Zeit aufwenden, um diese Rückmeldung zu lesen.
- Ich würde mein Lernverhalten aufgrund der Rückmeldung anpassen.
- Welche Information aus der Rückmeldung waren für Sie besonders nützlich? [offen]

Semantisches Differential

Das Feedback wirkt auf mich…

- speziell – allgemein
- sinnvoll - sinnlos
- unpersönlich – persönlich
- individuell - generell
- übersichtlich – unübersichtlich

- verwirrend - klar
- interessant – langweilig
- monoton – abwechslungsreich
- einförmig - aufgelockert
- nützlich - nutzlos
- unsympathisch – sympathisch
- freundlich – feindlich
- kaltherzig - warmherzig
- gekünstelt – natürlich
- technisch – organisch
- beruhigend – beängstigend
- hemmend – fördernd
- ermutigend – entmutigend
- bevormundend – unterstützend
- motivierend – demotivierend

[Präsentation Feedback zu Lernverlaufsmessung 2]

Im Folgenden wollen wir Ihnen eine Perspektive auf Feedback zeigen, die wir in einer späteren Lerneinheit noch tiefergehend betrachtet werden. Bitte geben Sie ihre Einschätzung, inwiefern die folgenden Aussagen bezogen auf den Dozenten und sein Feedback für Sie zutreffen:

Teacher Provision of Structure

Expectations

1. Mein Dozent macht deutlich, was er in diesem Kurs von mir erwartet.
2. Mein Dozent macht nicht klar, was er im Kurs von mir erwartet.
3. Die Erwartungen in diesem Kurs, die an mich gestellt werden, sind mir nicht ganz klar
4. Mein Dozent hat dafür gesorgt, dass ich die Ziele des Kurses und das, was ich dafür tun muss, wirklich verstanden habe.

Help/Support

1. Mein Dozent zeigt mir, wie ich in Zukunft besser lernen kann.
2. Die Hinweise meines Dozenten zu meinem Lernen helfen mir nicht besonders viel. Mein Dozent scheint nicht zu wissen, wie er mir wirklich helfen kann.
3. Ich bekomme von meinem Dozenten hilfreiche Hinweise zum Lernen für diesen Kurs

Teacher Provision of Autonomy Support

Choice

- Mein Dozent gibt mir viele Entscheidungsmöglichkeiten, wie ich meine Arbeit im Kurs gestalten will.
- Mein Dozent lässt mir nicht viel Freiheit bei der Gestaltung meines Lernens
- Mein Dozent lässt mir nicht viel Freiraum, wie ich mein Studium
- Mein Dozent regt mich an, selber Entscheidungen zum Lernen in diesem Kurs zu treffen.
- Ich habe das Gefühl, dass mein Dozent mir Wahlmöglichkeiten und Handlungsoptionen bietet.

Control

- Mein Dozent sagt mir in diesem Kurs immer, was ich zu tun habe.
- Es scheint, als ob mein Dozent mir immer sagt, was ich tun soll.
- Mein Dozent schreibt mir genau vor, wie ich zu lernen habe.

Relevance

- Mein Dozent begründet seine Rückmeldungen zu meinem Lernverhalten ausreichend.
- Mein Dozent erklärt nicht, warum das, was ich in diesem Kurs mache, wichtig für mein Lernfortschritt ist (R)
- Mein Dozent informiert darüber, wie ich in dem Kurs lernen soll, ohne mir klar zu machen wieso. (R)
- Mein Dozent spricht darüber, wieso ich auf eine bestimmte Art und Weise lernen soll.

Involvement

- Mein Dozent vermittelte Vertrauen in meine Fähigkeit, den Kurs gut zu absolvieren
- Ich fühle mich von meinem Dozenten verstanden.
- Mein Dozent geht sehr gut mit den Emotionen anderer Menschen um.
- Ich fühle mich nicht sehr gut damit, wie mein Dozent mit mir spricht. (R)

[Präsentation Feedback zu Lernverlaufsmessung 3]

Versuchen Sie abschließend die folgenden Fragen zum Lernen in diesem Kurs, anhand von dem Gefühl, dass Sie durch das Lesen der Rückmeldungen des Dozenten bekommen haben, zu beantworten:

Ich lerne im Kurs zu forschungsbezogenen Kompetenzen, ...

- … weil es mir Spaß macht
- … weil ich es mag, Aufgaben in diesem Thema zu lösen
- … weil ich gerne über dieses Thema nachdenke
- … weil ich die Sachen, die ich hier lerne, später gut gebrauchen kann.
- … weil ich etwas dazu lernen möchte.

- … weil ich den Stoff verstehen möchte.
- … damit die anderen Studierenden und mein Dozent denken, dass ich gut bin.
- … weil es mir peinlich ist, nichts zu wissen.
- … weil ich mich sonst schämen würde.
- … weil ich besser als meine Mitstudierenden sein möchte.
- … weil ich sonst Schwierigkeiten bekomme.
- … weil ich sonst Ärger mit meinem Dozenten bekomme.
- … weil Andere es von mir verlangen.

- ENGLISH -

Imagine you are taking a course at the university on research-related skills for teachers. The course concludes with a learning assessment that must be passed in order to receive credit for the course. During this course, you will complete three learning progress assessments that will not be included in your performance evaluation for the course, but will help you monitor your progress. Three weeks before each test, you were asked to set a goal. You were asked how much time you wanted to invest in preparation and what level of competency you wanted to achieve. Imagine that you received the following feedback after completing each of the three learning progress measurements. Read the feedback carefully. Attempt to assess how you perceive the feedback and the instructor based on the questions. It is best to put yourself in the shoes of a student in this course.

[Presentation of the feedback for formative assessment 1]

You have read the feedback on your learning progress measurements. Now attempt to assess the instructor's feedback and the impact on you as a participant in the course using the following questions.

Evaluation of the feedback

First, some general questions about how you, as a student in the course would rate the feedback at hand:*

- I would spend time reading this feedback.
- I would adjust my learning behavior based on the feedback.
- What information from the feedback was most useful to you? [open]

Semantic differential

The feedback appears to me...

- specific - general
- meaningful - senseless
- impersonal - personal
- individual - general
- straightforward - ambiguous
- confusing - clear
- interesting - boring
- monotonous - varied
- uniform - varied
- useful - useless
- unlikeable - likeable
- friendly - hostile
- cold-hearted - warm-hearted
- artificial - natural
- technical - organic
- calming - frightening
- inhibiting - promoting
- encouraging - discouraging
- patronizing - supporting
- motivating - demotivating

[Presentation of the feedback for formative assessment 2]

In the following, we would like to show you a perspective on feedback, which we will look at in more depth in a later learning unit. Please give your assessment of the extent to which the following statements apply to you in relation to the lecturer and his feedback:

Teacher Provision of Structure

Expectations

- My instructor makes it clear what he expects from me in this course.
- My instructor does not make it clear what he expects of me in this course.
- The expectations in this course that are placed on me are not very clear to me
- My instructor made sure I really understood the goals of the course and what I needed to do to achieve them.

Help/Support

- My lecturer shows me how to learn better in the future.
- My lecturer's advice on my learning doesn't help me very much.
- My lecturer doesn't seem to know how to really help me.

- I get helpful hints from my instructor on how to study for this course

Teacher Provision of Autonomy Support

Choice

- My instructor gives me a lot of choices in how to design my work in the course.
- My lecturer does not give me much freedom in how to organize my learning
- My lecturer does not give me much freedom in how to organize my learning
- My lecturer encourages me to make my own decisions about learning in this course.
- I feel that my lecturer provides me with choices and options for action.

Control

- My lecturer always tells me what to do in this course.
- It seems like my instructor always tells me what to do.
- My instructor tells me exactly how to study.

Relevance

- My instructor adequately justifies his feedback on my learning.
- My instructor does not explain why what I am doing in this course is important to my learning (R).
- My instructor provides information about how I should learn in the course without making it clear to me why. (R)
- My instructor talks about why I should learn in a certain way.

Involvement

- My instructor conveyed confidence in my ability to complete the course well
- I feel understood by my lecturer.
- My lecturer handles other people's emotions very well.
- I do not feel very good about how my lecturer talks to me. (R)

[Presentation of the feedback for formative assessment 3]

Finally, try to answer the following questions about learning in this course, based on the feeling you got from reading the instructor's feedback:

I am learning in the course on research-related skills, ...

- ... because I enjoy it
- ... because I like to solve tasks in this topic
- ... because I like to think about this topic

- ... because I can use the things I learn here later on.
- ... because I want to learn something new.
- ... because I want to understand the material.
- ... so that the other students and my lecturer think that I am good.
- ... because I am embarrassed not to know anything.
- ... because otherwise I would feel ashamed.
- ... because I want to be better than my fellow students.
- ... because otherwise I would get into trouble.
- ... because otherwise I would get into trouble with my lecturer.
- ... because others demand it of me.

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