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Faculty I - Department of Psychology

Knowledge Acquisition on the Learner Level: A Meta-Analysis, a Longitudinal Study and a Second-Order Meta-Analysis on Prerequisites, Processes, and Results of Learning

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by

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Summary

The ability to acquire knowledge helps humans to cope with the demands of the environment. Supporting knowledge acquisition processes is among the main goals of education. Empirical research in educational psychology has identified several processes mediated through that prior knowledge affects learning. However, the majority of studies investigated cognitive mechanisms mediating between prior knowledge and learning and neglected that motivational processes might also mediate the influence. In addition, the impact of successful knowledge acquisition on patients' health has not been comprehensively studied. This dissertation aims at closing knowledge gaps on these topics with the use of three studies. The first study is a meta-analysis that examined motivation as a mediator of individual differences in knowledge before and after learning. The second study investigated in greater detail the extent to which motivation mediated the influence of prior knowledge on knowledge gains in a sample of university students. The third study is a second-order meta-analysis synthesizing the results of previous meta-analyses on the effects of patient education on several health outcomes. The findings of this dissertation show that (a) motivation mediates individual differences in knowledge before and after learning; (b) interest and academic self-concept stabilize individual differences in knowledge more than academic self-efficacy, intrinsic motivation, and extrinsic motivation; (c) test-oriented instruction closes knowledge gaps between students; (d) students' motivation can be independent of prior knowledge in high aptitude students; (e) knowledge acquisition affects motivational and health-related outcomes; and (f) evidence on prior knowledge and motivation can help develop effective interventions in patient education. The results of the dissertation provide insights into prerequisites, processes, and outcomes of knowledge acquisition. Future research should address covariates of learning and environmental impacts for a better understanding of knowledge acquisition processes.

Inhalt

1. Introduction

Knowledge acquisition means to store of information in long-term memory (Aamodt & Nygård, 1995). It is influenced by many determinants, both learner characteristics, such as, for example, motivation, and environmental characteristics. The antecedents, processes, and results associated with knowledge acquisition are mutually dependent parts of a development that happens within the learners, not outside of them (Clark & Linn, 2013). Policy recommendations by Educational Psychologists in the APA state that prior knowledge and motivation affect students' learning and therefore should be considered in every kind of instruction (Walkington & Bernacki, 2021). The current dissertation aimed to investigate in more detail the prerequisites, processes, and results of knowledge acquisition and the role of motivation in learners. Three studies are at the center of this scientific work. Study 1 investigated the stability of knowledge within learners over time and how motivational variables mediate the influence of earlier on later knowledge. Study 2 is concerned with the prediction of learning gains based on prior knowledge and whether motivation mediates this relation. Study 3 examines how the dissemination of knowledge about diseases affects various health outcomes.

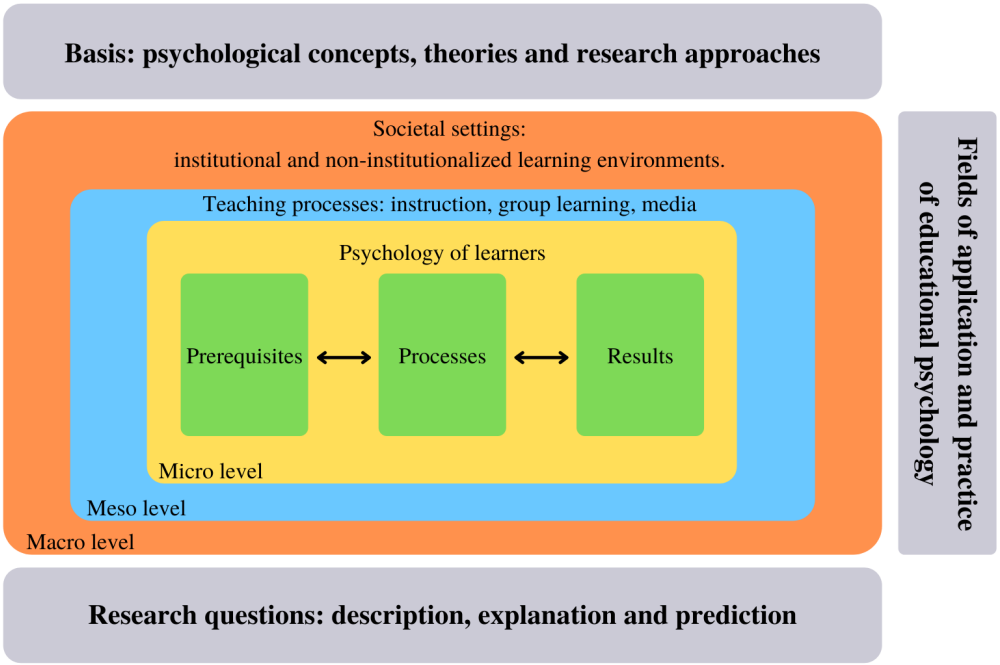
2. Key Concepts

To outline the key concepts of this dissertation systematically, I make use of the model of educational psychological subject areas (Seidel et al., 2014). The model describes learning from a multilevel perspective. Learning on the micro level (or *learner level*) takes place within the individual and includes the prerequisites for learning, the processes that lead to learning, and the internal or external outcomes that result from learning. These components interact with each other rather than being strictly sequential. Influences from the meso level such as instructional methods, social interaction, and learning materials affect learning on the micro level. The macro

level represents attributes from the institutional or non-institutional learning environments that influence the interplay of lower-level components. The contents of the levels are embedded in psychological theories and research questions as well as application contexts.

Figure 1

Models of Educational Psychological Subject Areas (adapted from Seidel et al., 2014)



In this dissertation, I examine the learner-level components, particularly the role of prior knowledge and motivation in knowledge acquisition. Both knowledge and motivation are key concepts that relate to the psychology of learners as they are a prerequisite for learning, influence the learning process, and are outcomes of learning. Therefore, I discuss these constructs in separate sections starting with knowledge. After I outline general prerequisites, processes, and results of knowledge acquisition in the second subchapter, I conclude with the motivation.

2.1. Knowledge

Depending on the research field, knowledge can be defined in different ways. In educational research contexts, knowledge is often viewed within the context of learning processes and learning achievement (e.g., Steinmayr et al., 2014; Weinert, 1999). Cognitive psychologists refer to knowledge as the content of *memory* and embed related aspects in models of information storage systems (Baddeley et al., 2015). Both perspectives have the storage and retrieval of information in common. For the current dissertation, I choose a rather generic definition for knowledge. I define *knowledge* as domain-specific information that is stored in memory (Simonsmeier et al., 2021). I define *prior knowledge* as domain-specific information stored in memory before learning (Simonsmeier et al., 2021). Although these definitions of knowledge and prior knowledge are general, the focus lies on the educational psychological perspective of knowledge.

There are many attempts to form categories and terms for characterizing knowledge. Alexander et al. (1991) identified 25 previously used definitions of knowledge and attempted to build a parsimonious framework that included conceptual and metacognitive knowledge as the remaining types of knowledge. Schneider (2006) found 18 different terms for the distinction between conceptual and procedural knowledge alone, which either had similar conceptualizations or differed only in nuances. De Jong and Fergusson-Hessler (1996) include four types of knowledge in their taxonomy, namely situational, conceptual, procedural, and strategic knowledge, each having different functions for interactions with the environment. Anderson and Krathwohl (2001) use factual, conceptual, procedural, and metacognitive knowledge in their framework that aims at supporting educational practitioners in the definition of their teaching goals. Each of these terms is a generalization of different clusters of information

stored in memory. They have unique mechanisms, methods of assessment, and research communities. Some of these knowledge types refer to facts (factual knowledge; Schneider & Grabner, 2012), interrelations of knowledge elements within a domain (conceptual knowledge; Rittle-Johnson et al., 2001), action sequences (procedural knowledge; Rittle-Johnson & Alibali, 1999), or own cognitions (metacognitive knowledge; Flavell, 1976). Specifications of domain specificity of knowledge are a subject of the work by McCarthy and McNamara (2021).

Other studies solely addressed properties of knowledge in use. A large research field is concerned with explicit and implicit knowledge (or declarative and non-declarative knowledge), which differ in the degree of verbalization (Hélie & Sun, 2010). Conceptual change researchers are interested in the fragmentation or integration of knowledge elements within concepts (Clark & Linn, 2013; diSessa et al., 2004). To describe the transfer of knowledge from learning situations to other situations, Barnett and Ceci (2002) created a taxonomy that includes nine different dimensions. Some researchers addressed the ease of knowledge retrieval (Alter & Oppenheimer, 2009), whereas others examined the effects of correct and incorrect knowledge (Fazio et al., 2013; Gallo, 2010; Vosniadou & Brewer, 1992). Another research field is concerned with the organization of knowledge in memory. Since knowledge and its organization is not directly observable, researchers have to make inferences from behavioral responses (Mayer, 2003). Such ideas of mental representations of knowledge are semantic networks (McNamara, 1992), schemata (Eysenck & Brysbaert, 2018), production rules (Anderson et al., 2004), mental models (Johnson-Laird et al., 1998), mental images (Reisberg, 2013) and neural networks (Radvansky, 2017). Every mental representation of knowledge underlies different theoretical considerations and is typically assessed with unique methods (e.g., priming for semantic networks; McNamara, 1992; computer simulations for production rules; Anderson,

2004; or interviews for mental models; Vosnidadou & Brewer, 1992). They all share the idea that knowledge elements are stored in memory and are connected to each other. From a neurological perspective, it seems safe to assume that most knowledge is stored as patterns of interconnected neurons (Patterson et al., 2007; Tyler & Moss, 2001).

Researchers debate how to treat knowledge under methodological aspects. Some investigations assume that knowledge can be modeled as a reflective latent factor (e.g., Shinas et al., 2013). Other researchers dispute that knowledge should be modeled as a reflective latent factor and argue that a formative model of knowledge better reflects the theoretical conception of knowledge (Stadler et al., 2021). In this view, knowledge is not a latent construct that affects measures of knowledge but conversely is defined by the factor indicators under consideration, which may be independent of each other. In addition, there are different methods for assessing knowledge. The simplest way of measurement is to ask participants how they rate their knowledge in the respective domain. However, these self-report measures are prone to biases such as overclaiming (Goecke et al., 2021) or the unawareness of missing expertise (known as the *Dunning-Kruger-effect*, Dunning, 2011). For this reason, research often employs objective knowledge tests that ask students to answer questions on the subject. This method increases the validity of the measures but requires decisions regarding the answer format and scoring (American Educational Research Association et al., 2014). The type of response format can already influence the way students prepare for the test (Bloxham & Boyd, 2007; Scouller, 1998). Hence, a test including either open questions or multiple-choice questions leads to increased use of deep learning or surface learning strategies, respectively.

2.2. Knowledge Acquisition

2.2.1. Prerequisites of Knowledge Acquisition

The basis of knowledge acquisition is the human cognitive architecture. The human cognitive architecture includes many interactions of systems, elements, and mechanisms that make it difficult to describe. The ability of humans to build up competencies that are necessary for a successful living in the world has evolved throughout evolution and includes predispositions to process psychological, biological, and physical information from the environment (Geary, 2002, 2008; Wellman & Gelman, 1992). Sweller and Sweller (2006) suggest five basic information processing principles that enable the acquisition of knowledge. First, information processing systems require storage of information for indefinite time frames, which is represented by long-term memory. Second, people can acquire information from the outside world through other humans by listening to them, imitating them, or learning from media. Third, learning can occur by chance, e.g., by trial and error during problem-solving. Fourth, the processing of information is limited, which allows humans to perform cognitive tasks more efficiently. This is reflected by the working memory which is limited in capacity. Fifth, knowledge stored in long-term memory can be retrieved on demand to help process and organize information from the environment.

There are various attempts to mimic the human cognitive architecture in computational models created by cognitive psychologists and computer scientists, which can even be used for designing robots that possess human-like cognitive abilities (see Langley et al., 2009, and Thagard, 2012, for reviews). Cognitive abilities involve the perception and processing of information to modify them, use them for the execution of actions, and store them for future occasions. Most cognitive architectures include short-term and long-term memories that contain

knowledge, goals and beliefs. The elements within the memory systems are embedded in a superordinate mental structure. The models contain processes that access the elements of the memory systems to use or modify them. Depending on the model, there are different underlying assumptions and specifications of how these processes occur. Artificial cognitive architectures have been successfully used to simulate human behavior during learning of a video game (Anderson et al., 2019) and air traffic control (Anderson et al., 2004).

Taken together, there are cognitive evolutionary predispositions for humans to acquire knowledge. Whereas these predispositions are the same in healthy humans, there can be differences in individual traits or states that learners bring into learning situations. Prior knowledge and motivation as prerequisites in learning situations are discussed in more detail in section 2.2.2.2. and section 2.3., where their important roles in knowledge acquisition processes become apparent. Intensive research on different constructs such as intelligence, epistemological beliefs, or goal setting found evidence for influences of these constructs on specific learning situations and outcomes. However, how individual differences in these variables affect learning cannot be discussed adequately within the scope of this dissertation. Readers interested in these constructs and their relation to knowledge acquisition are encouraged to read the works of Hambrick et al. (2014) and Grabner (2014) for intelligence, Bromme et al. (2008) for epistemological beliefs, and Eccles and Wigfield (2002) for goal setting.

2.2.2. Knowledge Acquisition Processes

There are different ways of looking at knowledge acquisition processes, ranging from neuronal plasticity at the cellular level to lifelong expertise acquisition. In this section, I will briefly discuss the different perspectives of learning, taking a closer look at the information processing process in concrete learning situations. I begin with processes at the neuronal level

and proceed with information processing followed by expertise development.

2.2.2.1. Knowledge Acquisition Processes From a Neurological Perspective. Research on the neurological basis of learning has made substantial progress since the middle of the 20th century. A central discovery here is the interconnection of synapses depending on the frequency with which they are activated together (synaptic plasticity; Bear & Malenka, 1994; Malenka & Bear, 2004; Takeuchi et al., 2014). Accordingly, the joint repeated excitation of action potentials causes an increase of synaptic activity (long-term potentiation), whereas asynchronous signals lead to a decrease in synaptic activity (long-term depression). In other words, "neurons wire together if they fire together" (Löwel & Singer, 1992, p.211). The connections made between neurons then reflect the outcome of learning processes, both for simple motor learning (Kandel, 2001) and for concept learning (Quiroga, 2012). There is evidence that groups of neurons and sometimes even individual neurons are specialized for some content. For example, neurons from the temporal lobe are specialized in retrieving mathematical facts (Amalric & Dehaene, 2018; Grabner et al., 2009) or encoding numbers (Kutter et al., 2018). In addition, learning was shown to foster neurogenesis, the formation of new neurons that can then start new connections, particularly in the hippocampus (Gould et al., 1999). Learning is not limited to the connections between neurons but is also determined by differences in the excitability of neurons (intrinsic plasticity; Daoudal & Debanne, 2003). The two forms of neuronal plasticity (synaptic plasticity and intrinsic plasticity) are not necessarily stable over time. The extent to which long-term potentiation or long-term depression occurs or the excitability of neurons is altered is determined by unique processes affecting the physiological and biochemical properties of neurons and synapses, thus their plasticity (metaplasticity; Abraham, 2008).

In sum, the reorganization and formation of neurons is the basis of learning and storage of

information memory. However, learning is not only determined by groups of neurons that build or break up connections with each other and change their transmission ability. In fact, large parts of the brain are involved in the processing of incoming information and the retrieval of information from long-term memory. The brain activities involved in learning start with the perception of environmental stimuli, as models of information processing suggest.

2.2.2.2. Knowledge Acquisition Processes From an Information Processing Perspective. Influential works by Allan Paivio and Richard Mayer who developed information-processing models have changed the way educational psychologists approach investigations of learning processes (Mayer, 1996, 2001, 2005; Mayer & Moreno, 2003; Paivio, 1991). Paivio's dual-coding theory synthesized previous research finding that humans have a visual and an auditory channel that independently encode nonverbal (e.g., images and videos) and verbal (e.g., spoken words) information. For information to enter the cognitive system, attention and perception are required. Environmental stimuli enter the cognitive system through the perceptional organs leading the channels to produce a pictorial and a verbal code. For example, watching an instructional video creates a verbal code for the words spoken and a pictorial code for the images shown. However, there is a limited capacity for each of the channels. Thus, one implication of the theory is that using both channels for learning enriches the representation of an object (e.g., the learning content in an instructional video) in memory and therefore improves retrieval.

In his cognitive theory of multimedia learning, Mayer extends the dual coding theory with additional memory systems and processes that occur during learning. The extension includes a sensory memory that can hold exact representations of visual or auditory stimuli for short periods, and the long-term memory that stores prior knowledge. At the center of the model,

working memory is the location in which cognitive operations such as holding and manipulating information occur. Working Memory is limited in capacity allowing humans to process only a restricted amount of information. Three processes are involved in learning. The first process is the selection of information from the sensory memory. During this process, relevant words and images are transferred into working memory, whereas other information is ignored and discarded from sensory memory. The organization of the selected materials is the second process, which takes place within the working memory. During the organization, mutual relations of elements of the images and words are formed for a coherent structure. For example, reading a text about how a car works requires relating the words that describe each component so that cause-and-effect relationships in the process can be identified. The third process is the integration of the active elements in working memory, a process of sense-making with the aid of prior knowledge from long-term memory. The combination of elements and the enrichment of preexisting schemata with additional information forms the basis for the development of skilled performance. Hence, the central aim of information processing theories is to facilitate processing even at the perceptual level and to reduce task-irrelevant extraneous load such as decorative elements to reach an optimal level of demands that is solely restricted to task-relevant elements (Mayer et al., 2020; Mayer & Moreno, 2003; Sweller, 2010).

Prior knowledge plays an important role in knowledge acquisition because it is one of the central components of information processing. Not surprisingly, prior knowledge is one of the strongest predictors of later knowledge and academic achievement (Dochy et al., 2002; Schneider & Preckel, 2017; Simonsmeier et al., 2021). Cognitive load theory (Sweller et al., 2011) states that extremely low or high processing demands (i.e., cognitive load) in working memory lead to decreases in learning performance and that the degree to which the processes in

working memory are demanding depends to a major part on the amount of prior knowledge learners possess (Paas et al., 2004). The limitation of working memory capacity is partially avoided when processing information for which schemata already exist in long-term memory. The more automated schemata become, the less demanding they are leaving more capacity for the integration of new, unknown information. For example, readers that have high topic-relevant prior knowledge are better in tasks that require the integration of multiple text elements compared to readers with low topic-relevant prior knowledge, probably because they can make more inferences (Ozuru et al., 2009). However, prior knowledge not only affects superior cognitive processes in the working memory but also lower levels of information processing. In their systematic review, Brams et al. (2019) synthesized 52 studies comparing the gaze behavior between experts and non-experts in different domains such as sports and medicine. They found medium to large effect sizes for the differences between the two groups regarding search rate, selective attention allocation, visual span, and systematicity of scan patterns. Experts used more systematic scanning strategies, were able to search for information more efficiently, and directed their attention more often towards relevant areas.

Brod (2021) suggested that the effects of prior knowledge on learning are determined primarily by whether it is activated, relevant, and congruent. An example of the effects of activation of prior knowledge is the study by Gurlitt and Renkl (2008) who used two different concept mapping tasks that differed in the degree to which they activated prior knowledge and a control group that did not work on a concept map. They found that both the low and the high activating task improved learning outcomes compared to the control group and that the degree of prior knowledge activation caused differences in information processing, concluding that prior knowledge needs to be activated before it can affect learning processes. To show that prior

knowledge needs to be relevant to affect learning, Brod (2021) quotes research on the Baker-baker paradox (Cohen, 1990; McWeeny et al., 1987). This phenomenon is characterized by the difficulty for participants to recall face-name associations (i.e., the surname of the person shown was Baker), whereas remembering face-profession associations (i.e., the profession of the person shown was a baker) elicits better retention rates, although participants probably knew someone who had the surname Baker because it is a common surname. Ultimately, the congruency of prior knowledge determines whether it is beneficial or hindering for learning. The more congruent the information to be learned is with prior knowledge from long-term memory, the better it is remembered, presumably because the object's memory trace is more elaborated (Bein et al., 2015).

2.2.2.3. Knowledge Acquisition Processes From an Expertise Development Perspective.

Research on the acquisition of domain-specific knowledge over long periods is closely intertwined with the research field of expertise and skill development (Ericsson, 2006, 2008, 2018). The performance of experts is characterized by the ability to repeatedly respond quickly and intuitively to typical situations in a particular field, which is the result of intensive engagement and long experience. In contrast, the performance of individuals newly introduced to a domain is accompanied by slow, step-by-step actions that closely follow teacher guidance. Expert performance can be observed in competitions as well as under laboratory settings in which critical situations are presented that require participants to make decisions or perform relevant actions such as playing a piece of music. In education, the performance of students can be assessed by standardized tests before and after learning. Educational psychological research is particularly interested in expertise development concerning the elements of instruction that lead to superior performance.

It is not the sole amount of experience within a domain that is necessary for expert performance, but the characteristics of practice. Ericsson et al. (1993) identified elements of engagement that lead to expert performance and introduced the term *deliberate practice* for an ideal form of practice. Without these elements, individuals can acquire some sort of automated behavior but they will not reach higher-level performance and obtain complex mental representations of tasks solely by repeating actions and accumulating experience. Deliberate practice is characterized by (1) tasks that have a well-defined goal, (2) maintenance of motivation for improving, (3) feedback on past performance, and (4) opportunities to optimize one's performance. In most cases, it requires some sort of teacher to accomplish these conditions. It has to be noted, that despite massive amounts of deliberate practice, some individuals may never reach the expert level. In contrast, some may display expert performance without intensive deliberate practice. Presumably, other factors contribute additionally to knowledge and skills acquisition (such as intelligence; Ackerman, 1992; Hambrick et al., 2014).

2.2.3. Effects of Successful Knowledge Acquisition

At the end of learning processes in general, a transition of individuals' intellectual skills, conceptual understandings, cognitive strategies, motor skills, or attitudes has occurred (Gagne, 1984). From the perspective of human capital (Becker, 2009), investing in psychological incomes such as skills and knowledge not only pays off in the long term for an individual, but also for society as a whole. On average, the individual financial returns for people with a degree in higher education are 226,800 to 287,200 USD, resulting in higher income taxes and contributions to society (OECD, 2021, p. 100). Learning achievement is also associated with psychological outcomes of individuals. Correlational meta-analyses found that higher-achieving students have higher self-perceived cognitive and affective academic well-being, academic self-

efficacy, as well as institutional integration, and experience less test anxiety and academic stress (Schneider & Preckel, 2017).

Some investigations found striking findings of education on health. The World Health Organization (2006) defined health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (p.1). They further remark that "the extension to all peoples of the benefits of medical, psychological and related knowledge is essential to the fullest attainment of health" (p.1). Furnée et al. (2008) found that each year of education positively contributes to health to a significant amount. Not surprisingly, people with tertiary education live five years longer on average than people with below upper secondary education (OECD, 2021, p. 116). Van Der Heide et al. (2013) found that health literacy mediated the association between education and health, stressing the importance of the promotion of knowledge about health-related topics. A comprehensive investigation of the effects of the promotion of health-related knowledge is indispensable to identify the magnitude of the effects. A meta-analysis of longitudinal studies found that academic achievement negatively predicted depression even after controlling for prior depression, especially for children (Huang, 2015). Other meta-analyses found positive associations with optimism, self-esteem, and overall well-being (Bücker et al., 2018; Richardson et al., 2012). These meta-analyses, however, investigated general education as a covariate, but not the straight promotion of health-related knowledge.

The aforementioned effects of successful knowledge acquisition are not only the ending point of learning but can also pose starting points for subsequent learning processes resulting in an upward spiral. For example, Lyubomirsky et al. (2005) found that success not only evokes positive emotions, but that positive affect also enhances creative thinking and performance on complex mental tasks. Additionally, as outlined in Chapter 2.2.2.2., knowledge affects

subsequent learning. Previous academic achievement is one of the best predictors of subsequent learning outcomes (Schneider & Preckel, 2017; Simonsmeier et al., 2021). The underlying processes for this association, however, have not been investigated much so far. There is reason to believe that prior knowledge positively affects motivation, which in turn affects subsequent learning outcomes (Vu et al., 2021).

2.3. Motivation

Motivation is an umbrella term for many constructs related to human behavior that is difficult to define. The term stems from the Latin word *movere*, which means to move, implying that it is somehow involved in performing actions. (Kleinginna & Kleinginna, 1981) found 102 different approaches to defining motivation, some of which differed greatly in the aspects they emphasized. They summarized these definitions and formed different categories for a better understanding of the research field. Accordingly, some definitions stressed internal mechanisms linked to motivation. This included phenomenological components of motivation that humans can consciously perceive, e.g., in forms of needs, desires, and affects. It also included the unique physiological processes linked to motivation. Other definitions emphasized the characteristic to energize or direct behavior (or both) including choices which actions to attend. In some cases, authors emphasized the temporary nature of motivation in the sense of reversible states, whereas others focused on the distinction from other psychological processes such as perception and emotion. In many cases, the scope of motivation is subject to definitions, ranging from interactions with other components of human behavior to motivation being the single determinant. Motivational psychological research is traditionally not restricted to learning and investigates person-centered determinants such as motives and needs, situational determinants, and person-situation interactions that lead to forms of behavior and their outcomes (Heckhausen

& Heckhausen, 2010).

There are motivational predispositions that have developed throughout human evolution (Heckhausen, 2000; Heckhausen & Schulz, 1995). Accordingly, motivated behavior is subject to two basic goals aimed at gaining control. The first goal is to gain primary control, which describes behaviors directed at the external environment to change it to meet the needs and desires of the individual. The secondary goal is referred to as secondary control, which is directed towards the minimization of losses of primary control, or the maintenance and extension of primary control. Some frameworks also posit a natural striving of humans towards mastery learning and active engagement with the environment, which leads to the automatic acquisition of knowledge, competencies, and skills (Geary, 2002; Ryan et al., 2021).

The Situated Expectancy-Value Theory (Eccles & Wigfield, 2020) is a motivational framework that aims at explaining choices and processes within and between persons with regard to academic behavior. The basic assumption is that expectancy for success (ES) and subjective task value (STV) are the most important determinants of choices, performance, and activities. ES is the belief of an individual to be successful in an upcoming task. STV is characterized by four components reflecting person-task attributes, namely intrinsic value, attainment value, utility value, and cost. The intrinsic value reflects the degree to which performing the task leads to enjoyment and is related to intrinsic motivation and interest. Utility value describes how useful performing a task is perceived by an individual compared to his or her plans and is more related to extrinsic motivation. For example, when the mere cause of performing an action is to receive an incentive, the behavior has a high utility value and is extrinsically motivated. The attainment value represents the magnitude to which a task fits the identity of a person. The higher the overlap between elements of the task and self-schema, the higher is the attainment value. The

fourth element that determines the STV is the anticipated costs tied to an action. The costs are higher, e.g., when the action requires effort, elicits fear, or impedes performing another appealing action. STVs can be different between persons in similar situations, which is why they were labeled subjective. There are many social-cognitive and situational influences on ESs and STVs from a meso and macro level that interact with expectancies and values, thus determining the respective choices. Interestingly, prior achievement (e.g., good performance on knowledge tests) is expected to affect STVs and ESs via the memory traces they create.

Results from research on ESs and STVs showed that the two constructs along with their subcomponents could repeatedly be shown in factor analyses and be used for predictions of performance (Eccles & Wigfield, 2020; Wigfield & Eccles, 2020). Trautwein et al. (2012) found that expectancy intrinsic, attainment and utility value, and cost predicted performance in a standardized mathematics achievement test when they were entered separately in the regression models. Moreover, they found significant interactions between ESs and STVs that could incrementally explain performance in the test. However, the predictive quality of ESs and SVTs, in general, depends on a variety of aspects such as school subject, gender, and culture as well as developments over time (Eccles & Wigfield, 2020).

The model from Rheinberg et al. (2000) attempts to explain the role of motivation in self-regulated learning and addresses questions such as why learners start learning activities and how motivation affects the learning process. As two antecedents of current learning motivation, the model includes person-related aspects (such as motives, interests, goals, and self-beliefs) and situational aspects (e.g., characteristics of a task, task difficulty, the subject matter, as well as potential gains and costs). Both types of antecedents interact with each other and thereby determine goals, expectancies, and the subjective perception of incentives. These variables

determine both the strength and the quality of motivation for learning in the respective situation in a way that can be compared with the mechanisms of the aforementioned model. The quality of learning motivation refers to *why* learners engage in a task, e.g., because they are intrinsically interested in it or expect praise. The effect of motivation strength and quality on learning outcomes is mediated by variables during the learning process such as learning strategies, time on the task, and the motivational state. The motivational state is the strength and quality of learning motivation during the task and may be different from the initial motivation, especially when the time on the task has advanced. The model implies that the greatest effects can be found when considering variables that are close to each other. Therefore, only small correlations are expected between person-related or situational antecedents and learning outcomes.

In line with the Situated Expectancy-Value Model and the model by Rheinberg et al. (2000), motivation is involved in each of the components located on the micro-level of learning. Similar to how knowledge serves as a prerequisite in future learning situations, affects learning processes outcomes of learning, motivation can be the starting point and the ending point of learning, and actively influence learning processes. How motivation influences behavior during learning phases is the subject of numerous models of self-regulated learning and related investigations (Panadero, 2017; Wolters, 1998; Wolters et al., 1996).

2.3.1. Motivational Constructs Covered in This Dissertation

Educational psychological research on motivational topics addresses, but is not limited to, interest, self-schemas, and the degree to which actions are performed intrinsically or extrinsically concerning learning and academic achievement (Murphy & Alexander, 2000). These constructs are subject to many investigations of big research communities.

The motivational constructs considered in this dissertation are interest, academic self-

concept, academic self-efficacy, intrinsic motivation, and extrinsic motivation. Thus, a wide range of motivational topics in educational psychological research is covered.

For this dissertation, interest is defined as a person-object relation that has cognitive and affective components and is associated with the tendency to engage with the specific object (Ainley et al., 2002; Krapp, 2005; Renninger & Hidi, 2011). Interest towards an object can be a rather stable, well-developed predisposition in terms of individual interest or a temporary state, or situational interest (Hidi & Renninger, 2006).

Academic self-concept is defined as a hierarchical and multidimensional construct that reflects the perception of oneself and particularly one's abilities in academic contexts, which are shaped by environmental influences (Arens et al., 2021; Marsh, 1992; Shavelson et al., 1976). Previous studies found that academic self-concept can be further distinguished into domain-specific self-concepts (Marsh et al., 1988; Valentine et al., 2004).

Academic self-efficacy is defined as the belief in one's capability to accomplish a certain task in a given situation (Bandura, 1994). Both self-concept and self-efficacy are related to perceptions of ability, but self-concept is more oriented towards past experiences and whole subjects, whereas self-efficacy is more oriented towards future challenges and refers to specific tasks (Bong & Skaalvik, 2003).

Intrinsic motivation is defined as the engagement in a task because it is inherently perceived as enjoyable, challenging, or interesting, whereas extrinsic motivation is defined as the engagement in a task to attain a particular outcome (Ryan & Deci, 2000a, 2000b).

All previous motivational constructs appear in Study 1. Interest, self-concept, and self-efficacy are also investigated in in Study 2.

3. Methods Applied in This Dissertation

The investigation of knowledge acquisition requires the consideration of multiple influences at the same time. For this reason, it is necessary to use appropriate statistical evaluation methods that allow a multivariate approach. In this dissertation, I make use of two different groups of analysis methods. In Study 1 and Study 3, we use a meta-analytical approach to statistically synthesize and extend findings from previous studies. In Study 1 and 2, we conduct mediation analyses, which allow for the examination of effects from process variables. In the next two subchapters, I will first describe the meta-analytic technique and an extension of it, and proceed with a description of mediation analyses.

3.1. Meta-Analysis

3.1.1. Classic Meta-Analysis

Meta-analytical methods allow for the integration, synthesis, and extension of findings from primary empirical studies using a statistical approach (Borenstein et al., 2009; Cooper et al., 2019; Glass, 1976; Schmidt & Hunter, 2015) along with certain quality criteria (Moher et al., 2009; Shea et al., 2017). In contrast to other research synthesis techniques such as narrative or systematic reviews, meta-analyses have the advantage that they can handle a larger pool of studies and provide an objective average effect size, while at the same time allowing researchers to replicate the findings more easily. Since meta-analyses are based on previous research, the sample size of participants is always larger than in primary studies, allowing for more precise estimations of true effects. Studies with larger samples provide better estimators for the true effect sizes, so they are assigned a higher weight in calculating a pooled effect size. Because the primary studies included in the meta-analysis are related but still have differences such as in subject groups, study designs, and operationalizations of constructs, there is some heterogeneity among them. Meta-analyses can deal with this heterogeneity and, in conjunction with moderator

analyses and subgroup analyses, provide both generalizable and more detailed results.

Conducting a meta-analysis follows a specific process that involves decisions for or against an aspect at many steps. Since the procedure can overwhelm inexperienced researchers, while at the same time interest in conducting meta-analyses is continuously increasing, there are now practical guides from experts that make it easier to get started (Buecker et al., 2021; Siddaway et al., 2019). Typically, the first step is to delineate the scope of the meta-analysis. This involves reviewing the relevant research literature to identify key concepts and related topics. The goal of this step is to formulate a research question that will guide all subsequent steps.

The second major step involves planning and conducting the literature search as well as determining inclusion and exclusion criteria along with decisions on how to treat fuzzy cases. The standardized literature search must be carefully worked out because the search hits will form the later database. The aim is to cover as many relevant studies as possible, which is why it is necessary to include all central terms and their synonyms for the search string. If possible, the search should be conducted in more than one database. It is recommended to include unpublished research as well to minimize the influence of publication bias, a bias in effect sizes based on the phenomenon that large and significant effects are more likely to be published than non-significant findings (Rothstein et al., 2006). For the search hits to be classified as relevant or not relevant, predefined inclusion and exclusion criteria are necessary, which contribute to the quality of the decisions and make them comprehensible. Possible criteria concern research designs, populations, measures of constructs, or the availability of effect sizes for later computations.

The third step is the screening of the search hits by at least two coders. Screening

includes decisions for or against the inclusion of articles, first at the abstract level and later at the full-text level. For the results of the meta-analysis not to be biased by subjective beliefs of the coders, the inter-rater agreement should be at least 80%. After the final sample of studies is determined, the effect sizes and relevant study characteristics have to be coded following a predefined coding manual for guiding decisions. Again, the agreement for the coding of the study characteristics should be at least 80%. In some cases, the quality of the included studies is evaluated for later interpretations of the results. After the coding is finished, the meta-analytic calculations can be performed.

Meta-analyses can underlie different statistical specifications (Cheung, 2015). One specification regards the assumption of whether there is a single true effect size for the population of studies (which represents a *fixed-effects model*) or whether there are multiple true effect sizes present in the population due to differences in study characteristics (which represents a *random-effects model*). While in fixed-effects models differences in observed effect sizes arise only from sampling error (the imperfect estimation of the true population effect due to sampling), in random-effects models additional differences in true effect sizes are also accounted for. In most psychological studies, a random-effects model is more appropriate. A second aspect of the statistical specifications is the consideration of dependency between effect sizes. When one study can provide more than one effect size, the effect sizes are not independent of each other causing results to be misleading. This problem can be addressed using multivariate meta-analysis or multilevel meta-analysis (Cheung, 2019). Recently developed methods of meta-analysis include a combination with structural equation modeling (Jak & Cheung, 2020).

Although meta-analysis has advantages, this method is not without flaws. However, there are methods to reduce the influence of biases. A common criticism of meta-analyses is that the

generalization of findings does not adequately reflect reality (*mixing oranges with apples*). Careful specifications of inclusion criteria and the application of moderator analyses can account for this criticism. Other criticisms concern the studies themselves that are included in the meta-analysis. First, if the quality of included studies is low, the quality of the meta-analytic results can be considered equally low (commonly referred to *as garbage in garbage out*). Second, due to publication bias, the findings could be overestimated or underestimated. However, a comprehensive literature search well as statistical and visual inspection methods can reduce the possibility of flawed results.

3.1.2. Second-Order Meta-Analysis

A second-order meta-analysis is a special form of meta-analysis that combines the pooled effect sizes from first-order meta-analyses (Cooper & Koenka, 2012; Schmidt & Oh, 2013). Similar to how a meta-analysis uses effect sizes from primary studies for calculations, second-order meta-analyses use the effect studies from first-order meta-analyses. Hence, a second-order meta-analysis is a meta-analysis of meta-analyses. This method has additional advantages over first-order meta-analyses. Just as there can be variance between effect sizes from primary studies, there can be variance between effect sizes from meta-analyses due to differences in inclusion criteria or studies in the dataset. In contrast to first-order meta-analysis, it is possible to determine this variance and the proportion of second-order sampling error. Another advantage is the opportunity to compare similarities and differences between meta-analyses and integrate them from a higher-level perspective. It should be noted that it is still debated how to treat dependency between meta-analytic effect sizes. Second-order meta-analyses have large a potential to address research questions that would otherwise be difficult to investigate. For example, Tamim et al. (2011) use results from first-order meta-analyses that had examined

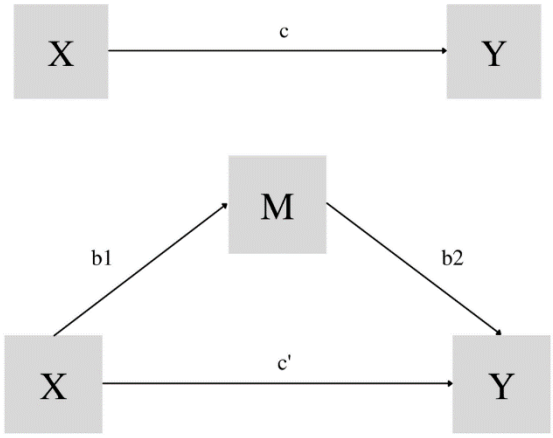
effects of certain technology applications in classrooms to determine an overall effect of all technology applications on learning. Study 3 makes use of second-order meta-analysis to integrate meta-analytic findings of impacts of patient education on health outcomes.

3.2. Mediation Analysis

Mediation analysis is a statistical method to investigate how the relation between an independent variable and a dependent variable can be accounted for by a mediator variable (Baron & Kenny, 1986; Hayes, 2018; Judd et al., 2014; Rucker et al., 2011). Mediation analyses are particularly suited for the determination of process variables and the test of hypotheses regarding underlying mechanisms of an effect. Thus, mediation analyses are a popular method in psychological research fields (Rucker et al., 2011).

Figure 2

A Conceptual Diagram of a Mediation Model



A schematic representation of a mediation model is depicted in Figure 2. A mediation model assumes that the independent variable X causally influences both the mediator variable M and the dependent variable Y and that M causally influences Y. This means that two sources

influence Y. Three different effects are of importance in a simple mediation model. The *total effect* of X on Y is represented as the path coefficient c in the upper half of Figure 2. When taking a mediator variable under consideration, the total effect can be divided into the *direct effect* and the *indirect effect* (also called the *mediation effect*). The direct effect is the path leading directly from X to Y, as denoted by the path coefficient c'. The indirect effect is the pathway leading from X to Y through M and involves the paths with the coefficients b1 and b2. The indirect effect is the product of b1 and b2 and tells, to what degree Y changes when X increases (or decreases) by one unit. Subtracting the indirect from the total effect results in the direct effect. The difference between the total effect and the direct effect is that the effect c' of X on Y is controlled for M. For each of the effects in mediation models, inferential statistics can be computed to determine the generalizability of the results. Readers interested in the statistical model of mediation analyses and the corresponding inferential statistics are encouraged to read chapters 3.2 and 3.4. in Hayes (2018).

There are different approaches to determine whether a significant mediation effect is present in the data. The traditional approach was first presented by Baron and Kenny (1986) who propose to examine whether a direct effect is significantly reduced or even becomes nonsignificant after subtracting the indirect effect from a (former significant) total effect. This method, however, has low power causing significant mediation effects more likely to remain undetected (Fritz & MacKinnon, 2007). Another method is the Sobel test (Sobel, 1982, 1986) which does not require the consideration of the total or direct effect. It assumes that the distribution of the indirect effect is normal so that a standard error can be calculated as well as a *p*-value for the particular indirect effect size. An indirect effect with $p < .05$ is significant, similarly to common inferential statistics. However, the normality assumption is often violated in

real data (Hayes, 2009). The PROCESS macro for SPSS is another method that also considers the indirect effect only but uses bootstrapping to simulate the sampling distribution of the indirect effect (Hayes, 2018). Hypothesis testing can be performed by inspecting the bootstrap confidence intervals. This method has the highest statistical power and does not require a priori assumptions of the distribution of indirect effects.

Many investigations are concerned with the questions to which degree the indirect effect can explain the total effect. Accordingly, in a full mediation, the indirect effect entirely accounts for the effect of X on Y, causing c' to be zero. If it does not fully mediate the effect so that the absolute magnitude of c' becomes smaller, but not zero, it is called a partial mediation. However, it is debated whether this distinction should be abandoned (Hayes, 2009; Rucker et al., 2011). One argument is that mediation can exist within a model in which the total and the direct effect are not significant. It is a persistent misconception among researchers that a significant effect of X on Y is a necessary condition to permit mediation analyses. For example, two indirect effects canceling each other out, or the omission of suppressor variables can decrease the effect of X on Y. Consequently, it does not seem plausible to use labels such as full and partial mediation when the observed total effects and/or direct effects are already zero. Another argument is the impediment of future research. If a study finds that a previously observed effect can be 'fully mediated' by a variable, other researchers would be discouraged to further investigate the original relation, which could lead to relevant variables being missed.

Another issue concerns the assumption of causal relations between variables in a mediation model. According to Hayes (2018, p. 81), it is permissible to perform mediation analyses without proof of causation, e.g., when using entirely correlational data or designs with only one measurement point, as long as causation seems plausible from a theoretical perspective and the

results are interpreted with caution.

4. The Current Dissertation

A comprehensive study of knowledge acquisition on the learner level requires the inclusion of prerequisites, processes, and outcomes of knowledge acquisition. Singly studies can hardly examine all three elements and their interactions at the same time, which is why the format of a dissertation is suited for a comprehensive approach. Models and theories from both cognitive knowledge acquisition research and motivation research postulate that prior learning situations influence future ones. Research in the two areas of prior knowledge and motivation is extensive and looks back on a long tradition that has helped instruction to drastically improve over time. However, there is too little interdisciplinary research that examines the interplay of prior knowledge and motivation in knowledge acquisition. At the hearth of Study 1 and Study 2 of this dissertation lies the assumption that motivational variables are mediators for the prior knowledge-later knowledge and the prior knowledge-learning association. To assess the results of knowledge acquisition, the impacts of the promotion of health literacy are analyzed in this work. This dissertation includes both research syntheses and a primary study. The advantage of the research syntheses is that generalized conclusions can be made, whereas the primary study provides the opportunity for specific research questions that could otherwise not be pursued.

Study 1 examines meta-analytically to what degree knowledge scores remain stable over time within groups of learners and whether different motivational variables mediate the relation between prior knowledge and later knowledge. It was hypothesized that prior knowledge can be a source of motivation and therefore showed positive effects. Moreover, motivation was expected to be a mediator variable that can explain why interindividual differences in knowledge scores remain rather stable. By integrating correlational effects from previous studies, Study 1 is

the first one to identify process variables of this interindividual stability using mediation analyses.

Study 2 is an empirical study that allowed for the investigation of the relation between prior knowledge, motivation, and learning in greater depth. In the meta-analysis (Study 1) we were limited by the fact that we could only include measures and designs used in previous empirical studies. In Study 2, we could target our research questions more precisely. In particular, Study 2 is a longitudinal study, in which we investigated to what extent individual differences in prior knowledge predicted individual differences in knowledge gains over time. This allowed us to test whether this relation is mediated by various motivational constructs.

Going beyond the first two studies, Study 3 investigated consequences rather than the antecedents of successful knowledge acquisition. Specifically, we investigated the effects of knowledge acquisition in patient education on health, for example, blood sugar levels, pain, or hospital readmissions. Health is an outcome of high personal and societal importance. Most interventions to improve health, such as operations and medication, are costly and have undesired side effects. By comparison, most patient education interventions are less costly, less risky, and free of side effects. The fact that already several meta-analyses had investigated the effects of patient education on health allowed us to synthesize this evidence in a second-order meta-analysis for broad ranges of interventions, health issues, and health outcomes.

5. Study 1: How Strongly Do Motivational Constructs Mediate the Influence of Prior Knowledge on Posttest Knowledge? A Meta-Analytic Investigation of Moderated Mediation Effects

5.1 Abstract

A recent meta-analysis averaging over 8000 effect sizes indicating the effect of prior knowledge on learning found that the stability of individual differences in knowledge from before to after learning was high (r_P^+ = .534), even though the predictive power of prior knowledge for knowledge gains was low (r_{NG}^+ = -.059). This raises the question of why the stability of individual differences in knowledge is high over time, a finding that remained even after controlling for intelligence. One possible explanation is that prior knowledge might improve motivation and related constructs that then lead to increased new knowledge. We conducted a meta-analysis to test this hypothesis. We tested how strongly motivational constructs (intrinsic motivation, extrinsic motivation, interest, self-concept, self-efficacy) mediate the effect of prior knowledge on knowledge after learning and what variables (age, content domain) moderate the strength of this mediation effect. The literature search provided 55 studies reporting 714 effect sizes. Significant mediation paths were found for all motivational constructs and had effect sizes ranging from r_{MED} = .199 (95% CI [.027, .373]) for interest to r_{MED} = .046 (95% CI [.037, .056]) for extrinsic motivation. Moderation analyses revealed that heterogeneity in effect sizes could be explained by specificity level of motivation as well as knowledge type and interest type. The results of the meta-analysis explain interindividual stability in knowledge and stress the role of motivation as an underlying mechanism. They imply

that low learner motivation can sometimes be improved by increasing prior knowledge and that low knowledge can sometimes be improved by increasing motivation.

5.2. Introduction

Prior domain-specific knowledge is assumed to be the strongest predictor of achievement and performance (Greve et al., 2019; Thompson & Zamboanga, 2003), yet identifying the processes responsible for this association remains an objective of educational psychology research. In a systematic review of meta-analyses, Schneider and Preckel (2017) identified over 100 variables related to achievement in higher education, among which prior achievement was one of the strongest predictors. It follows that high achieving students maintain their level whereas low achieving students do not seem to catch up to their more successful peers. What helps the former students and why can the latter not seem to overcome their difficulties? These questions address the interindividual stability of knowledge within groups of learners over time and the underlying mechanisms. While some cognitive explanations have been uncovered for this phenomenon, such as the increased processing of information through chunking (Gobet, 2005) and optimized attention allocation (Gegenfurtner et al., 2011), there has been scattered research on non-cognitive explanations so far. Motivational research, which plays an important role in educational psychology, could contribute to answering this question with its large body of research (Murphy & Alexander, 2000). However, it provides only isolated explanations for the relation between prior knowledge and learning achievement, which remain to be synthesized.

Uncovering mechanisms of prior knowledge on learning outcomes is pivotal: The promotion of knowledge is the essential target of education and leads to several desirable outcomes associated with a fulfilling life such as occupational success (Judge et al., 1995), well-being (Bücker et al., 2018), and health outcomes (Hahn & Truman, 2015; Simonsmeier et al.,

2021). In instructional contexts, referring to students' prior knowledge is an effective method (Amadieu et al., 2015), but it could be used more purposefully if its mechanisms were better understood.

5.2.1. Knowledge

Researchers have tried to conceptualize knowledge and the utilization of knowledge in different ways (Anderson & Krathwohl, 2001; Bloom, 1956; de Jong & Ferguson-Hessler, 1996). Perhaps the best-known attempt to describe knowledge comes from de Jong and Ferguson-Hessler (1996) with their distinction between types and qualities of knowledge. The types of knowledge refer to four types of knowledge that can be used in problem-solving, namely situational, conceptual, procedural, and strategic knowledge. Situational knowledge refers to knowledge about the relevant features of a situation, which can be based on conceptual or procedural knowledge. Conceptual knowledge refers to knowledge about facts, concepts, and principles that apply in a particular domain and can provide information for solving a problem. The particular actions or manipulations required for the solution characterize procedural knowledge. Knowledge about the organization of the phases of the problem-solving process, i.e., a general plan of action, is referred to as strategic knowledge.

Besides the types of knowledge, de Jong and Ferguson-Hessler (1996) suggest five different qualities to further specify knowledge in use. Some of them specify the knowledge types directly, others define the interrelationships between related knowledge, and sometimes the boundaries may overlap. First, knowledge level refers to the degree to which a knowledge type is thoroughly organized, elaborated, and well understood in problem-solving. Superficial knowledge is associated with pure memorization and is less amenable to critical judgment and abstraction than deep knowledge. Second, the structure of knowledge describes whether the

knowledge components within a domain are well or poorly connected. Structured knowledge can be achieved through efficient chunking and can be observed in the knowledge of experts (Gobet, 2005). Third, the use of knowledge in problem-solving can also be more or less automated. Whereas novices perform their actions slowly and consciously, experts rely on automatic routines that allow them to interpret situations as a whole. Fourth, the modality of knowledge regards whether knowledge is stored in memory either as a series of abstract sentences or as images containing perceptual details. Depending on the situation, one may be more appropriate than the other. Fifth, the generality of knowledge describes the scope of the content. Domain-specific knowledge applies to specific situations and can hardly be transferred to other situations. Domain-general knowledge includes heuristics or strategies that learners can apply to multiple situations.

In a recent approach to conceptualizing prior knowledge in the reading domain, McCarthy and McNamara (2021) propose the Multidimensional Knowledge in Text Comprehension framework, which can easily be adapted for prior knowledge research in general. Their framework comprises four dimensions, namely amount, accuracy, specificity, and coherence, with each dimension affecting how information during learning is processed. The amount of knowledge refers to the quantity of information that is relevant to the subject matter. Learners with more prior knowledge are better at lower-level word processing (Priebe et al., 2012), making inferences (Kintsch, 1998), activating relevant information and ignoring irrelevant information (McNamara & McDaniel, 2004), and tend to use more sophisticated strategies than subjects with less prior knowledge (Cromley & Azevedo, 2007). The dimension accuracy describes whether the knowledge is more or less accurate. While it is easy to identify some pieces of knowledge as misconceptions or as truly correct, some other pieces of knowledge

are harder to categorize, for example, when the correctness of an information depends on its context. Incorrect prior knowledge poses a threat to correct knowledge acquisition because it is resistant to change (Smith III. et al., 1993), leads to overconfidence of subjects in their responses in knowledge tests (Li et al., 2004), and remains as a misconception when previously or later acquired correct knowledge cannot be used for knowledge integration (Clark & Linn, 2013). The specificity dimension refers to the subject matter of knowledge and is related to the generality knowledge quality by de Jong and Ferguson-Hessler (1996). The authors suggest a taxonomy in which the domain-specificity of the content is organized into seven levels. Knowledge in the form of general knowledge refers to academic or personal domains and is the most comprehensive. Instruments such as the Woodcock-Johnson Academic Knowledge test (Wendling et al., 2009) capture knowledge of academic domains such as science, social studies, and humanities. These domains (e.g., science) can be subdivided into sub-domains (e.g., life science and physical science), which in turn include subjects (e.g., physics), sub-subjects (e.g., mechanics), and, at the most specific level, certain topics (e.g., momentum). The fourth dimension coherence describes the relations between the knowledge elements, which may be more interconnected and embedded in an overarching structure or rather fragmented and isolated.

For the present study, we define knowledge as information stored in memory, which includes declarative knowledge about facts and concepts as well as about procedures. We consider knowledge at the domain level of specificity and below (McCarthy & McNamara, 2021), and include both correct and incorrect knowledge as our object of investigation. We define prior knowledge as the knowledge that is present in a person's long-term memory at the onset of learning (Dochy & Alexander, 1995). We particularly focus on the amount of

knowledge and prior knowledge instead of the quality. We do not take the coherence of knowledge elements into account for this meta-analysis, as it would be necessary to analyze the wording of the knowledge instrumentation and the instructional material used in the primary studies, which are often not accessible in the articles.

5.2.2. The Impact of Prior Knowledge on Learning Outcomes

(Simonsmeier et al., 2021) empirically tested the predictive power of prior knowledge on learning achievement in a meta-analysis of 493 studies. In detail, they conducted a literature search aiming at capturing study designs with assessments of knowledge at two measurement points and retrieved the correlations between the scores of the knowledge pretest and the knowledge posttest to compute a pooled effect size. They found a high correlation between pretest and posttest knowledge indicating that prior knowledge is a powerful predictor for subsequent knowledge and learning achievement. This could also be demonstrated in randomized controlled studies suggesting that the underlying relation is causal. Controlling for the influence of intelligence did not lead to significant decreases in the effect size. However, the large heterogeneity of effect sizes suggested that there are other influences.

It is important to stress that the relation between pretest and posttest knowledge does not reflect the relation between prior knowledge and learning of new material. Rather, it tells how the interindividual differences among groups of learners remain stable over time. Consider a sample of 100 participants taking a knowledge test on two occasions. Some of them do very well on the knowledge test, whilst others make some mistakes, and some of them can barely answer a question correctly. This results in two rank orders of test scores, one for the pretest and one for the posttest. Correlating the participants' pretest scores with their posttest scores tells how the rank orders of the test scores remain stable. In a case in which the correlation coefficient is 1, the

rank order in the posttest scores is the same as in the pretest. If the correlation coefficient were -1, the ranking in the posttest would be exactly the opposite of the ranking in the pretest, with the person with the lowest test score in the prior knowledge test having the highest test score in the subsequent test and the best performing person the prior knowledge test performing worst in the posttest. Note that the correlation coefficient also does not indicate whether the performance of the participants improved or worsened over time. Thus, positive correlations between prior knowledge and posttest knowledge reflect the stability of individual differences in learners' knowledge but how prior knowledge affects learning or how much was learned.

(Simonsmeier et al., 2021) suggest that prior knowledge affects learning processes, which in turn influence learning outcomes. Therefore, these learning processes act as mediators between prior knowledge and learning outcomes. We hypothesize that motivational constructs may act as mediators because they can both be predicted by prior knowledge and be predictors of learning outcomes, as we will describe in the following section.

5.2.3. Key Constructs of Motivation

(Vu et al., 2021) provide a framework for how achievement can affect motivation and vice versa. The authors suggest that motivation can affect achievement via two routes: The first route is through the quantity of academic behaviors such as increased effort and persistence. The second route is through increased quality academic behaviors such as the use of effective learning strategies and metacognitive strategies. Similarly, achievement may affect motivation via two routes. First, past achievement leads to perceptions of self-efficacy and control thus affecting both future expectations and the intrinsic value assigned to learning activities. Second, if a high value is attached to academic behaviors, it can create an experience of flow that is rewarding in itself. Note that (Vu et al., 2021) do not focus on prior knowledge but on prior

achievement, which not only includes objective knowledge tests but also marks and subjective assessments of teachers or learners which are more likely to inflate effects found in association with motivational constructs than objective assessments (Howard et al., 2021).

As motivation is an umbrella term for different motivational constructs with unique research traditions, we focus on a selection of those with the largest bodies of research, namely interest, self-concept, self-efficacy, intrinsic motivation, and extrinsic motivation. In the following section, we provide short descriptions of the constructs and outline how they both can affect and be affected by knowledge.

5.2.3.1. Interest. Interest has five characteristics: It is content or object-specific, involves a person-environment-interaction, has both cognitive and affective components, may be temporarily unconscious, and has a physiological and neurological basis (Renninger & Hidi, 2011). Models of interest development distinguish between situational and individual interest (Hidi & Renninger, 2006; Krapp, 2007). Situational interest is triggered by environmental characteristics that catch an individual's attention. Over time, if situational interest is maintained, it can transform into individual interest, a motivational disposition that leads to self-initiated engagement with the task. Although being two separate constructs, knowledge and interest are highly related (Tobias, 1994). In the model of domain learning, Alexander et al. (1995) outline the interplay between forms of interest and knowledge in the development of expertise. During the early stages of expertise development, when individual interest and knowledge in the domain are rather low, situational interest is mainly responsible for the engagement with a certain task. As learners acquire more knowledge in the domain, their individual interest grows and the

influence of situational interest on engagement weakens.

Evidence suggests that the relation between knowledge and interest is bidirectional (Rotgans & Schmidt, 2017). Knowledge as a cause of interest, however, was rarely investigated. For example, in a longitudinal study, Zhang et al. (2016) used growth curve analysis to find that prior knowledge affects the development of interest in learning declarative and procedural knowledge about physical activity. Interest as a predictor of learning outcomes has been studied more frequently. In a meta-analysis, Schiefele et al. (1992) found that interest predicts achievement well in multiple subject areas.

5.2.3.2. Self-concept. In general, self-concept refers to an individuals' perceptions of him or herself, as shaped by experiences with the environment (Shavelson et al., 1976). In academic contexts, self-concept refers to a "mental representation of one's own academic abilities in general and in different academic domains" (Arens et al., 2021, p. 2). In addition to the cognitive self-evaluation, it has an affective component resulting from the comparison of one's attributes and competence to standard (Arens & Hasselhorn, 2015; Bong & Clark, 1999). Typical measures of academic self-concept refer to how well students do in a certain subject or how quickly they learn the material (e.g., Marsh et al., 2014). Although different structures of academic self-concept exist, most researchers agree that it is a multidimensional and hierarchical construct (Arens et al., 2021).

Due to the nature of academic self-concept being a self-evaluation of achievement, it is closely related to knowledge. Both marks and objective achievement tests affect later measures of self-concept with marks having a slightly greater impact (Helmke & Van Aken, 1995). In some cases, academic self-concept is as powerful as intelligence in predicting test performance (Lauermann et al., 2020). In turn, self-concept predicts later academic achievement, especially

when the assessments of self-concept are formulated more specific (i.e., stronger effects for task-specific self-concept than for academic self-concept and for general self-concept; Choi, 2005) and when they refer to the same subject area (Valentine et al., 2004). A meta-analysis of the longitudinal relation between academic self-concept and achievement found evidence for small reciprocal effects (Wu et al., 2021).

5.2.3.3. Self-efficacy. Self-efficacy refers to an individual's belief in his or her capability to be able to perform certain actions (Bandura, 1977). Similar to self-concept, it can be referenced to contexts with varying degrees of specificity (general, academic, or task-specific; Choi, 2005). Academic self-efficacy refers to judgments of the capability to accomplish certain academic tasks at a certain level (Schunk, 1991). Academic self-efficacy and academic self-concept share many similarities, which is why some researchers investigated whether they represent two different constructs (Bong & Skaalvik, 2003). Both constructs are based on a self-assessment of one's competence, they are both domain-specific and multidimensional, and they have similar predictive power for different outcomes. However, self-efficacy does not include an affective component and is concerned with the achievement of specified future goals thus being less stable over time than self-concept.

From a theoretical perspective, it seems plausible that prior knowledge and achievement in a domain pose a source for academic self-efficacy. However, few studies examine the impact of prior knowledge on self-efficacy (Honicke & Broadbent, 2016). It seems safe to assume, however, that past performance in academic contexts affects self-efficacy (Brown et al., 2008). The effects of self-efficacy on learning and achievement are better documented. Self-efficacy for learning and achievement predicts grade point average and course grades (Crede & Philips, 2011) and shows the second-largest impact on achievement in higher education in a review of

meta-analyses (Schneider & Preckel, 2017). Possible explanations for this relation are increased use of sophisticated monitoring strategies, effort, and adequate goal setting with high levels of self-efficacy (Cheng & Chiou, 2010; Kassab et al., 2015; Moos & Azevedo, 2009). The mediation hypothesis for the prior knowledge-knowledge relationship at least holds for high school GPA and college GPA (Brown et al., 2008).

5.2.3.4. Intrinsic Motivation. Intrinsic motivation is defined as the desire to perform a certain action because the action itself is perceived as interesting, challenging, or otherwise enjoyable (Ryan & Deci, 2000b). According to self-determination theory, intrinsic motivation is based on three basic needs of experiencing competence, autonomy, and relatedness that determine motivation and behavior (Deci & Ryan, 2000). Over time, actions that were originally initiated because of an external reward or punishment (e.g., receiving an ice cream for completing homework or being scolded for not doing so) may become internalized so that the performance of the action is consistent with mastery goals and personal values that are identified as part of one's self (e.g., doing homework because it is enjoyable; (Ryan et al., 2021).

It seems plausible to assume that prior knowledge can be a source of experiencing competence and therefore can affect intrinsic motivation. However, we know of only one record that investigated this relation (Achmetli et al., 2019). In this study, both conceptual and procedural knowledge led to experiences of competence in a mathematical multiple-solution task. Experience of competence then predicted conceptual and procedural knowledge at posttest. The effects of intrinsic motivation on academic performance have been investigated more thoroughly. A meta-analysis by Cerasoli et al. (2014) found a moderate correlation between intrinsic motivation on performance. The proportion of variance explained was higher when

quality of performance (e.g., creativity) rather than quantity (e.g., number of points in a test) was considered.

5.2.3.5. Extrinsic Motivation. Extrinsic motivation is characterized by the desire to perform a certain action to receive an expected reward or to prevent a negative consequence, making it a rather instrumental behavior (Ryan et al., 2021). Several forms of extrinsic motivation exist with different degrees of internalization ranging from complete external regulation to the involvement of personal goals. They can co-exist within learners (Ratelle et al., 2007) and lead to different academic outcomes. Extrinsic motivation is related to performance goals in goal-setting frameworks and is associated with surface processing of information (Elliot et al., 1999).

Prior knowledge may affect the forming of extrinsic motivation via increased expectations of success elicited by previous experiences of success and achievement (Eccles & Wigfield, 2020). This relation, however, was rarely addressed. Liu and Hou (2017) found that prior math achievement predicted test-taking motivation (the motivation to perform well on a given test) in mathematics. Again, the impact on learning outcomes was investigated more often. The meta-analysis by Cerasoli et al. (2014) found that extrinsically motivated behavior was related to performance with higher proportions of variance explained for quantitative outcomes than for qualitative outcomes.

5.2.4. Influences of Potential Moderators

Due to the broad field of motivational research, we expect high heterogeneity among the effect sizes reflecting associations between prior knowledge, motivation, and learning outcomes. Heterogeneity can emerge from features of the primary studies such as different instrumentations, knowledge domains, or features of learning phases. Moderator analyses can

identify influences of third variables and explain to which degree the results are affected by moderator variables. They can be based on theoretical assumptions as well as exploratory examinations.

5.2.5. Aims of the Current Study

Although motivational research has contributed a lot to the prediction of learning outcomes, it has not been identified as a process variable mediating the relation between prior knowledge and learning outcomes using meta-analytic methods. Research syntheses such as meta-analyses can provide insights into research questions although they have never been explicitly addressed in primary studies. In particular, investigating the effects of prior knowledge on later assessments of motivation was rarely the main purpose of studies. However, they are frequently reported in tables and can be used to determine an overall effect size across studies. Combining the effects of prior knowledge on motivation and the effects of motivation on learning outcomes allows the investigation of mediation effects.

In addition, if these mediation effects can be demonstrated, we test for moderating influences of third variables. As described in the motivation section, we expect higher effect sizes on the task-specific level of motivation than for motivation referred to the general and academic level (Choi, 2005). In addition, we conduct exploratory analyses on moderating influences of knowledge type (declarative vs. procedural) and interest type (situational vs. individual).

Hypothesis 1: Prior knowledge is a predictor of future interest, self-concept, self-efficacy, intrinsic motivation, and extrinsic motivation.

Hypothesis 2: The motivational constructs considered in hypothesis 1 act as mediator variables for the relation between prior knowledge and learning outcomes.

Hypothesis 3: The indirect effects are moderated by the specificity levels of motivation. Task-specific motivation shows higher effect sizes than motivation on the general or academic level.

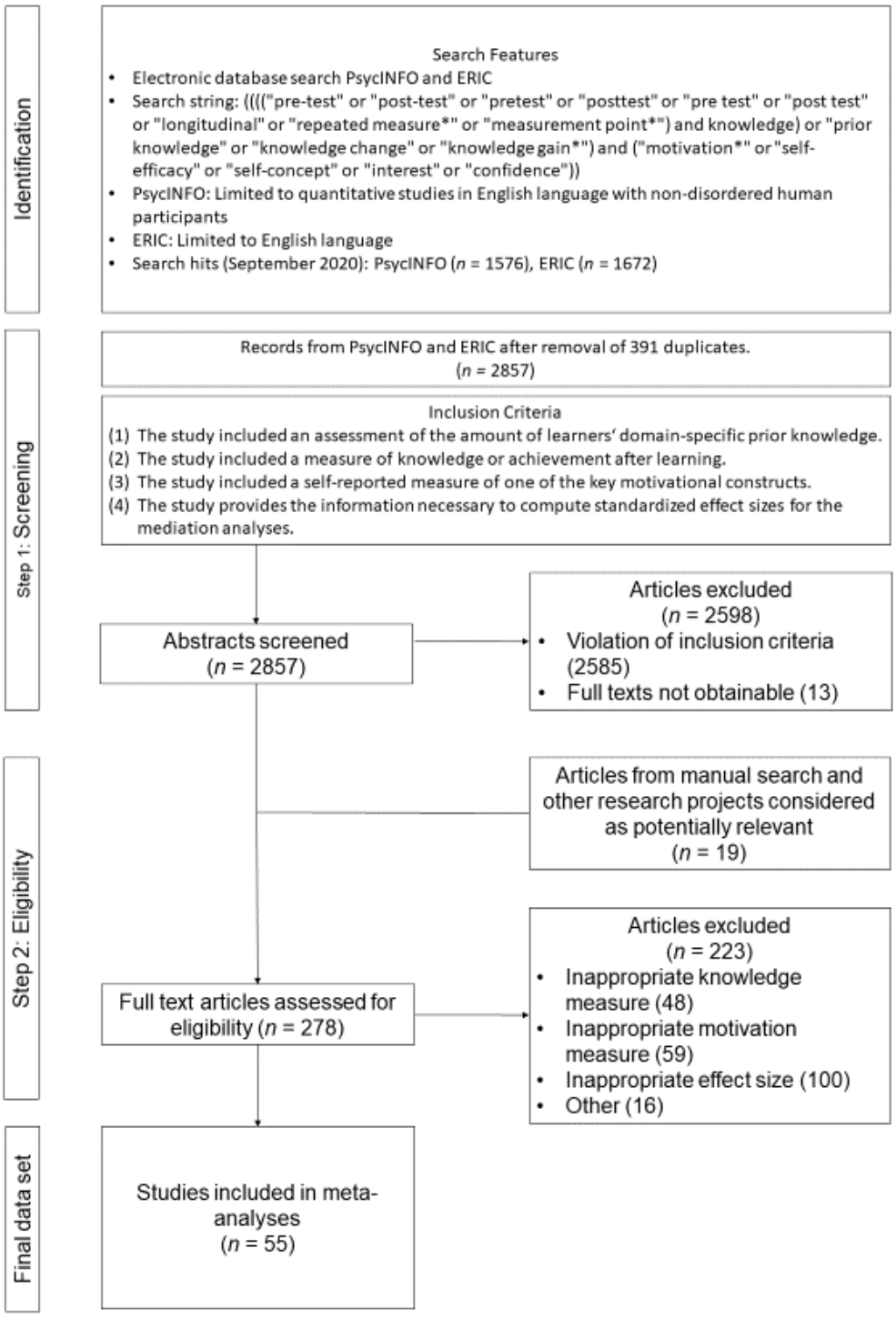
5.3. Method

5.3.1. Literature Search

The literature search was conducted in the databases PsycINFO and ERIC in September 2020. For the search, the default settings of the databases were used which, among other components, include the title, the abstract, and keywords of potentially relevant articles. The search string was: ((((("pre-test" or "post-test" or "pretest" or "posttest" or "pre test" or "post test" or "longitudinal" or "repeated measure*" or "measurement point*") and knowledge) or "prior knowledge" or "knowledge change" or "knowledge gain*") and ("motivation*" or "self-efficacy" or "self-concept" or "interest" or "confidence")). The search string was intended to not only capture studies that explicitly focused on the role of prior knowledge and motivation in learning as such. Rather, the search string should also capture designs that assessed knowledge at two measurement time points and motivation at at least one measurement time point. (e.g., pre-post educational interventions aiming at the acquisition of knowledge and skills including motivation as a predictor). Search results were limited to studies in the English language in PsycInfo and ERIC. Additionally, in PsycInfo the results were limited to quantitative studies with human non-disordered participants. Unpublished documents were included to reduce the probability of publication bias (Dickersin, 1990). After the removal of duplicates, the search results comprised 2857 research articles. Additionally, 19 articles from manual searches and other research projects were considered as potentially relevant. A summary of the literature search process and the inclusion criteria is depicted in Figure 3.

Figure 3

Flow Chart for the Literature Search and Inclusion Process



5.3.2. Inclusion Criteria

Based on the meta-analysis by (Simonsmeier et al., 2021), studies that met the following four criteria were included in the meta-analysis: (1) The study included an assessment of the amount of learners' domain-specific prior knowledge. Only objective quantitative measures of domain-specific prior knowledge were included. Self-assessments, composite scores from more than one domain, and measures of crystallized intelligence, abilities, achievement, or meta-cognitive knowledge were excluded. (2) The study included a measure of knowledge or achievement after learning. We excluded learner self-ratings of their learning outcomes and knowledge of a different domain than the prior knowledge domain. (3) The study included a self-reported measure of one of the key motivational constructs, namely interest, self-concept, self-efficacy, and intrinsic or extrinsic motivation. (4) The study provides the information necessary to compute standardized effect sizes for the mediation analyses. This requires information on all three relations between prior knowledge, posttest knowledge, and a motivational construct.

The 2857 articles from the literature search were screened to determine if they met the inclusion criteria. The first author and the third author first screened 100 titles and abstracts for inclusion. The intercoder agreement for this subset of articles was 81%. Disagreements were resolved by discussion. In the next step, the first author screened the remaining titles for inclusion. In sum, 278 articles were obtained for further examination. In the next step, the first author and the second author checked whether the first 100 articles were suited for the meta-analysis following the inclusion criteria. The agreement for this step was 91%. After that, the first author screened the remaining articles for inclusion. In sum, 223 articles were excluded resulting in 55 studies included in the meta-analysis.

5.3.3. Data Coding

The coding of study information was performed using predefined coding rules, that were used for coder training and the final extraction of study information with the aid of a standardized coding instrument. Table 1 lists the study and effect size characteristics that were considered for data extraction. The first author and the second author first independently coded a random selection of 50 effect size triplets consisting of the correlations between prior knowledge, the motivational measure, and posttest knowledge, as well as their corresponding characteristics from the full texts. The inter-rater agreement for the moderator variables ranged from 64% to 100%. The mean agreement across all moderators was 89%. Disagreements were resolved through discussion. After that, the first author coded the remaining effect size triplets. If a study included multiple measurement points with unique intermediary learning phases, all possible relations between the constructs were coded (e.g., T1 knowledge with T2 knowledge and T2 motivation as well as T1 knowledge with T2 motivation and T3 knowledge). However, correlations with a measure of motivation outside of the knowledge pretest and posttest time window were not coded (e.g., T1 motivation with T2 knowledge and T3 knowledge).

5.3.4. Requests for Missing Information in the Articles

Some of the included full texts formally met all inclusion criteria except for reporting the effect sizes necessary for the computations of the meta-analysis. For this reason, we sent 87 emails to the authors of the affected articles asking them to provide the missing correlations or the data so the effect sizes could be calculated. With this procedure, a total of 280 additional effect sizes were obtained from 13 different studies.

5.3.5. Statistical Analyses

5.3.5.1. Meta-Analytic Integration. To determine the pooled effect sizes for the unique paths in the mediation model, we followed the product-of-coefficients strategy by Baron and Kenny (1986). The path pointing from prior knowledge to motivation is called b1 and the path pointing from motivation to learning outcomes is called b2. The total effect in the mediation model is represented by the correlation between prior knowledge and posttest knowledge. The indirect effect in the mediation model reflecting the mediation was calculated by multiplying b1 with b2 for each study. Substracting the indirect effect from the total effect yields the remaining direct effect of prior knowledge on posttest knowledge controlled for motivation. To investigate Hypothesis 1, only the b1 paths were considered in which motivation was assessed between T1 and T2 or at T2. In all cases in which low scores represent high motivation, the effect sizes were inverted to adequately reflect the actual relations.

We applied a random-effects model using the *metafor* package (Viechtbauer, 2010) in R (R Core Team, 2014). Most of the studies reported more than one relevant effect size due to multiple measurement points or samples that provide valuable information. These effect sizes are statistically dependent because they may be based on the same individuals or investigated by the same research group in their laboratories. For this reason, we employed robust variance estimation (Hedges et al., 2010) to ensure that dependent effect sizes did not affect the validity of the meta-analytic results. In addition, we corrected for imperfect measurements of the knowledge and motivation measures using the formula from Schmidt and Hunter (2015, p. 144) and the reliability coefficients stated in the articles. If the reliability of the measures was not stated in the articles, no correction was made.

5.3.5.2. Moderator Analyses. We calculated the mean effect size separately for each

level within a moderator category and determined their confidence intervals and indicators. For moderator levels with less than four degrees of freedom, we reported only the mean as the estimates but not the confidence intervals because the test of significance is impaired by the small number of observations (Tanner-Smith et al., 2016). Each moderator level was dummy-coded so it could be entered as a predictor in the mixed-effect models. To identify significant differences between moderator levels, one moderator level served as a reference category in each moderator analysis and was compared with the other moderator levels. In addition, we computed the amount of explained variance R^2 for each regression model.

5.3.5.3. Publication Bias. Results from meta-analyses can be compromised by publication bias as large significant effect sizes tend to be published more than insignificant or small effect sizes. Therefore, we visually and statistically checked for publication bias using funnel plots and Egger regression (Egger et al., 1997) with the metafor package (Viechtbauer, 2010).

5.4. Results

5.4.1. Characteristics of Included Studies and Effect Sizes

The 55 included studies provided 714 effect size triplets. All of the effect sizes were bivariate correlations. The correlations from prior knowledge and learning outcomes ranged from r = -.09 to r = .92, whereas the correlations from prior knowledge and motivation ranged from r = -.22 to r = .90, and the correlations from motivation and learning outcomes ranged from r = -.16 to r = .94. The years of publication for the database ranged from 1994 to 2019 with a median of 2014. Seven of the 55 studies were gray literature (13%). The dataset comprised 56382 participants from 80 different samples and 14 different countries. The mean age of the samples

Table 1

Model Results and Heterogeneity Indices for Each Path Considered in the Mediation Models Separated by Mediators.

				Model Results							Heterogeneity Indices							
Mediator	Mediation path	j	k	r	SE	t	p	CI lb	CI ub	sig	τ^2	SE	τ	I^2	H^2	Q	df	p
Interest	Indirect	310	31	0,199	0,09	2,33	0,03	0,024	0,373	*	0,024	0,002	0,156	89,01	9,1	2.828,52	309	0
	Direct	310	31	0,424	0,05	8,87	0	0,326	0,521	***	0,029	0,003	0,169	95,75	23,55	14.103,66	309	0
	Total	310	31	0,617	0,07	8,48	0	0,468	0,765	***	0,045	0,004	0,211	99,73	370,9	35.991,46	309	0
	B1	310	31	0,351	0,1	3,45	0	0,143	0,559	**	0,045	0,004	0,213	95,07	20,26	6.432,92	309	0
	B2	310	31	0,421	0,12	3,4	0	0,168	0,674	**	0,064	0,005	0,253	97,12	34,78	10.480,35	309	0
Self-Concept	Indirect	97	8	0,142	0,04	3,68	0,01	0,051	0,234	**	0,018	0,003	0,133	97,55	40,85	2.580,23	96	0
	Direct	97	8	0,585	0,04	13,99	0	0,486	0,684	***	0,034	0,005	0,185	99,65	287,33	25.554,83	96	0
	Total	97	8	0,727	0,06	12,85	0	0,593	0,861	***	0,035	0,005	0,188	99,97	3.846,86	61.976,95	96	0
	B1	97	8	0,322	0,05	6,77	0	0,209	0,434	***	0,024	0,004	0,156	98,57	69,93	5.849,30	96	0
	B2	97	8	0,375	0,05	8,23	0	0,267	0,482	***	0,028	0,004	0,167	99,5	200,42	82.701,68	96	0
Self-efficacy	Indirect	208	21	0,077	0,01	11,56	0	0,063	0,091	***	0,01	0,001	0,1	79,28	4,83	875,68	207	0
	Direct	208	21	0,213	0,07	2,91	0,01	0,06	0,365	**	0,044	0,005	0,21	99,68	311,89	45.532,96	207	0
	Total	208	21	0,287	0,07	4,08	0	0,14	0,433	**	0,043	0,005	0,208	99,86	696,75	35.094,69	207	0
	B1	208	21	0,213	0,02	12,57	0	0,178	0,248	***	0,053	0,006	0,231	99,93	1.461,45	53.073,27	207	0
	B2	208	21	0,285	0,03	9,23	0	0,22	0,349	***	0,101	0,01	0,317	99,99	17.439,33	50.279,97	207	0
Intrinsic Motivation	Indirect	74	15	0,05	0,01	4,17	0	0,024	0,076	**	0,002	0,001	0,046	68,03	3,13	433,43	73	0
	Direct	74	15	0,539	0,1	5,3	0	0,321	0,757	***	0,075	0,013	0,273	99,92	1.176,52	14.795,68	73	0
	Total	74	15	0,582	0,1	5,67	0	0,362	0,802	***	0,079	0,014	0,282	99,96	2.516,17	12.396,77	73	0
	B1	74	15	0,18	0,03	6,23	0	0,118	0,242	***	0,023	0,005	0,152	96,59	29,3	1.638,64	73	0
	B2	74	15	0,218	0,02	10,18	0	0,172	0,264	***	0,012	0,003	0,109	93,32	14,96	1.568,49	73	0
Extrinsic Motivation	Indirect	25	6	0,046	0	12,46	0	0,037	0,056	***	0	0	0	0	1	6,52	24	1
	Direct	25	6	0,649	0,1	6,76	0	0,402	0,896	**	0,03	0,009	0,174	99,62	260,64	680,21	24	0
	Total	25	6	0,679	0,11	6,17	0	0,396	0,962	**	0,039	0,011	0,197	99,8	512,5	904,73	24	0
	B1	25	6	0,165	0,05	3,04	0,03	0,025	0,305	**	0,012	0,004	0,111	95,7	23,27	222,5	24	0
	B2	25	6	0,158	0,05	2,99	0,03	0,022	0,294	**	0,012	0,004	0,112	95,36	21,57	190,55	24	0

ranged from 4.35 years to 44.2 years with a median of 14.7 indicating that most of the participants were pupils. The sample sizes ranged from 22 to 16,110 participants, suggesting that both small local and large national studies were included in the dataset. The time between the measurement of prior knowledge and learning outcomes ranged from seven to 2,920 days with a median of 180 days.

Subdivided by motivational constructs, there were 31 articles for interest, eight for self-concept, 21 for self-efficacy, 15 for intrinsic motivation, and six for extrinsic motivation. The number of effect size triplets was 310 for interest, 97 for self-concept, 208 for self-efficacy, 74 for intrinsic motivation, and 25 for extrinsic motivation.

5.4.2. Main Meta-Analytic Results

5.4.2.1. Hypothesis 1: Effects of Prior Knowledge on Motivation. Prior knowledge significantly predicted motivation at a later point in time across all the motivational constructs considered. Prior knowledge most strongly predicted interest with $r = .409$ (95% CI [.382, .436]) followed by self-concept, $r = .306$ (95% CI [.268, .344]). The correlation between prior knowledge and extrinsic motivation was smaller, $r = .176$ (95% CI [.117, .234]), similar to intrinsic motivation, $r = .168$ (95% CI [.110, .225]) and self-efficacy, $r = .139$ (95% CI [.105, .172]). For all the pooled correlations, the heterogeneity Index I^2 (> 90%) was high (Higgins et al., 2003) indicating that a large proportion of variance in the effect sizes was due to influences of moderator variables (Borenstein et al., 2017).

5.4.2.2. Hypothesis 2: Analyses of Mediation Effects. As shown in Table 1, all of the paths considered in the mediation model were significant including the indirect mediation paths. The estimates of the indirect path coefficients were small but significant. The largest estimate was for interest as a mediator with rMED = .199 (95% CI [.027, .373]), followed by self-concept

with rMED = .142 (95% CI [.051, .234]). The indirect effects of self-efficacy with r = .077 (95% CI [.063, .091]), intrinsic motivation with rMED = .050 (95% CI [.024, .076]), and extrinsic motivation with rMED = .046 (95% CI [.037, .056]) were slightly smaller.

The pooled correlation between prior knowledge and learning outcomes across all studies was r = .53 (95% CI [.514, .555]), which is in accordance with the results from Simonsmeier et al. (2021) concerning the stability of individual differences. Heterogeneity among the effect sizes was high with I^2 = 99.96%. Depending on the subset of effect sizes divided by motivational constructs, the total effect ranged from r = .287 (self-efficacy) to r = .727 (self-concept). All of the direct paths are significant, implying that none of the motivational constructs fully accounted for the association between prior knowledge and learning outcomes.

5.4.3. Moderator Analyses

5.4.3.1. Hypothesis 3: Specificity Level of Motivation. A moderator analysis on the indirect effects averaged over all motivational constructs revealed no significant differences between the academic and the task-level of specificity (p = .23) but revealed significant differences when considered on some mediator levels. There was only one case of general specificity level and in one case the level of specificity could not be determined from the article. When the instrument measuring interest was formulated on the academic level, the estimate was r_{MED} = .025 (95% CI [-.025, .071]), whereas the estimate of indirect effect for task-specific formulations of interest was r_{MED} = .229 (95% CI [.210, .248]). This difference was significant (p < .001). The indirect effect for self-concept was also significantly higher when the instrument referred to (task-) specific contexts (r_{MED} = .281, 95% CI [.083, .219] for specific, r_{MED} = .129, 95% CI [-.112, .081] for academic, p < .001). However, this finding has to be interpreted with caution as less than four different studies were reporting specific self-concept. No significant

difference between the levels of self-efficacy was found despite having sufficient different articles for a moderator analysis (p = .513). For the other motivational constructs, there were not enough articles to compute reliable results.

5.4.3.2. Exploratory Moderator Analyses. Averaged over the indirect effects of all motivational constructs, the estimate for declarative knowledge was significantly higher for declarative knowledge (r_{MED} = .140, 95% CI [.128, .153]) compared to procedural knowledge (r_{MED} = .112, 95% CI [.087, .137], p < .001). Taking the subsets of mediator into account, significant differences also emerged for interest (r_{MED} = .21, 95% CI [.194, .233] for declarative knowledge and r_{MED} = .030, 95% CI [-.040, .100] for procedural knowledge, p < .05), for self-concept (r_{MED} = .180, 95% CI [..147, .213] for procedural knowledge and r_{MED} = .086, 95% CI [.050, .127] for declarative knowledge, p < .001). However, only two different studies reported self-concept in connection with declarative knowledge, so these results regarding cannot fully be trusted. There were no differences between declarative and procedural knowledge in indirect effect sizes for self-efficacy (p = .51). The same finding applies to intrinsic motivation (p = .23) and extrinsic motivation although there were not enough studies to fully confirm these relations.

The comparison of interest types revealed a significant difference between indirect effects of individual interest and situational interest. On average, the indirect effect for individual interest was significantly higher ($\boldsymbol{r_{MED}}$ = .208, 95% CI [.188, .227]) than for situational interest (r_{MED} = .107, 95% CI [.043, .171], p < .01). Twenty-seven different studies reported effect size triplets for individual interest whereas eight different studies reported situational interest, allowing this finding to be considered trustworthy.

5.4.4 Publication bias

The funnel plots are depicted in Appendix A. The examination of the funnel plot and the Egger regression test pointed towards an asymmetry of the overall correlation between prior knowledge and learning outcomes thus implying that large significant effect sizes were more likely to be published than small or not significant effect sizes. For interest, although the Egger test for asymmetry was significant for the b1-path and the b2-path, the visual inspection of the funnel plots does not imply that the results were biased towards larger effect sizes. Both the visual impression and the Egger tests for intrinsic motivation did not indicate publication bias. The effect sizes found for self-concept, self-efficacy, and extrinsic motivation, however, might be affected by publication bias, as supported by significant results of Egger regressions.

5.5 Discussion

5.4.1. Main Findings

The aims of the current meta-analysis were (1) to investigate the predictive power of prior knowledge on selected motivational constructs, (2) to test a mediating influence of motivation for the relation between prior knowledge and learning outcomes, and (3) to identify moderating influences on the mediation. As a first important finding, prior knowledge significantly predicts all of the motivational constructs considered, namely interest, self-concept, self-efficacy, intrinsic motivation, and extrinsic motivation. All relations were positive indicating that prior knowledge poses a resource for learners' motivation, which is in line with the framework proposed by Vu et al. (2021). The average effect sizes, however, varied depending on the motivational construct analyzed. Whereas the highest relations were found for interest and self-concept, the predictive quality of prior knowledge for later intrinsic and extrinsic motivation as well as self-efficacy was lower. To our knowledge, the current meta-analysis is the first one to address the impact of

objective prior knowledge as assessed with knowledge tests on later motivation. Previous studies focused on prior achievement, which is related, but not similar to prior knowledge because academic achievement also includes course grades and subjective assessments of teachers or learners' self-evaluations.

A second important finding of the meta-analysis was that motivation partly mediated the relation between prior knowledge and learning outcomes. Thus, successful students that score high on a previous knowledge test before the actual learning phase, also perform better than their peers, partly because they are more motivated by the knowledge they already possess. The strength of the mediating influence depends on the type of motivation being considered. Interindividual stability in knowledge test scores most strongly could be explained by interest and self-concept. The significant mediations of interest and self-concept are in line with two prior studies in which domain-specific curiosity, a construct closely related to interest, and mathematical self-concept mediated the relation between prior knowledge and achievement as well as learning outcomes (Watts et al., 2015; Witherby & Carpenter, 2021). The high confidence intervals for the indirect effects of interest and self-efficacy imply that the mediating influences could be considerably higher or lower. Nonetheless, self-efficacy, intrinsic motivation, and extrinsic motivation are also able to explain this issue. Due to the significant remaining direct paths controlled for the impact of motivation, motivational variables alone do not account completely for the shared variance between prior knowledge and learning outcomes.

The insights from the moderator analyses show that heterogeneity among the mediation paths is partly due to methodological differences and construct-related features. Taking all motivational constructs into account, there was no moderating influence of specificity level of motivation on the mediation path. However, an examination of the individual motivational

constructs revealed that specificity does produce higher effect sizes for interest and probably for self-concept, too. For self-efficacy, no impact of specificity on the strength of mediation was found. Considering the findings from Choi (2005) that pointed towards increasing effect sizes with increasing level of specificity for self-efficacy, the impact of specificity does not seem to be strong enough to influence the mediating role of self-efficacy. The low number of studies involved in the moderator analysis, however, might affect this outcome as well. The type of knowledge (declarative vs. procedural) also seems to affect the mediating role of motivation, albeit minimally when taking all motivational constructs at once into account. The difference became considerably larger when only interest was considered. In addition, interindividual differences between learners could be better explained by individual interest than situational interest.

5.4.2. Limitations

We caution against making causal statements about the influence of prior knowledge on motivation and learning using the results of our meta-analysis. First, all of the effect sizes considered in our dataset reflected longitudinal relationships between the variables. The mediation paths in our results were significant, which means that there is a significant amount of shared variance between motivation and the two knowledge assessments at two measurement points, and multiplying the correlation coefficients *b1* and *b2* still leads to significant results. However, if the underlying explanation is causal or if motivation simply acts as a third variable explaining variance in both prior knowledge and learning outcomes cannot be answered with our methodology. Note that we also coded effect sizes in which motivation was assessed together with prior knowledge or learning outcomes at the same measurement point. From a theoretical

perspective and with the support of the current results, we conclude that causal effects are plausible, but experimental designs would be needed for definite conclusions.

Second, our results suggest an explanation for why the rank orders of learners' test scores in a sequence of knowledge tests remain stable but do not provide evidence for the learning of new information. In other words, the results from our study explain why successful students in prior knowledge tests are also more successful than their peers in a knowledge test after learning, but they do not explain that students with high prior knowledge learn more than their less knowledgeable peers because they are more motivated to do so. To make statements about learning gains, the analysis of correlations with learning gains would be necessary, but for mediation analyses on a meta-analytical level, there are still too few effect sizes. Note that neither correlations between prior knowledge and learning outcomes nor correlations between prior knowledge and learning gains allow for statements about how much knowledge learners acquire.

5.4.3. Theoretical Implications

Different forms of motivation partly account for the relation between prior knowledge and learning outcomes. Our meta-analysis supports the motivation-achievement cycle as suggested by Vu et al. (2021). Motivational constructs related to both expectancy appraisals (such as self-efficacy) and value appraisals (such as interest) show significant mediating effects. Framed differently, the results suggest a rich-get-richer effect because high-achieving students can rely on their motivation formed by prior successes, whereas low-achieving students have to find other sources of motivation. Moreover, it seems difficult to close gaps between learners with much and little prior knowledge by promoting interest, since situational interest is a mediator of comparatively little importance, whereas sufficient prior knowledge would be necessary for a

strong individual interest. Researchers interested in the magnitude of effects of prior knowledge on motivational constructs should therefore be careful when considering high or low degrees of prior knowledge in the sample.

Eccles and Wigfield (2020) demanded more research on the development of values assigned to tasks and the expectancy of success when engaging in the tasks. It is not well understood yet, from which sources individuals draw their information to form task values and expectancies. Although our results do not provide causal explanations, they represent an important first step to consider objective prior knowledge as one of such possible sources.

5.4.4. Practical Implications

Our results imply that the most successful students in a group of learners continue to be the most successful ones due to increased experiences of interest, self-concept, self-efficacy as well as intrinsic and extrinsic motivation. Influential motivational theories such as the situated expectancy-value theory (Eccles & Wigfield, 2020) and self-determination theory (Ryan & Deci, 2002) suggest that one's experience of competence is an important component in the emergence of motivation. Accordingly, low-performing students may not have acquired sufficient experiences for developing these forms of motivation. In fact, low-achievers show different motivational patterns than high achievers (McCoach & Siegle, 2001). For this reason, interventions supporting students' sense of competence to raise their expectancies may help them catch up in their performance. One method that could be incorporated into such interventions could be a form of feedback that emphasizes what knowledge and skills the learner already possesses. Even if the feedback would be negative, there are ways to prevent lowering the motivation of learners (Fong et al., 2019). In a recent meta-analysis, Wisniewski et al. (2020) found that high-information feedback is more effective than simple forms of reinforcement and

punishment. However, they also found that feedback has lower effects on motivational outcomes than on cognitive outcomes. If the information on learners' current state of knowledge was implemented, this would perhaps lead to increased effects on motivational outcomes of feedback.

5.4.5. Implications for Future Research

With the results of our study, we wish to stimulate future research on the topic of prior knowledge in knowledge acquisition processes and therefore propose three suggestions. First, although there is a plethora of studies investigating knowledge as a dependent variable, there is much less research considering knowledge as an independent variable triggering non-cognitive learning processes. The field of motivational research in educational contexts is immense, but only a small proportion considered assessing prior knowledge, motivation, and learning outcomes yet. For example, the field of academic self-concept stimulates lots of research but only eight studies could be included in our meta-analysis because they provided correlations between prior knowledge, self-concept, and learning outcomes. Despite having sufficient studies that assessed knowledge at two occasions and motivation, only few studies explicitly addressed mediation processes. We consider it fruitful to address the mediation hypothesis with regards to motivational constructs in further studies.

Second, as noted in the limitations, the results of the current study do not provide causal explanations. Although longitudinal study designs provide valuable insights into the role of prior knowledge on knowledge acquisition processes, we encourage researchers to conduct experiments in which prior knowledge is manipulated to investigate causal effects of prior knowledge on knowledge acquisition. These experiments require a pre-learning intervention that is given to the experimental group to form truly randomized high and low prior knowledge groups. Existing designs use naturally occurring differences in prior knowledge to form groups,

which makes these studies quasi-experimental studies that can be influenced by confounding variables.

As the third impulse for future research, we want to address additional mediating processes that were not covered in the present study. There may be other non-cognitive mediators explaining the relation between prior knowledge and learning outcomes. For example, learners with high prior knowledge and sophisticated epistemic beliefs provided arguments of higher quantity, quality, and diversity on socioscientific issues (Baytelman et al., 2020). We also did not analyze models with two or more parallel mediators. As it seems reasonable to assume that the motivational constructs we considered are also intercorrelated, how much of the explained variance is unique to a specific type of motivation. Cheung (2021) discusses methods to conduct analyses with multiple mediators at once on a meta-analytic level. Additionally, it is also possible that motivation is part of a series of mediators. In models of self-regulated learning, motivation only provides the impetus for behavior that ultimately leads to storing information in long-term memory, such as the use of learning strategies (Panadero, 2017). Therefore, the relation between motivation and learning outcomes itself might be mediated by other factors.

5.6. Conclusion

This study is the first meta-analysis to investigate explanations for interindividual stability in knowledge scores and focused on the role of motivation. We considered popular motivational constructs for our analyses, namely interest, self-concept, self-efficacy, intrinsic motivation, and extrinsic motivation. Prior knowledge assessed via objective knowledge tests was found to significantly predict each type of motivation at a later point in time. We replicated the finding from (Simonsmeier et al., 2021) regarding interindividual stability in knowledge scores and found that motivation partially accounts for it. The effects, however, were highly heterogeneous,

which hampers the prediction of future studies. Our moderator analyses revealed that the magnitude of effect sizes depends on methodological aspects and features of knowledge and motivation. The current meta-analysis proposed starting points for future research of great potential. The effects of prior knowledge on other non-cognitive variables are not yet studied carefully enough. Moreover, there may be more process variables explaining relations between prior knowledge and learning outcomes as well as learning gains.

6. Study 2: Do Motivational Variables Mediate the Effect of Prior Knowledge on Learning in Higher Education? A Longitudinal Study

6.1. Abstract

Prior knowledge is assumed to be one of the strongest determinants of knowledge acquisition. However, the mechanisms by which prior knowledge affects learning are still only partly understood. Many studies emphasized the beneficial role of prior knowledge for cognitive learning processes. Comparably less is known about whether prior knowledge improves motivational processes which then lead to higher learning gains. We investigated how university students' prior knowledge predicted their knowledge gains in a lecture over the semester. We tested to what extent motivational variables (interest, self-concept, and self-efficacy) mediated the effect of prior knowledge on learning. Eighty undergraduate psychology students who attended a lecture in educational psychology participated on all three occasions. There was a nonsignificant correlation between learners' knowledge at pretest and at posttest indicating that learners' individual differences in knowledge did not remain stable over time. We found a small negative correlation between prior knowledge and normalized knowledge gains, which points towards a compensatory effect of the instruction. Mediation analyses showed that interest, self-concept, and self-efficacy did not mediate the relation between prior knowledge and knowledge gains. We conclude that lecturers can decrease individual differences between learners by using appropriate instruction and that it is not necessary to target motivational processes to do so. We discuss the results in light of the multiple mediation hypothesis (Simonsmeier et al., 2021) and suggest further approaches for research regarding the underlying mechanisms of prior knowledge in learning.

6.2. Introduction

Academic achievement is a central learning goal of higher education. Academic achievement leads to healthier living and higher wages (Furnée et al., 2008), occupational success (Judge et al., 1995), and well-being in academic contexts (Bücker et al., 2018). According to the *knowledge-is-power* hypothesis (KiP) learners' prior knowledge is one of the strongest determinants of the acquisition of knowledge and achievement (Greve et al., 2019; Hambrick & Engle, 2002). Grades in secondary school are used as a decision criterion for university entrance in many countries because they are a good predictor for study success. A systematic review of meta-analyses investigating associations of variables with achievement in higher education found that high school GPA showed the seventh strongest effect among a set of 105 different predictors of achievement (Schneider & Preckel, 2017). Remarkably, high school GPA predicted academic achievement in higher education even better than general cognitive ability did. Overall, a better understanding of the relation between prior knowledge and learning can help predict future study success, explain past study success, and design effective instruction that maximizes the beneficial effects of prior knowledge on learning.

However, there are ongoing discussions about to what extent the hypothesis is true in different contexts and what causal processes might underlie the effects of prior knowledge on learning. A recent meta-analysis investigated how strongly prior knowledge predicted posttest knowledge and pretest-posttest knowledge gains (Simonsmeier et al., 2021). The authors conducted a comprehensive literature search capturing studies assessing knowledge in pre-post designs with a learning phase in between and calculated the three types of correlation coefficients described earlier. The average correlation between prior knowledge and posttest knowledge was high (r_P = .53), indicating high stability in individual differences among groups of learners. The

correlation between prior knowledge and absolute knowledge gains was statistically significant (r_{AG} = -.26), whereas the correlation between prior knowledge and normalized gains did not differ significantly from zero (r_{NG} = -.06). This difference was likely to be influenced by the ceiling effects caused by the computation of absolute knowledge gains. The values of r_{NG} were almost normally distributed with a mean close to zero indicating the presence of a Matthew effect in some cases, and the presence of compensatory effects in other cases. The distribution of r_{NG} had a wide range and a 95% prediction interval from -.688 to .621. This raises the question of how this extraordinary large variability in the effect sizes r_{NG} over studies can be explained.

A moderator analysis comparing instructions with low cognitive demands (e.g., high teacher guidance) and high cognitive demands (e.g., high elaboration and inferences during learning) revealed that correlations with normalized gains in these two conditions differed significantly from each other, albeit both correlations barely did not differ from zero. Thus, instruction with low cognitive demands has compensatory effects whereas instruction with high cognitive demands is associated with Matthew effects. This finding can be explained by the expertise-reversal effect (Kalyuga et al., 2003), which explains differences in learning as a function of cognitive demands for experts and novices. Accordingly, providing guidance in tasks is helpful for novices who need more working memory capacity during instruction due to missing schemas beneficial for information processing. Contrary, this guidance can pose an additional cognitive load on experts thus hampering the learning process. This effect alone, however, cannot explain the wide range of effect sizes found for normalized learning gains. This raises the question of how, that is, mediated through what mental processes, prior knowledge affects learning.

6.2.1. How Does Prior Knowledge Affect Learning?

Simonsmeier et al. (2021) proposed the multiple mediation hypothesis. The hypothesis states that prior knowledge cannot affect learning as long as it is only stored in long-term memory. It needs to be activated, recalled from long-term memory, and used in learning. When prior knowledge is used in learning, it does not directly cause learning gains. Instead, prior knowledge affects several learning processes that then lead to increased or decreased learning. Simonsmeier et al. (2021) review studies showing that prior knowledge influences learning mediated through several processes, some of which have positive effects and others of which have negative effects. Prior knowledge can affect learning positively mediated through guiding attention, facilitating encoding, allowing for chunking, aiding the construction of new solution strategies, helping to evaluate the credibility of information sources. Prior knowledge can affect learning negatively by leading to wrong conclusions, guiding attention away from relevant aspects of a situation (e.g., in the Einstellung effect), making behavior inflexible through automatization, causing interference, and inducing negative transfer. These processes do not exclude each other, but might partly run in parallel or interact. The overall effect of prior knowledge on learning results from the combined effects of these processes.

As the review shows, relatively few studies so far have investigated to what extent prior knowledge affects learning mediated through motivational processes. In our view, such mediating effects likely have considerable strength, because knowledge and motivation have been found to correlate in previous studies.

6.2.2. Relations between Motivation and Learning

Motivational research is a lively field of research in educational psychology, which can represent the missing piece of the puzzle between prior knowledge and learning in higher

education. As Moreno and Mayer (2007, p. 313) state, “motivational factors mediate learning by increasing or decreasing cognitive engagement”. There is a wide range of different constructs in educational-psychological motivation research (Murphy & Alexander, 2000). The commonality among all of the constructs is that they energize and guide behavior. The different terminologies can be divided into the following groups: Goal orientation, intrinsic and extrinsic motivation, interest, and self-beliefs, which include academic self-concept and academic self-efficacy. Following Vu et al. (2021), it seems safe to assume that there are reciprocal relations between knowledge and motivational constructs. Prior knowledge and achievement can therefore be a source for expectancy appraisals (e.g., self-concept and self-efficacy) and value appraisals (e.g., interest and goals) that form the core of motivation. Motivation then has the potential to influence the quantity and the quality of learning. For the current study, we selected three of the most researched motivational variables in academic contexts, namely interest, self-concept, and self-efficacy.

Interest

The five characteristics of interests are (a) object or content specificity, (b) involvement of a person-environment interaction, (c) cognitive and affective components, (d) partial unconsciousness, and (e) physiological and neurological patterns (Renninger & Hidi, 2011). Theories of interest development include knowledge as a component, suggesting that these constructs are closely related (Alexander et al., 1995; Hidi & Renninger, 2006). Tobias (1994) suggests that the shared variance of prior knowledge and interest is about 20%. It is safe to assume that interest is both affected by knowledge and affects learning (Rotgans & Schmidt, 2017), for example through the increased use of metacognitive learning strategies (McWhaw & Abrami, 2001).

Self-concept

Academic self-concept refers to individuals' self-evaluations of their academic abilities in one or more domains based on social comparisons (Arens et al., 2021). Typical measures of academic self-concept require participants to rate their past performance in subjects (e.g., "I have always done well in mathematics classes"; Marsh & O'Neill, 1984). There are several models of academic self-concept, but they agree that the structure is both multidimensional and hierarchical with differences in the number of levels and dimensions (Arens et al., 2021). Academic self-concept is likely to have a reciprocal relation with knowledge and achievement (Marsh & Martin, 2011; Marsh et al., 2005). Students with a well-developed academic self-concept tend to use helpful self-regulation strategies, such as increased persistence, concentration ability, elaboration, and reduced self-handicapping (Ommundsen et al., 2005).

Self-Efficacy

Self-efficacy is an individual's perception of the ability to accomplish certain tasks and is an important construct in the motivational literature in academic contexts (Bandura, 1977; Schunk, 1991). Similarly to academic self-concept, self-efficacy is a multidimensional and hierarchical construct that is based on an evaluation of one's competence, but it refers to the ability to accomplish future challenges and is less stable than self-concept (Bong & Skaalvik, 2003). Measures of academic self-efficacy require participants to state how confident they are regarding the ability to perform typical academic tasks such as attaining good grades (Sander & Sanders, 2009; Wood & Locke, 1987). Although there is much more research on learning achievement as an outcome of academic self-efficacy, there is scattered evidence on the inverse association stating that knowledge can also be a source of self-efficacy (Honicke & Broadbent, 2016). Self-efficacy can affect learning processes via increased use of effort regulation and deep-

learning strategies such as monitoring and understanding (Kassab et al., 2015; Moos & Azevedo, 2009).

6.2.2. Research Strategies for Investigating Prior-Knowledge Effects on Learning

To investigate whether motivational processes mediate the effect of prior knowledge on learning it is necessary to first validly measure and model the total effect of prior knowledge on learning before testing for any moderation effects. Researchers have two possibilities for examining the impact of prior knowledge on learning. They can either conduct (quasi-)experiments with high and low prior knowledge groups and compare group mean differences or they can devise a one-group longitudinal study and analyze correlation coefficients. On the one hand, experiments allow for causal inferences and it is possible to control the effects of third variables making them the gold standard. On the other hand, it is difficult to conduct true experiments on this topic, because forming randomized groups differing in prior knowledge requires a pre-intervention in which participants are randomly assigned to a learning condition or a control condition. In applied higher education, it would be unethical to conduct such an experiment in a lecture that is part of the curriculum because some students would be privileged if they belonged to the high prior knowledge group that received additional instruction. Dividing the attendants of a lecture into high and low prior knowledge groups (e.g., via median split), however, would result in reduced variance and statistical power (Cohen, 1983). Therefore, we decided to devise a one-group longitudinal study and analyze correlation coefficients.

Prior knowledge can function as a predictor for learning-related investigations in two ways (Simonsmeier et al., 2021). First, computing the correlation coefficient between prior knowledge and learning outcomes allows for inferences on the interindividual stability in knowledge scores among a group of learners. Therefore a high correlation coefficient reflects

high stability in the rank orders of participants' scores from pretest to posttest. Second, computing the correlation coefficient between prior knowledge and the increase in the knowledge test scores from pretest to posttest. This correlation coefficient reflects the degree to which learners with differing levels of prior knowledge acquire new knowledge during the learning phase. If the correlation is ($r_G < 0$) the learning intervention has a compensatory effect, meaning that the gap between students with low and high prior knowledge becomes smaller. In this case, previously less knowledgeable students learn more than their peers with high prior knowledge. If the correlation is ($r_G > 0$), students with high prior knowledge would benefit more from learning, thus acquiring more new knowledge than students with low prior knowledge (the *Matthews effect*, Stanovich, 1986).

There are two ways to calculate the increase in knowledge from pre to post (Hake, 1998). The first one is to simply calculate the difference between the scores of the knowledge tests, called the absolute gains:

$$AG = Posttest\ Score - Pretest\ Score$$

However, in this method, those who score high on the pretest, do not have many possibilities to improve because the maximum score of the test is closer to the pretest score than for those who score low on the pretest. For this reason, there is an alternate way to calculate learning gains that do not put those with higher scores at disadvantage, the normalized gains:

$$NG = \frac{Posttest\ Score - Pretest\ Score}{Maximum\ Score - \ Pretest\ Score}$$

In this calculation, the difference between the knowledge values is relativized to the score still to be achieved. Therefore, student A who scored 10 points higher at the posttest compared to

the pretest has higher normalized learning gains than student B who scored 20 points higher than before, if their pretest scores were 80 for student A and 10 for student B, respectively.

6.2.3. The Current Study

In the present study, we investigated how strongly motivational variables mediate the effect of prior knowledge on learning in a sample of university students. We investigated this using pretest-posttest knowledge gains as dependent variables. As motivational variables, we investigated interest, self-concept, and self-efficacy. For this purpose, we conducted a longitudinal study in which we tracked students' knowledge acquisition and motivation over a semester. We put forward three hypotheses:

Hypothesis 1: Hypothesis 1: The stability of individual differences in knowledge is high. We expected the correlation to be high (i.e., $r \geq .50$) according to the standards of Cohen (1992a) and in line with the meta-analytic results from Simonsmeier et al. (2021) and Study 1 in this dissertation.

Hypothesis 2: The correlation between prior knowledge and learning gains is negative. Due to the low cognitive demands of the instructional design of lectures (strong guidance, presentation format), students with less prior knowledge benefit more from the instruction than students with high prior knowledge.

Hypothesis 3: The indirect effects (i.e. mediation effects) of prior knowledge over interest, course-specific self-concept, and course-specific self-efficacy on knowledge gains are positive. This would indicate that prior knowledge improves motivation that then improves learning. Prior knowledge affects learning not only mediated through motivational processes but also mediated through cognitive processes (e.g., attention, encoding, etc.; Simonsmeier et al., 2021). Therefore, we do not expect that the total effect

of prior knowledge on learning is fully mediated by the motivational variables. Instead, we expected a partial positive mediation as indicated by standardized path coefficients greater than zero and smaller than one for the indirect effects.

6.3. Method

6.3.1. Sample

The sample consisted of 99 undergraduate psychology students (14 males, 85 females) enrolled in a lecture on introductory educational psychology at a German university. The mean age was 22.54 and ranged from 19 to 31 years. Three participants stated that their first language was different from German. All participants participated voluntarily and received either money or partial course credit for compensation. At the onset of the study, the participants were informed that participating in the study did not affect their grades in the exam at the end of the semester. All participants gave their informed consent. From the initial sample of 99 students, only 80 participated on all three measurement points.

6.3.2. Procedure

The participants completed all tests and questionnaires in an online assessment environment. There were three measurement time points, two of which occurred before the start of the first lecture and one of which occurred after the exam at the end of the 2020/21 winter term. The first measurement point (T1) served to assess prior knowledge. The second (T2) and third (T3) time points served to measure the knowledge gains from before to after learning. A different test was used at T1 than at the other two time points so that prior knowledge could be measured independently of the knowledge gains. The same test was used at T2 and T3 so that difference scores could be computed.

At each time point, participants also completed a set of instruments covering cognitive,

motivational and behavioral predictors and covariates of knowledge acquisition processes before completing the knowledge tests. The order of these measurement instruments was randomized. Each measurement point took approximately 2.0 to 2.5 hours. Participants were allowed to take part at T3 even if they missed T2 to examine learning during the semester.

The online lecture was about educational psychology and was given in an asynchronous format by an experienced professor of educational psychology. Most of the time, the lecturer presented the information via direct instruction using presentation slides. The slides had been developed based on multimedia design principles (Mayer, 2008). The students could watch the lecture videos multiple times and control the pace of learning according to their needs using pause, rewind, and fast-forward functions. The exam at the end of the semester included both the content of the lecture about applied educational psychology as well as a previous lecture about basic knowledge acquisition processes. None of the questions from the knowledge tests of the study were used for the exams to provide equal chances among participants and non-participants.

6.3.3. Measures

6.3.3.1. Knowledge Tests. There were two different versions of knowledge tests, which were based on the content of the lecture. In both versions, there were two tasks for each session of the lecture, resulting in a total of 22 tasks. For each of the eleven topics, on task was a group of six or seven statements (67 in total), which required the participants to highlight whether the statement was true or false. For each correct decision, participants received one point. The rest of the tasks were either open or half-open questions, which required the participants to write short texts, sort answer options or fill in blanks. The tasks were presented in a randomized order. One version of the knowledge test (Version A) was exclusively used at T1 and captured the prior knowledge of the lecture content. The tasks in Version A were mostly modified questions of

previous exams and they were carefully worded so that the content of the question captured the same relevant knowledge as in the second version of the knowledge test without utilizing the same tasks. For example, in Version A one question was: "*Imagine you had to plan a study investigating the learning achievement of students all over the world. Which problems could occur and how could they be solved?*", and in Version B the corresponding question was: "*Explain the problems that occur when comparing students test scores in the PISA-study and how these problems were solved*"). It was possible to achieve a maximum of five or six points for each question. Prior to the study, the questions were piloted in a small sample of students from a lower semester to check for comprehensibility and errors. Version B was used at T2 and T3. The tasks in Version B were previous exam questions that we selected based on item difficulty, discrimination, and content. The original German versions of the knowledge tests and the answer keys are provided in Appendix B and C.

The first author and two undergraduate research assistants first coded a sample of ten responses on each of the open and half-open questions of T1 and T3 using predefined answer keys. We checked the agreement for each criterion in the answer key. If the agreement was below 80% for a criterion, we checked another ten responses of the respective task until the agreement for each criterion was 80% or higher. In one case (Task 14 in Version A), we revised the answer key after three agreements. If the agreement was satisfactory, the undergraduate research assistants continued with the coding separately. In difficult cases, they consulted the first author.

6.3.3.2. Motivation.

Interest. Interest in educational psychology was assessed using the shortened version of the Study Interest Questionnaire (SIQ; Schiefele et al., 1993). The SIQ is a widely used

unidimensional instrument for assessing interest in German studies and was shown to have good reliability indices as well as good convergent and discriminant validity. The items were adapted to fit the topic of educational psychology (e.g., "If I had enough time, I would study educational psychology more intensively, regardless of the examination requirements"). Participants responded on a four-point rating scale ranging from 1 ("does not apply at all") to 4 ("is completely true"). Higher scores represent a higher interest in educational psychology.

Self-Concept. Self-concept in educational psychology was assessed using an adapted form of the Academic Self Description Questionnaire II (ASDQ II; Marsh, 1992). The scale is one of the most used instruments internationally for assessing academic self-concept. For the German version, we closely followed the translations for the PISA assessments carried out by Kunter et al. (2002). The instrument consisted of six items that were modified to assess the course-specific self-concept, which was shown to have higher relations with learning achievement than the more general academic self-concept (Choi, 2005; Huang, 2011). A sample item was: "Compared to others, I am good at educational psychology". Subjects were asked to rate whether the statements applied to them on a scale ranging from 1 ("does not apply at all") to 6 ("fully applies"). Higher scores represent a higher self-concept in educational psychology.

Self-Efficacy. We used an instrument developed by Wood and Locke (1987) for assessing course-specific self-efficacy. The instrument consisted of seven subscales, each representing a skill that is typically needed in academic contexts. The skills were class concentration, memorization, exam concentration, understanding, explaining concepts, discriminating concepts, and note-taking (for detailed descriptions of the subscales, see Wood & Locke, 1987. For each of the skills, participants had to decide first whether they were able to reach a certain magnitude of a skill (e.g., being concentrated 70% percent of the time in a lecture

session). After that, students hat to state their confidence in reaching the magnitude of the respective skill on a scale from 0 (“completely unconfident) to 10 (“completely confident”). For each skill, there were five magnitudes ranging from 60% to 100%, and participants had to rate their confidence in reaching each of the magnitudes. Similar to the assessment of self-concept, we decided to assess course-specific academic self-efficacy referring to the educational psychology lecture, because it is a better predictor of learning achievement than broader academic self-efficacy (Choi, 2005).

6.3.3.3. Exam Grades.

We asked the participants to provide their exam grades voluntarily. The exam grades could either be entered in the online environment or, due to study participation immediately after the exam where course grades were not available yet, could be stated via email or anonymously in written form. In German universities, lower grades reflect better performance with 1.0 being the best possible grade and 5.0 being the worst. In psychology programs, however, most grades range from excellent grades to good grades, therefore being rather range-restricted.

6.3.4. Statistical Analyses

For the calculation of learning gains, we only considered the True/False statements tasks of the knowledge tests due to the time-consuming coding of the responses in the open and half-open tasks. The maximum possible score that could be achieved in the tests was therefore 67. According to the formulas for calculating the learning gains, we subtracted the pretest knowledge scores from the T3 knowledge test score for absolute learning gains and divided them by the difference between the maximum score and the pretest score for the normalized gains. We computed the correlation coefficients between the T1 and T2 knowledge test scores and the T3 knowledge test score to investigate interindividual stability in knowledge. To analyze the

predictive quality of prior knowledge on the learning of new material, we computed the correlation coefficients between the prior knowledge test scores and both forms of learning gains. Since the correlation coefficients do not allow inferences on the learning outcomes, we computed a repeated measures *t*-Test for comparing the mean scores of the T2 and T3 knowledge tests. Due to differences in item difficulties, it would not be valid to compare the mean differences between the T1 knowledge score and the other knowledge test scores. To investigate possible mediating influences of motivation, we conducted three separate mediation analyses using the PROCESS macro for SPSS (Hayes, 2018). For this purpose, we used the T1 knowledge test score as the predictor, the T3 knowledge test score or the normalized learning gains as the criterion, and the sum scores of the motivational variables from T2 as mediators.

For the motivational variables, we recoded inverted items and computed a sum score for each scale. For the computation of a self-efficacy score, we followed the recommendations by Lee and Bobko (1994) and summed the confidence values for each skill magnitude that was answered with yes, separately for each of the seven skills considered in the instrument.

6.4. Results

Table 2 displays correlations, means, standard deviations, and internal consistencies. From the starting sample of 99 individuals at T1, 87 of these took part at T2, whereas 83 participated at T3. In sum, 80 people participated at all three measurement time points. The *t*-test for comparing the mean difference between the T2 and the T3 knowledge score was significant indicating that the participants acquired a large amount of new knowledge during the lecture, $t(79) = 18.75$, $p < .001$, $d = 2.1$. Due to the true-false answer format of the questions considered it was possible to achieve half of the maximum points only by chance. One-sample *t*-tests for both knowledge tests at T1 and T2 compared to 33.5 (half of the maximum possible score of 67)

revealed that the scores were better than chance ($t(79) = 21.35$, $p < .01$ for T1 and $t(79) = 20.46$, $p < .01$ for T2). The self-reported exam grades were negatively associated with knowledge at T3 and all types of learning gains. Since lower grades are better in Germany, those who scored high in the knowledge test at T3 also performed better in the exam. For this reason, we conclude that the knowledge test used in our study was valid and reflected the actual knowledge tested in the lecture.

The internal consistency of the instruments was satisfactory to good for the motivational variables on T2 and T3 ($\alpha \geq .75$). Cronbach's α was very low in the knowledge tests at T1 and T2 ($\alpha \leq .39$), which was to be expected for a prior knowledge test where participants have not yet built coherent knowledge structures (Stadler et al., 2021). At T3, the internal consistency of the knowledge test was good ($\alpha = .81$). The item difficulties for all items in the T1 and T2 knowledge tests were well distributed ($M = .65$, $SD = 0.25$ for T1 and $M = .65$, $SD = 0.25$ for T2). At T3, after learning, the mean difficulty across all items was lower, $M = .84$, $SD = 0.18$. The mean item discrimination indices for the prior knowledge tests were rather low ($\bar{r} = .06$, $SD = .10$ and $\bar{r} = .04$, $SD = .11$ for T1 and T2, respectively) but satisfactory at T3 ($\bar{r} = .23$, $SD = .19$).

6.4.1. Hypothesis 1: The Stability of Interindividual Differences in Knowledge is High

The stability of individual differences in knowledge is reflected by the correlation between two knowledge test scores before and after learning. Due to the use of two different knowledge tests before the lecture, two correlations reflecting interindividual stability were available. Contrary to our expectations, neither of the correlations were significant, $r_{T1\text{-}T3} = -.10$, $p > .05$ and $r_{T2\text{-}T3} = .11$, $p > .05$. A post-hoc statistical power analysis with $\alpha = .05$ suggested that the sample was large enough to find a conservative benchmark effect size of $r = .35$ ($1\text{-}\beta = .90$).

Table 2

Zero-order correlations, means (*M*), standard deviations (*SD*), and internal consistencies (Cronbach's α) for sex, age, exam grade, course-specific interest, course-specific academic self-concept (ASC), course-specific academic self-efficacy (ASE), knowledge test scores, absolute learning gains and normalized learning gains.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	M	SD	α
1.	Sex	-																		
2.	Age	-.20*	-															22.54	2.37	
3.	Exam	-.28*	0.02	-														1.28	0.24	
4.	Interest T2	-0.08	.24*	-0.09	-													23.03	4.54	.81
5.	Interest T3	-0.10	0.13	-0.03	.86**	-												23.16	4.2	.77
6.	ASC T2	-0.13	0.02	-0.07	.41**	.45**	-											24.36	3.7	.84
7.	ASC T3	-.25*	-0.02	-0.26	.37**	.44**	.75**	-										25.85	3.76	.81
8.	ASE T2	-0.07	-0.17	0.17	-0.02	-0.05	.27*	0.14	-									213.85	53.91	.75
9.	ASE T3	-.26*	-0.13	0.03	0.05	0.14	.37**	.46**	.60**	-								224.42	57.41	.83
10.	Knowledge T1	-0.19	.25*	-0.03	-0.08	-0.13	0.03	-0.01	-0.13	-0.15	-							43.77	4.26	.39
11.	Knowledge T2	-0.17	0.20	-0.18	0.01	-0.03	0.17	.25*	-.22*	-0.09	.43**	-						42.45	3.91	.26
12.	Knowledge T3	0.02	-0.13	-.64**	0.11	0.12	0.03	.31**	0.08	.33**	-0.10	0.11	-					56.29	5.77	.81
13.	Abs.Gains T1-T3	0.14	-.24*	-.41**	0.16	0.16	0	.24*	0.13	.34**	-.65**	-0.14	.82**	-				12.49	7.53	
14.	Abs.Gains T2-T3	0.12	-0.21	-.34*	0.11	0.13	-0.11	0.12	0.18	.34**	-.33**	-.50**	.81**	.80**	-			13.84	6.6	
15.	Norm.Gains T1-T3	0.12	-.24*	-.53**	0.17	0.17	0.01	.28*	0.13	.32**	-.46**	-0.09	.90**	.95**	.83**	-		.51	.31	
16.	Norm.Gains T2-T3	0.07	-0.19	-.54**	0.12	0.14	-0.04	.24*	0.14	.36**	-.27*	-.22*	.93**	.86**	.94**	.92**	-	.56	.24	

From this, it follows that the rank orders of the participants' knowledge tests before and after learning were not similar to each other. The correlation between the knowledge tests at T1 and T2 was medium-high according to the standards by Cohen (1992a), $r_{T1\text{-}T2} = .43$, $p < .01$, indicating that before learning, the rank orders were similar to some degree.

6.4.2. Hypothesis 2: The Correlation between Prior Knowledge and Learning Gains is Negative

The correlations between prior knowledge and absolute and normalized learning gains were negative, confirming Hypothesis 2. There was a compensatory effect of instruction as reflected by an effect size smaller than zero, $r_{T1\text{-}NG23} = -.27$, $p < .05$. Thus, participants with low prior knowledge were able to catch up with their peers who were more familiar with educational psychology at the beginning of the lecture. As expected, the correlations between prior knowledge and the corresponding absolute learning gains were inflated towards -1 due to ceiling effects for participants with high prior knowledge, $r_{T1\text{-}AG23} = -.33$, $p < .05$.

6.4.3. Hypothesis 3: Motivation Mediates the Relation Between Prior Knowledge and Learning Gains

Contrary to our expectations, none of the indirect effects in the mediation analyses became significant ($\beta_{MED} = -.001$, SE = .001, 95% CI [-.004, .001] for interest, $\beta_{MED} = 0$, SE = .001, 95% CI [-.002, .002] for self-concept, and $\beta_{MED} = -.001$, SE = .001, 95% CI [-.004, .001] for self-efficacy), indicating that motivation is not a process variable for the relation between prior knowledge and learning gains. As can be seen in Table 2, mediation already failed due to the missing links between prior knowledge at T1 and interest, self-concept, and self-efficacy at T2. According to the standards by Cohen (1992b), the sample size was large enough to detect hypothetical effect sizes that corresponded to the b1-paths of Study 1 for interest ($r = .35$, $\alpha =$

.05, 1-β = .92) and self-concept (r = .32, α = .05, 1-β = .86) but not for self-efficacy (r = .21, α = .05, 1-β = .50). In addition, neither of the correlations between motivational constructs at T2 and normalized learning gains reached significance indicating that motivation prior to the lecture was not associated with subsequent learning during the semester. A paired t-test revealed that course-specific academic self-concept developed together with the acquisition of knowledge during the semester, $t(79) = 4.47$, $p < .01$, $d = 0.35$. The means of interest at T2 and T3 did not differ significantly, $t(79) = -0.13$, $p = .63$, so did the means of self-efficacy, ($t(79) = -6.66$, $p = .23$).

6.5. Discussion

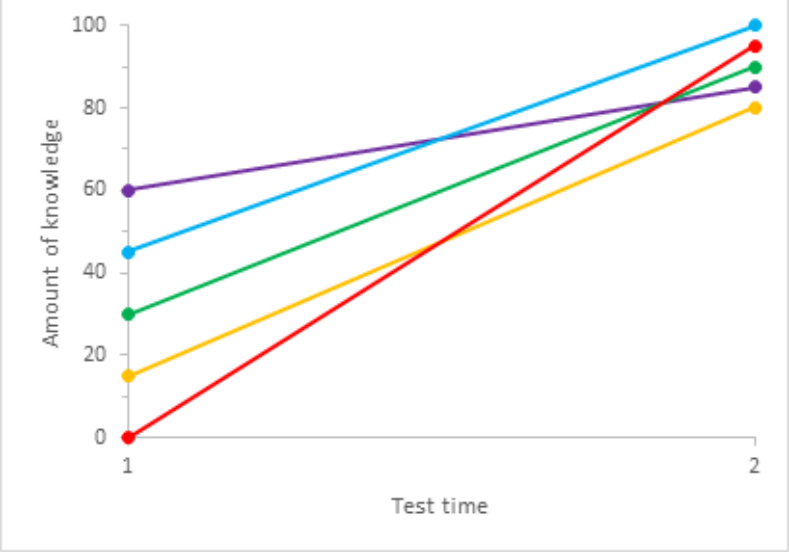
6.5.1. Main Findings

The current study investigated learning processes in higher education with a longitudinal design that tracked knowledge acquisition and motivation of psychology students attending a lecture. We were interested in the stability of knowledge scores from before to after attending the lecture and the preparation for the exam. We constructed two comprehensive knowledge tests and showed that the knowledge about the lecture content was represented in the tests and measured with precision. Contrary to the findings from Simonsmeier et al. (2021) and Study 1 of this dissertation, we found no significant stability of individual differences in knowledge over time. However, as expected, we did find a negative correlation between prior knowledge and learning gains. This indicates a compensatory effect meaning of the lecture so that students with lower prior knowledge gained more knowledge than their peers with higher prior knowledge. Contrary to our expectations, we did not find that motivation mediated the association between prior knowledge and learning gains. To our knowledge, our study was the first one to investigate whether motivation mediates knowledge acquisition in higher education. As Simonsmeier et al. (2021) showed, the interindividual stability of knowledge and the learning gains can be

independent of each other. Figure 4 displays a simplified representation of knowledge acquisition as observed in the current study. Regarding stability, the rank order of participants' score at T1 is different from the rank order at T2 (e.g., purple is first at T1 and fourth at T2). At the same time, the differences between the knowledge scores are smaller at T2 than at T1 indicating that the gaps between the participants became smaller. The zero-correlation for stability and the negative correlation for learning gains do not reflect how much was learned during the two measurement points. In fact, we found a high effect size for the difference between prior knowledge and learning outcomes, which represents a large amount of knowledge participants acquired. It is not valid to conclude that the nonsignificant correlations are simply poor retest reliability because the knowledge test scores of the two prior knowledge tests were significantly correlated and Cronbach's alpha of the posttest knowledge test was high.

Figure 4

Line diagram representing the change in knowledge scores at T1 and T2 of five fictional participants in absence of interindividual stability of knowledge $r_{T1\text{-}T2} = 0$ *and in presence of a compensatory effect with* $r_{T1\text{-}NG} = -.44$.



Two features of the lecture can explain this finding. First, the lecture had low cognitive demands because the most important information was presented and students did not have to make independent inferences or engage in independent reasoning. They primarily had to memorize what was presented in the lecture. Based on the framework of cognitive demands in science education by Tekkumru-Kisa et al. (2015), most of the activities required to learn the content of the lecture and answer the questions in the knowledge tests are at the lowest or second-lowest of five levels. Following the multimedia design principles (Mayer, 2008) additionally reduced cognitive demands for the learners. Second, the exam at the end of the semester was a criterial test, whose purpose was to test the achievement of the predefined learning objectives. According to the Standards of Educational and Psychological Testing (American Educational Research Association et al., 2014), educational tests can be either norm-referenced or criterion-referenced. In a norm-referenced test, students would pass the exam if they belong to the upper X percent of the whole sample, regardless of how much they learned or did not learn. If the instruction and the test were norm-referenced, students would be urged to learn as much as possible to perform better than a certain number of their peers and to exceed the threshold necessary to pass. However, as the lecture and the exam were criterion-referenced, the goal was to provide every student with the knowledge necessary to be able to accomplish the test and prevent any individual from failing the exam. Interestingly, the self-reported exam grades correlated significantly negatively with the knowledge test scores.

6.5.2. Why was Motivation not a Mediator of Knowledge Acquisition?

Although we argued that interest, self-concept, and self-efficacy are based on prior knowledge and competence and play an important role in learning in higher education, we found no significant mediating effect for any of the motivational constructs. We provide three different

explanations for this. First, as we outlined in the theoretical background, interest, self-concept, and self-efficacy are closely related to knowledge. As Vu et al. (2021) suggested, expectancy and value appraisals are based on perceived performance and flow experiences elicited by prior knowledge and achievement. As our sample did not have much experience with applied educational psychology before the lecture, their perceptions of ability in the subject and the value assigned to the content matter were possibly not enough to activate the motivation-achievement cycle. This implies that there is a certain threshold necessary for motivation to affect learning. If the assessment of motivation had taken place in the middle of the semester, there would possibly have been enough knowledge to trigger experiences of competence that would in turn affect knowledge acquisition. Results from the current study support this hypothesis: As demonstrated by significant correlations of self-efficacy and self-concept with the T3 knowledge test score and learning gains, the shared variance between the self-referenced motivational constructs, knowledge, and learning became larger over time.

Second, it is possible that motivation functions as a mediator in knowledge acquisition, but not in the current investigation. One reason for this assumption is that the learning activities required during the lecture and for the exam consisted of listening and memorizing to a major degree. As outlined in the theoretical background, most studies in self-regulated learning found that motivation was associated with deep learning strategies. However, sometimes deep learning strategies have no advantage compared to rote learning (Khoii & Sharififar, 2013). Scouller (1998) compared the learning approaches and achievement of two groups of education students that either prepared for a multiple-choice question exam or an assignment essay. The results indicated that students who prepared for the multiple-choice question exam used surface learning approaches more frequently. In contrast, students preparing for an assignment essay showed

more deep learning strategies. If this holds also for the current study, different degrees of motivation would have no impact on learning because both motivated and unmotivated students used surface-oriented learning strategies for the preparation for multiple-choice questions. Differences between both types of students could emerge in additional analyses including the tasks with an open format. An additional explanation for motivation not being a mediator in the current study is that strong motivation can be redundant for achievement if external requirements such as exams and deadlines are present (Kerdijk et al., 2015; Vu et al., 2021).

The third explanation for the absence of a mediating effect of motivation is that motivation is not a mediator for the association between prior knowledge and learning. To our knowledge, the current investigation is the first one to link normalized knowledge gains and motivational covariates. Previous investigations (e.g., Song et al., 2016) erroneously concluded that prior knowledge could have an impact on learning that is mediated by motivation. However, as posttest knowledge was the criterion for the analyses, these investigations reflected mediation analyses of interindividual stability of knowledge. As Ning and Downing (2012) suggest, prior achievement may not be the only source of motivation and self-regulated learning. Therefore, motivation could be an important factor in learning, as suggested by the correlations of self-concept and self-efficacy with learning gains we found, but perhaps it relies on other sources rather than prior objective knowledge. As the multiple mediation hypothesis states, there may be multiple mediators for the relation between prior knowledge and learning. The results from the current study do not speak against the multiple mediations hypothesis. It does, however, not seem that interest, self-concept, or self-efficacy are one of these mediators.

6.5.3. Strengths and Limitations

Our study contributes to research in prior knowledge and its role in learning. We found

clear evidence for a compensatory effect using a comprehensive, reliable, and valid knowledge instrument. Additionally, as one of few studies, we analyzed normalized learning gains instead of absolute learning gains and therefore considered ceiling effects of learners with certain amounts of prior knowledge. We showed how the patterns of knowledge change over time in a field study in a typical higher education context. To our knowledge, our study is the first one to take motivational covariates of learning gains into account and test for an underlying mediation. We found that interest, self-concept, and self-efficacy were not process variables for the compensatory effect in our study, and contributed to the role of motivation in the light of the multiple mediation hypothesis (Simonsmeier et al., 2021).

However, our study was not without limitations. First, the assessments before and after learning took place with a rather large time lag. Thus, our conclusions on motivation and learning processes during the semester and the preparations for the exam are limited. More information on learning processes could be gathered using microgenetic studies (Siegler, 2007). The idea of microgenetic studies is to observe learning and conceptual change the moment it takes place. Three components are crucial: first, the observation period takes place in a time window where conceptual change happens. It starts with the previous concept and ends with the updated form of the concept. Second, the density of observations is high compared to the frequency of conceptual change. It is important to include more observations than conceptual changes to capture each regression and progression learners make. Third, it is necessary to intensively analyze the observed changes to be able to infer the processes that took place during learning. One possibility to assess learning strategies and aspects of motivation in higher education is to combine self-reports of learning with the use of learning diaries (Peterson et al., 2015; Spörer & Brunstein, 2006) or to use think-aloud protocols (Cotton & Gresty, 2006). As we discussed earlier, prior

knowledge and subsequent motivation were not associated, probably due to the low level of perceived knowledge necessary for constructing appraisals. If we assessed knowledge and motivation in an additional measurement point in the middle of the semester when students have already acquired some knowledge of the content, perhaps we would have observed significant correlations already at this time.

Second, we concluded that motivation was a potential mediator for the relation between prior knowledge and learning gains because higher degrees of motivation promote more sophisticated learning behavior. However, we did not directly consider the assessment of learning strategies in this study. Further analyses of the data gathered on self-reports of learning strategies could shed light on the processes. It would then be interesting to include the open format questions in the analyses and investigate differences in the results that may arise from different preparations for the mixed-format exam Scouller (1998).

6.5.4. Theoretical Implications

We did not find that interest, self-concept, or self-efficacy were mediators for the association between prior knowledge and learning gains. We discussed that motivation may still be a process variable as suggested by Simonsmeier et al. (2021), but not in our current investigation. If this was true, it would imply that there are moderators that can activate or deactivate the motivational mediation process. We provide two examples, in which contextual features affect prior knowledge and motivation along with subsequent learning outcomes. Gurlitt and Renkl (2010) conducted an experiment in which they manipulated the activation of participants' prior knowledge and examined effects on self-efficacy and performance. Students were either given the task of drawing lines and labeling the semantic relations of the nodes on a concept map (low coherence), or they were given a concept map in which the lines were already

filled in and they only had to label the lines (high coherence). Participants used more elaboration strategies in the high coherence mapping task and used more model-construction and organization processes in the low coherence task. In a second experiment, participants first worked on either the high or low coherence task and then entered a hypertext learning environment. Results indicated that the high coherence mapping task positively affected learning outcomes and self-efficacy. In another study, Bouffard-Bouchard (1990) showed that perceived self-efficacy can be manipulated by social comparisons. Participants who received the feedback that they performed better than a reference group performed better in a subsequent task than participants who received negative feedback. Although the two groups did not differ in knowledge, the high self-efficacy group completed more problem-solving tasks and used more efficient strategies.

We also discussed that motivation is not a mediator for the prior knowledge learning relation. There may be other mediators that could explain how this association emerges (e.g., learning strategies). From the perspective of self-regulated learning, framing motivation as a process variable in knowledge acquisition implies a model with two serial mediators: The first pathway leads from prior knowledge to motivation, the second pathway leads from motivation to learning processes and the third pathway leads to learning outcomes and learning gains. It would be interesting to analyze these pathways using structural equation modeling of data from larger samples in future studies. However, it is also possible that the multiple mediation hypothesis does not hold and that no mediators are canceling each other out leading to an overall zero correlation between prior knowledge and learning gains.

6.5.5. Practical Implications

Based on our findings, we recommend lecturers in higher education focus on providing

instruction that prepares students for a criterion-oriented test if they are interested in closing the knowledge gaps between them. We found a compensatory effect meaning that the gaps between high and low prior knowledge students narrowed after attending the lecture. In the context of our study, differences in prior knowledge did not lead to higher degrees of motivation. Still, the students acquired a large amount of new knowledge, and differences between learners decreased. Therefore, it does not seem necessary to give students additional motivation to perform better in the context of a lecture. A reduction in extraneous cognitive load itself can already lead learners to experience higher levels of motivation (Feldon et al., 2018; Likourezos & Kalyuga, 2017). We think that this implication is also valid for instructional contexts outside of higher education.

6.5.6. Implications for Future Research

Further investigations of the predictive power of prior knowledge for learning gains and the underlying processes are needed. In our study, we found that there was no interindividual stability in knowledge and the presence of a compensatory effect of instruction, which likely occurred due to the provision of a cognitively low demanding instruction for a criterion-based test. However, the meta-analysis by Simonsmeier et al. (2021) found a clear, albeit lower than the average, stability of knowledge in higher education samples. We consider it a promising research approach to assess both interindividual stability and the prediction of learning gains via prior knowledge in other higher education contexts, for example in courses that require higher amounts of reasoning and elaboration.

In addition, researchers need to better understand the interplay of prior knowledge and learning processes. Brod (2021) has recently provided promising ideas under which conditions prior knowledge helps or hinders learning. However, these ideas as well as the conditions and systematic processes remain to be tested thoroughly in multiple instructional settings. As we did

not find clear evidence for a mediating relation of self-concept, self-efficacy, and interest, we hope to stimulate further studies in either testing the same motivational constructs in different contexts or using different constructs that may represent a process variable.

6.6. Conclusion

We conducted a longitudinal investigation of knowledge acquisition processes in higher education and uncovered relations of prior knowledge, learning, motivation, and learning outcomes. We found a compensatory effect of instruction that narrowed the gaps between students with low and high prior knowledge. We aimed at identifying motivation as a process variable that could explain how prior knowledge affects learning processes but failed to find a significant mediation effect. We interpreted this result as suggesting that motivation is not a strong mediator between prior knowledge and learning in higher education. The generalizability of this finding needs to be tested further. We advise lecturers interested in providing instruction with a compensatory effect to focus on the cognitive demands of instruction rather than motivating students with low prior knowledge to engage with the learning material. We hope that further investigations reveal the underlying mechanisms of prior knowledge and learning.

7. Study 3: What Sixty Years of Research Says About the Effectiveness of Patient Education on Health: A Second-Order Meta-Analysis[1]

7.1. Abstract

Although many meta-analyses have examined the association between patient education and health outcomes, the scope, validity, and quality of this evidence have not been comprehensively assessed. In this second-order meta-analysis, four databases were searched to identify meta-analyses that examined the effectiveness of patient education on health outcomes. An overall weighted grand mean $\bar{\bar{d}}$ was computed and the effects across different health issues and health outcomes were compared. Further, measures of methodological quality, meaningful variability across first-order meta-analyses, and evidence for publication bias were examined. Forty meta-analyses were identified, investigating 156 associations between patient education and health outcomes summarizing data from over 776 studies including more than 74.947 patients. Quantitative analyses showed that patient education positively affects health outcomes with $\bar{\bar{d}}$ = 0.316 (95% CI [0.304, 0.329]). Summarizing data exclusively from randomized controlled trials indicated a causal effect. Patient education was effective for patients with neoplasms, diabetes, mental and behavioral disorders, diseases of the circulatory system, diseases of the respiratory system, and diseases of the musculoskeletal system. Patient education was effective in the reduction of medication use, pain, and visits to medical facilities, and significantly improved physiological, physical, psychological outcomes, and patients' general function. Overall, the findings reveal firm evidence for the effectiveness of patient education on

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health outcomes. As patient education is cost-beneficial and has no known side effects, it is a useful tool for medical treatment. However, theory-based interventions are lacking and need to be implemented to enable a successful transfer from theory to practice.

7.2. Introduction

Patients and health professionals experience many challenges during healthcare delivery, especially since the number of chronic diseases grew rapidly within the last decades and is the largest cause of death and disabilities worldwide (World Health Organization, 2020). The high rate of growth in chronic diseases and medical innovations results in the need for different practices of health care including new roles for patients, physicians, and other health professionals (Holman & Lorig, 2004). Education has been discussed as an essential factor to achieve effectiveness and efficiency in today's health care, as the patient and health professional must share complementary knowledge and authority in the health care process (Holman & Lorig, 2004). Patient education is a planned, systematic, sequential, and logical process of teaching and learning provided to patients and clients in all clinical settings (Lorig, 2001). Such interventions are based on the patient's assessment, evaluation, diagnosis, prognosis, individual needs, and requirements related to the medical treatment. The rationale to implement patient education is wide and includes philosophical, medical, practical, legal, and economic reasons (Blaes, 1984; Feste & Anderson, 1995; Krosnick, 1974; Stenberg et al., 2018; World Health Organization, 1998). Contrary to other medical treatments, patient education is not known to cause any side effects (Howland et al., 1990) making it a desirable component of medical treatment. Although many meta-analyses have examined the association between patient education and health outcomes, the generalizability of this evidence has not been comprehensively assessed. The

present second order meta-analysis aims to summarize the existing evidence and shed light on the generalizability of the effects of patient education on health.

7.2.1. History of Patient Education in Health Care

Despite the rather short history of systematic patient education, the concept has already gone through several alterations. These changes occurred due to several factors, for example, the development of professional health education as a discipline and its foundation in scientific research, cultural changes in society, and a shift from acute to chronic diseases in developed countries. For many years, patient education was not part of medical treatment, mostly due to a medico-centric perspective of physicians and health care professionals (Hoving et al., 2010). In the 1960s and 1970s, more emphasis was put on patient education in general and in form of individual information supply. Since then, patient education gradually became more popular due to governmental stimulation of patient education in primary health care (e.g., United States Department of Health Education and Welfare, 1971; Visser, 1984), active patient organizations (e.g., Roter et al., 2001), promotion of research on patient education (e.g., Roter et al., 2001; Visser, 1984), and the introduction of university programs (e.g., Deccache & van Ballekorn, 2001).

Many of the early patient education programs emphasized transfer from knowledge on health status alone, did not account for the more complex aspects of health behavior and were frequently developed in an unsystematic way. As a result, most of the early interventions were only effective among the most educated and economically advantaged in the community (Hoving et al., 2010). During the 1980s patient education was considerably strengthened by the development of a new generation of more sophisticated, theory-informed interventions, which considered the social and economic circumstances of individuals and their health behavior.

Starting in the 1990s, patient education became an integral part of today's medical treatment (Nutbeam, 2000). Interdisciplinary standards for patient education were established and developed further (Giloth, 1993; Joint Commission on Accreditation of Healthcare Organizations, 1999). Health care providers have embraced patient education as a critical aspect of chronic care management and shared decision-making. Modern health care has been evolving away from a disease-centered model towards a patient-centered model (e.g., Robinson et al., 2008) introducing the new paradigm of patient empowerment (Anderson & Funnell, 2005). Patient education is an officially recognized strategy in secondary or tertiary prevention but is still less known compared to health education, a form of primary prevention (Albano et al., 2018). At present, the patient education literature is vast and includes approaches based on a number of behavioral theories (Bandura, 1997; Fishbein, 1979; Rosenstock, 1974). More recently, the beneficial role of learning theories (Mayer, 2005; Paivio, 1991; Sweller et al., 2011) and evidence from neuroscience (Ekhtiari et al., 2017) has been discussed when developing patient education interventions. Further, nationwide and international patient education programs have been developed aiming to empower patients to actively engage in their care (e.g., Joint Commission on Accreditation of Healthcare Organizations, 2020; National Institute of Diabetes and Digestive and Kidney Diseases, 2020). However, a low percentage of patient visits include patient education (Coonrod et al., 1994; Waitzkin, 1984), raising the question of why patient education is still a side issue in medical treatment.

7.2.2. Conceptualizations of Patient Education

Resulting from the broad range of application possibilities of patient education and the different paths in historical and scientific developments, educational interventions can greatly differ across different medical fields. As such, different terms have evolved describing patient

education programs. Interventions termed *patient educational* interventions, *patient teaching*, or *patient instruction* provide information on diseases to enhance the patients' factual knowledge and conceptual understanding of mechanisms related to health maintenance and improvements (e.g., Forster et al., 2012; Heisler et al., 2002; Williams et al., 1998). *Psychoeducational* interventions target the patients' attitudes representing the levels of perception of responsibility toward their disease (de Weerdt et al., 1989; Masaki et al., 1990) and aim to improve the patients' coping with their illness. They are defined as an intervention with systematic, structured, and didactic knowledge transfer for an illness and its treatment, integrating emotional and motivational aspects (Ekhtiari et al., 2017). Psychoeducational is different from other psychological interventions, such as Cognitive Behavioral Therapy or Family-Focused Therapy, as it includes core elements that are not defining aspects of other psychological interventions, such as education about the illness (Bond & Anderson, 2015). As such, it is a patient educational intervention focusing to enhance patients' knowledge and coping strategies. *Self-management education* especially targets people with chronic diseases (Lorig & Holman, 2003), stresses the role of patient education in preventive and therapeutic health care activities, and commonly consists of organized learning experiences designed to facilitate the adoption of healthy behaviors (Warsi et al., 2004). While interventions on self-management education primarily provide information on different topics, such as problem-solving skills or dietary intake (Jonkman et al., 2016), some also include behavioral components, such as physical activities, relaxation training, or changes in medical treatment. For the current review, we only included meta-analyses that assessed the effectiveness of self-management education without combination with other treatments such as exercise or relaxation training. As such, self-management

education interventions are educational programs aiming to encourage patients to enhance their knowledge, acquire self-management skills, and seek to guide their health behavior.

All of the above terms have in common that they describe interventions that focus on knowledge and transfer information about an illness and its treatment to maintain or enhance the patients' health status. As such, patient education is a gradual process of learning by which a person experiences changes in knowledge, behavior, skills, and attitude (Falvo, 1994; Pekkala & Merinder, 2002).

7.2.3. The Effectiveness of Patient Education – Strengths and Weaknesses of Previous Meta-Analyses

There exists broad evidence that patient education is an effective tool to enhance and maintain health. Several observational studies (e.g., Bordin et al., 2007), clinical case reports (e.g., Janson-Bjerklie et al., 1993), controlled trials (e.g., Roumie et al., 2006), and randomized controlled trials (e.g., Traeger et al., 2019) have suggested a positive effect of patient education on health outcomes. Moreover, narrative reviews (e.g., Gagliano, 1988), systematic reviews (e.g., Blackstone & Webster, 2007; Cooper et al., 2001), meta-analyses (e.g., Conn et al., 2009; Ellis et al., 2004), and reviews of systematic reviews (Woolley et al., 2018) summarized these studies and have generally supported the effectiveness of patient education.

Previous meta-analyses provide valuable insights into the effectiveness of patient education but do not provide a comprehensive integration of the existing literature on patient education thus far. Specifically, it is still unclear whether patient education is effective across different diseases, different outcomes, and what intervention characteristics determine its effectiveness. Most commonly, meta-analyses summarize the effectiveness of patient education for a specific disease or patient group. In these cases, the meta-analysis summarizes the effects of

different educational interventions, performed in various clinical settings with patient education delivered by varying clinical staff members (e.g., physicians, nurses, health workers). These meta-analyses are useful to determine whether patient education is effective within a specific medical field as the effects of patient education may vary due to the characteristics of the individuals (e.g., Davis et al., 1990; Fredericks et al., 2010; Mayeaux et al., 1996; Rosenstock, 1974) and disease-specific challenges (e.g., Tan et al., 2012). However, it remains still unclear whether the effects of patient education generalize across health issues as this has not been systematically investigated in previous meta-analyses. Insights whether the effects of patient education show for various patient groups are useful in that regard that patient education can be seen as a universal tool to promote and maintain health, independent of the characteristics of the patients' disease.

Another variable not systematically considered in existing meta-analyses is the effectiveness of patient education to maintain or enhance different health outcomes. Most commonly, meta-analyses report the effectiveness of the patient education intervention on various outcomes. Systematic differences in the effectiveness on varying outcomes cannot be determined as such. However, this is relevant when considering that patient education is proposed to improve health by enhancing the patients' knowledge, helping to transform knowledge about health behavior into effective strategies for health enhancement resulting in better health (Glanz et al., 2008; Rosenstock, 1990). Most commonly, meta-analyses include physiological or physical outcomes, e.g., blood pressure (e.g., Brown, 1990; Devine & Reifenschneider, 1995) or pain (e.g., Guruge & Sidani, 2002; Jho et al., 2013). Some meta-analyses include psychological outcomes or measures of general functioning, such as anxiety (e.g., Faller et al., 2013; Ramesh et al., 2017) or quality of life (e.g., Rehse & Pukrop, 2003;

Timmer et al., 2011). Others, report changes in knowledge (e.g., Forster et al., 2012) and skills, e.g., insulin injection skill (e.g., Brown, 1990), or health behavior, for example, medication adherence (e.g., Devine, 1996). Even less is known about the effect of patient education on clinical decision-making (Devoe et al., 2016). As such, it is still unclear whether patient education is more effective for specific outcomes than others.

Patient education programs greatly differ in their delivered content. From a theoretical perspective, it is suggested that patient education is most effective when it targets the patients' knowledge, attitudes, and self-management to perform changes in health behavior (de Weerdt et al., 1989; Glanz et al., 2008). Most commonly, patient education programs provide information on diseases to enhance the patients' factual knowledge and conceptual understanding of mechanisms related to health maintenance and improvements (e.g., Forster et al., 2012; Heisler et al., 2002; Williams et al., 1998). Educational interventions can further target the patients' attitudes representing the levels of perception of responsibility toward their disease (de Weerdt et al., 1989; Masaki et al., 1990) as in psychoeducational interventions or the adoption of healthy behaviors (Warsi et al., 2004), for example in form of self-management education. Despite the great variety in educational goals across interventions, only few meta-analyses have examined the effect of specific components such as the provision of information (e.g., Gibson et al., 2015; Suls & Wan, 1989) or self-management interventions (e.g., Chodosh et al., 2005; Guevara et al., 2003; Minet et al., 2010). As such it is still unclear whether some educational components are more useful than others.

7.2.4. The Value of Second-Order Meta-Analysis

First-order meta-analyses can be summarized via second-order meta-analyses to gain insights into the amount of true variance between meta-analyses. Whereas first-order meta-

analyses quantitatively combine the results from multiple primary studies to generate a synthesis of the outcomes on a given topic or relationship (Glass, 1976), second-order meta-analysis is a meta-analysis of several methodologically comparable existing first-order meta-analyses that examined similar issues or relationships on a given topic (Cooper & Koenka, 2012; Schmidt & Oh, 2013). Second-order meta-analyses are also referred to as overviews of reviews, systematic reviews of reviews, umbrella reviews, meta- meta-analyses, and meta-analyses of meta-analyses. The relationship between a second-order meta-analysis and related meta-analyses are quite similar to that of a meta-analysis to primary studies. While these overviews provide valuable insights, none of the techniques has been considered fully satisfactory, especially in estimating the amount of between-meta-analysis true variance (Cooper & Koenka, 2012). To address this issue, techniques for second-order meta-analysis have been developed (Schmidt & Oh, 2013). Consequently, second-order meta-analyses have gained an increase in importance and this relatively new form of scholarship can facilitate the accumulation of meta-analytic research to converge a more representative mean of the distribution.

Second-order meta-analysis particularly aims to estimate to what extend second-order sampling error (i.e., sampling error because the number of included studies is always less than infinite) accounts for the difference across meta-analytic means obtained in first-order meta-analyses on a specific topic. When combining results in a second-order meta-analysis, first, first-order meta-analytic means are used to calculate a weighted grand mean. Second, the proportion of between-meta-analysis variance explained by second-order sampling error is calculated. As such more accurate estimates of the overall mean are produced. Second-order sampling error can either explain some of the true variance or all of the true variance. If the second-order sampling error accounts for only a portion of the variance, different mechanisms for at least some of the

results must be assumed. If it accounts for all variance, the same mechanisms likely occur in the populations included in the first-order meta-analyses. Following, second-order meta-analyses provide important information that cannot be obtained from first-order meta-analyses, such as second-order sampling error or the reliability of the first-order meta-analytic effect sizes (Schmidt & Oh, 2013).

In summary, second-order meta-analyses serve some important purposes, such as (a) summarizing the existing evidence from more than one meta-analysis, (b) comparing findings and resolving discrepancies among these meta-analyses, and (c) identifying research gaps and potential directions for future research. In this way, the results can provide valuable insights into the generalizability of the effectiveness of patient education. As such, we employ second-order meta-analytic techniques in the current review to summarize the effect of patient education on health outcomes studied with different patient populations.

7.2.5. The Present Study

While many meta-analyses have examined the association between patient education and health outcomes, the scope, validity, and quality of this evidence have not been comprehensively assessed. The previous investigations were specific to particular diseases and health conditions. We aimed to address these limitations and provide an integrative overview of the breadth and effectiveness of patient education for a wide range of diseases and health outcomes using a second-order meta-analysis (Schmidt & Oh, 2013).

In line with the purposes mentioned above, the objective of this second-order meta-analysis was to provide a comprehensive synthesis of the effects of patient education on health outcomes across different diseases. Our review addressed the following three research questions:

1. How strong are the effects of patient education on health outcomes as shown by integrating findings of existing meta-analyses?
2. How broadly and consistently generalize these findings over types of diseases?
3. How broadly and consistently generalize the effects of patient education over health outcome types?
4. How effective are different educational approaches to patient education?

7.3. Method

7.3.1. Eligibility Criteria

Studies were included in this second-order meta-analysis when they fulfilled each of the following four criteria:

1. The study is a meta-analysis, that is, the study averages effect sizes from at least two original studies. Narrative reviews that did not report quantitative synthesis to aggregate effect sizes were excluded.
2. The meta-analysis investigates the effect of a patient educational intervention, which is designed to convey or enhance patients' knowledge of a physical disease or psychological disorder, and/or its causes, symptoms, progression, and potential for change.
    a. The intervention can be in any form, that is, in an individual setting or group setting; with or without personal contact, in any clinical setting such as home care, outpatient, treatment, in-patient care, among other settings, and delivered by general practitioners, nurses, pharmacists, or others.
    b. The intervention addressed patients only. Meta-analyses that included studies with interventions for patients and caregivers, family members, and/or peers combined were not considered.

c. Whenever a control group was employed, the intervention and the control group differed only in terms of patient education. If this difference was confounded with other differences between the treatments of the two groups, e.g., for multicomponent interventions, the meta-analysis was excluded. As such, we only included interventions providing educational interventions components and excluded meta-analyses where a combination of different interventional strategies was summarized (e.g. education combined with physical exercise).

3. The meta-analysis included studies that investigated the effect of patient education on health outcomes. Meta-analyses that focused exclusively on knowledge, attitudes, or behavior as outcomes were not included.
4. The meta-analysis reports quantitative and standardized effect sizes (e.g., standardized mean difference, Odd's Ratios) and the respective number of included studies (*k*).

7.3.2. Search Strategy and Determining Eligibility

We performed a standardized search of titles and abstracts in six major digital databases (i.e. Medline, PubMed, Cochrane Library, Web of Science, PsychINFO, and ERIC) for papers published from database inception to August 2020 limited to English or German language. The same search string was used for each database search, which was (("patient education" or "educational intervention" or "health education" or "psychoeducation" or "self-management") and ("meta-analysis")). We additionally performed an exploratory hand search.

Two trained and independent raters (Rater A and Rater B) both screened a little over 25% of the same titles and abstracts for inclusion following best practice guidelines for the screening of abstracts (Polanin et al., 2019). Their inter-rater agreement for the inclusion of studies based on the abstracts was 84%. The remaining abstracts were coded by Rater A. A total of 317 full

texts were obtained for further investigation. Two raters (Rater A and Rater C) independently screened 49 full texts for inclusion in the meta-analysis. The inter-rater agreement for the inclusion of the full-texts was 81%. We initially identified 40 meta-analyses meeting the inclusion criteria of the current second-order meta-analysis.

7.3.3. Data Extraction

Data extraction was conducted following standardized coding rules and predetermined data extraction forms. From each study, we extracted the health issue, type of control, year range of included studies, number of studies, number of RCTs, number of participants, the content of the education program, the temporal distance of the post-test in relation to the intervention, outcome variable, category of the outcome variable, reported effect size type, effect size, 95% *CI* or *SD* or *SE* of the effect size, the direction of the effect, and significance of the effect. For odds ratios and risk ratios, we further coded the contingency tables. We categorized the health issues according to the ICD-10 classification (World Health Organization, 2004). A medical practitioner double-checked these codes. We planned to systematically code the instructional methods used in the patient education intervention. However, due to a lack of detailed information reported in the meta-analyses, we were not able to include this information in our statistical analyses. Instead, we extracted the definition of patient education used by each meta-analysis and the specific educational components of the single studies included in the meta-analysis. We coded educational interventions as didactic interventions, psychoeducational interventions, and self-management education following the description of the authors, respectively. For all included meta-analyses, we additionally extracted effect sizes for the effects of patient education on knowledge and skills, as well as health behavior to allow for exploratory analyses of these possible mediators of education effects on health.

Missing data or additional information were requested from the corresponding authors of the articles by email. Two trained and independent raters (Rater A and Rater C) double-coded 61 full texts (reporting 73% of the included effect sizes). The inter-rater agreement for the coding of all moderators and effect sizes was 96%. The rest of the full texts were coded by Rater A. Further, we extracted the specific components of patient education employed within the single studies for each meta-analysis included in our review (Rater A).

7.3.4. Assessing Study Overlap and Methodological Quality of the Meta-Analyses

Second-order meta-analyses are hampered by the problem that the same original study can be included in several reviews (Cooper & Koenka, 2012). If we had included partly overlapping meta-analyses, the same original study would enter our second order meta-analysis not once, but twice or more. To account for this problem, whenever there was overlap between meta-analyses, we included only the most recent of these meta-analyses, which was usually also the largest. To identify any overlap, we screened the included single studies of the meta-analyses for duplicates whenever more than one meta-analysis reported data for the same combination of health issue and outcome. We had to exclude 20 effect sizes from eight meta-analyses. As a result, five of the eight meta-analyses were fully excluded from the analyses due to study overlap.

We assessed the methodological quality of the meta-analyses using an extended version of the Assessment of Multiple Systematic Reviews questionnaire (AMSTAR-2; Shea et al., 2017). We followed the recommendations on rating the overall confidence in the results of each meta-analysis by using a scheme for interpreting weaknesses instead of using an overall score. Rater A and Rater D performed the quality assessment and had 78% inter-rater agreement. Differences were resolved through discussion.

7.3.5. Preparation of Effect Sizes and Statistical Analyses

First, we converted all extracted effect sizes other than Cohen's *d* into Cohen's *d* to enable comparison across the outcomes. One study reported a correlation, which we converted with the following formula (Borenstein et al., 2009):

$$\bar{d} = \frac{2\bar{r}}{\sqrt{1-\bar{r}^2}} \quad (1)$$

We converted all odds ratios to Cohen's *d* as follows (Chinn, 2000):

$$\bar{d} = LogOddsRatio \times \frac{\sqrt{3}}{\pi} \quad (2)$$

When a risk ratio was reported, we calculated the odds ratios from contingency tables relating to the overall meta-analytic effect size. We used the following formula for the conversion (Higgins et al., 2019):

$$OR = \frac{cases\ bad\ outcome\ in\ PE\ group \times cases\ good\ outcome\ in\ control\ group}{cases\ good\ outcome\ in\ PE\ group \times cases\ bad\ outcome\ in\ control\ group} \quad (3)$$

where PE group stands for patient education group.

For the meta-analytic integration, we obtained or calculated the variances of the reported effect sizes. We information reported in the single meta-analyses to estimate the variance of the reported effect size. We computed the variance as the square root of the standard deviation, whenever possible. If no standard deviation was reported we calculated the standard deviation and derived the variance of the effect size as follows (Chinn, 2000; Schmidt & Hunter, 2015, pp. 230, 298)

$$SD\ (\bar{d}) = \sqrt{k} \times \frac{(CI_{U\bar{d}} - CI_{L\bar{d}})}{2 \times 1.96} \quad (4)$$

$$Var(\bar{d}) = SD(\bar{d})^2 \quad (5)$$

Whenever the study reported odds ratios, each odds ratio and associated confidence interval was ln-transformed before estimating the variance (Chinn, 2000).

Whenever we converted an effect size to Cohen's *d*, we also converted the obtained variance using the following formulas, respectively. For the variance of the correlation we used (Borenstein et al., 2009, p. 48):

$$Var(\bar{d}) = \frac{4\,Var(\bar{r})}{(1-\bar{r})^3} \quad (6)$$

For the variance of odds ratios, we used (Borenstein et al., 2009, p. 47):

$$Var(\bar{d}) = Var(\text{logOddsRatio}) \times \frac{3}{\pi^2} \quad (7)$$

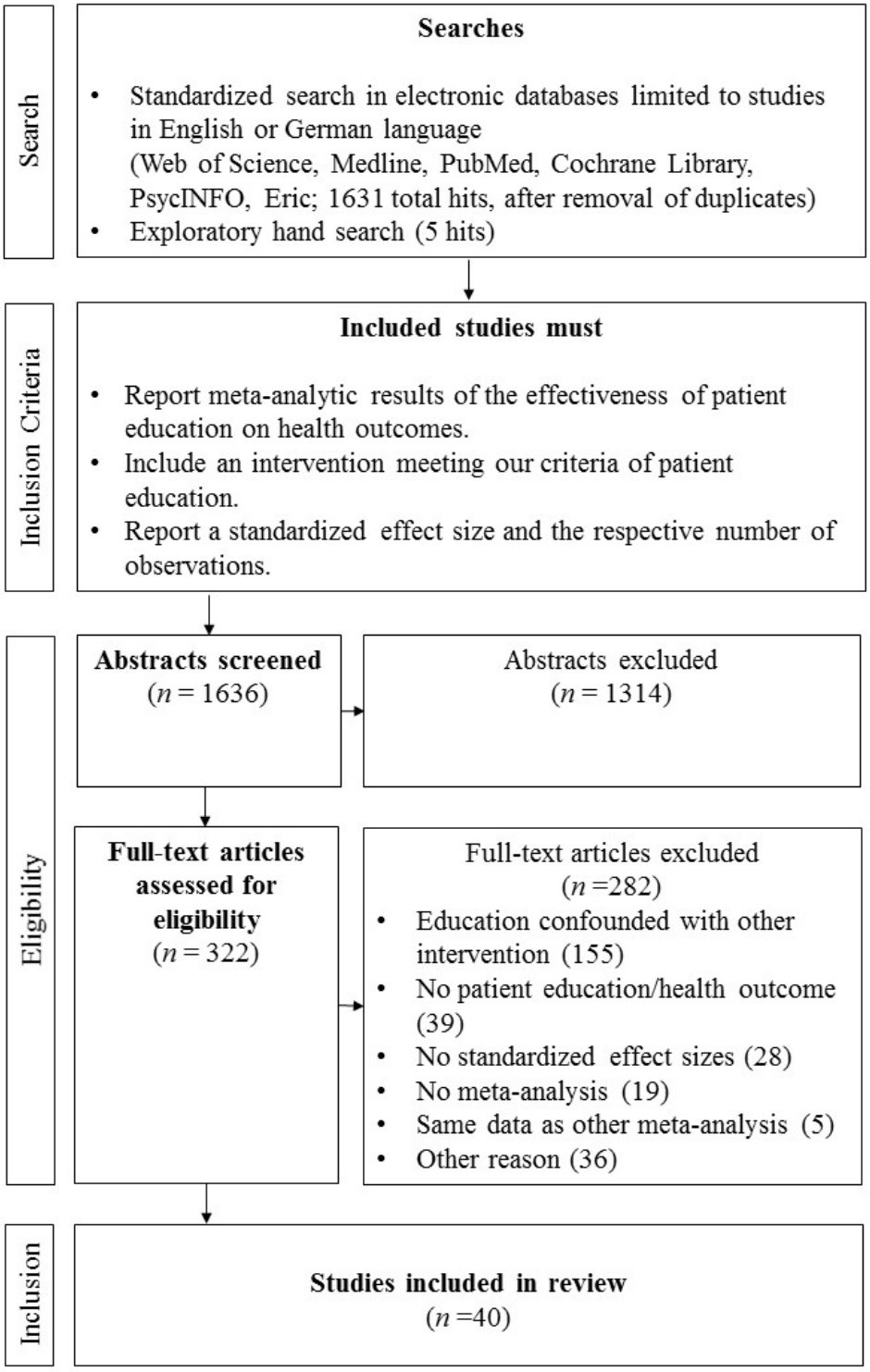
After identifying outliers, we integrated the mean effect sizes across meta-analyses using second-order meta-analysis (Schmidt & Oh, 2013). We performed all second-order meta-analytic analyses in R using the *psychmeta* package (Dahlke et al., 2020). We accounted for publication bias by analyzing the symmetry of the distribution around the mean through visual inspection of the funnel plots using the *metafor* package (Viechtbauer, 2010) in R.

7.4. Results

Overall, 1631 articles were identified in the literature search, of which 1314 were excluded after a screening of titles and abstracts (including duplicates). Of the 322 remaining articles, 282 were excluded after full-text screening for different reasons (see Figure 5). Finally, the second-order meta-analysis included 40 first-order meta-analyses. The 40 eligible meta-analyses comprised data from more than 74.947 participants from over 776 primary studies and reported 156 meta-analytic effect sizes. Appendix D lists the details of the meta-analyses included in the review.

Figure 5

Flow Chart for the Literature Search and Inclusion Process



7.4.1. Methodological Quality of the Included Meta-Analyses

Of all 40 meta-analyses included in the review, two meta-analyses were rated as having low methodological quality, and 38 as having very low methodological quality according to the AMSTAR-2 criteria (Shea et al., 2017). The critical weaknesses of the specific meta-analyses are presented in the last column of Appendix D. Most commonly, meta-analyses failed to report the sources of funding for the studies included (Item 10), followed by a missing explanation of the selection of study designs (Item 3), no protocol before conducting the review (Item 2), no provision of a list of excluded studies (Item 7), and a lack of publication bias analyses (Item 15).

7.4.2. Effects of Patient Education

7.4.2.1. Outlier Analysis and Publication Bias. Outlier analyses for all included effect sizes indicated four outliers from three studies (Brown, 1990, 1992; Gad et al., 2020). We conducted sensitivity analyses by removing the outlier from estimating the overall effect size. The changes in the overall effect size were only marginal. We thus did not remove the outliers for all following analyses.

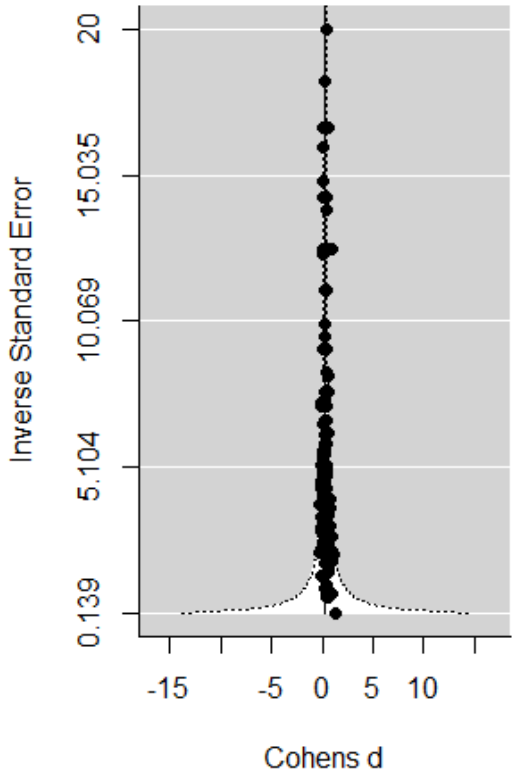
We performed analyses of publication bias using a funnel plot (Lau et al., 2006) considering all effect sizes included in our second-order meta-analysis. The funnel plot did not indicate any publication bias and is visualized in Figure 6.

7.4.2.2. Integrated Outcomes across Meta-Analyses. Of all 156 effect sizes, 69 were statistically significant and positive (44%), 87 indicated no statistically significant effect (56%) and none was statistically significant and negative. Meta-analytic synthesis of the mean effects found in the 40 included meta-analyses indicated a positive and significant effect of patient education on health outcomes with $\bar{\bar{d}}$= 0.302 (95% CI [0.295, 0.309]). The proportion of the observed variance explained by the second-order sampling variance was ProVar = 0.101,

indicating meaningful variability between meta-analyses, that might indicate the influence of moderator variables.

Figure 6

Flow Chart for the Literature Search and Inclusion Process



When combing all 156 meta-analytic effect sizes reported in the 40 included meta-analyses, the effect was similar in magnitude with $\bar{\bar{d}}$ = 0.316, 95% CI [0.304, 0.329]. ProVar was 0.063, indicating a high proportion of between-study heterogeneity not due to sampling error. When combining the 59 effect sizes from the 22 meta-analyses that included randomized controlled trials only, we also found a significant positive effect with $\bar{\bar{d}}$ = 0.271, 95% CI [0.253, 0.290], indicating a causal effect of patient education on health outcomes. The second-order

meta-analytic results are presented in Appendix E. We performed several moderator analyses based on the 156 meta-analytic effects described in the following.

7.4.2.3. Effects of Patient Education on Different Health Issues. Second-order meta-analysis revealed the effectiveness of patient education to maintain or enhance health for patients with neoplasms ($\bar{\bar{d}}$ = 0.151), diabetes ($\bar{\bar{d}}$= 0.331), mental and behavioral disorders ($\bar{\bar{d}}$= 0.366), diseases of the circulatory system ($\bar{\bar{d}}$ = 0.315), diseases of the respiratory system ($\bar{\bar{d}}$= 0.155), diseases of the musculoskeletal system and connective tissue ($\bar{\bar{d}}$ = 0.162), and patients undergoing surgery due to various reasons or hospital patients in general ($\bar{\bar{d}}$ = 0.261). Across the analyses, ProVar had low to medium values ranging from 0.021 to 0.505, indicating that the observed variance is mainly not attributable to second-order sampling error.

7.4.2.4. Effects of Patient Education on Different Health Outcomes. Patient education was effective in the reduction of medication ($\bar{\bar{d}}$ = 0.179), pain ($\bar{\bar{d}}$ = 0.226), and visits to medical facilities ($\bar{\bar{d}}$ = 0.279), and had positive effects on physiological functioning ($\bar{\bar{d}}$ = 0.339), physical functioning ($\bar{\bar{d}}$ = 0.254), psychological functioning ($\bar{\bar{d}}$ = 0.189), and general functioning ($\bar{\bar{d}}$ = 0.392). We did not find an overall effectiveness of patient education on mortality ($\bar{\bar{d}}$ = 0.086). ProVar had values ranging from 0.028 to 1 indicating that the proportion of observed variance can be explained by second-order sampling error in some cases (e.g., mortality), but not in others (e.g., general functioning). However, the values should be interpreted with caution, as the observed variance is close to zero for most moderator levels (Schmidt & Oh, 2013).

7.4.2.5. Effects of Different Forms of Patient Education. We found significantly positive effects of didactic interventions ($\bar{\bar{d}}$ = 0.147), psychoeducation ($\bar{\bar{d}}$ = 0.359), and self-management education ($\bar{\bar{d}}$ = 0.335) on health outcomes. Based on the overlap of the confidence intervals, psychoeducation and self-management seem to be more effective when compared to

didactic interventions and psychoeducation.

7.4.2.6. Effects of Patient Education on Knowledge, Skills, and Health Behavior. For the included meta-analyses, we performed additional exploratory analyses to test whether patient education was also effective for enhancing knowledge and skills, and positive health behavior, because these are possible mediators that might partly explain the effect of patient education on health. Data from 6 meta-analyses reporting 19 meta-analytic sub-effects obtained from 7 meta-analyses indicated a positive and strong effect of patient education on knowledge with $\bar{\bar{d}}$ = 0.748, 95% CI [0.694, 0.803]. Similarly, data from 6 meta-analyses reporting 10 meta-analytic sub-effects indicated positive effects of patient education on health behavior with $\bar{\bar{d}}$ = 0.265, 95% CI [0.231, 0.300]. The results are consistent with the view that knowledge, skills, and behavior mediate between patient education and health outcomes.

7.5. Discussion

7.5.1. Principal Findings

The present second-order meta-analysis summarized the evidence on the effectiveness of patient education on health outcomes by combining the results from first-order meta-analyses across different diseases and health outcomes. The results provide four key insights. First, the overall effect of patient education on health outcomes is statistically significant and positive. Considering that patient education has no side effects (Howland et al., 1990) and is cost-efficient (Bartlett, 1995; Boren et al., 2009) it can enhance medical treatment and as such should be implemented in clinical practice as an inherent part.

Second, the effects of patient education generalize across different health issues. While there already exists a great amount of evidence suggesting positive effects of patient education for specific diseases, a comparison of the effects has been outstanding thus far. In our review, we

show that patient education is effective for a wide range of diseases and that patient education is most effective for patients suffering diabetes and diseases of the circulatory system or undergoing any surgery. There are at least three possible explanations for the results. First, the long history of implementing patient education in medical treatment in these areas may lead to more sophisticated and structured implementation of patient education which in turn may result in greater effects. Second, for all three health issues, lifestyle changes play a major role, which is commonly addressed by patient educational interventions. Third, the instructional methods used for patients of these diseases may differ from patient education programs designed for patients suffering from other health issues.

Third, patient education can improve a variety of health outcomes, including physiological, physical, and psychological outcomes. This is remarkable, as patient education has the potential to address different kinds of disease parameters (e.g., lowering blood sugar, improving psychological status) whereas most other medical treatments, for example, medication primarily address single parameters (e.g., insulin shots). Further, patient education enhances knowledge and health behaviors, potentially serving as mediators for improving health outcomes. As such, patient education has the potential to lead to sustainable improvements.

Fourth, the effect sizes differed strongly across meta-analyses on patient education. This is likely due to the great variability of the educational interventions employed in the single studies. Differences can, for example, exist in the taught content, the delivery formats, the person delivering patient education, or the clinical contexts (Cooper et al., 2001; Friedman et al., 2011). The results suggest that differences in the intervention contribute to differences in their effectiveness, e.g., the provision of information has shown to be less effective when compared to more complex interventions such as psychoeducation or self-management education. More

detailed analyses of differential effects of patient education interventions are needed to get an overall picture of its effectiveness and third variables moderating the effect.

7.5.2. Strengths and Weaknesses of the Study

We performed a quantitative second-order meta-analysis instead of a qualitative umbrella review and were able to quantitatively summarize the existing evidence from more than one meta-analysis. We found a positive effect of patient education across different health issues and health outcomes, indicating a robust effect of patient education.

The main limitations of the current review are those of the meta-analyses included, which mirror the limitations of the primary studies. Quality ratings assessed by AMSTAR-2 (Shea et al., 2017) indicated only low and critically low methodological quality. The most frequently reported shortcomings were no information on the sources of funding for the studies included, missing explanation of the selection of study designs, and the absence of a review protocol describing review methods before conducting the review. Second, we were not able to cover the broad range of instructional methods of patient education in our statistical analyses. For example, we were not able to systematically analyze differential effects due to different components or teaching methods employed in the interventions due to the great heterogeneity across the interventions. A tandem approach of quantitative and qualitative analyses seems to be necessary to fully understand the mechanisms of patient education.

7.5.3. Future Research Directions and Practical Implications

Given the great variability of effects of patient education after adjusting for second-order sampling error and the variety of different patient education programs, it is important to test for potential moderations regarding characteristics of the patient education intervention. While we report the different educational components and strategies narratively, a lack of meta-analyses

collecting primary evidence of whether the effects vary due to the characteristics of the intervention permitted a quantitative analysis. Previous reviews focusing on the effects of different educational strategies in chronic disease patient education found similar results, with the nature of the interventions being poorly described and failing to adhere to theoretical models (Cooper et al., 2001; Lima de Melo Ghisi et al., 2014; Sudre et al., 1999). Decades later, we come to the same conclusion. Furthermore, in many cases, patients rarely receive any form of patient teaching (Coonrod et al., 1994). A structured and standardized approach for designing and implementing patient education programs is needed, especially when patients inform themselves using false or misleading information, for example on the internet (Cline & Haynes, 2001).

To promote and establish educational interventions in clinical contexts, a link between theory and practice is needed. For practitioners, established learning theories may serve as a useful framework to guide and establish interventions. As such, future studies have the potential to fill this research gap and establish theory-driven interventions that may be used as best practice guidelines. This is especially important, as patient education aims to empower patients to make informed choices and actively participate in their treatment (Jotterand et al., 2016; Yeh et al., 2018). It seems valid to question why so many researchers neglect existing theories in their research and whether new theories need to be established that may better address the needs of researchers and health care workers. There exists a great amount of research on instructional effectiveness based on established learning theories which have been summarized in over 800 meta-analyses and several reviews (Hattie, 2009; Schneider & Preckel, 2017). There are first attempts connecting results from instructional science and patient education (Hewson, 1993; Pusic et al., 2014). Parts of the principles of effective teaching are already included in guidelines

for health practitioners (American Academy of Ambulatory Care Nursing, 2020; American Academy of Family Physicians, 2000), however comprehensive standards and guidelines are still needed. Patient education programs can benefit from the insights provided by research on instructional effectiveness which can lead to evidence-based and highly effective instruction.

7.6. Conclusion

Patient education is a useful and cost-beneficial intervention without side effects that enhances health outcomes across patients with different diseases. More research is needed on differential effects due to different teaching strategies, the provider of the education, and the clinical setting. Theories on patient education and research on instructional effectiveness are commonly neglected in research thus far but have the potential to serve as a foundation to establish interventions broadly and reliably improve patients' health in clinical practice.

8. General Discussion

Knowledge acquisition processes lie at the heart of learning and competence development. This dissertation tried to provide insights into several underlying processes. By means of a meta-analysis, a longitudinal study, and a second-order meta-analysis, aspects of learners' knowledge acquisition processes were investigated. Study 1 found that prior knowledge and motivation are important prerequisites of successful learners and that motivation partly mediates the effects of prior knowledge. Study 2 examined individual differences in learning processes in greater detail and identified a compensatory effect of instruction that was, against our hypotheses, not mediated by motivation. Study 3 synthesized previous findings on results of patient education and demonstrated several positive effects on health-related outcomes. Six key insights can be concluded along with implications for practice and future research. These aspects are outlined in this chapter. At the end of this chapter, I close this dissertation with an overall conclusion.

8.1. Key Insights From the Studies

Based on the results of the three studies within this dissertation, six key insights can be derived. Key Insight 1 and 2 regard the findings from Study 1 on the stability of individual differences in knowledge over time and how motivational variables function as mediators. Key Insight 3 and 4 build on the results of Study 2, where transitions in knowledge are derived from the type of instruction, and motivation was found to be independent of prior knowledge. Key Insights 5 and 6 integrate the findings from Study 2 and 3 by looking at the outcomes of knowledge acquisition from a higher-level perspective and by demanding evidence-based patient instruction.

8.1.1. Key Insight 1: Motivation Mediates the Stability of Individual Differences in Knowledge

Study 1 identified motivation as a mediator for the stability of individual differences in knowledge. The correlation between prior knowledge and posttest knowledge was $r = .53$, which is the same effect that was found in the meta-analysis by Simonsmeier et al. (2021). Prior knowledge predicted interest, self-concept, self-efficacy, intrinsic and extrinsic motivation. These constructs again predicted knowledge after learning. All motivational variables that were considered were significant mediators between prior knowledge and posttest knowledge, with mediation effect sizes ranging from $r = .05$ to .20. Thus, learners that consistently performed well compared to others do so because they are more motivated than their less successful counterparts. Prior knowledge can hence be a source of a variety of different forms of motivation. These findings are in line with the assumption that the experience of having (prior) knowledge improves self-beliefs and thereby also increases expectations of success and subjective task values (Eccles & Wigfield, 2020; Vu et al., 2021). As the correlations among the motivational constructs could not be determined with the applied methods, the degree of overlap remained unknown. The confidence intervals of the effect sizes were also rather large which may be due to the rather small number of studies for some variables that possibly lead to imprecise estimates, or high heterogeneity of true effect sizes, or both. In fact, all mediation effects were highly heterogeneous meaning that motivation stabilizes individual differences in knowledge more in some cases than in others. The specificity level of motivation moderated the mediation effect for interest and self-concept. The findings from Choi (2005) can therefore only partially be confirmed because higher specificity was associated with higher effects for self-concept but not for self-efficacy. In sum, different forms of motivation were found to mediate the association between prior knowledge and learning outcomes as well as moderators that influence some of

these mediations.

8.1.2. Key Insight 2: Interest and Self-Concept Stabilize Individual Differences in Knowledge More Than Self-Efficacy, Intrinsic Motivation, and Extrinsic Motivation

The mediating effects found in Study 1 differed across the motivational constructs indicating that some forms of motivation stabilize individual differences in knowledge more than others. Descriptively, the highest mediation effects were found for interest (r = .20) and self-concept (r = .14). Considerably lower, but still significant were the mediation effects for self-efficacy (r = .08), intrinsic motivation and extrinsic motivation (both r = .05). Therefore, the stability of rank orders of two knowledge tests before and after learning was best explained by interest and self-concept. However, as the intercorrelations of the motivational variables could not be determined with the applied methods, the amount of unique variance explanation for each variable was uncertain. Interest can be linked to intrinsic task values such that individuals perceive the respective content as rather enjoyable (Krapp, 2007). For self-concept, either increased expectations of success (Marsh et al., 2005), or the assignment of positive values to academic tasks for increasing or maintaining self-worth (Covington, 2000), or both may explain this finding. Nevertheless, the differences in mediation effects cannot simply be traced back to the distinction between expectations of success or subjective task values. Self-efficacy, which is linked to increased expectations of success, showed a lower mediation effect than interest and self-concept which can be related to intrinsic values and attainment task values. However, intrinsic motivation and extrinsic motivation are also related to forms of subjective task value, namely, intrinsic value and utility value, but showed low mediation effects. The mediation effects were higher for individual interest than for situational interest. This finding is in line with the conceptions of interest development, which is closely related to knowledge and knowledge

acquisition in a domain (Alexander et al., 1995; Hidi & Renninger, 2006). It is assumed that individual interest develops over time, as does knowledge. Situational interest primarily guides attention and behavior in earlier stages of engagement within a domain but can also activate in later stages of interest development. Since the stability of individual differences in knowledge by definition requires a time window in which knowledge is acquired, it seems plausible to find higher mediation effects for individual interest than for situational interest. A moderator analysis considering the time between a pretest and a posttest of knowledge may uncover whether this assumption holds. In summary, interest and self-concept were identified as the mediators most accounting for the stability of individual differences in knowledge.

8.1.3. Key Insight 3: Instruction That Prepares Learners for a Test can Lead to a Compensatory Effect of Prior Knowledge on Knowledge Gains

In Study 2, prior knowledge negatively predicted the amount of newly acquired knowledge over the course of a lecture in educational psychology (r = -.27). In other words, students with low prior knowledge at the beginning of the semester acquired more knowledge than their counterparts who were more familiar with the content. This effect was also present after controlling for the fact that highly knowledgeable students have less room to improve. The instruction was intended to prepare learners for an exam, which required a certain threshold of knowledge in educational psychology to pass. Therefore, the instruction and the exam were criterion-referenced (American Educational Research Association et al., 2014), which may be responsible for the closing of knowledge gaps between learners. This assumption is supported by previous research in reading development that found evidence for a compensatory effect of school attendance and instruction (Baumert et al., 2012; Huang et al., 2014; Pfost et al., 2014). Leppänen et al. (2004) explained the findings of compensatory effects in reading by the view of

Western societies on early education that aims at narrowing individual differences between learners instead of increasing them, similar to the goal of the lecture in Study 2. It can be concluded that instruction can be designed towards closing knowledge gaps between learners when it prepares learners to accomplish a given test.

8.1.4. Key Insight 4: High-Aptitude Students' Motivation is Independent of Prior Knowledge

Study 2 found no significant correlations between prior knowledge and subsequent course-specific forms of interest (r = -.09, p = .46), self-concept (r = .03, p = .78), and self-efficacy (r = -.13, p = .24). The sample size was large enough to detect hypothetical effect sizes that corresponded to the b1-paths of Study 1 for interest and self-concept, but not for self-efficacy. As prior knowledge did not predict subsequent motivation, consequently no mediating effects of each motivational variable were found for the relation between prior knowledge and learning gains. The finding that prior knowledge is not a predictor of subsequent motivation is in contrast to previous research on academic achievement as a predictor of interest (Rotgans & Schmidt, 2017), self-concept (Helmke & Van Aken, 1995), and self-efficacy (Honicke & Broadbent, 2016). Prior knowledge can be unrelated to motivation, but the absolute values of self-beliefs can still be high. Experienced students at an advanced stage of their studies (i.e., experts in studying), might base their judgements on previous experiences from academic contexts (Pajares & Miller, 1994; Wolff et al., 2018), but not on their prior knowledge in the lecture content. Our results show that after the lecture and the exam, self-concept and self-efficacy did not increase, whereas knowledge was positively associated with these variables. Therefore, students who initially perceive themselves as successful can integrate acquired knowledge into the structure of their self-beliefs.

8.1.5. Key Insight 5: Knowledge Acquisition Processes do not Only Affect Motivation but Also Health Outcomes.

The results from Study 2 and Study 3 demonstrate that knowledge acquisition has very different impacts on human experience and behavior. Study 2 demonstrated that knowledge has influences on the structure of motivational self-beliefs. Study 3 showed that knowledge can also affect the health of humans. Patients who suffer from neoplasms, diabetes, mental or behavioral disorders, diseases of the circulatory or respiratory system, or diseases of the musculoskeletal system improve in various health outcomes. They report increased physiological, physical, and psychological functioning, and reduced pain. Patients receiving patient education show decreased medication intake, fewer visits to medical institutions, and increased overall functioning. By considering the results of randomized controlled trials, these effects can be considered causal. In previous studies, knowledge was found to mediate between demographic variables such as socioeconomic status as well as level of education and indicators of health and health-related behavior (McLeod et al., 2011; Noroozi et al., 2018; Schillinger et al., 2006). Therefore, resource disparities between patients that shape health behaviors can be reduced to some extent by promoting health-related knowledge.

8.1.6. Key Insight 6: A Better Understanding of the Interplay of Knowledge and Motivation can Help Develop Cost-Effective Interventions for Patient Education

The results of Study 3 show that patient education is effective in improving health-related outcomes, but the interventions applied could possibly be even more effective if research on instruction, including influences of prior knowledge and motivation on learning, would be taken into account. This is, so far, rarely the case. Differences in levels of education cause patients to have different amounts of prior knowledge about their diseases (Furnée et al., 2008). The aim of

patient education is therefore not only to convey health-related knowledge and skills, but also to close the knowledge gaps between patients with high and low prior knowledge. As Study 2 showed, this compensatory effect can be achieved via criterion-oriented instruction that prepares learners for a given test. Moreover, influences of motivation could be considered. Studies investigating the processes that lead to health-related behavior found that self-efficacy mediated the relation between health knowledge and self-care behavior (i.e., monitoring the disease and symptom management) in chronic kidney disease patients (Wu et al., 2016), quality of life in patients with epilepsy (Amir et al., 1999), disease-preventive behavior (Isa et al., 2013), and dietary behavior (Rimal et al., 2011). Experiences of disease-related self-efficacy can be fostered by implementing role models as a part of patient education (e.g., through the use of patient interviews in educational videos; (Appalasamy et al., 2018)). Although patient education is an effective cost-beneficial intervention, it is rarely used by medical practitioners, presumably due to lack of time and earnings (Girois & Sanson-Fisher, 1996). One proposal for an element of evidence-based patient instruction derived from the findings of this dissertation is given in Chapter 8.2.

8.2. Practical Implications

Two practical implications are proposed on the basis of the findings of this dissertation. The first one is to assess learners' prerequisites such as prior knowledge and motivation in educational contexts to adapt instruction to the needs of the learners. As noted in Key Insight 4, high-aptitude learners with low prior knowledge can have well-developed self-beliefs that are based on other sources than their prior experiences with the content. Therefore, it would not be reasonable to foster students' motivation by referring to their prior knowledge when they possess only little of it. In contrast, students who have already acquired some knowledge about a topic,

increasingly relate their academic self-efficacy and self-concept to what they know. For these students, referring to their knowledge and skills can promote motivation for future learning activities. The assessment of (prior) knowledge and motivation can be accomplished within the context of formative assessments and be combined with techniques such as feedback on the progress towards learning goals and the attribution of students' success to the effort they put into the tasks (Cauley & McMillan, 2010). The assessment of prior knowledge also makes it possible to adapt instruction so that a compensatory effect is accomplished. If individual differences in prior knowledge are high, the main goal of instruction could be to provide learners with a defined minimum set of competencies rather than providing them with as much diverse content knowledge as possible. For example, in a group of children who have large differences in basic arithmetic knowledge, the assessment of prior knowledge could provide the teacher with valuable knowledge that allows him to close arithmetic knowledge gaps before continuing with instruction on algebra.

The second practical implication is to introduce mandatory tests of conceptual understanding in applied health practice to ensure that patients can make genuine decisions when undergoing medical treatment. There are few, if any, non-academic or non-vocational contexts in which it is important for people to have the knowledge necessary to make decisions. In most clinical settings, patients have to give their informed consent to medical treatments, which requires an understanding of the relevant medical information to make a responsible decision for or against a particular treatment (American Medical Association, n.d.). However, when patients are tested for their comprehension of the basic components of informed consent, they score considerably low (Pietrzykowski & Smilowska, 2021). From an ethical perspective, this finding is alarming because patients often seem unaware of what they consent to. As mentioned in Key

Insight 6, patients differ in their prior health-related knowledge, which influences the acquisition of knowledge and skills as taught by medical practitioners. Key Insight 3 suggests that instruction towards a test leads to a compensatory effect that closes previous knowledge gaps while providing effective knowledge dissemination. A short standardized mandatory test for undergoing medical treatment could be implemented to ensure that patients have a basic understanding to give genuine informed consent, similar to the theory test required for the driver's license. If patients failed the test, they could recap the instructional material and take the test repeatedly until they succeeded. The implementation would, on the one hand, reduce ethical concerns and, on the other hand, make the dissemination of knowledge more criterion-oriented. To introduce this approach into mainstream health practice, it would first need to be better researched. Subsequently, it would be the responsibility of practitioners to implement this practice cost-effectively.

8.3. Implications for Future Research

The findings of this dissertation shed light on aspects of knowledge acquisition with an emphasis on intra-learner processes. However, the results also pose starting points for future research. In the next sections, I propose four different clusters of research implications to encourage researchers to pursue some uncovered mysteries of knowledge acquisition that could not be answered within this dissertation.

8.3.1. Methodological Implications

The first set of implications for future research concerns methodological issues. Foremost, the use of prior knowledge as an independent measure is necessary to detect learning gains but it may not be the best predictor of motivation. Therefore, the operationalization of competence-based constructs should carefully be selected for research. Dochy et al. (1999) found that studies

that used self-reports or familiarity ratings as a proxy for prior knowledge reported ambiguous effects of prior knowledge on learning outcomes. In some cases, significant effects were not present or even negative. In these cases, it remains unclear whether prior knowledge was not related to learning outcomes (as reported in Study 2) or whether the measure was flawed. Therefore, Dochy et al. (1999) recommended using objective prior knowledge tests to analyze learning. However, methods other than objective knowledge tests could provide insights into different processes. As noted in Key Insight 4, objective prior knowledge may not be the primary source for self-efficacy and self-concept, especially when the magnitude of prior knowledge is rather low. In this case, other measures may be better predictors of motivational constructs. Considering that self-schemata likely depend on interpretations of one's own experience (Eccles & Wigfield, 2020), subjective measures may be better suited for the prediction of self-efficacy and self-concept. For example, Morony et al. (2013) argued that confidence in the correctness of a previously given answer or a taken test is closely related to evaluations of the item difficulty, the likelihood of having given a correct answer, and one's capabilities. Given these similarities, it looks promising to observe the development of self-referenced motivational constructs along with judgments of confidence. In addition, as found in Study 2, self-efficacy and self-concept were related to objective knowledge and learning after the lecture. Therefore, for the investigation of the development of these constructs, both confidence measures and objective measures may be used in conjunction.

The second methodological aspect is the plea for more analyses of learning gains in educational research. Although the main goal of instruction is to achieve some sort of change in cognitive structures or behavior as a result, a better understanding of the processes that lead to this goal would be helpful for research and instructional design. The calculation of values that

reflect the *growth* of knowledge allows for analyses of covariates and mediation analyses. If more researchers decided to include measures of growth, systematic reviews and meta-analyses of covariates would be possible to identify the most important variables related to learning processes. In addition, heterogeneity among effect sizes and conditions that influence the relation between learning and could be determined. A sophisticated method of analyzing the mediation effects of multiple mediators at once in a meta-analysis is described by Cheung (2021).

The analysis of knowledge growth can be performed with a third method that was not applied in this dissertation. As explained in Study 2, the calculation of normalized learning gains has advantages over absolute gains. However, a third method was proposed by Walstad and Wagner (2016). This method considers four types of transitions of scores from pretest to posttest for each item in the test, two of which reflect desirable for instruction and two of which reflect failed learning. Learners that gave an incorrect response at the pretest but a correct response in the posttest underwent a desirable transition, which is called *positive learning*. Learners that previously gave a correct response that they later replicated also showed a desirable performance because they were able to maintain the correct knowledge, which is called *retained learning*. Nevertheless, the opposite patterns are also possible. Learners that gave a correct response to an item in the pretest but an incorrect response on the same item in the posttest show *negative learning* because they were not able to retrieve the necessary knowledge anymore. Students that gave an incorrect response on both occasions were not able to acquire knowledge during the learning phase and therefore show *zero learning*.

The advantage of this method is that it provides more detailed information on the processes that take place during learning. The traditional method that calculates differences in scores on the test level fail to capture all of these transitions. For example, a student who has the

same score before and after learning has an absolute and a normalized gain of 0. This does not provide information on the pieces of knowledge the student newly acquires, maintained, forgot, or failed to memorize. Forgetting the complete prior knowledge while acquiring the same amount of new knowledge or completely maintaining prior knowledge while no new knowledge is acquired would both yield a difference score of 0. The application of this method would provide more detailed insights into the processes that take place during learning. For example, Ramirez et al. (2017) found that students' perception of stress in a mathematics course interacted with their mathematics self-concept with their mathematical self-concept and facilitated the extent to which they forgot the course content.

As a third methodological implication, the inclusion of third variables is encouraged to detect influences on the predictive quality of prior knowledge on posttest knowledge and pretest-posttest learning gains. This was done in Study 1 and 2 where a mediation analysis was performed to test the hypothesis of whether motivation mediated these relations. Whereas a significant mediation effect was found in Study 1 for the stability of individual differences in knowledge, no significant mediation effect was found for the relation between prior knowledge and learning gains. More mediation analyses on these relations are required. However, there is another possible result that can be detected apart from the explanation of shared variance when taking third variables into account. The presence of a suppressor variable is another possibility that was previously not mentioned. When a suppressor variable is included in a model, the direct effect of the predictor on the criterion becomes larger than the total effect where the suppressor variable is not controlled (Judd et al., 2014). In the case of the zero correlations for learning gains found in the meta-analysis by Simonsmeier et al. (2021) and the zero correlations regarding the stability of individual knowledge differences in Study 2, the responsible suppressor variable was

perhaps simply not detected. The identification of the possibility of hidden suppressor variables remains an objective of future research.

8.3.2. Covariates of Learning

In this dissertation, the role of motivation in knowledge acquisition was investigated in detail, but many other constructs would be worth examining in conjunction with learning, too. There is plenty of research on covariates of learning outcomes and achievement (e.g., see Hattie, 2009; Schneider & Preckel, 2017 for research syntheses), but Study 2 of this dissertation was the first one to examine covariates of learning gains. In this paragraph, I give two examples of additional psychological variables that could be covariates or mediators of learning but were not investigated within the scope of this work.

First, it may be that individual differences in attitudes toward knowledge and performance influence learning of new content. Baytelman et al. (2020) found that students' prior content knowledge was both associated with the quality of given arguments in topic-dilemmas and their epistemic beliefs. Additionally, epistemic beliefs regarding the structure of knowledge incrementally accounted for variance in the quality of given arguments. Epistemic beliefs may therefore be a possible strengthening mediator variable for the association between prior knowledge and learning. Test anxiety, in contrast, is a construct that could be negatively related to learning. Schneider and Preckel (2017) identified test anxiety as having the second-highest negative association with academic achievement in a list of 105 variables. Calvo et al. (1992) found that students with high test anxiety differed from their counterparts with low test anxiety in their vocabulary knowledge. Students' amount of prior knowledge explained this finding better than the hypothesis of a reduced working memory due to inferences of worrying thoughts. It is unclear whether test anxiety leads to impaired knowledge acquisition or whether low knowledge

causes experiences of test anxiety or both, which would be represented by a downward spiral.

Second, although motivation is an important variable in self-regulated learning, e.g., because it determines the time spent for studying (Everaert et al., 2017), the quality of learning activities is crucial for the outcomes of learning. Plant et al. (2005) found that study time was only a significant predictor of cumulative GPA when deliberate practice in learning activities and prior achievement were included in the regression model. Hence, it is more important *how* students spend their time learning than *how much time* they spend learning. The authors suggested that the amount of previously acquired studying skills and domain-specific knowledge influenced the quality of studying. This assumption is supported by previous evidence of prior knowledge affecting increased metacognitive strategy use and less variability in strategy use during learning (Moos & Azevedo, 2008). In conjunction with better learning outcomes, deliberate practice would be a mediator for the relation between prior achievement and learning outcomes (and probably learning gains as well).

Mediators of learning processes may be influenced by moderator variables so that they are process variables in some circumstances but not in others, which would imply the presence of moderated mediation effects (Preacher et al., 2007). This makes it difficult to clearly identify or rule out variables as mediators for learning within single studies. It is possible that the findings of the mediation analyses in Study 1 and 2 largely differ if other samples, methods, domains or learning settings were investigated. For example, stress can negatively influence academic achievement (Richardson et al., 2012), but this effect is weaker with increasing age (Gustems-Carnicer et al., 2019). Cognitive abilites of learners could interact with learning processes in many ways. In a study by Hambrick and Engle (2002), participants benefited from higher working memory capacity in a baseball learning task but also from their amount of prior

knowledge. This resulted in an interaction effect which caused high knowledge participants with high working memory capacity to better use their knowledge for learning. Fuchs et al. (2014) found that students with very low working memory capacity learned better when they explained mathematical procedures whereas students with higher but still low working memory capacity benefited more from automatization tasks. Motivation may interact with working memory in learning. Brooks and Shell (2006) considered both constructs in their model and posited that novice learners need to allocate working memory resources for motivational regulation when struggling with the learning material, whereas experts do not need to allocate additional working memory recourses to motivation because of higher automatization.

In sum, more research is needed on third variables associated with the learning of new information. Some of them may simply covary with learning gains, whereas others may be mediators for learning. Attitudinal variables such as epistemic beliefs and test anxiety as well as behavioral variables such as deliberate practice and the use of learning strategies can be interesting variables. The investigation of the relations of third variables and learning is complicated by the impacts of moderator variables that can leverage effects so that careful theoretical considerations for the planning of studies and the interpretation of results are essential.

8.3.3. Research on Meso- and Macro-Level Influences

This dissertation mainly focused on knowledge acquisition on the micro level, but there are many influences from the meso and the macro level that affect the intra-learner processes. Large research syntheses have already uncovered the impacts of influences from the meso level such as those of social interaction, instructional methods, and the appropriate use of media (Hattie, 2009; Schneider & Preckel, 2017). Accordingly, there are large effects of social

interaction that can be stimulated by the teacher, e.g., encouraging discussion, asking open-ended questions, or providing feedback. By thoroughly preparing lessons and explicitly communicating the goals of lessons, teachers can also achieve large impacts on student learning. The use of a blended learning format or interactive video methods as well as avoiding seductive details in the learning material can additionally foster learning. Influences from the meso level can not only affect learning outcomes but also the interplay of knowledge and motivation. For example, mathematically gifted students who differ in their performance also differ in their motivational patterns and their perceptions of the classroom structure (Lüftenegger et al., 2015).

Influences on the macro level regarding learning environments also influence knowledge acquisition of many individuals, although the magnitude of effects is considerably weaker than from influences on lower levels. A literature review by Wang et al. (1993) showed that proximal variables such as classroom management and learner characteristics have stronger influences on learning than distal variables such as school demographics and state-level policies. However, it has to be taken into account that elements on the macro level affect whole populations of learners. For example, the impact of the economic, social, and cultural status on children's reading performance differs between countries (OECD, 2019, p. 49). Hence, in some societies, the impact of the families' socioeconomic status is larger than in other societies.

8.3.4. The Need for an Integrated Model of Learning

The findings from this dissertation and the aforementioned implications for future research make clear that learning is an inconceivably complex process that has numerous sub-processes and interactions with variables within and outside of learners. This complexity makes it possible to conduct a variety of studies that address both very specific and more generalizable research questions, each of which attempts to explain partial aspects of learning. However, the

interplay of many influences causes the interpretation of effects, especially if they are not significant, to become more difficult. In consequence, the main goal of educational research, namely to explain and predict human learning for application in practice (Berliner, 1992), is threatened if reality cannot be represented systematically and parsimoniously. Therefore, an integrated model that represents intra-learner processes as well as environmental influences is highly necessary. Such an integrated model could be used as a starting point for educational interventions in different contexts such as patient education, where evidence-based interventions are still lacking.

9. Conclusion

The present dissertation includes three studies that examine knowledge acquisition at the learner level and provide insights into the interplay of prior knowledge and motivation, as well as health-related outcomes of learning within the context of patient education. It becomes evident that knowledge acquisition begins with the prerequisites that learners possess. Successful students are likely to maintain their good performance because they experience higher degrees of motivation. The processes leading to the acquisition of new knowledge can be influenced by instruction that is criterion-oriented and reduces the influences of motivation. The results of knowledge acquisition range from increased knowledge and improved skills to changes in motivation and people's health-related quality of life. It can also be concluded that learning is more than the sum of its parts. Rather, it is a highly complex process, which in turn arises from many other processes and is subject to influences from the environment. The numerous investigations on knowledge acquisition provided insights on both universal and highly specific aspects of learning and pose the foundation of what we currently know. Educational research is only able to explain, predict and improve human learning when findings from different lines of

research are considered together.

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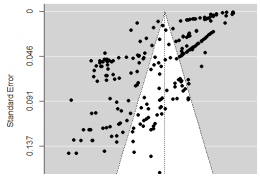
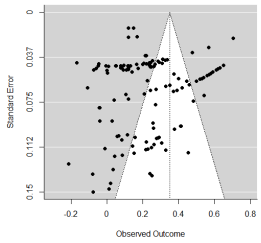
Appendix

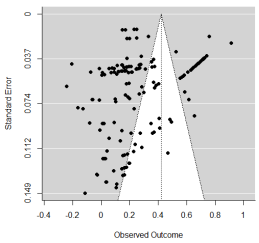
Appendix A: Funnel Plots for the Overall Correlation Between Prior Knowledge and Learning Outcomes, b1-Paths (left), b2-Paths (right), Separated by Mediators (Study 1)

Correlations between prior knowledge and learning outcomes

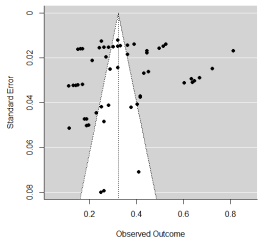


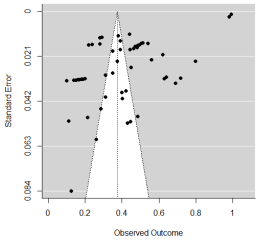
Funnel plots for interest



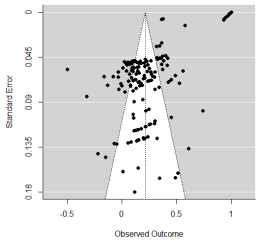


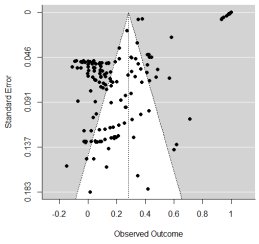
Funnel plots for self-concept



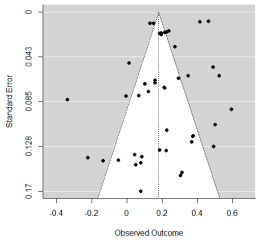


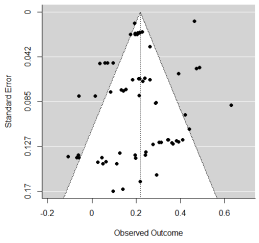
Funnel plots for self-efficacy



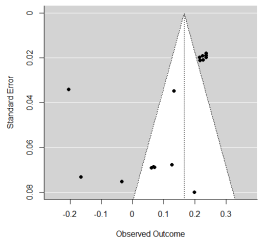


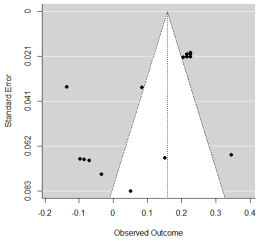
Funnel plots for intrinsic motivation





Funnel plots for extrinsic motivation





Appendix B: Original Knowledge Test (Version A) Used in Study 2

Allgemeine Instruktionen

Der folgende Test enthält Fragen zu unterschiedlichen Themen der pädagogischen Psychologie. Versuchen Sie, so viele Punkte wie möglich zu erzielen, indem Sie alle Fragen zu gut wie möglich beantworten. Greifen Sie für die Beantwortung der Fragen auf Ihr gesamtes Wissen und Ihre Erfahrungen zurück. Dazu gehören zum Beispiel Ereignisse aus Ihrer persönlichen Lebensgeschichte oder der von anderen Personen, Inhalte aus Ihrer Schullaufbahn oder Ihres Studiums, Informationen aus Medien oder persönliche Meinungen.

Geben Sie bei jeder Frage an, wie sicher Sie sich bei Ihrer Antwort sind. Tragen Sie hierfür eine Zahl von 1 bis 5 in die vorgesehenen Felder ein, wobei 1 für *Überhaupt nicht sicher* und 5 für *Sehr sicher steht*.

Für die Bearbeitung haben Sie 90 Minuten Zeit. Wenn Sie weniger Zeit brauchen, können Sie Ihren Test auch vor Ablauf der Zeit abgeben. Versuchen Sie, das Ausfüllen des Tests so selten wie möglich zu unterbrechen. Bitte verwenden Sie keine Hilfsmittel für die Beantwortung der Fragen.

Instruktionen zu den Aufgaben und der Bewertung

Bei den Ankreuzaufgaben können jeweils alle, einige oder keine der Aussagen korrekt sein. Für jede richtig bewertete Aussage erhalten

Einige Aufgabentexte verlangen von Ihnen, dass Sie für Ihre Antwort eine maximale Anzahl an Sätzen zur Verfügung haben. Antworten Sie in einem Fließtext aus vollständigen Sätzen. Gezählt werden volle Sätze (also nicht jeder Nebensatz einzeln). Alle Sätze, die über die erlaubte Anzahl hinausgehen, werden bei der Bewertung ignoriert. Grammatikalisch unvollständige Sätze werden ebenfalls ignoriert.

Aufgabe 1 (6 Punkte)

Stellen Sie sich vor, Sie müssten eine internationale Studie planen, in der die schulische Leistung von SchülerInnen aus unterschiedlichsten Ländern mit eigenen Lehrplänen untersucht wird. Welche Probleme hinsichtlich der Inhaltsvalidität des Tests sehen Sie? Wie könnte man dieses Problem lösen? Erklären Sie in maximal drei Sätzen.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort? (1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*) ☐

Aufgabe 2 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Schülerleistungsstudien.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Domänenspezifisches Grundwissen und domänenspezifische Grundbildung sind synonyme Begriffe.			
Man kann bessere Aussagen über die Grundgesamtheit der Schülerpopulation treffen, wenn die Studienteilnehmer nur einen ausbalancierten Anteil des gesamten Aufgabenpools bearbeiten.			
Für die Einschätzung von Fähigkeiten ist es sinnvoll, Ergebnisse aus Schülerleistungstests in Kompetenzstufen zu unterteilen.			
Im Ländervergleich zeigen die Schulsysteme mit einer Auslese von schwachen Schülern zwar im Schnitt die besten Ergebnisse, dafür geht die Schere zwischen guten und schlechten Schülern dort aber weiter auseinander.			
Kinder, die besser lesen können, nutzen überzufälllig oft auch adäquate Lernstrategien.			
Wenn gute und schlechte Schüler zusammen unterrichtet werden, hat das im Schnitt eine positive Auswirkung auf die Leistung der gesamten Gruppe.			

Aufgabe 3 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Unterrichtsqualität.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Die Schulgesetze und Lehrpläne der Länder sind wichtiger für den Lernerfolg der SchülerInnen als die Unterrichtsgestaltung durch die Lehrkräfte.			
In der Lernforschung sind generalisierbare Aussagen kaum möglich, weil jede Studie andere Lernmaterialien, Lernerfolgsmaße etc. verwendet.			
In großen Klassen lernen die SchülerInnen deutlich schlechter als in kleinen Klassen.			
Lehrertrainings gehören zu den stärksten Einflüssen auf den Lernerfolg der SchülerInnen, die bisher in der Forschung gefunden wurden.			
Je mehr soziale Interaktionen es zwischen Dozierenden und Studierenden in der Lehre gibt, desto besser ist auch der Lernerfolg.			
Für den Lernerfolg im Studium ist es nicht ausschlaggebend, in welchem Ausmaß Technik in der Lehre verwendet wird.			

Aufgabe 4 (6 Punkte)

Ordnen Sie die folgenden Variablen danach, wie sehr sie einen Einfluss auf Lernerfolg in der Schule haben:
Gestaltung des Lehrplans, Gesellschaftliche Rahmenbedingungen, Häusliches Klima und elterliche Unterstützung, Soziale Interaktionen zwischen SchülerInnen und Lehrkräften, Demographische Eigenschaften der Schule, Arbeits- und Sozialverhalten der SchülerInnen.

Klicken und ziehen Sie die Felder so, dass am Ende oben der stärkste Effekt steht und unten der schwächste.

1. (stärkster Effekt)		Wie sicher sind Sie sich?
2.		
3.		
4.		
5.		
6. (schwächster Effekt)		

Aufgabe 5 (7 Punkte)

Bewerten Sie untenstehende Lernziele daraufhin, ob sie eher gut oder eher schlecht formuliert wurden.

	Eher nicht gut	*Eher gut*	*Wie sicher sind Sie sich?*
„Die Lernenden können selbstständig einen Ölwechsel bei einem Auto durchführen.“			
„ein Verständnis dafür aufbauen, ein eigenes Experiment durchführen können“			
„Die Lernenden können ein Urteil über die Qualität einer Studie abgeben.“			
„Die Lernenden werden zu mündigen Bürgern erzogen.“			
„Die Lernenden sollen eine Inhaltsangabe zu Goethes Faust schreiben.“			
„Die Lernenden können eine Definition des Begriffs Selbstwirksamkeit aufstellen.“			
„Die Lernenden wissen, welche Untersuchungsmethoden im Behaviorismus eingesetzt werden und können diese von kognitivistischen Methoden unterscheiden.“			

Aufgabe 6 (6 Punkte)

Lernziele können unterschiedlich anspruchsvolle kognitive Kompetenzen umfassen (zum Beispiel unterschiedlich anspruchsvolle Kompetenzen im Umgang mit einem Text). Bennen Sie sechs Kategorien von Kompetenzen (2. Spalte), wovon Stufe 1 am wenigsten anspruchsvoll ist und Stufe 6 am anspruchsvollsten. Erklären Sie jeweils, welche Fähigkeiten Personen auf diesen Stufen besitzen (3. Spalte).

Stufe	Name der Kompetenzstufe	Erklärung	Wie sicher sind Sie sich?
1			
2			
3			
4			
5			
6			

Aufgabe 7 (6 Punkte)

Gruppenarbeiten sind manchmal mehr, manchmal weniger erfolgreich. Was sind Erfolgskriterien für eine gelingende Gruppenarbeit? Begründen Sie Ihre Antworten, indem Sie die Sätze vervollständigen.

1. Gruppenarbeiten funktionieren gut,

   wenn_____

   _____ ,

   weil

   _____

   ____.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort? ☐
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*)

2. Gruppenarbeiten funktionieren gut,

   wenn_____

   _____,

   weil

   _____

   ____.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort? ☐
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*)

3. Gruppenarbeiten funktionieren gut,

   wenn_____

   _____,

   weil

   _____

   ____.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort? ☐
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*)

Aufgabe 8 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Unterrichtsmethoden.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Bei Lehrervorträgen im Unterricht haben SchülerInnen keine Gelegenheit zum aktiven Aufbau von Wissensstrukturen.			
Man kann Frontalunterricht als Gruppenarbeit gestalten, um die Lernenden ins Unterrichtsgeschehen mit einzubinden.			
Fragen, die zum Denken in unterschiedliche Richtungen einladen, nennt man auch diskriminierende Fragen.			
Längere Wartezeiten auf die Beantwortung von Fragen der Lehrkraft gehen einher mit längeren Antworten und weniger unbeantworteten Fragen.			
Der Einsatz von Frontalunterricht eignet sich besonders gut am Anfang einer Unterrichtseinheit, wenn die Lernenden noch wenig Vorwissen haben.			
In einer Gruppenarbeit sollen die individuellen Beiträge der Mitglieder am Ende ersichtlich bleiben und einzeln bewertet werden.			

Aufgabe 9 (6 Punkte)

Bewerten Sie die Korrektheit folgender Aussagen über Klassenführung.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Wenn kleine Vergehen an Schulen sofort und streng geahndet werden, führt dies zu Unsicherheit und Anspannung in der Schülerschaft.			
Man kann sich operante Konditionierung im Unterricht zunutze machen, indem man unerwünschte Verhaltensweisen (z.B. unaufgeforderte Zwischenrufe) bestraft.			
Zur Schaffung eines produktiven Lernklimas gehören unter anderem die effektive Nutzung der Lernzeit, das Aufstellen sinnvoller Regeln und Maßnahmen zur Aufrechterhaltung von Disziplin und Sicherheit.			
Eine gute Klassenführung im Laufe eines Schuljahrs ist wichtiger für die Zeugnisnote als das Vorwissen, das die Lernenden am Anfang mitbringen.			
Aus motivationspsychologischen Theorien lässt sich ableiten, dass beschädigte Möbel im Klassenzimmer zu schlechterer Mitarbeit seitens der Schülerinnen führen.			
Störungen vorzubeugen ist generell effektiver als sie durch Strafen zu ahnden, weil Strafen oft den Unterrichtsfluss unterbrechen.			

Aufgabe 10

Eine Lehrkraft kommt zu Ihnen in die Beratung. Ihr Stil in der Klassenführung ist vor allem am Prinzip des Strafens ausgerichtet. Damit hat sie schon einige Erfolge erzielt. Beispielsweise hat sie erreicht, dass ihre SchülerInnen nicht mehr im Unterricht am Handy spielen. Sie klagt aber darüber, dass die mündliche Mitarbeit weiterhin unzureichend ist. Suchen Sie eine Erklärung für diesen Sachverhalt und nennen Sie mindestens drei Punkte, die bei der Nutzung von Strafen im Unterricht beachtet werden sollen. Schreiben Sie maximal fünf ganze Sätze.

Aufgabe 11 (6 Punkte)

Kopfnoten stellen eine Ergänzung zu den Schulnoten im Zeugnis dar. Nennen Sie ein Beispiel für Sozialverhalten und ein Beispiel für das Lern- bzw. Arbeitsverhalten. Erklären Sie, nach welchen Kriterien Sie für Ihre Beispiele bei der Benotung verfahren würden. Schreiben Sie maximal fünf ganze Sätze.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort?
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*) ☐

Aufgabe 12 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Leistungsbeurteilung.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Formatives Assessment beschreibt die Auswahl von Prüfungs- und Lernmaterial anhand der individuellen Fähigkeiten eines Prüflings.			
Für eine Standortbestimmung des Wissens während einer Unterrichtsstunde können sowohl Meinungen der SchülerInnen als auch kleine Zwischentests genutzt werden.			
Prozessevaluation kann in einer laufenden Unterrichtsstunde stattfinden.			
Die Ergebnisevaluation des Lernzuwachses im Unterricht fließt nicht in die Noten der SchülerInnen ein.			
Solange SchülerInnen mit einbezogen werden, stellt das Festhalten am Plan einer Unterrichtsstunde ein formatives Assessment dar.			
Die Überprüfung des Zwischenstands des Lernerfolgs in einer Unterrichtsstunde nennt sich auch summatives Assessment.			

Aufgabe 13 (6 Punkte)

Bewerten Sie die Korrektheit folgender Aussagen zu Emotionen in Lernkontexten.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Toleranz für Fehler und die Betrachtung von Fehlern als Chance fördern positive Emotionen der Lernenden.			
Die Entstehung von Emotionen im Leistungskontext lässt sich mit der Valenz des Ereignisses (positiv oder negativ) und dem akademischen Selbstkonzept (stark vs. schwach ausgeprägt) erklären.			
Es gibt wirkungsvolle Programme gegen Prüfungsangst.			
Emotionen setzt sich aus genau drei Teilen zusammen, die man als Ausdruckssanteil, Organismusanteil und Motivationsanteil beschreiben könnte.			
Wenn Lehrer für ihre Arbeit brennen, haben sie öfter das Gefühl, schwierige Situationen meistern zu können und zufrieden mit ihrer Arbeit und ihrem Leben zu sein.			
Der Lernerfolg der Schüler ist größer, wenn die Lehrkraft Spaß am Unterrichten hat, als wenn sie Spaß an den Unterrichtsinhalten hat.			

Aufgabe 14 (6 Punkte)

Anlässlich eines Beratungsgesprächs mit einem Schüler, der unter Prüfungsangst in einem Unterrichtsfach leidet, suchen Sie den Kontakt mit der zuständigen Lehrkraft. In der Hoffnung, dass Sie ihr Verhalten und die Vermittlung des Lernstoffs in den Unterrichtsstunden verändern können, geben Sie der Lehrkraft Ratschläge, wie man generell das Risiko von Prüfungsangst verringern kann. Was würden Sie ihr raten? Schreiben Sie maximal vier Sätze.

Aufgabe 15 (6 Punkte)

Burnout ist im Lehrerberuf ein großes Problem, weshalb dies in der Vergangenheit genauer erforscht wurde. Dabei sind Personengruppen mit erhöhtem Burnout-Risiko identifiziert worden. Welche Probleme müssen diese Gruppen bewältigen und welche Unterstützungsangebote für den Umgang mit diesen Problemen halten Sie sinnvoll? Nennen Sie drei Probleme und drei passende Unterstützungsangebote in maximal vier Sätzen.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort?
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*)

Aufgabe 16 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Burnout bei Lehrern.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Das Diagnoseinstrument von Burnout im Lehrerberuf erfasst emotionsbezogene Aktivierungsmuster von Lehrkräften.			
Es gibt einen Selbstüberforderungstypen, der zu viel arbeitet und schlecht von der Arbeit abschalten kann.			
Lehrkräfte die wenig Verausgabungsbereitschaft für ihren Beruf aufweisen, leiden auch am wenigsten unter körperlichen und psychischen Beschwerden.			
Vor allem ältere Lehrkräfte haben ein höheres Burnout-Risiko, was auf den stetigen Wandel an Unterrichtskonzepten und die technischen Neuerungen zurückzuführen ist.			
Lehrkräfte mit einem guten sozialen Umfeld und offener Problembewältigung leiden seltener unter Burnout.			
Schulungen für Lehrkräfte, in denen Kompetenzen wie Zeitmanagement und Problemlösekompetenzen vermittelt werden, haben sehr große förderliche Effekte.			

Aufgabe 17 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Amokläufen an Bildungseinrichtungen.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Im Unterschied zu Terroristen unterscheiden sich Amokläufer darin, dass sie während des Amoks die Kontrolle über ihr eigenes Verhalten verlieren.			
Amokläufe sind oft durch frühere vergleichbare Taten inspiriert.			
Man kann die ausgehende Gefahr einer Person einschätzen, indem man sie mit dem typischen Amokläufer vergleicht.			
Ein Amoklauf ist ein verhaltensbezogenes Symptom einer vorausgehenden psychischen Störung.			
Die Anbahnung eines Amoklaufs startet lange vorher mit einer Phase der Insichgekehrtheit, die depressive Züge aufweist.			
Je konkreter eine Person eine Amokdrohung formuliert, desto wahrscheinlicher wird sie diese auch demnächst begehen.			

Aufgabe 18 (5 Punkte)

Nennen Sie fünf Verhaltensweisen oder Erlebnismuster von Amokläufern im Vorfeld einer Tat.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort?
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*) ☐

Aufgabe 19 (6 Punkte)

Im Jahr 2005 fand eine Gerichtsverhandlung zum Verbot von Gewaltspielen vor dem US Supreme Court statt. Die American Psychological Association (APA) wurde hierfür um eine Stellungnahme gebeten. Liefern Sie drei Argumente für die Seite der Ankläger und drei Argumente für die Seite der Verteidigung und begründen Sie sie mit Ihrem Wissen über Forschungsergebnisse und Forschungsmethoden. Schreiben Sie maximal sechs Sätze.

Auf einer Skala von 1 bis 5: Wie sicher sind Sie sich bei dieser Antwort? ☐
(1 = *Überhaupt nicht sicher*, 5 = *Sehr sicher*)

Aufgabe 20 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu psychischen Auswirkungen von Medien.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Computerspielsucht hat die vergleichbare Suchtsymptome wie eine stoffgebundene Sucht.			
Die Gefahr eines Suizids ist bei computerspielsüchtigen Jugendlichen höher als bei anderen Jugendlichen.			
as häufige Erleben von Misserfolgen in der realen Welt begünstigt Computerspielsucht.			
Die Nutzung von Gewaltspielen kann Gewaltverbrechen gegen reale Personen positiv signifikant vorhersagen.			
Nutzer von Actionspielen haben signifikant häufiger eine bessere räumliche Wahrnehmungsfähigkeit.			
Wiederholte Erfahrungen mit aggressiv konnotierten Situationen führen auf lange Sicht zum Aufbau von aggressiven Erwartungsschemata.			

Aufgabe 21 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zur Kindeswohlgefährdung.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Unter Kindeswohlgefährdung fallen auch Formen der Misshandlung, die keine Gewalttaten sind.			
Körperliche Misshandlung kann sich auf die kognitive Leistungsfähigkeit des Kindes auswirken.			
Etwa drei Viertel der Opfer von sexueller Misshandlung sind Mädchen.			
Menschen, die ein Kind sexuell misshandeln, sind häufiger Männer als Frauen, und sind zu einem gewissen Prozentsatz selbst sexuell misshandelt worden.			
Sexuelle Misshandlungen, bei denen eine Frau der Täter war oder bei denen das Opfer männlich war, bleiben häufiger unentdeckt.			
Positive Ausstrahlung, Vertrauen in sich und andere Menschen sowie eine ausgeprägte Selbstwirksamkeit eines Kindes verringern die Gefahr eines Missbrauchs.			

Aufgabe 22 (6 Punkte)
Offene Frage zu Kindeswohlgefährdung.

Vernachlässigung ist die häufigste Form von Kindesmisshandlung. Erklären Sie, was Vernachlässigung genau bedeutet und geben Sie drei Beispiele für Vernachlässigung. Schreiben Sie maximal fünf ganze Sätze!

Appendix C: Original Knowledge Test (Version B) Used in Study 2

Allgemeine Instruktionen

Der folgende Wissenstest enthält Fragestellungen zu unterschiedlichsten Themen aus dem Feld der pädagogischen Psychologie. Versuchen Sie, so viele Punkte wie möglich zu erzielen, indem Sie alle 22 Fragen zu gut wie möglich beantworten. Greifen Sie für die Beantwortung der Fragen auf Ihr gesamtes Wissen und Ihre Erfahrungen zurück. Dazu gehören zum Beispiel Ereignisse aus Ihrer persönlichen Lebensgeschichte oder der von anderen Personen, Inhalte aus Ihrer Schullaufbahn oder Ihres Studiums, Informationen aus Medien oder persönliche Meinungen. Lassen Sie bei der Bearbeitung keine Aufgabe aus.

Wenn Sie bei den Fragen das Gefühl haben, die Antwort nicht zu kennen, versuchen Sie trotzdem, so viele Punkte wie möglich zu erzielen.

Geben Sie bei jeder Frage an, wie sicher Sie sich bei Ihrer Antwort sind. Tragen Sie hierfür eine Zahl von 1 bis 5 in die vorgesehenen Felder ein, wobei 1 für *Überhaupt nicht sicher* und 5 für *Sehr sicher steht*.

Für die Bearbeitung sind 90 Minuten vorgesehen. Wenn Sie weniger Zeit brauchen, können Sie Ihren Test auch vor Ablauf der Zeit abgeben. Versuchen Sie, das Ausfüllen des Tests so selten wie möglich zu unterbrechen. Bitte verwenden Sie keine Hilfsmittel für die Beantwortung der Fragen.

Instruktionen zu den Aufgaben und der Bewertung

Bei den Ankreuzaufgaben können jeweils alle, einige oder keine der Aussagen korrekt sein. Für jede richtig bewertete Aussage erhalten Sie einen Punkt. Es gibt keinen Punktabzug für falsch beantwortete Aussagen.

Einige Aufgabentexte verlangen von Ihnen, dass Sie für Ihre Antwort eine maximale Anzahl an Sätzen zur Verfügung haben. **Antworten Sie in einem Fließtext aus vollständigen Sätzen**. Gezählt werden volle Sätze (also nicht jeder Nebensatz einzeln). Alle Sätze, die über die erlaubte Anzahl hinausgehen, werden bei der Bewertung ignoriert. Grammatikalisch unvollständige Sätze werden ebenfalls ignoriert.

Aufgabe 1 (6 Punkte)
Erklären Sie in maximal drei Sätzen, worin das Problem der mangelnden Lehrplanvalidität international vergleichender Schulleistungsstudien besteht und wie es im Rahmen der PISA-Studie gelöst wurde.

Aufgabe 2 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Schülerleistungsstudien.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Literacy ist das Grundwissen einer Person in einem bestimmten Inhaltsgebiet (z.B. Mathematik).			
In Schülerleistungsstudien dient das Multi-Matrix-Design dazu, die Repräsentativität der Stichprobe zu erhöhen.			
Um die PISA-Testwerte inhaltlich interpretierbar zu machen, haben Didaktiker Kompetenzstufen definiert, die angeben, welche Kompetenzen Lernende in einem Range von Testwerten in der Regel besitzen.			
Die PISA-Ergebnisse zeigen, dass Staaten mit hohem Mittelwert auch eine hohe Streuung der Leistungen aufweisen, weil von anspruchsvollem Unterricht die guten SchülerInnen profitieren, während die schlechteren abgehängt werden.			
PISA-Ergebnissen zufolge hängen das Wissen um effektive Lernstrategien mit der Leseleistung zusammen.			
Staaten, die SchülerInnen häufig nach ihren Leistungen gruppieren, haben im Durchschnitt eine niedrigere PISA-Leistung als Staaten, die dies seltener tun.			

Aufgabe 3 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Unterrichtsqualität.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Die Integration empirischer Befunde von Wang, Haertel & Walberg (1993) belegt, dass state-level policies (z.B. Lehrpläne) besonders wichtig für den Lernerfolg von SchülerInnen sind.			
John Hattie fasste in seiner Synthese die Befunde von mehr als 800 einzelnen empirischen Studien zu den Korrelaten akademischer Leistung zusammen.			
Nach Hattie hat die Klassengröße einen starken Effekt auf den Lernerfolg.			
Nach Hattie hat unter anderem micro-teaching, also Lehrertrainings mit video- und peer-feedback, einen besonders starken Effekt auf den Lernerfolg der SchülerInnen.			
Ein Literaturreview von Metaanalysen zeigt, dass die akademische Leistung Studierender eng mit dem Ausmaß an sozialer Interaktion in der Lehre zusammenhängt.			
Die Leistung Studierender korreliert eng mit dem Ausmaß des Technikeinsatzes in der Lehre.			

Aufgabe 4 (6 Punkte)
Eine Metaanalyse von Wang, Haertel & Walberg (1993) vergleicht die Stärken der Einflüsse vieler unterschiedlicher Variablen auf den Lernerfolg. Ordnen Sie folgende Variablen nach ihrer Effektstärke: cognitive processes, state-level policies, classroom instruction, metacognitive processes, classroom management, student demographics

1. (stärkster Effekt)	
2.	
3.	
4.	
5.	
6. (schwächster Effekt)	

Aufgabe 5 (7 Punkte)
Bewerten Sie untenstehende Lernziele und Bloom-Stufen daraufhin, ob sie eher gut oder eher schlecht formuliert wurden.

	Eher nicht gut	*Eher gut*
„Die Lernenden können selbstständig einen Knopf an ein Kleidungsstück annähen. (K3)“		
„einen Leistungstest konstruieren können (K2)“		
„Die Lernenden sind in der Lage zu bewerten, ob ein Lehrziel gut oder schlecht formuliert wurde. (K6)“		
„Die Lernenden werden zu guten Psychologen. (K6)“		
„Die Lernenden sollen Systeme aus zwei Gleichungen mit zwei Unbekannten lösen. (K3)“		
„Die Lernenden können den Begriff Arbeitsgedächtnis mit eigenen Worten definieren. (K2)“		
„Die Lernenden wissen, was Synapsen sind, und können Texte über Synapsen analysieren. (K1, K4)“		

Aufgabe 6 (6 Punkte)
Benennen Sie in der Tabelle die sechs Kategorien der Lehrzieltaxonomie von Bloom (2. Spalte) und erklären Sie jeweils, welche Kompetenzen Personen auf der jeweiligen Stufe besitzen (3. Spalte).

Stufe	Name der Lehrzielkategorie	Erklärung
K1		
K2		
K3		
K4		
K5		
K6		

Aufgabe 7 (6 Punkte)
Im Rahmen des praktischen Teils einer technischen Ausbildung bauen Lernende in Kleingruppen einen Elektromotor. Schlagen Sie drei Dinge vor, die man tun sollte, um den Lernerfolg der Gruppenarbeit sicherzustellen. Wie könnte man sie konkret umsetzen? Vervollständigen Sie die Sätze.

Man sollte _____

sicherstellen, indem man_____.

Man sollte _____

sicherstellen, indem man_____.

Man sollte _____

sicherstellen, indem man_____.

Aufgabe 8 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Unterrichtsmethoden.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Im Frontalunterricht sind die SchülerInnen ununterbrochen passiv, weil die Lehrkraft die ganze Zeit spricht.			
Gruppenpuzzles sind Beispiele dafür, wie auch im Rahmen von direkter Instruktion soziale Interaktion angeregt werden kann.			
Diskriminante Fragen sind besser als konvergente Fragen zum Anregen von Diskussion und Elaboration geeignet.			
Nach dem Stellen einer Frage, sollte man 10 bis 20 Sekunden auf Antworten warten.			
Direkte Instruktion eignet sich gut zum effizienten Legen einer Wissensgrundlage.			
Zu den Voraussetzungen erfolgreicher Gruppenarbeit gehören positive Interdependenz, individuelle Verantwortlichkeit und die Reflektion der Zusammenarbeit in der Gruppe.			

Aufgabe 9 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zum Classroom Management.

	Eher falsch	*Eher richtig*	*Wie sicher sind Sie sich?*
Die Zero Tolerance Policy an Schulen führt nicht dazu, dass die Lernenden sich dort sicher und entspannt fühlen.			
Wie der Behaviorismus zeigt, kann man Strafen gut dazu nutzen, um unerwünschtes Verhalten abzubauen.			
Gutes Classroom Management besteht u.a. darin, klare Regeln und Routinen für die gemeinsame Arbeit zu etablieren.			
Gutes Classroom Management ist ein besserer Prädiktor für die Schulleistung als das Vorwissen zu Beginn des Schuljahres.			
Laut der Broken Windows Theory müssen die körperlichen Grundbedürfnisse erfüllt sein, bevor man lernen kann (z.B. heile Fenster und Heizung im Winter).			
Low Profile Classroom Management macht Unterricht durch Störungsprävention effektiver.			

Aufgabe 10
Ein befreundeter Lehrer sagt Ihnen, er würde seine Schüler niemals bestrafen, weil Strafen ineffektiv. Erklären Sie, was Strafen bewirken können, was nicht und nennen Sie mindestens drei Punkte, die bei der Nutzung von Strafen im Classroom Management beachtet werden sollen. Schreiben Sie maximal fünf ganze Sätze.

Aufgabe 11 (6 Punkte)
Bewerten und erklären Sie in maximal sechs Sätzen so konkret wie möglich, was Kopfnoten sind, welche Vor- und Nachteile sie haben und warum Sie für oder gegen eine Nutzung von Kopfnoten in Schulzeugnissen sind.

Aufgabe 12 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen.

	Eher falsch	*Eher richtig*
Die Idee des formativen Assessments stammt ursprünglich aus der Pilotenausbildung.		
Sowohl qualitative als auch quantitative Daten können als formative Assessments genutzt werden.		
Formative Assessments können vor oder während einer Unterrichtseinheit stattfinden.		
Summative Assessments werden oft nicht benotet.		
Eine Lehrerin plant eine Unterrichtseinheit vollständig im Voraus. In der Mitte befragt sie Lernende, um einen Zwischenstand des Lernerfolgs zu erheben. Die Befragung stellt ein formatives Assessment dar.		
Ein Lehrer unterhält sich in der Pause zwischen zwei Unterrichtseinheiten informell mit einem Schüler. Er passt die zweite Unterrichtseinheit an das an, was er im Gespräch über das Funktionieren der ersten Lerneinheit erfahren hat. Es handelt sich beim Pausengespräch um ein summatives Assessment.		

Aufgabe 13 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Emotionen in Lernkontexten.

	Eher falsch	*Eher richtig*
Für positive Leistungsemotionen ist es förderlich, wenn die Lehrkraft verdeutlicht, dass Fehler der Schüler im Unterricht erlaubt und als Lerngelegenheiten sogar nützlich sind.		
Nach Pekruns Kontroll-Wert-Theorie hängen Leistungsemotionen von der Valenz eines Ereignisses (positiv oder negativ) sowie vom eigenen Selbstwertgefühl (hoch oder niedrig) ab.		
Prüfungsangst lässt sich durch therapeutische Ansätze sehr effektiv reduzieren.		
Emotionen haben genau drei Komponenten: eine expressive, eine physiologische und eine motivationale.		
Die Begeisterung von Lehrern korreliert positiv mit ihrer Selbstwirksamkeit, ihrer Arbeitszufriedenheit und ihrer Lebenszufriedenheit.		
Bei Lehrkräften korreliert die Begeisterung für das Unterrichten stärker mit dem Lernerfolg der Schüler als die Begeisterung für die Unterrichtsinhalte.		

Aufgabe 14 (6 Punkte)
Beschreiben Sie in maximal vier Sätzen, wie das Lehrerverhalten und die Vermittlung des Lernstoffs die Entstehung von Leistungsängstlichkeit begünstigen können.

Aufgabe 15 (8 Punkte)
Mittels Clusteranalysen wurden in den Studien von Schaarschmidt vier Typen von arbeitsbezogenen Verhaltens- und Erlebensmustern gefunden. Benennen und beschreiben Sie diese in maximal vier Sätzen.

Aufgabe 16 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Burnout bei Lehrern.

	Eher falsch	*Eher richtig*
Ein wichtiges Erhebungsinstrument zur Diagnose des Burnout-Risikos bei Lehrern ist der EVAM (Emotionsbezogene Verhaltens- und Aktivierungsmuster).		
Personen mit Risikomuster A zeichnen sich durch hohe Verausgabungsbereitschaft und niedrige Distanzierungsfähigkeit aus.		
Sich im Berufsalltag so weit wie möglich zu schonen, ist die beste Burnoutprophylaxe.		
Wie die vielen Frühpensionierungen zeigen, ist Burnout vor allem ein Problem von älteren Lehrern, deren Kräfte nachlassen, während die Berufsanforderungen gleichbleiben.		
Soziale Ressourcen sowie systematisches und aktives Angehen von Problemen gehören zu den wichtigsten Schutzfaktoren vor Burnout.		
Durch das Training zur Burnout-Prävention von Schaarschmidt konnte die Häufigkeit des Gesundheitsmusters in der untersuchten Stichprobe mehr als verdreifacht werden.		

Aufgabe 17 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu Amokläufen an Bildungseinrichtungen.

	Eher falsch	*Eher richtig*
Amok kann sinngemäß definiert werden als ein Kontrollverlust über das eigene Verhalten, der zu einer Episode mörderischen oder erheblich destruktiven Verhaltens führt.		
Aufgrund von Nachahmungstaten ist die Wahrscheinlichkeit eines Amoklaufes an Jahrestagen früherer Amokläufe erhöht.		
Bei Personen, die dem typischen Täterprofil entsprechen, besteht eine hohe Wahrscheinlichkeit dafür, dass sie einen Amoklauf begehen werden.		
In 100% aller bisher wissenschaftlich untersuchten Fälle hatte der Täter bereits im Vorfeld der Tat eine schwere psychische Störung.		
Im Vorfeld der Tat gehen über einen längeren Zeitraum hinweg Grübeleien fließend über in eine immer detailliertere Tatplanung.		
Jemand, der eine vage und unkonkrete Amokdrohung ausspricht, wird die Tat mit niedrigerer Wahrscheinlichkeit kurz später wirklich begehen als jemand, der eine konkrete und detaillierte Drohung ausspricht.		

Aufgabe 18 (5 Punkte)
Zählen Sie in Stichworten die typischen Phasen der Anbahnung von Amokläufen an einer Bildungseinrichtung auf.

Aufgabe 19 (6 Punkte)
Die Auswirkungen von Computerspielen mit aggressiven Inhalten auf die Aggressivität von Menschen außerhalb von Computerspielen ist ein aktuelles Forschungsfeld. Fassen Sie den derzeitigen Stand der Forschung in maximal drei Sätzen zusammen.

Aufgabe 20 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zu psychischen Auswirkungen von Medien.

	Eher falsch	*Eher richtig*
Die häufige und lange Nutzung von Computerspielen geht in der Regel mit Kontrollverlust, Toleranzentwicklung, einer Einengung des Handlungsspielraums und ähnlichen Suchtsymptomen einher.		
Die Häufigkeit von Selbsttötungsgedanken ist in Jugendlichen mit Computerspielsucht höher als in anderen Jugendlichen.		
Ob für eine Person Computerspiele die einzige Quelle von Erfolgserlebnissen darstellen, ist ein guter Prädiktor für eine Computerspielabhängigkeit.		
In einer Metaanalyse korrelierte die Häufigkeit des Spielens von Gewalt-Computerspielen mit der Häufigkeit echter Gewalttaten zu r = .15.		
Es gibt Hinweise darauf, dass das Spielen von Actionspielen am Computer mit guter visueller Aufmerksamkeit assoziiert ist.		
Das general aggression model von Anderson und Bushman besagt, dass die Akkumulation von vielen einzelnen aggressiv gefärbten Lernerfahrungen über längere Zeit hinweg letztlich zu einer stärker aggressiven Persönlichkeit führt.		

Aufgabe 21 (6 Punkte)
Bewerten Sie die Korrektheit folgender Aussagen zur Kindeswohlgefährdung.

	Eher falsch	*Eher richtig*
Vier Formen der Kindeswohlgefährdung, die häufig unterschieden werden, sind Vernachlässigung, körperliche, psychische und sexualisierte Misshandlung.		
Körperliche Misshandlung führt unter anderem auch zu massiven psychosozialen Beeinträchtigungen der kindlichen Entwicklung.		
Von körperlicher Misshandlung sind leicht mehr Jungen als Mädchen und von sexualisierter Misshandlung sind deutlich mehr Mädchen als Jungen betroffen.		
Wer als Kind misshandelt wurde, wird dadurch mit gewisser Wahrscheinlichkeit, aber nicht immer automatisch später selbst wieder zu einem Täter.		
Gesellschaftlich weniger bekannte Konstellationen sexualisierter Misshandlung (z.B. weibliche Täterinnen und/oder männliche Kinder) verstärken Scham und Verschwiegenheit der betroffenen Kinder.		
Zu den Schutzfaktoren für Misshandlung zählen u.a. sprachliche, motorische und kommunikative Kompetenz sowie gute Problemlösefähigkeiten eines Kindes.		

Aufgabe 22

Laien vergessen manchmal, dass auch die Vernachlässigung eine ernstzunehmende Form der Kindesmisshandlung darstellen kann. Erklären Sie, warum es sinnvoll ist, Vernachlässigung als eine Form der Kindesmisshandlung anzusehen.

Appendix D: Details of Included the Studies in the Second-Order Meta-Analysis (Study 3)

Reference	Health issue	Description of educational intervention[a]	Components of patient education	List of outcomes	List of included comparison groups	Year Range	Number of ESs indicating positive /no/negative effects	Mean Cohen's *d*	Methodological quality[c] (critical items)
Adiewere et al. (2018)	Diabetes	Patient education	• Individual sessions • Group sessions • Presentation • Handouts • Video • Discussion • Telephone call	• Diabetic foot ulcers	• Standard care	1987-2015	0/1/0	0.55	Critically low (3, 7, 10, 15)
Alahakoon et al. (2020)	Diabetes	Patient education *"Structured education provided to participants aimed at improving their knowledge and foot care"*	• Information provision • Leaflets • Face-to-face session • Group session	• Total amputations	• Standard care	2012-2019	0/1/0	0.17	Critically low (3, 7, 10)
Alipanah et al. (2018)	Tuberculosis	Adherence interventions *"Education and counseling interventions were those aimed at providing adequate knowledge and ensuring patient understanding of*	• Oral and written educational materials	• Treatment success • Loss of follow up • Mortality	• Standard care	1999-2014	1/2/0	0.19	Critically low (2, 3, 5, 6, 7, 8, 10)

		the disease process and risks and benefits associated with treatment adherence"							
Bennett et al. (2016)	Cancer	Educational interventions "*Any advice, information, or self-management education (verbal, written, or audiovisual) provided in order to help people understand and manage cancer-related fatigue."*	• Telephone sessions • Provision of written information • Internet based education • Presentation • Audio-visual and computerized educational materials • Audiotape • Self-guided interactive videodisc module • Individualized intervention • One-to-one and education • Group education • Face to face group discussion	• General fatigue • Fatigue intensity • Fatigue distress • Fatigue interference • Use of fatigue management strategies • Activities of daily living or physical functioning • Depression	• Standard care • Waitlist • Attention control • Other intervention	2004-2015	5/2/0	0.32	Low (15)
Bernard-Bonnin et al. (1995)	Asthma	Teaching intervention on self-management of asthma	• NA	• Asthma attacks • Stay at the hospital in days	• Standard care	1981 - 1991	2/0/0	0.01	Critically low (1, 2, 3, 8, 10, 15)
Beynon et al. (2008)	Bipolar disorder	Group psychoeducation	• NA	• Relapses to hospital • Relapses (as stated by author)	• Non-structured group meeting	2003-2003	4/0/0	0.74	Critically low (1, 2, 3, 4, 7, 10, 15)

				• Manic relapses • Depressive relapses					
Bond and Anderson (2015)	Bipolar disorder	Psychoeducation "*Discrete psychological intervention involving primarily the patient with bipolar disorder; providing information about bipolar disorder and/or its treatment; and relating this information to aiding self-management of the disorder"*	• Individual sessions • Group sessions • Individual and group sessions	• Relapse • Manic/hypomanic relapse • Depressive relapse	• Standard care • Non-directive group sessions • Relaxation group sessions • Individual brief medication explanation • Cognitive behavioral therapy • Family-focused therapy • Functional remediation	1999-2011	0/3/0	0.10	Critically low (2, 3, 10)
Brand et al. (2013)	Osteoarthritis	Arthritis self-management education	• Skills mastery • Modeling • Reinterpretation of symptoms • Persuasion • Pain coping strategies • Provision of information (.e.g., current research, medications, diet) • Practical demonstrations • Ergonomics	• Pain • Other symptoms • Function	• No control group • Standard care • Waiting list • Arthritis education spousal support	1993-2001	5/0/0	0.29	Critically low (2, 3, 4, 7, 10, 11, 14, 15)

Brown (1990)	Diabetes	Diabetes patient education	• Individualized and group instruction • Information sheets, handouts, booklets • Slides • Cassettes • Audiovisual materials • Computer-based instruction	• Insulin injection skill[a] • Urine testing skill[a] • Dietary compliance[b] • Glycosylated hemoglobin HbA1c • Blood sugar • Urine sugar • Insuline dose • Cholesterol • Blood pressure • Medical care	• No control group • Control group (N/A)	1954 - 1989	7/0/0	0.32	Critically low (1, 2, 3, 7, 10, 15)
Brown (1992)	Diabetes	Diabetes patient education	• NA	• Knowledge[b] • Weight loss • Skill performance[b] • Glycosylated hemoglobin HbA1c • Psychological outcomes	• No control group • Control group (N/A)	1961-1989	10/5/0	0.36	Critically low (1, 2, 3, 5, 6, 7, 10, 15)
Coffman et al. (2008)	Asthma	Pediatric asthma education	• Individual and group education • Educational computer game	• Number of hospitalizations	• Standard care	1981-2000	1/0/0	0.35	Critically low (1, 2, 3, 5, 6, 7, 9, 10, 12, 13)
Devine and Reifenschneider (1995)	Hypertension	Patient education	• Structured or self-directed content on hypertension	• Blood pressure • Knowledge[b] • Medication compliance[b]	• Standard care • Placebo • Placebo and routine care • No control group	1965-1993	4/0/0	0.33	Critically low (1, 2, 3, 5, 7, 10, 16)

Devine (1996)	COPD	Patient education	• Didactic content, for example what is asthma, self-management of asthma, breathing techniques, and use of medication	• Asthmatic episode • Dynamix respiratory volume • Peak expiratory flow rate • Functional status • Medication adherence[b] • Utilization of health care • Use of PRN medication	• Standard care • Placebo/alternate treatment • No control group	1965-1994	6/1/0	0.45	Critically low (1, 2, 3, 5, 7, 10)
Donker et al. (2009)	Depression	Passive psychoeducation „*A passive psychoeducational intervention is defined as an intervention which provides information, education materials or feedback/advice. Examples of passive psychoeducation are programmes offered to individuals through leaflets, posters, audio-visual aids, lectures, internet material or*	• Website • Provision of information and feedback on test results via telephone calls and email • Leaflets	• Depression symptoms	• No intervention • Attention-placebo • Waitlist	1999-2008	1/0/0	0.26	Critically low (2, 3, 7, 10)

		software which aims to educate the recipient about the nature and treatment of depressive and/or anxiety disorders or psychological distress.“						
Effing et al. (2007)	COPD	Self-management education	• Individual and group sessions • Patient brochure • Action plan • Medical management	• Medication • Respiratory-related hospital admissions • All cause hospital admission • Lung function • Distress • Anxiety • Depression	• Standard care	1991-2005	1/3/0	0.12	Critically low (3, 10, 15)
Faller et al. (2013)	Cancer	Information-only interventions *“Information-only interventions typically have short duration and low intensity, and they provide health information without the other components of psychoeducation.”*	• NA		• No intervention • Attention-placebo	1975-2010	0/7/0	0.04	Critically low (2, 3, 7, 10)
Forster et al. (2012)	Stroke	Information provision *„An intervention was classified as passive if the*	• Copy of medical history, clinical resumes, pertinent lab results, etc. • Leaflets	• Knowledge[b] • Death	• Standard care	1998-2007	1/1/0	0.11	Critically low (3, 10, 15)

		information was provided on a single occasion and there was no subsequent systematic followup or reinforcement procedure. An intervention was classified as active if, following the provision of the information, there was a purposeful attempt to allow the participant to assimilate the information and a subsequent agreed plan for clarification and consolidation or reinforcement"	• Action plan • Medical management						
Fredericks et al. (2009)	Coronary artery bypass graft surgery	Provision of post-operative self-care CABG information	• Face-to-face contact • Phone contact • Written resources	• Self-care Knowledge[b] • Self-care behavior[b] • Symptom experience	• Control group (N/A)	1986-2005	5/0/0	0.35	Critically low (1, 2, 3, 5, 6, 7, 9, 10, 12, 13, 14, 15)
Gad et al. (2020)	Diabetes	Ramadan focused education	• NA	• Glycosylated hemoglobin HbA1c • Fasting blood glucose • Weight • BMI	• Standard care	2008-2019	4/8/0	0.38	Critically low (1, 7, 8, 10)

				• Waist circumference • Total cholesterol • LDL cholesterol • HDL cholesterol • Triglycerides • Systolic blood pressure • Diastolic blood pressure • Hypoglycemia					
Galdas et al. (2015)	Patients with long-term conditions	Education *"Includes any study where education is taught or educational materials are provided to patients."*	• NA	• Health-related quality of life • Depression • Anxiety • Fatigue	• Standard care	NA	2/2/0	0.20	Critically low (3, 4, 5, 7, 10, 15)
Guruge and Sidani (2002)	Various (Operation)	Preoperative teaching *"Provision of information about the preoperative experience"*	• NA	• Length of hospital stay • Pain	• No treatment	1970-1996	2/2/0	0.43	Critically low (2, 3, 5, 6, 7, 10, 13, 15, 16)
Hildebrand et al. (2019)	Type 2 diabetes	Self-management education *"Educational topics included components to*	• Individual sessions • Group sessions • Combined individual and group sessions	• Glycosylated hemoglobin HbA1c	• Standard care • Waitlist	2002-2017	1/0/0	0.23	Critically low (2, 3, 5, 7, 10)

		improve participants' knowledge, skills and ability to achieve self-management activities that can positively affect glycemic control"							
Jho et al. (2013)	Cancer	Pain education	• Face-to-face Interview • Phone calls • Printed education materials	• Pain	• Standard care • Attention control	1986-2011	1/0/0	0.17	Critically low (1, 2, 7, 10, 14, 15)
Lincoln et al. (2007)	Psychotic disorders	Psychoeducation *"Focus on conveying relevant information about the disorder and its treatment while promoting better coping."*	• Individual and group education	• Rehospitalization • Symptoms	• Standard care • Other intervention • Waiting-list	1982-2005	0/2/0	0.21	Critically low (2, 3, 7, 10)
McDonald et al. (2014)	Hip replacement	Preoperative education	• Video • Individual information session • Small group information session • Leaflets	• Pain	• Standard care	2000-2004	0/1/0	0.17	Critically low (3, 10)
Mugunthan et al. (2011)	Benzodiazepine users	Minimal interventions	• Consultation • Self-help booklet • Letter • Information sheets	• Benzodizepine reduction • Cessation of benzodiazepine	• Standard care	1994-2004	2/0/0	0.57	Critically low (1, 2, 3, 7, 10, 15)

Osborn et al. (2006)	Cancer	Patient education *"Patient education (PE) typically includes information regarding the illness or symptom(s), symptom management, and/or discussion of treatment options and may include the use of booklets, videos or other educational materials."*	• NA	• Depression • Pain	• Standard care	2001-2004	0/2/0	0.09	Critically low (1, 2, 5, 6, 7, 10)
Paquette et al. (2019)	Patients treated with oral anticoagulation	Supplemental education "*Broad types of supplemental education interventions aimed at improving patient knowledge, TTR, or clinical outcomes were considered;"*	• Information provision • Individual sessions • Group sessions • Instruction booklet • Video	• Thromboembolic events • Any bleeding events • Knowledge[b]	• Standard care	1972-2019	1/2/0	0.38	Critically low (2, 3, 5, 10, 15)
Pinquart et al. (2007)	Depression	Psychoeducation	• NA	• Depression	• No treatment	1974-2006	1/0/0	0.70	Critically low

		"This intervention involves the provision of information about depression and related problems and ways to overcome the constituent symptoms. Intervention formats include reading materials (bibliotherapy), lectures and group discussion."							(2, 3, 5, 7, 10, 14, 15, 16)
Powell et al. (2016)	Surgery	Procedural information *"Describes the process the patient will undergo in terms of what will happen, when it will happen and how it will happen."*	• Leaflets • Oral information • Website	• Pain • Negative affect	• Standard care	1999-2012	0/2/0	0.34	Low (3)
Ramesh et al. (2017)	Cardiac Surgery	Preoperative education	• Individualized one-to-one education • Booklet • Audiotape • Video • Teaching through video • Lecture • Discussion	• Anxiety • Pain • Depression • Length of hospital stay	• Standard care	2000-2015	1/3/0	0.41	Critically low (2, 3, 7, 10, 12, 15)

Rehse and Pukrop (2003)	Cancer	Patient education	• Interactive sessions • Group education • NA	• Quality of life	• Standard care	1979-1999	1/0/0	0.95	Critically low (2, 5, 7, 8, 10, 16)
Riemsma et al. (2003)	Arthritis	Patient education *"We defined a patient education intervention as one that includes formal structured instruction on rheumatoid arthritis and on ways to manage arthritis symptoms."*	• Leaflets • Overhead projection • Discussion • One-to-one sessions • Self-instruction • Distribution of supporting literature • Films • Group sessions	• Pain • Disability • Joint counts • Patient global assessment • Psychological status • Anxiety • Depression • Disease activity	• No treatment • Standard care	1988-2001	0/15/0	0.03	Critically low (3, 10)
Saffari et al. (2014)	Diabetes (Type 2)	Health education	• Website • SMS	• Glycosylated hemoglobin HbA1c	• Standard care	2005-2013	1/0/0	0.60	Critically low (2, 3, 7, 10)
Suls and Wan (1989)	Medical or laboratory procedures designed to induce pain (e.g., dental extraction, gastrointestinal diagnostic, endoscopy)	Pre-operative information	• Sensory information • Procedural information • Combined sensory-procedural information	• Negative affect • Pain • Distress • Other outcomes	• No treatment • Attention control	1972-1983	7/4/0	0.49	Critically low (1, 2, 3, 5, 6, 7, 9, 10, 12, 13, 15, 16)
Timmer et al. (2011)	Inflammatory bowel disease	Patient education	• Group sessions • Patient-centered guidebook	• Quality of life • Depression • Anxiety	• No treatment • Other treatment	1986-2007	0/13/0	0.06	Low (10)

		"Programs aiming to improve self management skills, coping and social integration"	• Face-to-face information • Lectures	• Not in readmission • Disease activity				
Traeger et al. (2015)	Lower back pain	Primary care-based education *"Any set of planned condition-specific educational activities in a one-to-one situation, designed to improve patients' health behaviors and/or health status in regard to the low back pain problem."*	• Booklet • Advice sessions • Brief pain management	• Number of primary care visits	• Standard care • Other treatment	1989-2011	0/1/0	0.14	Critically low (1, 2, 3, 7, 10)
Wong et al. (2013)	Patients taking oral anticoagulants	Supplemental patient education	• Video teaching sessions • Self-guided instruction booklet • One-to-one teaching • Written information • Group sessions • Interactive sessions	• Hemorrhagic events • Thromboemic events	• Standard care	1972-2008	0/2/0	0.35	Critically low (2, 3, 7, 10, 15)
Xia et al. (2011)	Schizophrenia	Psychoeducation	• NA	• Relapse • Non compliance[b] • Readmission	• Standard care	1988-2008	2/0/0	0.31	Critically low (3, 10)

Zimmermann et al. (2007)	Cancer	Education *"Treatments primarily providing information about the nature of the cancer and its medical treatment (e.g., information about side effects of chemotherapy)."*	• NA	• Emotional adjustment	• Standard care	1980-2004	1/0/0	0.53	Critically low (1, 2, 7, 9, 10, 12)

Note. ESs - effects sizes, NA – not applicable

[a] Whenever possible, we extracted (a) how the authors named the included interventions and (b) the respective definition. If one or more of these three components are not reported in this table, it has not been reported in the original paper.

[b] These outcomes were not included in the overall analysis.

[c] We rated the methodological quality using AMSTAR 2 recommending the following classification (Shea et al., 2017)*: High*, Zero or one non-critical weakness, indicating that the systematic review provides an accurate and comprehensive summary of the results of the available studies that address the question of interest; *Moderate*, More than one non-critical weakness, indicating that the systematic review has more than one weakness, but no critical flaws. It may provide an accurate summary of the results of the available studies that were included in the review*; Low*: One critical flaw with or without non-critical weaknesses, indicating that the review has a critical flaw and may not provide an accurate and comprehensive summary of the available studies that address the question of interest; *Critically low*: More than one critical flaw

with or without non-critical weaknesses, indicating that the review has more than one critical flaw and should not be relied on to provide an accurate and comprehensive summary of the available studies.

Appendix E: Second-Order Meta-Analytic Results (Study 3)

	Meta-analyses j	Meta-analytic effect sizes k	Overall grand mean $\bar{\bar{d}}$	95% Confidence Interval	$E\left(S^2_{e_{\bar{d}_i}}\right)$	$S^2_{\bar{d}}$	$\sigma^2_{\bar{d}}$	ProVar
Overall								
Averaged over meta-analyses	40	40	0.302	[0.295, 0.309]	0.00109	0.01082	0.00972	0.101
Averaged over effect sizes	40	156	0.316	[0.304, 0.329]	0.00222	0.03534	0.03312	0.063
Averaged over effect sizes, RCTs only	22	59	0.271	[0.253 0.290]	0.00446	0.02434	0.01988	0.183
Health Issue[a]								
C	4	16	0.151	[0.113, 0.188]	0.01494	0.02958	0.01464	0.505
E	7	38	0.331	[0.311, 0.351]	0.00074	0.03460	0.03386	0.021
F	7	21	0.366	[0.327, 0.405]	0.00960	0.02624	0.01664	0.366
I	5	9	0.315	[0.276, 0.354]	0.00468	0.01932	0.01464	0.242
J	4	13	0.155	[0.098, 0.211]	0.00788	0.04285	0.03497	0.184
M	4	22	0.162	[0.131, 0.192]	0.01042	0.02103	0.00593	0.01061

Various (across single studies)	5	21	0.261	[0.227, 0.296]	0.01831	0.04203	0.02372	0.02372
Health Outcome								
Physiological functioning	12	39	0.339	[0.218, 0.360]	0.00076	0.03610	0.03534	0.021
Physical functioning	10	17	0.254	[0.226, 0.281]	0.00536	0.02074	0.01538	0.258
Psychological functioning	14	37	0.189	[0.163, 0.216]	0.01108	0.03240	0.02132	0.342
Pain	9	13	0.226	[0.184, 0.267]	0.01020	0.02924	0.01904	0.349
Medication	4	5	0.179	[0.121, 0.237]	0.00173	0.01613	0.01440	0.107
Relapse or visits of medical facilities	14	25	0.279	[0.251, 0.308]	0.00533	0.02465	0.01932	0.216
Mortality	3	3	0.086	[-0.001, 0.173]	0.01300	0.00000	0.08600	1
General functioning	6	14	0.392	[0.302, 0.483]	0.00228	0.08237	0.08009	0.028
Intervention Type								
Didactic	19	68	0.147	[0.125, 0.168]	0.00898	0.03960	0.03063	0.227
Psychoeducation	8	26	0.359	[0.328, 0.390]	0.01057	0.02403	0.01346	0.440

Self-management education	16	62	0.335	[0.318, 0.352]	0.00106	0.03168	0.03063	0.033

Note. The number of actually included single studies might be slightly lower than reported here due to overlap within meta-analyses when reporting several outcomes, see main text for more details. $E\left(S^2_{e_{\bar{d}_i}}\right)$ - expected second order sampling error variance across the meta-analyses, $S^2_{\bar{d}}$ - weighted variance of the uncorrected mean effect-sizes across the included meta-analyses, $\sigma^2_{\bar{d}}$ - population variance across the included meta-analyses without second order sampling error, ProVar - proportion of the observed variance across first order mean operational validity estimates that is due to second order sampling error variance.

[a] the health issue was classified after ICD-10.

C – Neoplasms

E - Endocrine, nutritional and metabolic diseases, this category includes studies of diabetes patients only

F - Mental and behavioral disorders

I - Diseases of the circulatory system

J – Diseases of the respiratory system

M - Diseases of the musculoskeletal system and connective tissue

Authorship and Publication Status

Studies 1 to 3 are research articles that were or will soon be submitted for publication to international, peer-reviewed scientific journals. The authors and publication status of the papers are listed below.

1. Study 1: **Simacek, T.**, Dlugosch, A., Simonsmeier, B., & Schneider, M. (manuscript in preparation). How Strongly Do Motivational Constructs Mediate the Influence of Prior Knowledge on Posttest Knowledge? A Meta-Analytic Investigation of Moderated Mediation Effects

2. Study 2: **Simacek, T.**, & Schneider, M. (manuscript in preparation). Does Motivation Mediate the Relation Between Prior Knowledge and Learning Gains? A Longitudinal Study in a Higher Education Context

3. Study 3: Simonsmeier, B. A., Flaig, M., **Simacek, T.**, & Schneider, M. (2021). What sixty years of research says about the effectiveness of patient education on health: a second order meta-analysis. Health Psychology Review, 1-61.

Declaration of Authorship

I hereby declare that this dissertation was written by me independently and that no sources and aids other than those indicated were used. Content taken verbatim or in spirit from other works has been identified as such. Furthermore, the thesis has not been submitted in the same or similar form to any other university for the purpose of obtaining an academic degree.

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