Making math interesting

An experimental study of interventions to encourage interest in mathematics

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Abstract

Many students lose interest in mathematics as they progress through school. Therefore, the purpose of this project was to examine ways to encourage interest in mathematics by investigating two instructional interventions among middle school students.

This article-based dissertation is comprised of three articles and an extended summary. The extended summary includes a review of the theoretical field of interest in education, theoretical framing, method and research design, a summary of results, and a general discussion. The theoretical framing was based on the model of interest development by Hidi and Renninger, which focuses on how situated experiences of interest during learning (situational interest) can promote long-term motivational disposition (individual interest) for specific content. Environmental features can encourage situational interest; however, those with an individual interest in mathematics are more likely to be interested in learning math. Therefore, the overarching aim of this research was to identify ways to encourage situational interest among students who are not disposed to interest in math.

The theoretical framing was based on the instructional interventions used to promote interest, context personalization and example choice, which involve different ways to connect concepts students need to learn with knowledge they are already familiar with or interested in. Methodologically, a quantitative approach to the research field was adopted, including an experimental random-control group design, to examine the effect of the interventions.

Article I is a quantitative analysis of the relation between individual and situational interest for different grade levels and genders. The findings showed that although girls reported less individual interest than boys, they experienced the same level of situational interest when learning mathematics. For the grade levels, there were similarities between reports of individual and situational interest. These findings suggest that age-related declines in individual interest can also be observed in specific learning situations, unlike gender differences.

Article II is an experimental study of three types of instructional interventions on situational interest: context personalization based on students' out-of-school interests, example choice, and a "one-size-fits-all" approach that provides all students with an example. The findings showed that context personalization and example choice had positive effects on situational interest, particularly among those with low individual interest and perceived competence in mathematics, as well as on effort. The "one-size-fits-all" approach did not have any effect on interest or effort. Neither intervention affected students' problem-solving skills during the experiment.

Article III is an experimental study of three instructional interventions: context personalization based on students' preferences, example choice with selected topics, and a "one-size-fits-all" approach that provides all students with an example that other students find interesting. Example choice had a small effect on triggered situational interest, whereas context personalization did not positively influence situational interest.

Based on the findings from the three articles, the main contribution of this project is the introduction of a new theoretical distinction for the context personalization literature related to the differences between interest and preference-based approaches used to encourage students' interest. It also contributes to increasing knowledge regarding the more newly developed interventions of example choice. Furthermore, the findings demonstrate that not all observed differences in individual interest correspond to differences in situational interest, which can influence the ways schools and teachers approach changes in individual interest.

List of publications

Article I

Høgheim, S. & Reber, R. (2017). Interesting, but less interested: Gender differences and similarities in mathematics interest. *Scandinavian Journal of Educational Research*. doi: http://dx.doi.org/10.1080/00313831.2017.1336482

Article II

Høgheim, S. & Reber, R. (2015). Supporting interest of middle school students in mathematics through context personalization and example choice. *Contemporary Educational Psychology,* 42: 17-25. doi: http://dx.doi.org/10.1016/j.cedpsych.2015.03.006

Article III

Høgheim, S. & Reber, R. (2017). Eliciting mathematics interest: New directions for context personalization and example choice. *The Journal of Experimental Education*, 85(4): 597-613. doi: http://dx.doi.org/10.1080/00220973.2016.1268085

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Extended summary

1. Introduction

Learning in school should be interesting for students. In the book *Interest and Effort in Education,* John Dewey (1913) claimed that it is only through interest that schools can ensure that students learn and develop a desire to continue schooling after the obligatory education. Without interest, Dewey argued, schools can ensure students' presence; however, they cannot ensure they are attentive and willing to learn the content taught in the classroom. Therefore, a critical task for teachers is to help students discover interest in the learning content; however, as Dewey (1899/1956) described in *The School and Society*, efforts to encourage interest in schools are often misdirected due to a continuing gap between the learning content and students' lives outside of school:

> *When the child gets into the schoolroom he has to put out of his mind a large part of the ideas, interests, and activities that predominate in his home and neighborhood. So the school, being unable to utilize this everyday experience, sets painfully to work, on another tack and by a variety of means, to arouse in the child an interest in school studies* (Dewey, 1899/1956, p. 77).

The important task for teachers resides in "making things interesting" (Dewey, 1913, p. 23), which involves linking content students believe is neutral or even tedious to topics that are significant to them to bridge the gap between school content and the students' lives. Dewey's concept of making things interesting is not about finding ways to persuade students to follow directions, which is often the case in classrooms. The aim is to provide students with environments that will encourage them to form a personal relationship between themselves and the learning content. In doing so, interest, effort, and learning will follow (Dewey, 1913).

Currently, over a hundred years later, "making things interesting" remains a relevant notion, described as one of the most pressing challenges for modern schools (Hidi & Harackiewicz, 2000). In this vein, The Norwegian Ministry of Education and Research stated that "measures must be taken to increase students' engagement and

interest in learning during middle school[1]" (KD, 2009, p. 25)[2]. This statement is based on the tendency for students to gradually lose interest in school as they progress through obligatory education (Topland & Skaalvik, 2010), which is related to student dropout, lack of motivation, and underachievement (see also KD, 2011); however, there is a constraint involved in making things interesting that is inherent in its embedded concept of interest. According to Dewey (1913), interest is "the accompaniment of the identification, through action, of the self with some object or idea…" (p.14). His description highlights interest as a result of acting upon the environment with *particular* content that has personal significance to the individual. This depiction continues to influence modern conceptualizations of interest (e.g. Hidi & Renninger, 2006; Schiefele, 2009). Consequently, one cannot increase general interest in school because "interest is always content specific" (Hidi & Renninger, 2006, p. 112), which in an educational setting relates to specific subjects or topics (Ainley, Hidi, & Berndorff, 2002). Therefore, to make something interesting in school, the "something" must be a specific type of academic content[3].

This backdrop leads to the overarching topic of this dissertation, which is identifying ways to make math interesting for middle school students. Mathematics is one of the subjects most prone to interest decline along with science (Harackiewicz, Smith, & Priniski, 2016; Krapp & Prenzel, 2011). The tendency for interest in mathematics to decline appears to be stable across time and educational systems (e.g. Frenzel, Pekrun, Dicke, & Goetz, 2012; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Kaarstein & Nilsen, 2015; Watt, 2004). Although there is a marked gap in mathematics, in which boys typically report more interest in math than girls, the majority of students follow the same decline with age (Frenzel, Goetz, Pekrun, & Watt, 2010). Therefore, the topic of making mathematics interesting, particularly during the middle school years, is a continuing and significant issue.

[1] This is ungdomsskole in the Norwegian school system and the final level of the compulsory education.
[2] Kunnskapsdepartementet (KD)
[3] Ainley (1998) claimed that there is a general interest in learning, but this is a less explored concept in interest research. Nevertheless, this is not synonymous with a general interest in school but is seen as a general attitude toward seeking and expanding one's knowledge.

1.1 Making math interesting

Although Dewey has influenced modern conceptualizations of interest, the phrase "making things interesting" can benefit from being positioned within modern terminology. In contemporary theories, the term *interest* refers to two distinct experiences: a lasting affective and cognitive disposition to re-engage in specific content and an immediate experience of being captivated in a particular moment (Hidi & Renninger, 2006; Renninger & Hidi, 2015; Schiefele, 2009; Silvia, 2006). The concepts of *individual interest,* which is related to cognitive re-engagement, and *situational interest*, which is related to being captivated, capture these experiences (Hidi & Renninger, 2006; Krapp, 2002; Mitchell, 1993; Renninger & Hidi, 2015; Schiefele, 1991, 2009). In others words, individual and situational interest mark the difference between "having interest" in specific content and "being interested" at a particular moment.

Individual and situational interest are interrelated. As Dewey proposed, individual interest represents a side of "the self" that can influence how a person experiences a particular situation, which can support the elicitation of situational interest (Schiefele, 2009). For example, students interested in mathematics might be expected to experience situational interest during a lesson on probability calculus because it appeals to their disposition toward this domain. Situational interest, on the other hand, which is a product of students' responses to the environment, can support the maintenance or development of individual interest in the content at hand (Renninger & Hidi, 2015). Consequently, students with less individual interest in mathematics are less likely to experience situational interest during a math lesson, which in turn can impede the development of individual interest for some students. Therefore, in contemporary terms, the primary challenge of "making things interesting" is increasing situational interest among students who are not disposed to this experience.

The significance of Dewey's theory of interest is not only that learning should be interesting but also that it *could* be interesting for all students. Contemporary

approaches emphasize a similar principle. Hidi and Renninger (2006) claimed that "the potential for interest resides in the person but the content and environment define the direction of interest and contribute to its development" (p. 112). Therefore, to encourage situational interest in mathematics, measures should be taken to organize the learning environment and content for this purpose. The potential causes for the decline in academic interest may be a point of reference for such measures; however, they are numerous and complex. For example, Krapp (2002) viewed interest development as a selection process. During childhood, individuals have a broad curiosity and a desire to learn about their surroundings; however, as individuals age, they develop a more selected scope due to their developing perspectives of a "self" with certain preferences, identities, and abilities. Others have explained the decline as a mismatch between the curriculum in school and students' interests (cf. Schiefele, 2009). The growing awareness of a "self" as a social being along with emerging vocational interests during adolescence may cause students to overlook some subject areas (Wigfield et al., 2015), which is also a central theoretical explanation for the gender gap in mathematics interest (Eccles, 2009). Some scholars have also suggested that students develop a strong social interest during adolescence that can overshadow academic interests (Hidi, 2000). Changes in school practices as students age may influence the decline of interest, moving from more project-based methods to lectures and demonstrations as students progress through grade levels (cf. Renninger & Hidi, 2015).

Most of the presented explanations for the decline of academic interest share similar characteristics because they involve an opposing development of out-of-school interests or *identity*. Identity in learning and development refers to a student's self-representation as a person who pursues certain content and activities that uphold this representation (Harter, 2003, 2006). Therefore, due to the increasing awareness of out-of-school interests and identity during the adolescent years, bridging the gap between schools and students seems an appropriate approach to making math interesting. Others involved in the field of education have also reached this conclusion. For example, a committee appointed by KD to evaluate mathematics education proposed the amendment of subject content to the needs of pupils with a

specific focus on highlighting the relevance of content to their everyday lives and vocational paths to prompt motivation (Botten-Verboven et al., 2010); however, ways to amend subject content to the needs of students and to what end are still unclear.

1.2 The scope and aims of the dissertation

The overarching topic of this dissertation is the task of making math interesting for middle school students. Contemporary approaches to interest emphasize the influence of the environment and content in encouraging situational interest, especially when individual interest is lacking (e.g. Hidi & Renninger, 2006; Schiefele, 2009). Therefore, the focus of this project was one of the most common materials used for learning in school, namely texts (Schraw, Flowerday, & Lehman, 2001). Whether computers, textbooks, homework, group activities, or self-studying are used, learning in school often relies on texts. Texts are an environmental feature that students most often interact with and are therefore an appropriate medium to make content interesting. This project examines *instructions* as an effective approach to text learning, referring to the written presentation of mathematical principles and problems similar to the presentation of subject content in textbooks.

Thus, this dissertation examines the overarching topic through the following research question: Can instruction "make math interesting" for middle school students? The aim of this dissertation was to examine two specific instructional interventions: a popular strategy in mathematical research called *context personalization* (e.g. Anand & Ross, 1987; Walkington, 2013) and a more newly developed technique called *example choice* (Reber, Hetland, Chen, Norman, & Kobbeltvedt, 2009). The fundamental idea behind context personalization and example choice is to use students' experiences and interests from their everyday lives when learning new content, which according to Dewey (1913) is the core of cultivating interest in school. Due to the overarching topic of making math interesting based on texts, the scope of

this dissertation includes the instructional interventions of context personalization and example choice.

Context personalization refers to instructional interventions that use students' out-of-school interests or preferences to customize a text without altering the learning content (Walkington & Bernacki, 2014). There are several approaches to context personalization that differ in the degree of customization (see Walkington & Bernacki, 2014); however, this dissertation focuses on the "fill-in-the-blanks" approach. Fill-in-the-blanks is a type of personalization that involves limited customization, such as a single word or phrase of a text, which has led to an assessment of this intervention as practical for educational purposes (Walkington & Bernacki, 2014). The individual learner (i.e. individual personalization: Bernacki & Walkington, 2014; Ku, Harter, Liu, Thompson, & Cheng, 2007; López & Sullivan, 1992) or a specific group of students (i.e. group personalization: Ku & Sullivan, 2000, 2002) can be the basis for the customization of the texts. Example choice combines the customized texts with the opportunity for choices in learning. When using example choice, students are given a choice between different topics of instruction before engaging, which all lead to the same formal principle for learning (Reber et al., 2009). Students can select the topic they find most interesting and learn new content in a context that is appreciated by and perhaps also relevant to them.

The goal of this project was to investigate *whether context personalization and example choice can encourage situational interest during mathematics learning among middle school students*, a goal that is hypothesized to counteract the tendency of individual interest in math to decline with age and to differ between boys and girls. Three related articles constituted the basis of this dissertation.

The first article investigated whether encouraging situational interest can be used to mitigate the decline in math interest and the gap between boys and girls, which is essential to the aim of this dissertation. The study involved an analysis of individual and situational interest among 366 middle school students during mathematics learning. The overarching question was: *Do the well-documented trends in individual*

interest in mathematics for gender and grade level correspond to differences in situational interest? Quantitative data was used to examine whether differences in individual interest before learning could also be observed for situational interest during learning. The purpose of this study was to investigate whether increasing situational interest, which was the aim of the context personalization and example choice, could be related to the tendency for individual interest to decline with age and to differ between boys and girls.

In the second and third articles, the main topics were context personalization, example choice, and situational interest. The two experimental studies examined different approaches to context personalization and example choice during a learning activity in mathematics involving instructions, collectively including 1571 middle school students. The main research question was: (1) *Can context personalization and example choice encourage situational interest among middle school students during mathematics learning?* Furthermore, to evaluate whether these interventions could apply to learning, the secondary research question was: *How do the instructional interventions affect learning and learning behavior?* Both articles consisted of quantitative data from randomized experimental studies.

1.3 Structure

In addition to this introductory chapter, this extended summary includes four other chapters. *Chapter 2* provides a review of the theoretical and conceptual framework used in this dissertation, drawing primarily on the perspective of Hidi and Renninger, in which interest is a multidimensional phenomenon that can be encouraged to arise and develop; however, other relevant theoretical approaches are also reviewed and linked to the framing of this dissertation. Interest and its development can occur in any area in the life-space of an individual, whether formal or informal (Krapp, 2002; Renninger & Hidi, 2015); however, the focus of this dissertation is interest development in an educational context regarding subject content.

Chapter 3 presents a review of the study intervention approaches, context personalization and example choice, and previous empirical findings. Based on the theoretical and empirical framework, this chapter concludes with the research hypotheses of the three articles.

Chapter 4 describes the methodology of the studies, which emphasizes the need for an experimental design and online assessment to examine the effects of the instructional interventions on situational interest. This chapter presents details regarding the design, participants, procedure, and instruments in addition to treatment fidelity, validity, and ethical concerns.

Chapter 5 summarizes the three articles of this dissertation and provides additional analyses that are not included in the articles but are significant to the overarching topic, followed by an overall summary and discussion of the results. This chapter highlights the main findings as well as the theoretical and practical implications of the studies.

2. Theoretical framework

This chapter presents and discusses the theoretical concepts and framing of this dissertation, which centers on the phenomenon of interest in education. One of the key theoretical standpoints in this project is Hidi and Renninger's (2006) *four-phased model of interest development,* which emphasizes the relationships between individual and situational interest and between the student and the environment to encourage and develop interest.

As Renninger and Hidi (2011) pointed out, the contemporary field of interest is still in the state that Allport (1946) referred to when he wrote: "One of our greatest defects is our lack of a consistent and adequate theory of interest" (p.341). Therefore, this chapter discusses related theoretical frameworks from the perspective of Hidi and Renninger for a more general viewpoint of interest. These frameworks include interest as a basic emotion (Silvia, 2008), the *person-object theory of interest* (Krapp, 2002; Schiefele, 2009), interest value (Eccles et al., 1983), and intrinsic motivation (Ryan & Deci, 2000a). I review those theoretical perspectives that are relevant to the interventions we explored. Hidi and Renninger's model explains how the relationship between the student and the environment can elicit situational interest; however, to explain in detail how the different aspects of the study interventions may influence interest, such as choice and relevance, other theories can supplement the focal theoretical framework.

Conceptually, interest and its development can occur in any area in the individual's life-space, whether formal or informal (Krapp, 2002; Renninger & Hidi, 2015); however, the focus of this chapter is on interest in education related to specific subject content.

2.1 Hidi and Renninger's concept of interest

According to Hidi and Renninger (2006), the term *interest* refers to both a psychological state during engagement with content (situational interest) and to a motivational disposition to re-engage with certain content over time (individual interest). Renninger and Hidi (2015) posited that interest emerges in the connection between the students and their environments in which the two concepts of interest intertwine in a continuing development of academic interest:

> *When we talk about a student who has an individual interest in mathematics and therefore is looking for ways in which he could solve word problems, we conceptualize his/her interest as a predisposition. When we consider this student's behavior while working with an interesting word problem, we refer to his/her psychological state of interest that is generated both by the task and predisposition. However, another student who does not have an interest in mathematics may also find the word problem interesting, and thus experience the psychological state of interest triggered by the situation* (Hidi, 2006, p. 73).

> *…if the psychological state of interest is generated, or triggered repeatedly, it may support the development of interest as a motivational variable* (Renninger & Hidi, 2015, p. 10).

As the quotes indicate, there is a continuing reciprocal relationship between individual interest, the environment, and situational interest (see Figure 1). Situational interest always arises as a response to the environment. Individual interest is a sufficient but not necessary condition to elicit situational interest at a particular moment (Hidi, 2006). On the other hand, experiencing situational interest can support the development of individual interest over time, which in turn influences how the students experience subsequent situations with similar content.

In addition to the shared characteristics with Dewey's definition of interest, Hidi and Renninger (2006) claimed that interest has neurological roots. The psychological state of interest refers to a condition of heightened attention, positive affect, and increased effort and persistence (Renninger & Hidi, 2015). This state stems from innate cognitive mechanisms used to respond to the environment, which are particularly related to the brain's reward circuitry (see Ainley & Hidi, 2014; Hidi,

2015 for detailed reviews). The neurological mechanism underlying interest is beyond the scope of this dissertation; however, the implications of this perspective are important. The potential for interest resides in all individuals as an innate ability to respond to external stimuli (Renninger & Hidi, 2011). This perspective also highlights that interest is initially without content, but it develops based on the individual's responses to his or her environment. Finally, this neurological perspective emphasizes that interest can function as a reward for the individual when the psychological state arises (Ainley & Hidi, 2014). This position underlines Krapp's (2002) assertion that "every area of a person's knowledge can sooner or later become the object of a situational or personal [individual] interest" (p. 387).

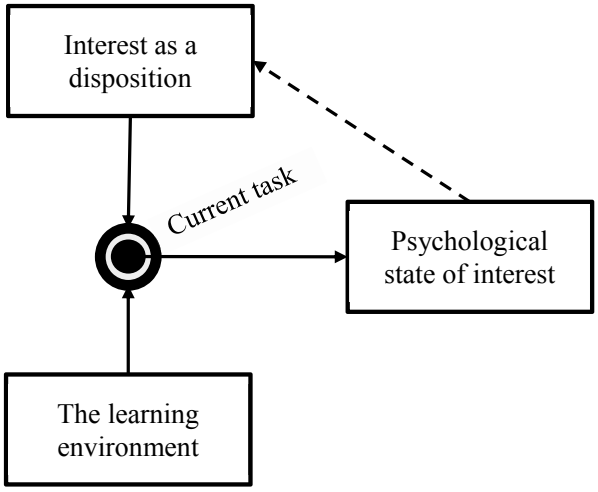

Figure 1 *Interest and the environment*[4]

Using the four-phase model of interest development, Hidi and Renninger (2006) described the transition from interest as a state to a disposition in four sequential phases: triggered situational interest, maintained situational interest, emerging individual interest, and well-developed individual interest (see embedded articles).

[4] Inspired by Krapp, Hidi, and Renninger (1992, p. 10)

2.1.1 Situational interest

Hidi and Renninger conceptualized situational interest as two responses to the environment that may or may not occur as sequential phases: *triggered* and *maintained situational interest*[5] (see also Renninger & Hidi, 2015; Renninger & Su, 2012).

Triggered situational interest refers to the eliciting of the psychological state of interest, often initiated by attracting the learner's attention (Renninger & Hidi, 2015). According to Hidi (2006), triggered situational interest parallels another theoretical perspective in interest literature: interest as an emotion. Reeve (2005) defined emotions as temporary expressive, feeling-arousing, and purposive phenomena that aid people in adapting to immediate challenges and opportunities. According to Silvia (2008), the purpose of interest is to attract people to new and unfamiliar objects in their environment. Triggered situational interest and interest as an emotion share the assumption that structural features of the environment that are novel, surprising, and complex or incongruity in visual stimuli can prompt interest (Berlyne, 1970; Renninger & Hidi, 2015; Silvia, 2006); however, they differ in that emotion theories emphasize that interest arises due to the individual's judgment of the environment, whereas Hidi and Renninger referred to the events themselves as "triggers" (Renninger & Hidi, 2015). Other scholars have also argued that making learners aware of a knowledge gap between what they know and what needs to be known for a particular task can trigger situational interest, which is referred to as the knowledge-deprivation hypothesis (Rotgans & Schmidt, 2014, 2017).

The psychological state of interest can fade quickly, or it can transform into *maintained situational interest.* Students' needs, experiences, identities, and knowledge as well as their ability to make a connection between themselves and the content are significant contributors to this transition (Renninger & Hidi, 2015), which is in line with Dewey's conclusions. Maintained situational interest is therefore said

[5]These phases are often analogous to the concepts of *catch* and *hold*, respectively (Dewey, 1913; Mitchell, 1993), referring to catching and holding a person' attention.

to arise based on *content features* of the situation rather than *structural features*, as with triggered situational interest (Linnenbrink-Garcia et al., 2010). Triggered and maintained situational interest therefore represent different responses to the environment, which can be caused by the learner's individual interest in the learning content, though not necessarily[6] (Knogler, Harackiewicz, Gegenfurtner, & Lewalter, 2015; Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008).

It is not clear from the theoretical framework of Hidi and Renninger whether triggered and maintained situational interest can and should occur at the same moment or whether they occur sequentially in different situations with similar content. Based on the cases presented by Hidi and Renninger (2006, p. 116) and other researchers' interpretations of the theory (Harackiewicz et al., 2016), it seems reasonable to assume that triggered and maintained situational interest should ideally occur at the same moment. Moreover, repeated experiences of triggering and maintenance of situational interest support the development of individual interest (Renninger & Hidi, 2015). Consequently, when eliciting situational interest, this experience should include both triggered and maintained situational interest.

Schiefele (2009) has criticized Hidi and Renninger for what he called a "vaguely defined" psychological state of interest (p. 199). One challenge in interpreting Hidi and Renninger's framework is that they sometimes referred to "the psychological state of interest" (e.g. Renninger & Hidi, 2015, p. 8), while other times they referred to "a psychological state" for the different phases of interest (see Renninger & Su, 2012, p. 170). Hidi and Renninger's model is understood in this dissertation as entailing one psychological state of interest that the phase of triggered situational interest captures; however, during the transition to maintained situational interest, the psychological state is prolonged and focuses attention toward the content of the environment.

[6] This stance stands in contrast to previous perspectives on interest, which view the experience of different is elicited due to a pre-existing individual interest (actualized individual interest) or due to environmental factors (situational interest) (e.g. Schiefele, 1991). This distinction is no longer present in the modern conceptualizations of interest (e.g., Hidi & Renninger, 2006; Schiefele, 2009).

The majority of research on situational interest has focused on how to nurture situational interest during learning. Methods such as relevance interventions (Canning & Harackiewicz, 2015; Durik & Harackiewicz, 2007; Hulleman & Harackiewicz, 2009), attention-grabbing settings (Palmer, 2009), and problem-based instructions (Rotgans & Schmidt, 2014, 2017) have been found to positively influence the experience of interest; however, phenomenological research on situational interest is limited. Across three studies, Linnenbrink-Garcia et al. (2010) found support for the concept of situational interest as outlined by Hidi and Renninger; however, they observed that maintained situational interest could benefit from being conceptualized as two distinct connections to content based on affect and value (Linnenbrink-Garcia, Patall, & Messersmith, 2013).

2.1.2 Individual interest

Individual interest refers to a more continuous motivational disposition to seek out, re-engage, and respond positively to certain content (Hidi & Renninger, 2006). It denotes an affective and cognitive relation between a person and some content in his or her living space. The affective components refer to stored positive feelings toward specific content, such as enjoyment, fascination, and excitement, whereas the cognitive components refer to perceived personal value and the meaningfulness of the content to the individual (Renninger & Hidi, 2011, 2015). Furthermore, Hidi and Renninger (2006) emphasized that knowledge is a component of individual interest, which is related to the drive to pursue content based on individual interest. Knowledge is central for students to form curiosity questions. Berlyne (1954) defined curiosity as the desire to learn new ideas, acquire knowledge, or solve problems related to certain content. Although curiosity and interest are related, they are distinct phenomena according to the literature (Renninger & Hidi, 2015). A fundamental difference is that interest is conceptualized as a positive psychological state, whereas curiosity is an aversive state (Litman, 2008). Nevertheless, individual interest can lead to curiosity questions due to the motivation to re-engage and learn more about specific content.

According to Hidi and Renninger's model (discussed in more detail in the embedded articles), there are two phases of individual interest, which follows repeated experiences of situational interest. *Emerging individual interest* arises when a student takes the initiative to re-engage in content due to independent reflections; hence, a more self-regulated predisposition has emerged, but a student in this phase may not persevere if difficulties are encountered. Over time, emerging individual interest can transform into a *well-developed individual interest* in which students have stored positive feelings and value for the content and can persevere despite challenges. Acquired knowledge and mostly voluntary re-engagement also characterize this phase (Renninger & Hidi, 2015).

Students' levels of individual interest in content have been found to influence the choices they make to re-engage and seek challenges (Köller, Baumert, & Schnabel, 2001), achievement goals (Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008), attention (Ainley et al., 2002), and learning (Harackiewicz et al., 2008; Hoffmann, 2002; Köller et al., 2001). Individual interest also influences the elicitation of situational interest (Knogler et al., 2015; Tsai et al., 2008), which in turn has been found to promote learning behaviors (Rotgans & Schmidt, 2011). Research on interest-enhancing interventions has illustrated that individual interest shapes students' experiences with the environment because it moderates the effect of measures used to increase interest (see Article II and III for reviews). Furthermore, research also supports the notion that situational interest can foster individual interest in different domains and among different age groups (e.g. Fisher, Dobbs-Oates, Doctoroff, & Arnold, 2012; Guthrie, Hoa, Wigfield, Tonks, & Perencevich, 2005; Linnenbrink-Garcia et al., 2010; Palmer, Dixon, & Archer, 2016; Rotgans & Schmidt, 2017). Consequently, it is expected that declines in individual interest in mathematics stem from a reduction of experiences involving situational interest as students age. Similarly, gender differences in mathematics interest may stem from differences in experiences involving situational interest while engaging in mathematics (see Hoffmann, 2002 for similar arguments for the domain of physics).

2.1.3 Summary

Based on the theoretical framework of Hidi and Renninger (2006), interest development is initiated by the elicitation of a psychological state by the *environment* (triggered situational interest). This state can be maintained (maintained situational interest) if the learner forms a personal connection with the learning *content* based on affect and value (Linnenbrink-Garcia et al., 2010). The repetition of these two phases during learning can support the development of an emerging individual interest and eventually to a well-developed individual interest (Renninger & Hidi, 2015).

As can be observed in Hidi and Renninger's model of interest development, other personal characteristics are involved in the experience of interest, especially for maintained situational interest, which entails forming a personal connection to the learning content. Therefore, the model presented in Figure 1 can be expanded based on the model presented in Renninger and Hidi (2015, p. 9).

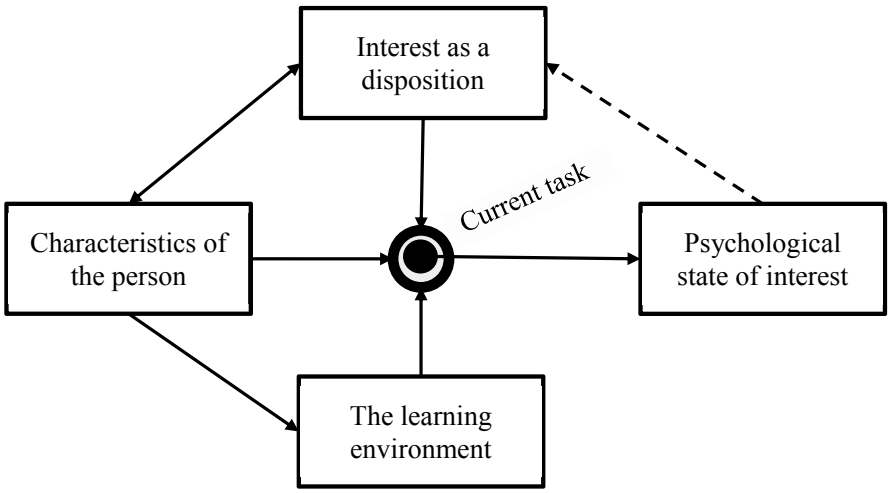

Figure 2 *The person, environment, and interest*

The characteristics of a person encompass qualities such as prior knowledge, experience, identity, and needs (Renninger, 2009; Renninger & Hidi, 2015; Renninger & Su, 2012), which are not included in the concept of individual interest but can still shape the experience of interest in a particular moment. Consequently, these characteristics also influence the development of individual interest.

Furthermore, the characteristics of the person can also influence the choice to engage in certain activities because a person with specific characteristics seeks out certain environments. The following section discusses this perspective.

2.2 Related theoretical frameworks

2.2.1 Person-object theory of interest

The person-object theory of interest (POI) is a framework that focuses on the relation between individuals and objects, which are understood as all conceivable content within the living space of the individual, and their relation to educational practices (Krapp, 2002; Schiefele, 1991). There is a substantial overlap between Hidi and Renninger's model of interest and POI: both view interest as content-specific, emphasize positive affect and value, and focus on the relation between the individual and the environment (or *objects*); however, they differ in their conceptualization of individual interest, particularly regarding including knowledge in the model of Hidi and Renninger (2006). POI does not distinguish between different phases of individual interest but focuses on different levels of positive affect and evaluations related to certain content (Schiefele, 2009). Still, given the consensus regarding many major theoretical positions, POI and Hidi and Renninger's model are complementary rather than conflicting (Krapp, 2002).

An important aspect of POI is the focus on identity and "the self" in developing an interest (see Krapp, 2002 for review). Specifically, POI claims that interest, identity, and stable personality traits develop concurrently. It also specifies that the individual has a sense of a "self" and that the "object" of interest one way or another represents the person's self-perception. Although Hidi and Renninger's theory encompasses similar thoughts (Renninger, 2009), it highlights the significance of personal characteristics in the elicitation of situational interest in particular moments in addition to individual interest (see Figure 2).

2.2.2 Expectancy-value theory of achievement motivation

The expectancy-value model of achievement motivation was initially developed by Eccles et al. (1983) to understand adolescents' choices and performance in mathematics; however, this framework has since extended to include achievement situations (Wigfield, 1994). The basis of this theory is that students' expectancy for success and personal values related to an upcoming task directly influence their choices, levels of persistence, and performances[7].

Wigfield and Eccles (2000) defined expectancy for success as a student's evaluation of how well they will perform on an upcoming task. This expectancy is often assessed by students' *self-concepts* (Marsh, 1993), which represent domain-specific ability beliefs. Students' expectancy for success is reciprocally related to their assessments of task value in this framework, for which Wigfield et al. (2015) identified four types: *interest value*, *attainment value*, *utility value*, and *cost*[8]. Perhaps most relevant to the current project is the concept of interest value, referring to the enjoyment (intrinsic value) one receives from an activity (Wigfield & Eccles, 2000). As duly noted by Wigfield and Cambria (2010), the modern interest construct by Hidi and Renninger, Schiefele, and Krapp may also include attainment value, which is the personal significance of performing well in an upcoming event (Eccles & Wigfield, 2002). Utility value refers to the perceived usefulness of a task for future goals, either immediate or long-term, whereas cost refers to what a student must sacrifice to complete the task (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). This framework may be more relevant to the concept of individual interest than situational interest because it focuses on the factors that influence the choice to engage in a learning situation rather than psychological mechanisms used during learning; however, Wigfield and Cambria (2010) argued that the concepts of values

[7] See also the framework of the control-value theory of achievement emotion (e.g. Pekrun, 2006; Pekrun & Perry, 2014) for similar antecedents for students' emotions during learning; however, unlike Wigfield et al. (2005), Pekrun (2006) did not explicitly refer to interest but rather to related emotions, such as enjoyment and curiosity.

[8] These values are often presented under different but related labels (see Eccles et al., 1983, Wigfield, 1994; Wigfield & Eccles, 2000 for comparison). This section was based on the labels used in Wigfield et al. (2015).

also include a situational component: “interest value as defined in expectancy-value theory contains both situational and enduring aspects” (p. 9).

An important implication of this theory is related to the various factors that can influence interest value, such as upbringing, identity, gender roles, and attribution of prior experiences (see Wigfield et al., 2015, p. 3 for the model in its entirety). All these factors will manifest in either a student’s expectancy for success or in task values according to this theory. Furthermore, the expectancy-value model also describes a constant interaction between ability beliefs and task value. In this vein, research has repeatedly observed interest as being highly related to competence perceptions (e.g. Eccles & Wigfield, 2002; Skaalvik, Federici, & Klassen, 2015; Skaalvik & Rankin, 1995; Skaalvik & Skaalvik, 2008, 2011). It is therefore not surprising that studies on interest-enhancing interventions have found that students’ ability beliefs influence the experience of situational interest (Durik, Shechter, Noh, Rozek, & Harackiewicz, 2015; Hulleman & Harackiewicz, 2009), which is similar to individual interest (Durik & Harackiewicz, 2007). The influence of ability beliefs on situational interest is not unexpected because knowledge is a part of individual interest (Hidi & Renninger, 2006) and can therefore influence students’ assessments of their competences within a particular domain (Eccles & Wigfield, 2002).

2.2.3 Self-determination theory

The self-determination theory (SDT) is a theoretical framework for well-being and psychological health (Deci & Ryan, 2012; Ryan & Deci, 2000b). Of particular relevance is its emphasis on *intrinsic motivation*, which is included in a sub-theory within SDT, the *cognitive evaluation theory* (CET). Intrinsic motivation is defined as “participating in an activity because it is interesting and enjoyable” (Deci & Ryan, 2012, p. 88). Moreover, Sansone and Thoman (2005) proposed a broader definition of intrinsic motivation that further highlights the significance of interest for this concept: “people are *intrinsically motivated* when their behavior is motivated by the *anticipated*, *actual*, or *sought experience of ‘interest’*” (p. 175). Therefore, the theoretical framework of SDT for intrinsic motivation can underline perspectives that

are relevant to the concept of interest (see also Schiefele, 2009). Its counterpart is *extrinsic motivation*, which refers to completing an activity for some separate outcome, such as receiving a good grade or avoiding punishment (Ryan & Deci, 2000a). According to SDT, well-being depends on satisfying three basic psychological needs: to feel *competent*, to feel *autonomous* (or self-determined), and to experience *relatedness* to other people and groups (Deci & Ryan, 2000, 2012; Ryan & Deci, 2000a). According to the cognitive evaluation theory, which aims to account for variability in intrinsic motivation (Ryan & Deci, 2000b), the first two psychological needs are essential: intrinsic motivation can flourish in contexts that support a student's need for autonomy and competence.

The necessity of autonomy is often related to interest, especially its practical consequences, offering students choices during learning (Patall, 2012). Choice is an autonomy-supportive practice because it can increase students' feelings of control and involvement in a learning situation. Several studies have shown that offering choices increases student interest and intrinsic motivation (Cordova & Lepper, 1996; Linnenbrink-Garcia et al., 2013; Patall, Cooper, & Wynn, 2010; Patall, Sylvester, & Han, 2014; Schraw et al., 2001; Tsai et al., 2008) and that teachers evaluate choice as a positive and sought-after practice to promote student engagement (Fives & Manning, 2005; Flowerday & Schraw, 2000).

Similar to environmental features, individual interest and perceived competence have been found to influence how students perceive choices. Across four experimental studies, Patall et al. (2014) observed that choice increased motivation for those with high competence beliefs. Likewise, Patall (2013) found that choice increased interestingness for those with a high individual interest in the core learning content. Different types of choices have been found to vary in effect, such as instructionally relevant and irrelevant choices (Patall, Cooper, & Robinson, 2008). Instructionally relevant choices refer to options provided that influence the effectiveness of the learning assignment (e.g., task difficulty), whereas irrelevant choices refer to options irrelevant to learning, such as choices related to fantasy aspects of a computer game when learning mathematics (Cordova & Lepper, 1996). Instructionally irrelevant

choices have been evaluated as the most efficient approach to enhancing intrinsic motivation, presumably because they require the least effort from students (see Patall et al., 2008 for additional conclusions).

The influence of interest on choice is accounted for in the cognitive evaluation theory (CET):

> *It is critical to remember, however, that people will be intrinsically motivated only for activities that hold intrinsic interest for them, activities that have the appeal of novelty, challenge, and aesthetic value. For activities that do not hold such appeal, the principles of CET do not apply, because the activities will not be experienced as intrinsically motivating to begin with* (Ryan & Deci, 2000b, p. 71).

When interest is lacking, Ryan and Deci (2000b) proposed external measures, such as identification, which is similar to approaches emphasized in the interest literature, in addition to supporting the psychological needs of the student.

2.3 Chapter summary

Hidi and Renninger presented a theoretical model that explains the development from situational to individual interest. They also proposed several ways situational interest can be triggered and maintained at the interface between the student and the environment. The person-object theory of interest contributes to this framework by explicitly addressing the concurring development of identity and personality as personal characteristics that can influence interest and its development (Krapp, 2002). The expectancy-value theory includes various factors that can affect students' motivation, both before and during learning (Wigfield et al., 2015); however, this model adds ability beliefs as a central factor in how students experience the learning environment alongside interest. The self-determination theory highlights the psychological needs of students that the learning environment should fulfil to stimulate interest (Ryan & Deci, 2000b). All the theoretical frameworks contribute to Figure 2, both in characteristics of the person and in the environment that can influence students' momentary state of interest.

3. Experimental interventions

This chapter outlines and reviews the theoretical perspectives and empirical findings on the instructional interventions examined in the current dissertation: context personalization and example choice. Furthermore, this chapter describes the phenomenon known as *seductive details* (Garner, Gillingham, & White, 1989), which can be highly relevant when evaluating interest-based interventions for learning.

3.1 Context personalization

Context personalization is a collective term for instructional interventions that customize the surrounding context in academic texts (e.g., problems, instructions) to the student without altering the core learning content (Walkington & Bernacki, 2014). Context personalization has been subject to empirical research for decades, particularly in mathematics education related to *mathematical word problems.* Mathematical word problems are tasks that present problems in text format (Reikerås, 2007), often as a story or a specific scenario (Walkington, Petrosino, & Sherman, 2013). The primary focus of context personalization in mathematics research is its potential positive effects on problem-solving skills (e.g. Bates & Wiest, 2004; Cakir & Simsek, 2010; Ku & Sullivan, 2000; López & Sullivan, 1992; Walkington, 2013). One assumption regarding the effects on problem-solving is that personalized texts can increase student interest, which in turn heightens motivation and effort to solve problems (e.g. Anand & Ross, 1987; Boaler, 1994; Ku & Sullivan, 2002); however, evidence of the effect of interest is mostly based on indirect inferences, such as observed positive effects on performance (Walkington et al., 2013). Other assumptions regarding the effect of personalization on problem-solving, which is not discussed in detail in this dissertation, are related to reducing the cognitive load when presenting a problem and grounding a formal principle in terms that are familiar and conceivable concepts for the students (Walkington & Hayata, 2017).

3.1.1 Designing personalization

Over time, different approaches to context personalization have been proposed. Based on three design principles, Walkington and Bernacki (2014) distinguished between four approaches to context personalization (see p. 161)[9]. The three principles are depth, grain size, and ownership. Depth refers to the quality of the personalized aspect of the text, which can range from the simple insertion of something relevant to the students (low depth) to elaborated texts that build on students' interests or preferences (high depth). Grain size refers to the scale of the reference group, which distinguishes between customization based on the individual or a group of students. Finally, ownership is related to the autonomy in the generation of customization. Here, the difference resides in how involved students are in customizing the text and whether they are aware of what has occurred. Finally, Walkington and Bernacki (2014) evaluated the practicality of the approaches, and approaches with a low depth, a grain size based on the individual or group, and little ownership were considered the most applicable in an educational setting. In a more recent review, Walkington and Hayata (2017) supplemented the three principles with *richness*, which refers to the extent to which other elements of the context besides the personalized aspects are part of real-world problem solving.

The focus of the dissertation is the approach labeled "fill-in-the-blanks," which is considered a feasible yet low-depth form of context personalization with some student ownership. This method is commonly used in research, both on an individual and group level (Ku et al., 2007; Ku & Sullivan, 2000, 2002; López & Sullivan, 1992). It usually involves the implementation of information that is familiar to students (e.g., name of the favorite drink, food, pet, toy) into a text. An example of the fill-in-the-blanks approach from the research is presented in the study by Ku and

[9] Walkington and Bernacki (2014) included utility value intervention as a type of context personalization; however, given that this is an intervention that does not involve altering the context of a written material, this was evaluated as a different form of intervention than context personalization.

Sullivan (2000, p. 52)[10], which identified the difference between the two versions of a word problem:

> *Nonpersonalized: Four pieces of cake cost 60 NT [New Taiwan dollars]. How much do 3 pieces of cake cost?*
>
> *Personalized: At the Ivy Bakery, four pieces of pineapple cake cost 60 NT. How much to 3 pieces of pineapple cake cost?*

As illustrated, only specific words were changed to personalize the text for students. This method differs from the approach labeled *personalization to topic interest,* which involves altering the entire wording of a text based on interviews and ranking students' interests based on survey methods (see Walkington et al., 2013 p.98 for example). Personalization to topic interest is considered to have more depth than fill-in-the-blank, but it is considered only somewhat feasible due to the time-consuming process of altering the text to an individual student. A final approach to context personalization is *group personalization* in which the dominant interest or preference of a group of students is used to customize a text (e.g. Ku & Sullivan, 2000).

3.1.2 Personalization and interest

Although context personalization is theorized to evoke interest, few studies have addressed this intriguing topic. Based on an assumption of novelty and surprise, Walkington et al. (2013) theorized that context personalization can trigger situational interest when students notice that the text has changed. This assumption is supported by an observed effect on triggered but not maintained situational interest for both low and high-depth context personalization (Bernacki & Walkington, 2014). Students who compose personalized problems themselves have also been found to have increased mathematics interest (Walkington & Bernacki, 2015). Other studies have reported more positive attitudes toward personalized versus non-personalized materials (Ku et al., 2007; Ku & Sullivan, 2000, 2002) with a more beneficial effect for individual personalization than group personalization (López & Sullivan, 1992). The context in which subject content is embedded has been found to influence how

[10] This particular study was based on group personalization; thus, the altered words refer to the dominant preferences of a group of students.

students connect with content (Renninger, Ewen, & Lasher, 2002), their affective responses, and their persistence when drawing on students' interests (Ainley et al., 2002).

After reviewing the literature on context personalization, an distinction of the intervention emerged in addition to the design principles posed by (Walkington & Bernacki, 2014) and Walkington and Hayata (2017). Most research on context personalization has used students' *preferences* to customize texts (see Article II), which refers to something that individuals would choose from two or more options based on affect (Reber, 2016). Examples are implementing students' favorite foods, drinks, places, stores, or other biographical information, such as names of friends or birthdays (e.g. Bates & Wiest, 2004; Cakir & Simsek, 2010; Cordova & Lepper, 1996; Ku et al., 2007; Ku & Sullivan, 2000, 2002; López & Sullivan, 1992). On the other hand, customization can also include students' *interests*, such as content that the individual has a personal relationship with based on affect and value. Interest-based approaches to context personalization have been subject to research (Bernacki & Walkington, 2014; Renninger et al., 2002), though to a smaller extent than preference-based approaches.

Based on the interest theory, it is reasonable to assume that using students' interests to personalize a text rather than students' preferences is more efficient when the aim is to "make something interesting." As noted by Hidi and Harackiewicz (2000):

> *All children have interests, motivation to explore, and engage, but not all children have academic interests and motivation to learn to the best of their abilities in school* (p. 168).

By implementing students' out-of-school interests into texts, individual interests other than the specific academic content at hand can be used to elicit situational interest and to help students form a connection with the learning content. Figure 3 illustrates this assumption. The same influence might not be relevant for preferences because they are not personally significant to the learner, such as interests.

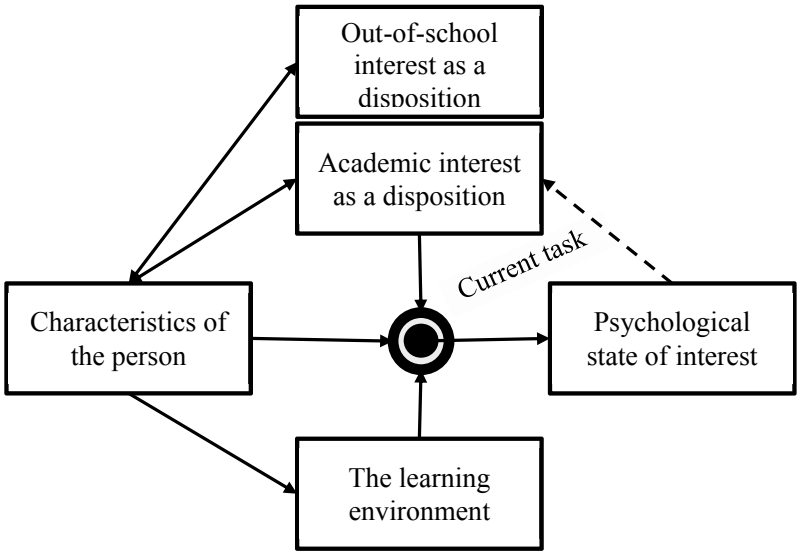

Figure 3 *Interest-based context personalization*

3.2 Example choice

Example choice is an instructional strategy that combines a contextual intervention similar to context personalization with the opportunity to provide choices in learning. The basic concept is that when students are learning content, such as mathematics, they can choose among different predefined topics for the instructions (Reber et al., 2009). All topics offered lead to the same formal principle for learning but differ in the embedded context of the subject content. Moreover, example choice also follows a specific design. Before learning, students are given an *example task* framed in the context of the chosen topic. The example task provides students with a specific sample of how the selected topic can serve as a backdrop for the learning content. Figure 4 provides an overview of the design of example choice.

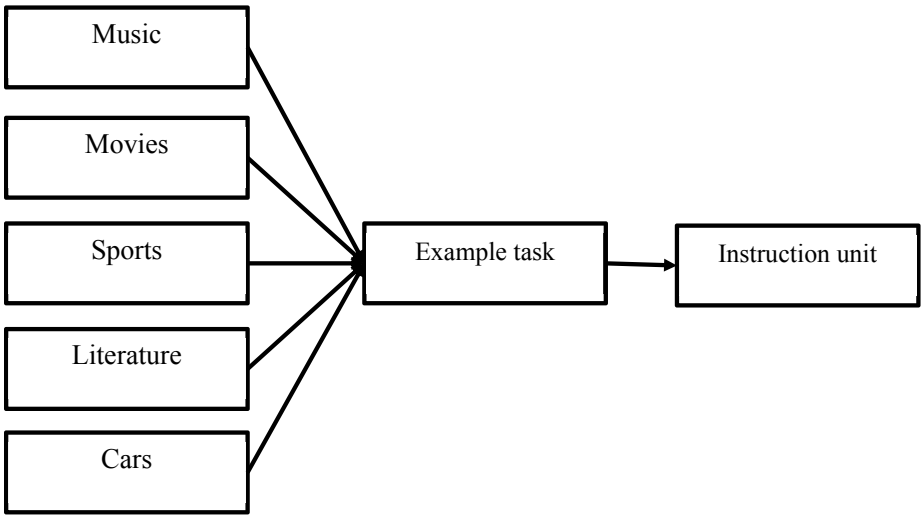

Figure 4 *The design of example choice*

Research on example choice is limited; however, instructional intervention has been found to positively influence college students' interest[11] when learning about *confirmation bias*[12] in psychology (Reber et al., 2009). In their study, Reber et al. (2009) offered students a choice of 14 topics with different themes, such as horoscopes, love, police work, and music. Arguably, there is a substantial overlap between example choice and the approach to context personalization Walkington and Bernacki (2014) referred to as *personalizing to topic interest* (see also: Walkington, 2013; Walkington et al., 2013; Walkington, Sherman, & Howell, 2014). When personalizing to topic interest, students rank their interests in different subjects (e.g., music, movies, sports) and subtopics (e.g., rock, horror, soccer) before reading a mathematics problem that is personalized based on the students' responses. Example choice and personalizing to topic interest both include predefined topics and pre-customized texts either chosen by students or offered to them based on a ranking system; however, the approach by Walkington and Bernacki (2014) does not entail explicit choices as in example choice, although choices are indirectly made based on a rating system of options.

[11] This study did not differentiate between different facets of situational interest but focused on the affective experiences related to this situated state.
[12] Confirmation bias is the tendency to observe what we want or expect to observe (see Reber et al. 2009).

Like context personalization, example choice can be based on students' out-of-school interests and preferences during learning. Building on the perspective of the self-determination theory (Deci & Ryan, 2012), example choice includes the autonomy supportive practice of offering students choices for learning activities. Because the choices involved in example choice are related to the context of the content, it can be argued that the choices involve instructionally irrelevant choices, which have been found to be effective in increasing intrinsic motivation (Patall et al., 2008).

3.3 Seductive details

A pitfall of citing Dewey when investigating interest-enhancing interventions is that Dewey (1913) warned against teaching strategies he called "sugar coating" methods:

> *Everything is made play, amusement. This means over-stimulation; it means dissipation of energy. (...) The reliance is upon external attractions and amusements. Everything is sugar-coated for the child, and he soon learns to turn from everything that is not artificially surrounded with diverting circumstances (Dewey, 1913, p. 4-5).*

In the contemporary research literature, "sugar coating" can be paralleled to the phenomenon of *seductive details* (Garner et al., 1989). Seductive details refer to including features in learning materials that are highly attractive to the learners but unimportant or irrelevant to the text's main topic (Garner et al., 1989; Lehman, Schraw, McCrudden, & Hartley, 2007). For example, seductive details may include interesting but irrelevant facts to the text's main topic (Garner et al., 1989; Schraw, 1998), decorative illustrations (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014), or both (Park, Flowerday, & Brünken, 2015). The concept of seductive details is highly relevant for interventions such as context personalization and example choice because they entail inserting textual cues within instructional materials that may be unrelated to the formal principle of learning.

The significance of seductive details is that they can impair learning, such as reducing the recall of the main topic (Garner et al., 1989; Lehman et al., 2007), and can function as a distraction (Harp & Mayer, 1998), particularly among weaker learners,

despite triggering situational interest (Magner et al., 2014); however, the potential adverse effects of seductive details may be reduced by helping students focus on the main topic of a text (Park et al., 2015). Seductive details can also negatively influence situational interest among those with high individual interest in the core content to be learned, as shown by Durik and Harackiewicz (2007: Study 1). The reviewed studies highlighted that when examining interest-enhancing interventions, which often include the insertion of features used to increase perceived interestingness, the learning outcomes of the interventions must be considered. If the intended interest-increasing interventions negatively influence learning outcomes, the interventions may serve as seductive details that are not suitable for learning purposes.

For context personalization, research has shown mixed results regarding its effect on performance. Some studies have found that instructional strategies enhance problem-solving skills (Anand & Ross, 1987; Bernacki & Walkington, 2014; Ku & Sullivan, 2002; Walkington, 2013; Walkington et al., 2013), whereas others have observed no effect on problem-solving skills (Bates & Wiest, 2004; Cakir & Simsek, 2010; Ku et al., 2007; Ku & Sullivan, 2000). To the author's knowledge, no studies have reported adverse effects of context personalization. Example choice has not been found to influence performance (Reber et al., 2009). In sum, these findings indicate that neither context personalization nor example choice has been found to function as a form of seductive details.

3.4 Summary and hypotheses

Students gradually lose interest in mathematics as they age (Frenzel et al., 2010). In addition, there is a marked gender gap in mathematics interest. Therefore, a significant task is to "make things interesting" in mathematics learning, which can be understood as increasing situational interest among those with less individual interest in mathematics. In doing so, the model by Hidi and Renninger (2006) proposes that students will be more motivated to learn and may develop individual interest in the learning content if repeated over time.

The first article examines the backdrop for this dissertation. The overarching research question was whether the well-known tendencies for individual interest in mathematics to decline and to differ based on gender also manifest during students' experiences of situational interest. Drawing on the perspective of Hidi and Renninger (2006) and the expectancy-value model (Eccles et al., 1983), the main hypothesis was that the gender gap in individual interest is not observable for situational interest during mathematics learning. This assumption was made because the assessment of individual interest can be influenced by several factors that are not directly related to interest or to the domain of mathematics, which may not be the case when examining interest as a state while learning (see Article I for detailed hypotheses). The study also examined the influence of grade level on the relationship between students' individual and situational interest assessments. This study provides preliminary insight into the need to "make things interesting" to counter the tendency for individual interest in mathematics to decline with age and to reduce the gap between boys and girls.

Article II and Article III examine the effects of context personalization and example choice on situational interest during mathematics learning. For context personalization, the main hypothesis was that the instructional intervention using the fill-in-the-blanks approach could encourage situational interest among those with less individual interest in mathematics, especially when using students' interests to customize texts. For the example choice intervention approach, the main hypothesis was that it could encourage situational interest. In addition to the focal interventions, the studies also included two "one-size-fits-all" approaches to context personalization and example choice (Article II: example given; Article III: group personalization), which was not expected to promote situational interest (see Article II and Article III for detailed hypotheses). Despite the anticipated effect on situational interest, none of the investigated interventions was expected to affect problem-solving skills.

In summary, the aims of the studies of this dissertation were to examine the framework that emphasizes the need to encourage the use of situational interest in mathematics and to investigate two instructional interventions designed for this

purpose. In this dissertation, research on individual and situational interest among middle school students in mathematics and on two instructional inventions used to increase situational interest during mathematics learning is presented.

4. Method

This chapter outlines the methodological approach of this dissertation. The purpose of this chapter is to provide a detailed account of the methods and procedures of the studies and the methodological choices related to the topic of the dissertation. Building on the Campbellian validity system (Shadish, Cook, & Campbell, 2002), this chapter first introduces the validity concept that underpins this research. Validity is discussed throughout the chapter, which includes the design, procedures, and descriptions of participants, followed by treatment fidelity and ethical considerations.

4.1 Validity

Shadish et al. (2002) define validity as:

> *... the approximate truth of an inference. When we say something is valid, we make a judgment about the extent to which relevant evidence supports that inference as being true or correct ... Assessing validity always entails fallible human judgments* (p. 34).

As the quote underlines, validity is not related to the quality of the data material or the research method but to the property of the knowledge claims made in a study. According to Kleven (2008), this approach to validity is within the post-positivistic research tradition called *critical realism*, though it was not specifically defined by Shadish et al. (2002). Critical realism is a philosophy of science that assumes the existence of a reality that accounts for the phenomena encountered in science and everyday life, rejecting among others skepticism. A skeptic position holds that the empirical world is nothing but the sum of people's descriptions of it (cf. Kleven, 2008). Furthermore, critical realism emphasizes that knowledge about the reality depends on reiteration influenced by human activities (Lund, Fønnebø, & Haugen, 2006). Importantly, when making inferences from empirical data, researchers must take a critical stance to assert how the research captures and corresponds to reality.

Shadish et al. (2002) defined four types of validity corresponding to different inferences: internal validity, external validity, construct validity, and statistical

(conclusion) validity. *Internal validity* refers to inferences about causality by interpreting cause and effect relationships between variables for some individuals in a given setting (Lund, 2010). For example, an educational intervention (cause) can influence an outcome (effect), such as achievement or interest. However, internal validity is concerned with the question of how certain one can be in interpreting a cause-effect relation: Does the cause precede the effect in time? Is the cause related the effect? Can alternative explanations other than the cause account for changes in the effect? These are significant issues to assess internal validity according to Shadish et al. (2002). *External validity* refers to inferences about whether causality holds over variations of people and settings. Can we make inferences about the population the study sample is drawn from? Is the study context representative for contexts in the "real world"? *Construct validity* refers to inferences about theoretical constructs that represent sampling characteristics. For example, when making interpretations about a psychological concept, such as interest, one must be attentive to the question of whether our instrument measures what it claims to be measuring (cf. Kleven, 2008). In our example, how does the instrument reflect the theoretical concept of interest? Finally, *statistical validity* refers to inferences about covariations between cause and effect, whether it is trivial or worth further interpretation (Kleven, 2008). As Shadish et al. (2002) note, there is an overlap between internal and statistical validity. However, a distinction is that the former refers to an interpretation of the relationship between variables as cause and effect, whereas the latter refers to how we assess the relationship between cause and effect. Central issues to statistical validity are: Are the measurements of variables sufficiently reliable to assess covariations between variables? Can situational factors in experiments affect the assessment of cause and effect among the study variables? (cf. Shadish et al., 2002). This chapter addresses these four concepts of validity throughout the description of the studies of this dissertation.

4.2 Methodological approach

> *The well-known virtue of the experimental method is that it brings situational variables under tight control. It thus permits rigorous tests of hypotheses and confident statements about causation* (Cronbach, 1957, p. 672).

Because the topic of "making math interesting" contains an implied question of causation, an experimental approach was applied because as the quote above highlights, it is well-suited for making causal inferences. Shadish et al. (2002) defined experiments as "a study in which interventions are deliberately introduced to observe its effects" (p. 12). Furthermore, causal inference refers to the interpretation of cause and effect relations between variables for some individuals in a given setting (Lund, 2005, 2010). In this project, the *cause* refers to the instructional interventions of context personalization and example choice, whereas the *effect* refers to the potential changes in students' experiences of situational interest.

Using experiments is suitable for the investigation of causation, but there are limits to this method. Building on the work of Rubin (1974) and Holland (1986), Shadish et al. (2002) defined *effects* as relative and counterfactual and as "the difference between what did happen and what would happen" (p. 5). It is not possible to simultaneously expose and withhold an intervention for the same group of individuals. Therefore, it must be assumed, contrary to fact, that effects can be assessed based on a comparison of the outcome with a cause to the outcome without the hypothesized cause. Furthermore, experiments do not provide direct insight into the causal process under study and are therefore metaphorically referred to as a "black box" (cf. Maxwell, 2004). To this end, regarding the causal inferences from experiments, Shadish et al. (2002) emphasized that:

> *The unique strength of experimentation is in describing the consequences attributable to deliberately varying a treatment. We call this causal description. In contrast, experiments do less well in clarifying the mechanisms through which and the conditions under which the causal relationship holds – what we call causal explanation* (p. 9).

Drawing from the perspective of critical realism (Lund, 2010; Shadish et al., 2002), for this dissertation, causality was approached probabilistically at a molar level, focusing on cause and effect as a likely and general process rather than deterministic and detail-oriented.

As the quote from Cronbach (1957) indicates, control is a central part of experiments, particularly for experiments related to extraneous factors that can inference the study of effects. One of the most powerful designs is the approach called a *randomized experiment* (Shadish et al., 2002), also referred to as the "true" experiment (Lund et al., 2006) *controlled experiment* (Lund, 1996), and *randomized control group design* (Lund, 2010). Randomized experiments are designs that include two or more conditions, with and without intervention, in which a random process assigns participants to the different groups (Lund, 1996; Lund et al., 2006; Shadish et al., 2002). The random process of assignment is essential for the creation of groups that are probabilistically similar (Fraenkel, Wallen, & Hyun, 2012; Lund et al., 2006; Shadish et al., 2002). In doing so, individual factors that can interfere with the study of effects, such as gender and age of participants, as potential sources of an outcome are mitigated (Nelson, Cordray, Hulleman, Darrow, & Sommer, 2012).

4.3 The studies

This section supplements the accounts provided in the three articles and provides an overview of the studies of this dissertation.

4.3.1 Design

The randomized experiment was the core design of this research. According to Shadish et al. (2002), most experimental studies are highly localized and particularistic, meaning that they often occur in a restricted range of settings with a particular version of one type of treatment using a convenient sample of participants. It was therefore imperative that the study of context personalization and example choice included different versions of the same interventions in samples that may reflect a larger population of middle school students. Therefore, for the experimental

approach, survey methods were used for data collection. A survey method is a standardized approach to data collection that allows for testing a group of participants simultaneously based on the same instruments (Lund et al., 2006), thus producing a broad cross-section of participants.

Two randomized experiments were conducted using the survey method. The studies were carried out by providing middle school students with an instructional unit in mathematics and assessing their interest before and during engagement in addition to other variables related to learning; however, to accomplish this in one session, in addition to implementing the manipulation in the instructional unit using context personalization and example choice, the experiments were conducted using *Surveyxact*, which is a platform used for the development and administration of Internet-based questionnaires (Deibjerg & Krog, 2014). Using an online platform to distribute the instructional units allowed for the manipulation to be implemented on-site using the embedded features of the instrument. Furthermore, the approach also made data collection and experimental manipulations feasible for a large sample of middle school students.

The two randomized experiments were conducted using similar designs and materials and identical instruments. The two experiments were designed to examine different versions of context personalization and example choice as well as a related "one-size-fits-all" approach to the interventions. Figure 5 provides an overview of the interventions included in the experiments.

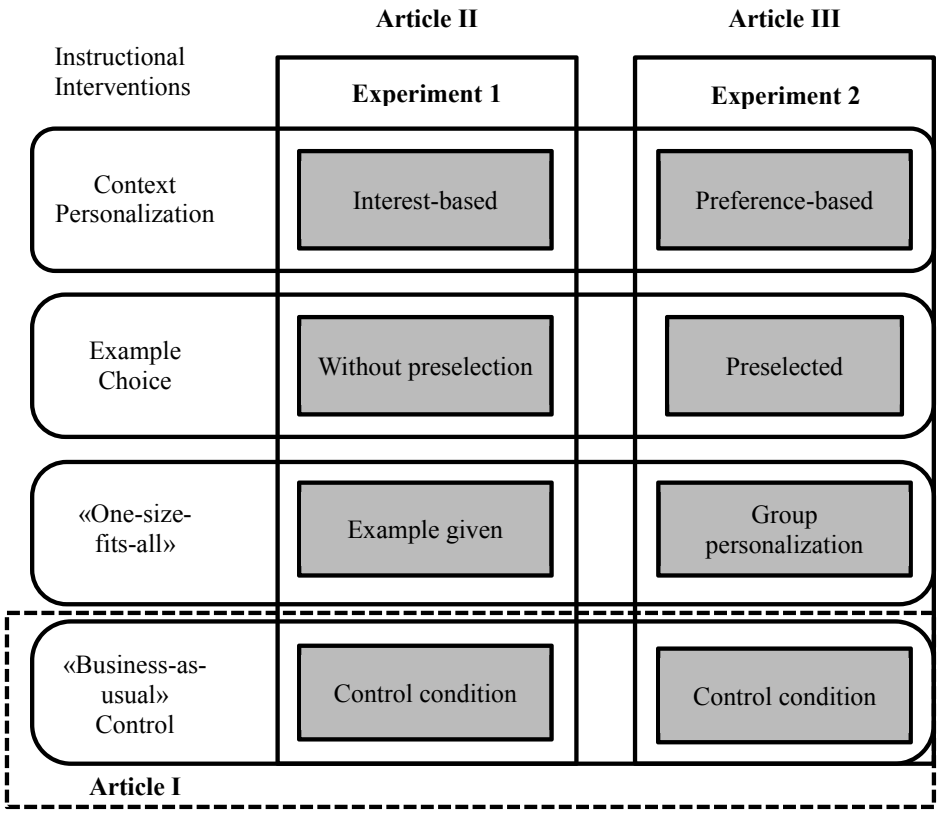

Figure 5 *Overview of experimental studies, interventions, and articles of the dissertation*

Experiment 1

In the first randomized experiment, context personalization and example choice were examined during mathematics learning from a written text. Context personalization was operationalized as a fill-in-the-blanks approach (Walkington & Bernacki, 2014) using students' out-of-school interests from popular culture to customize materials, which were limited to six interest domains: music, sports, movies, the Internet, literature, and gaming. Example choice was operationalized by offering students a choice between twelve topics for the learning materials (Reber et al., 2009), which were developed by creating two topics per interest domain listed to ensure similarities between context personalization and example choice. The choices were developed

arbitrarily from the six interest domains without knowledge of the middle school students' interests. In addition, the study included a third intervention, referred to as *example given.* For the example given approach, students were randomly given one example from the example choice condition without viewing the topics offered for selection. This condition was included to examine an approach to instruction following a "one-size-fits-all" logic to examine whether altering materials can influence situational interest despite the materials not being subject to individual customization or choices. A control condition was included following the assumption of "business-as-usual" (Nelson et al., 2012). In this case, participants were given generic mathematics learning materials without references to popular culture. The four conditions were implemented through questionnaires that were identical, with the exception of the experimental manipulations embedded in the instructional unit.

Experiment 2

The second randomized experiment can be regarded as an extension and replication of the first experiment conducted to examine context personalization and example choice. Similarly, context personalization was operationalized as a fill-in-the-blanks approach (Walkington & Bernacki, 2014), but students preferences (e.g., favorite drinks, foods, names of friends) were used to customize materials instead of interest. Furthermore, example choice was operationalized by giving students a choice between twelve topics for the learning materials; however, instead of developing the choices arbitrarily, these topics were developed based on the data collected during Experiment 1. From a sub-sample taken from Experiment 1, the most popular interests from popular culture were used to establish the topics for selection, an approach referred to as *preselected example choice*. Furthermore, an example given condition was included, but in this experiment, it was operationalized as *group personalization*, thus containing the most popular interest topics but without choice or individual customization. Similar to Experiment 1, a control condition was included following the assumption of "business-as-usual" (Nelson et al., 2012).

The experiments included three approaches to context personalization: Interest-based, preference-based, and group personalization based on dominant interests. Furthermore, three approaches to example choice were investigated: with and without preselection and examples without student choice (example given).

4.3.2 Participants

Sample article I

The sample for Article I was comprised of participants from both experiments but only those assigned to the control condition. The purpose of this sampling method was to capture individual and situational interest among middle school students when engaging in a mathematics activity without attempts to influence the experience of situational interest. The total sample consisted of 366 middle school students from the 8th, 9th, and 10th grades. See the following sections for details on recruitment and data collection.

Sample article II

The sample for the first experimental study was recruited during the winter and early spring of 2013. All public middle schools from a single municipality were invited to participate in the study (see Appendix II for the invitation letter) via emails sent to the principals. The principals were informed of the intentions of the study and the practical implementations. Five principals accepted this invitation, and data collection was planned to fit each of the five schools' schedules. Data collection began in March 2013 and ended in November of the same year. Given the shared recruitment of participants for another study within the same project, all 8^{th} and 10^{th} grade students from the five schools were invited to participate in the study. A total of 800 middle school students participated in Experiment 1. Based on predefined criteria for exclusion (see details in Article II), the final sample consisted of 736 middle school students. On average, each participant took part in the experiment for 28 minutes.

Sample article III

Recruitment followed the same procedure as in Experiment 1 and was initiated in the late summer of 2013. Given the lack of responses from several middle schools, all

schools from a second municipality were invited to participate in addition to those included in Experiment 1. A total of six schools agreed to participate, and five were from the same municipality as the first experiment. In addition to including a second municipality, this sample differed from the first sample in that it included all grade levels from the Norwegian middle school system (8^{th}-10^{th} grade). All grade levels participated for one school, only the 9^{th} grade participated for two schools, only the 8^{th} and 9^{th} grades participated for one school, only the 8^{th} grade participated for one school, and only the 10^{th} grade participated for one school. Data collection began in October of 2013 and ended in June of 2014. A total of 771 middle school students participated in Experiment 2. After the same exclusion criteria as in Experiment 1 was applied, the total sample consisted of 713 middle school students. On average, each participant took part in the experiment for 29 minutes.

4.3.3 Procedure

Both experiments followed the same procedure. All participants completed the online questionnaire at their respective schools either in a computer lab or a classroom specifically prepared for the study with laptops. Students were grouped based on their class affiliations but completed the questionnaires individually[13]. One or two experimenters were present for each test session, including the author.

The random process of assigning participants to the different conditions also ensured participant privacy. A function in SurveyXact called "self-registration via code" was used for data collection (Deibjerg & Krog, 2014, p. 223). Using this function, each questionnaire (i.e., condition) was activated by a unique code on a shared web page. When participants entered the prepared classroom, all computers were loaded to this web page for code activation. In preparation for each test occasion, envelopes with 32 codes for activation (8 codes for each of the four conditions of the experiments) were shuffled in random order and folded to conceal the code from the experimenters.

[13] The groups ranged in size from 15 to 60 students. Some of the schools in the studies did not operate with traditional classes, but were organized in different "bases" based on grade levels. Therefore, there was a broad range in group sizes in the experiments; however, they did not differ from the ways students were organized when working at their respective schools.

When participants were seated, they were given a code to activate a certain questionnaire. To this end, the random assignment of participants occurred at the class level, ensuring there were participants from different schools and classrooms for each condition. The experimenters also provided participants with the necessary equipment (pencil, paper, and a calculator) to ensure identical utilities were used.

Before participants were given the code to activate the questionnaire and embedded learning material, the experiment, the purpose of the study, and their right to withdraw from the study at any time were explained without revealing the experimental manipulation. When the code was activated, participants were allowed to ask questions about the practical aspects of the experiment but did not receive any guidance related to mathematics. The experimenter's role in the test situations was to ensure that all participants received the same information, that the technical equipment worked, and that the experiments followed the same procedure in all testing situations.

4.3.4 Summary

The three studies included two randomized experiments as well as an analysis of the control conditions of the experiments. The experiments followed a strict protocol to ensure standardization between the test occasions and the random assignment of participants to the different conditions to control for extraneous factors. These steps were taken to ensure the internal validity of the inferences made regarding the effect of the interventions on students' experiences of situational interest. The standardization and control included in the experiments allowed for reasonably trustworthy inferences regarding the causal description of the interventions compared to a control condition; however, the strength of the internal validity may compromise the external validity because other settings might not emphasize monitoring and supervision in a similar manner, which may be particularly relevant for educational contexts. Given the relatively large sample of middle school students, it could be argued that the results can be applied to other middle school students; however, given the restricted settings of the studies, the results may be more applicable to similar

learning situations, such as test taking and self-study sessions, than for learning in a natural classroom setting.

Furthermore, internal validity is closely related to statistical validity, as they are both concerned with study operations (Shadish et al., 2002). The design of the studies also included steps to promote statistical validity, such as the large sample size and the relatively equal sizes of condition samples.

4.4 The material

This section describes the overall design of the questionnaires used in the experiments.

4.4.1 Questionnaires

For the sake of this presentation, this section outlines the questionnaires with the embedded instructional units in different phases, though they refer to a single session. The steps included information and pre-test assessment (Phase 1), reading activity and mid-measure (Phase 2), problem solving (Phase 3), and post-test assessment and demographic measures (Phase 4). This presentation is relevant for all three studies.

The first phase of the questionnaires was information and pre-test assessments. The questionnaire began with a screen that provided participants with information regarding the study and their rights during the experiment. Next, students' out-of-school interests (experiment 1) or preferences (experiment 2) were assessed by asking students open-ended questions about their favorite subjects or objects from the selected interest areas (gaming, music, movie, sports, literature, or Internet) or different preferences (e.g., foods, friends, drinks, and stores). After the open-ended questions, pretest measures of individual interest and perceived competence in mathematics were assessed. These were included based on the theoretical framework of Hidi and Renninger (2006) and the expectancy-value model of Eccles et al. (1983) as focal predictors of situational interest, which is a major step in assessing statistical validity, to include the significant influences of the investigated effect.

Phase 2 encompassed the learning activity and mid-measures. The learning activity represented the instructional unit students interacted with during the experiments. The main topic for this presentation was probability calculus with independent conjoint events. This topic was chosen because it involves basic mathematical operations, making it suitable for students from different grade levels in middle school. The complete instructions are shown in Appendix I in Norwegian, exemplified by the control condition in Experiment I. Professional experts from mathematics and didactics fields helped develop this instructional unit. The instructions began with a general description of what probability calculus is and how probability can be expressed numerically. The focus was on probability expressed as decimal numbers because this was easiest to combine with the use of online questionnaires. After the general presentation (two screens), students were given an *example task* related to the main topic of the presentation. In this case, an example task refers to an interactive case in which students attempted to solve a problem, and the questionnaire provided immediate feedback about students' answers (four screens). For participants in the context personalization condition, the example tasks contained information they provided in Phase 1, whereas participants in the example choice condition were given a choice among twelve topics for the task. The following learning presentation explains the main theme based on the example task, which contained experimental manipulation for textual intervention. After this explanation, all questionnaires contained the same generic pre-worked example, providing a further explanation of the main topic based on coin tosses. In total, this presentation contained eleven screens. Immediately after reading the instructions, triggered situational interest was assessed, which is referred to as a mid-measure.

Phase 3 contained seven mathematical word problems for the participants to solve, meaning that the problems were presented in textual form (Reikerås, 2007). The seven problems were identical for all conditions in both experiments in terms of mathematical operation; however, for all experimental conditions, the first three problems, similar to the example tasks, contained textual interventions based on the condition. The final four tasks were identical for all participants in both experiments. While solving the problems, students were allowed to draft the problem using a pen

and paper and a calculator; however, they only provided a solution in the questionnaire by writing their answers as decimal numbers in a text box of the survey.

In Phase 4, the post-test assessment was conducted to measure maintained situational interest based on affect and value as well as students' efforts to solve the problems. At the end of the questionnaire, students answered questions about their genders and grade levels. These questions were deliberately asked at the end to avoid potential stereotype threats (e.g. Steele, 1997; Thoman, Smith, Brown, Chase, & Lee, 2013), influencing participants answers, or perceptions of interest and abilities related to the subject. Also, before exiting the questionnaire, participants were shown the correct answers to the mathematics problems they solved.

All questionnaires in all conditions were identical in structure, appearance, and content, except the textual aspects of the interventions. The instructional unit did not include pictures or colorful fonts to prevent the inclusion of seductive details that were not associated with the interventions. Figure 6 provides an overview of the questionnaires and the test-situation.

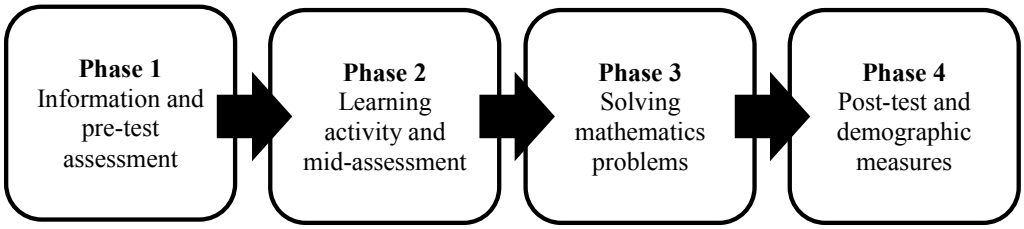

Figure 6 *Structure of the questionnaires*

4.4.2 Measures

The articles include all measures used in the studies. In Appendix II, the scales are presented in Norwegian, which is the language used for the questionnaires.

Previous research inspired the instruments used to assess individual interest and perceived competence in mathematics as well as situational interest. The study by Köller et al. (2001) inspired the assessment of individual interest in mathematics using a scale based on lasting affective and evaluative relations to the domain. The assessment of perceived competence was taken from the theory of self-concept (Marsh, 1990), conceptualized as ability judgments in a particular domain (Marsh, 1993). Situational interest measurements were based on the Student Interest Survey (SIS: Linnenbrink-Garcia et al., 2010), encompassing triggered situational interest and maintained situational interest based on affect and value; however, the use of the SIS was modified from a hindsight assessment of a course to a real-time assessment confined to a single learning session. As explained in the previous section, the timing of the assessments is critical in the evaluation of construct validity as well as internal and statistical validity. The theoretical precursors for situational interest were assessed before this experience to consider the time dimension. Furthermore, the dimensions of situational interest were evaluated at different times during the experiment corresponding to the responses for triggered and maintained situational interest. The use of real-time assessments of situational interest is highly significant for the evaluation of construct validity. When examining situated experiences such as situational interest, the use of foresight or hindsight may include other beliefs that are not related to the situation at hand (Robinson & Clore, 2002); however, when using real-time assessments, the respondents have a clear reference point.

All instruments used in the studies had adequate reliability as assessed by Cronbach's alpha; however, this is only one step of assessing construct validity related to *random measurement errors* (Kleven, 2008). The question remained whether the applied instruments captured the broad concepts of individual and situational interest and perceived competence in mathematics, which are central to this research. This question is related to *systematic measurement errors*, particularly to construct underrepresentation and overrepresentation (Kleven, 2008), which refer to the degree to which the instruments correspond to the theoretical concepts. As part of the assessment of construct validity, these constructs were evaluated based on theory and previous research to evaluate their "behaviors". Similar to previous theoretical and

empirical work (e.g. Eccles & Wigfield, 2002; Schiefele, 2009; Skaalvik & Rankin, 1995; Skaalvik & Skaalvik, 2008; Trautwein, Lüdtke, Marsh, Köller, & Baumert, 2006), there was a high correlation between individual interest and perceived competence and a high correlation between the three facets of situational interest (Linnenbrink-Garcia et al., 2010; Linnenbrink-Garcia et al., 2013); however, some aspects regarding operationalization should be noted. The scale for measuring individual interest did not include measures of knowledge, as posited by Hidi and Renninger (2006). Second, individual interest was not distinguished between the two phases, as theorized by Hidi and Renninger (2006). Therefore, a concept of individual interest that resembles that of Schiefele (2009) was employed for this research. Nevertheless, as mentioned, the inclusion of perceived competence may have at least captured some of the participants' perceived knowledge. The measure of situational interest assessed the experience; thus, it did not include other components, such as facial expressions and physiological arousal (Silvia, 2006, 2008).To this end, the assessment of interest may be underrepresented when compared to the theoretical foundation of the research.

Although there are limitations to the measures used in this research, the psychological measures were evaluated to be acceptable regarding construct validity. Using relevant theory, timing, and real-time assessments are effective approaches that shape the appraisal of construct validity, even with its limitations taken into account.

4.5 Treatment fidelity

Treatment fidelity, or interventions fidelity, is the degree to which an intervention has been planned and implemented equally for all study participants over time (Nelson et al., 2012; Smith, Daunic, & Taylor, 2007). Treatment fidelity is often related to studies in which an experimenter is not present during the implementation of an intervention (Smith et al., 2007); however, certain steps were taken for the current experiments to ensure trustworthiness. First, the author of this dissertation and/or a research assistant were present in all testing situations. The same research assistant participated in all experiment situations. Second, a standard introduction was written

to ensure that all participants received the same information before the experiment began. Third, the types of questions that would be answered and the questions the participants would be asked were determined beforehand. The final concern was related to the mathematics content, for which no assistance was provided. Furthermore, all participants were given the same material aids (i.e., calculator, pen, and paper) in the testing situation, and the researcher and researcher assistants' presence was to ensure that the same procedures were followed and that participants worked individually. To this end, the treatment fidelity of the experimental studies is considered satisfactory for the implementation of a comparable practice.

4.6 Ethical considerations

Before beginning data collection, the Norwegian Social Science Data Service (NSD) approved the overall design and approach of the study (see Appendix III) [14]. Because the approach to data collection ensured participants' anonymity and did not entail sensitive information, active parental consent to participation was evaluated as unnecessary, despite researching children and youth below the age of 15 (NCREN, 2006); however, several steps were taken during the procedure to ensure participants' informed consent and confidentiality and to avoid any distress during the experiment, which are essential concerns in all research involving humans (Fraenkel et al., 2012; NCREN, 2006). All schools invited to participate in the studies were informed about the research, its purpose, procedure, data handling, and the participants' rights in the study situation (see Appendix IV). After accepting the invitation to participate, the schools were given copies of a letter to inform the parents of the study their child would participate in (see Appendix V). The students could then decide whether to participate with their parents, which is a form of *passive* parental consent.

In the testing situation, several steps were taken to ensure that the participants received and understood their rights and informed consent. First, all participants were

[14] The first application to NSD did not include a detailed account of the "self-registration via code," and active parent consent was evaluated to be necessary; however, in a second application, this procedure was described in detailed, which changed the need to involve parents in students' decisions to take part in the study. Both NSD letters are included in the appendix.

provided with information regarding their right to withdraw from the study at any time without explaining this decision, both during the briefing before beginning the experiment and while completing the questionnaire. Before beginning the experiment, all participants were offered the opportunity to ask questions about the test. Without active parental consent, it was imperative that all participants received and understood this information. Second, participants' anonymity was ensured by the generation of a random respondent-id in the response file related to the experiment. Also, certain demographic measures were not included in the questionnaire to ensure that none were identifiable, such as specific age (only grade level was related to students' ages), ethnicity, or specific school affiliation. This was done to ensure that any information provided by the initial interest or preference questions could not be paired with demographic variables to identify individual participants. All students from the same schools used a computer connected to the internet using the same log-in information. Third, because the learning activity embedded in the questionnaire was based on self-studying without the assistance of an educator, a recommendation was made to each school to not include any students with special needs in either reading or mathematics to avoid participant distress.

A major challenge in the research conducted for this dissertation was the recruitment of participants. Therefore, all schools were compensated 100 NOK (about 11.5 USD) per student participating in the study. To avoid the compensation influencing the experiment and its associated experience, the money was given to the school with encouragement that the payment should benefit all students, regardless of participation. Principals and teachers were instructed not to tell students about the compensation to avoid any form of pressure on the students to participate in the study; however, another step was included to prevent any retrospect stress on students who chose not to participate. To prevent teachers and students from determining who participated and who did not, students were given a learning assignment on the computer where they were seated regardless of their decision to participate, which was either provided by the experimenter or the teachers. To this end, the compensation should not have influenced students' decisions to participate in this research and should not have served as a form of pressure or distress.

5. Results and discussion

This chapter summarizes the three articles included in this dissertation and presents additional analyses not published, followed by a general discussion of the findings and their contributions and implications. The chapter concludes with suggestions for future research and final remarks.

5.1 The articles

The topic of this dissertation is determining how to "make math interesting" for middle school students due to the tendency for mathematics interest to decline with age. This overarching focus was investigated through three articles: the first article examined the background of this topic, whereas the other two articles directly addressed the dissertation's topic.

5.1.1 Article I

Article I is entitled: Høgheim, S. & Reber, R. (2017). Interesting, but less interested: Gender differences and similarities in mathematics interest. *Scandinavian Journal of Educational Research.*

The aim of this article was to examine the background of the experimental studies by investigating the theoretical framing of the concept of interest. As discussed in Section 4.3.2, the sample in this study consisted of participants from the control condition of two experimental studies (see Figure 5), which constituted 366 middle school students from the 8^{th}, 9^{th}, and 10^{th} grades. From the perspective of Hidi and Renninger (2006), experiencing situational interest can support the development of individual interest. Therefore, it is reasonable to assume that when studies often show that there is a tendency for mathematics interest to decline and to have a marked gender gap (Frenzel et al., 2010), this occurs due to differences in situational interest. To this end, this article examined whether differences observed in individual interest corresponded to differences in the experiences of situational interest while learning. Another way to frame this focus is whether increasing situational interest is essential

to countering the common tendencies in individual interest in mathematics, following the model developed by Hidi and Renninger.

Data were analyzed using multiple regression analyses (see article for details), which included components from the theoretical framework of Eccles et al. (1983). The association between individual and situational interest was the dependent variable of the analyses, whereas gender, grade level, and perceived competence in mathematics were the focal predictors.

As the title suggests, one of the main results of the study was a discrepancy between individual and situational interest between boys and girls. Girls reported lower individual interest in mathematics than boys, but this gender gap was not observed in students' experiences of situational interest when engaged in a mathematics activity. A less emphasized finding is the lack of discrepancy regarding grade level, which suggests that the observed decline in individual interest is also observable in students' experiences of situational interest. Figure 7 shows the means for individual and situational interest for the three grade levels of the Norwegian middle school system.

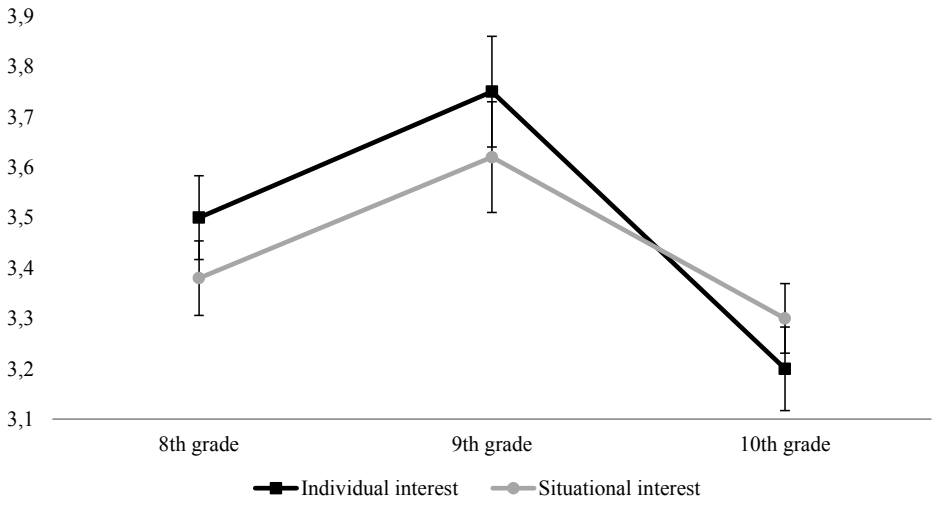

Figure 7 *Individual and situational interest (mean and standard error) for grade levels in middle school (N = 366)*

Additional analyses revealed that differences in perceived competence between boys and girls contributed to the discrepancy between individual and situational interest. Boys reported higher competence in mathematics than girls, despite similar prior achievements, which may influence their assessments of individual interest. The influence of perceived competence beliefs may be less influential for the assessment of situational interest because students had a clear point of reference to the mathematics at hand.

The results of this study were interpreted to suggest that increasing situational interest can be linked to the tendency for mathematics interest to decline with age to a larger extent than for the gap between boys and girls.

5.1.2 Article II

Article II is entitled: Høgheim, S. & Reber, R. (2015). Supporting interest of middle school students in mathematics through context personalization and example choice. *Contemporary Educational Psychology,* 42: 17-25.

The aim of this study was to examine the effect of context personalization and example choice on middle school students' experiences of situational interest and learning. As mentioned in Section 4.3.2, the study consisted of 736 middle school students that were randomly assigned to one of four conditions (see Figure 5): interest-based context personalization, example choice without preselection, example given ("one-size-fits-all"), and a control condition.

Data were analyzed using multiple regression analyses, and the experimental effects were determined based on differences in the control condition. Because individual interest and perceived competence are significant predictors for the experience of situational interest (Eccles et al., 1983; Renninger & Hidi, 2015), they were included as moderators in the analyses in addition to the instructional interventions. As explained in detail in the article, the analyses examined whether the interventions differed from the control condition in students' experiences of situational interest,

effort, and task performance, controlling for individual interest and perceived competence in mathematics.

The results revealed that interest-based context personalization had a positive effect on all facets of situational interest and effort, though only among students with low individual interest and perceived competence in mathematics. For those high in interest and competence beliefs, the interventions had a reversed effect. Example choice increased triggered situational interest, maintained situational interest based on affect, and effort among those with low individual interest in mathematics. Compared to the control condition, example given had no effect on situational interest, effort, or performance. The results showed that interest-based context personalization and example choice can positively influence situational interest among students who lack individual interest. None of the instructional interventions functioned as seductive details that impaired problem solving for the embedded tasks, nor did they support problem solving.

5.1.3 Article III

Article III is entitled: Høgheim, S. & Reber, R. (2017). Eliciting mathematics interest: New directions for context personalization and example choice. *The Journal of Experimental Education,* 85(4): 597-613.

This study was a replication of the experiment in Article II, but different versions of context personalization and example choice were examined. This study examined preference-based context personalization, example choice with preselection, group personalization ("one-size-fits-all"), and a control condition (see Figure 5). In total, 713 middle school students were randomly assigned to one of these conditions.

The results revealed that preference-based context personalization had a small positive effect on students' perception of value (i.e., maintained situational interest – value) and effort, though only among those with low perceived competence in mathematics. Example choice with preselection had a positive effect on triggered situational interest. Other than a small detrimental effect on maintained situational interest based on value among those with high individual interest in mathematics, no

effects were observed for group personalization. None of the interventions had any effect on problem solving.

5.1.4 Additional analyses

In addition to the three articles, it was also relevant to this dissertation to investigate whether Norwegian middle schools follow the same tendency of a decline in mathematics interest and a gender gap as observed in other studies from other educational systems (e.g. Fredricks & Eccles, 2002; Frenzel et al., 2010; Watt, 2004).

The pre-test assessments of individual interest and perceived competence in mathematics from both experiments were merged into one sample. Because these concepts were pre-test measures in the experiments, they were not likely to be influenced by the experimental manipulation. The combined sample consisted of 1449 middle school students (50.9 % girls) from the 8^{th} (n = 596), 9^{th} (n = 293), and 10^{th} (n = 560) grades. The two concepts were subject to a multivariate analysis of variance (MANOVA) to examine the effects of gender and grade level. Also, an interaction effect (gender × grade level) was included to determine whether the effect of age (i.e., grade level) differed between boys and girls.

Results from the MANOVA revealed a significant effect of gender on individual interest (F (1, 1443) = 23.26, $p < .001$) and perceived competence in mathematics (F (1, 1443) = 49.24, $p < .001$). The significant gender differences are shown in Figure 8, which illustrates that boys reported higher interest and competence in mathematics compared to girls. The effect of grade level was also significant for interest (F (2, 1443) = 30.45, $p < .001$) and perceived competence in mathematics (F (2, 1443) = 17.89, $p < .001$). Figure 9 shows the results for grade level. Tukey HSD post-hoc test showed that students in 10^{th} grade reported a significantly lower interest than students in 9^{th} grade (M_{diff} = -.50, $p < .001$) and 8^{th}grade (M_{diff} = -.36, $p < .001$). The difference between 8^{th} and 9^{th} grade students did not reach a statistical significance. Similarly, for perceived mathematics competence, students in 10^{th} grade reported a lower competence than students in 9^{th} grade (M_{diff} = -.38, $p < .001$) and 8^{th} grade (M_{diff} = -.36, $p < .001$). The difference between 8^{th} and 9^{th} grade students did not reach a

statistical significance. Finally, the gender × grade level interaction did not reach a statistical significance for interest (F (2, 1443) = 1.10, p > .33) or perceived competence (F (2, 1443) = .79, p > .45), indicating that age (i.e., grade level) has the same effect for both boys and girls.

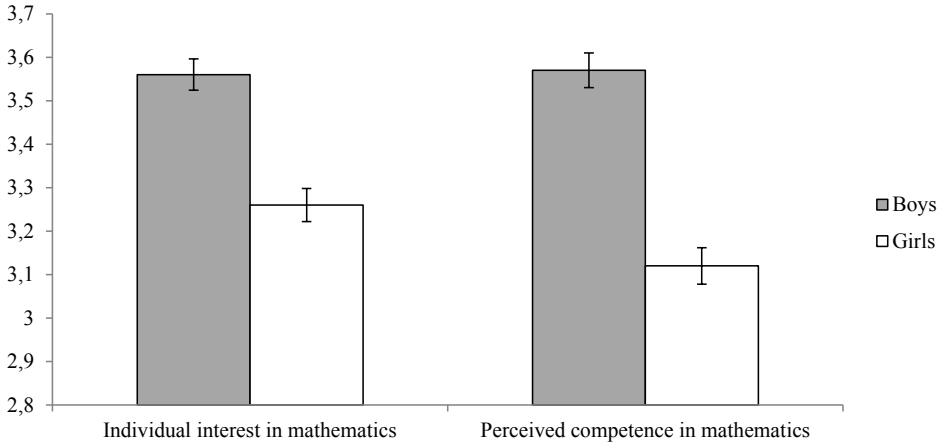

Figure 8 *Individual interest and perceived competence in mathematics (mean and standard error) for boys and girls in middle school (N = 1449)*

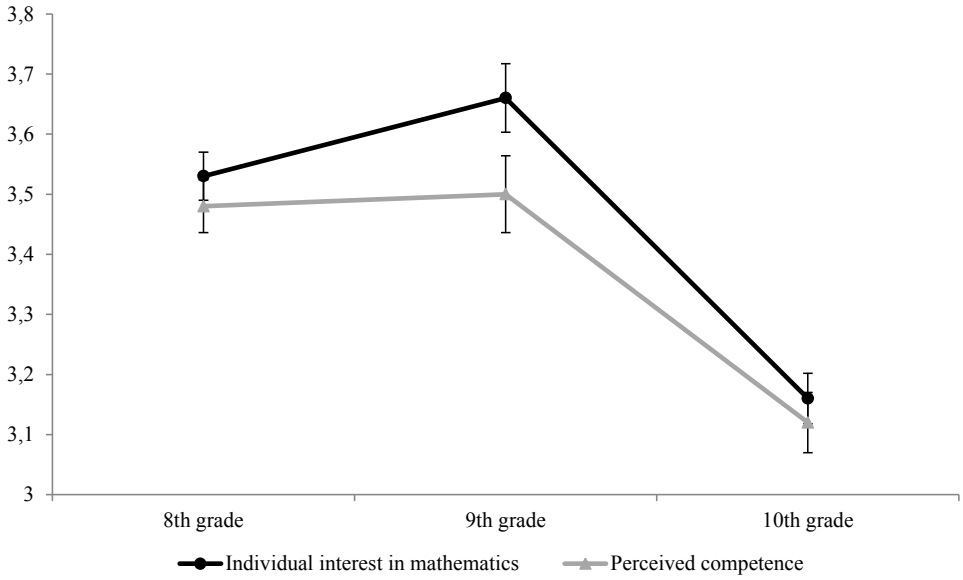

Figure 9 *Individual interest and perceived competence in mathematics (mean and standard error) for the grade levels in middle school (N = 1449)*

The results of the additional analyses replicated findings regarding the challenge of declining mathematics interest in the current sample of middle school students; however, in contrast to studies in which a steady decline was observed (Frenzel et al., 2010), for the current sample, a steep decrease in the final grade levels of compulsory education in Norway was observed. The results showed the same tendency for perceived competence in mathematics. This analysis also replicated previous findings that boys do report higher interest and competence in mathematics compared to girls.

5.2 Discussion of contributions and implications

Due to the tendency of mathematics interest to decline as students age, the overarching topic of this dissertation is related to determining how to "make math interesting" for middle school students. The additional analyses discussed in the previous section further support the need to find ways to encourage interest in mathematics in middle schools.

5.2.1 Empirical contributions

The primary contributions of this dissertation are insight into the necessity to promote situational interest in middle school (Article I) and an increased knowledge regarding how to encourage situational interest in middle school mathematics using texts (Articles II and III). This section further elaborates on these points.

First, this dissertation research has provided evidence to support the assertion that documented differences in individual interest do not necessarily correspond to differences in the experiences of situational interest. Student interest in mathematics declines as they progress through school, and although there is a marked gender gap, boys and girls follow the same downward trajectory (e.g. Fredricks & Eccles, 2002; Frenzel et al., 2010; Watt, 2004). Based on the theoretical framework of Hidi and Renninger (2006), one way to counter these well-documented trends is to encourage situational interest at school (e.g. Frenzel et al., 2012), which in turn can increase

individual interest, as supported by empirical studies (Palmer et al., 2016). Conversely, it can be assumed that individual interest declines with age and that boys and girls develop contrasting individual interests in mathematics due to the lack of the experiences of situational interest during learning; however, this dissertation has provided evidence that suggests that gender differences may be caused by influences other than the learning environment, as would be the case for situational interest. Gender differences in individual interest did not correspond to differences in situational interest: boys and girls experienced the same level of situational interest when engaging with mathematics content. For grade levels, there was a relatively small, insignificant discrepancy between individual and situational interest, suggesting that there are age-related differences in individual interest when students engage in mathematics. In line with the theoretical framework of Eccles et al. (1983), among others, the discrepancy between individual and situational interest was in part explained by differences between boys and girls in how competent they perceived themselves in mathematics. The difference in competence evaluation was not only observed before engaging in mathematics activities but also after, regardless of similar achievements.

A second contribution is increased knowledge regarding how to encourage situational interest among middle school students using texts. Context personalization and example choice encouraged situational interest only among students with low individual interest and perceived competence in mathematics. For highly interested students, the interventions had a detrimental effect on situational interest, similar to studies on the use of visual stimulation (Durik & Harackiewicz, 2007); however, this dissertation shows that the efficiency of the interventions in promoting situational interest is dependent on the design of the context personalization and example choice.

For context personalization, there were positive results when using students' interests to customize the instructional unit rather than preferences. Although the approaches investigated for this project have been subject to research before (e.g. preferences: Ku et al., 2007; interest: Renninger et al., 2002), to the author's knowledge, no study has distinguished between the two approaches to context personalization to promote

situational interest. This project demonstrates that there is a difference between the two strategies when using interest and preferences in their effect on situational interest, which makes this distinction relevant to the interest-enhancing literature. As noted, a limitation to experimental studies is that they do not provide insight into the causal mechanism, only the causal description; however, one possible explanation might be illustrated by the model shown in Figure 3, which is that interest-based context personalization draws from both academic and non-academic individual interests to elicit situational interest in a particular moment. A similar outcome might not be the case for preferences, as they do not hold personal significance for the learner. Arguably, interest-based approaches to context personalization are not new (e.g. Walkington et al., 2013); however, researchers have primarily studied the effect on problem-solving. This dissertation focused on eliciting situational interest using context personalization in which interest versus preferences was not made categorical.

For example choice, the design with randomly created topics for selection (i.e., without preselection) showed more positive results than preselection. Example choice without preselection has previously been shown to encourage interest (Reber et al., 2009), and a design with preselection was developed for this project; however, the original concept of this instructional intervention appears to be superior in encouraging student interest. In Article II, it is theorized that a design with preselection might not have the same effect because this approach operates with multiple topics that are attractive to the learner. Therefore, the opportunity to select choices loses its significance; however, in line with Patall et al. (2008), an alternative explanation might be that when all topics are appealing, the choices become more effortful.

A third empirical contribution is increased knowledge regarding how *not* to encourage interest. Several of the investigated interventions did not promote situational interest: preference-based context personalization, example given, and interest-based group personalization; however, a lack of significance does not have the same weight as significant results. Group personalization in particular has been

subject to research based on the assumption that it increases students' interest (e.g. Ku & Sullivan, 2000, 2002). Although the current approach to group personalization utilizes dominant *interests* to modify the text rather than preferences, this mode of personalization did not positively affect interest. Along with example given, these findings underline the point made by Harackiewicz et al. (2016): "No interest intervention is one size fits all" (p. 6).

A fourth contribution is that although not the primary objective of this project, increased knowledge has been provided regarding the immediate effects of interest-enhancing interventions on mathematics performance and effort. In line with the theoretical framework (e.g. Hidi & Renninger, 2006; Schiefele, 2009), the interventions that promoted situational interest also increased students' efforts. Therefore, this dissertation provides some evidence that encouraging interest has immediate motivational consequences. It should also be noted that the interventions had a discouraging effect on those high in interest and perceived competence: when a detrimental effect was observed in situational interest, a similar effect was observed for effort. Despite the effect on effort, either positive or negative, none of the interventions supported students in their problem-solving skills, as indicated by the lack of effect on performance. On the one hand, these results suggest that none of the interventions operated as seductive details that could harm performance (e.g. Garner et al., 1989; Magner et al., 2014); however, these observations also contribute to the field of context personalization. Given the positive outcomes in problem-solving skills, Walkington et al. (2013) speculated that "the role of personalization and other interest-based interventions may be conceptualized as providing scaffolding for students who are struggling to solve problems" (p. 110). Because interest-based context personalization and example choice had positive effects on both situational interest and effort but not on problem-solving skills, situational interest may not provide scaffolding when students encounter difficult problems. In other words, it is not the experience of situational interest that can facilitate performance.

Across the three studies, this dissertation highlights the need to focus on situational interest in schools, especially related to changes in individual interest due to

increased age. Furthermore, the investigated interventions support (Dewey, 1916) statement that "one who recognizes the importance of interest will not assume that all minds work in the same way because they happen to have the same teacher and textbook" (p. 136).

5.2.2 Practical implications

Article I showed that observed differences in individual interest do not necessarily correspond to differences in situational interest. A practical implication of this observation is the need to approach interest from different theoretical viewpoints to address both age and gender-related differences in individual interest. Regarding the domain of physics, which is also a subject with a marked gender gap (Krapp & Prenzel, 2011), Hoffmann (2002) stated that "what is interesting for girls is also interesting for boys, but not necessarily vice versa" (p. 451). Therefore, gender-specific interventions were developed to account for the specific interests of girls; however, because boys and girls experience the same level of situational interest when engaging in mathematics, the model developed by Hidi and Renninger (2006) might not be sufficient to close the gender gap, as it focuses on increasing situational interest. In other words, increasing situational interest specifically for girls might not lead to a level of interest equal to boys. In the periphery of this dissertation, interventions targeted toward students' competence assessments might be a more applicable approach to countering the gender gap in mathematics interest. For grade level declines, on the other hand, increasing situational interest, such as by using context personalization and example choice, might be more suitable for increasing individual interest.

The practical implications of context personalization and example choice (Article II and Article III) are primarily related to the use of interest-enhancing interventions. Context personalization was conceptualized as fill-in-the-blanks for this research, which is considered practical for use in education (Walkington & Bernacki, 2014). It is possible for educators to alter a generic text in mathematics to the individual learner by changing the subject and object of the text to something that is of interest

to the student, similar to the practices in the experiments. Although it is possible, customizing the text to the learner can be a time-consuming practice, even if it follows the principle of fill-in-the-blanks. As the results for the "one-size-fits-all" condition implies, customization should be based on individual students. Therefore, educators must gain insight into the individual student's out-of-school interests before using context personalization. A more practical approach is example choice, especially since the approach without preselection showed the most promising effect on situational interest. Educators can prepare a set of topics students can choose from when learning something new from texts. In the current research, participants were offered 12 topics for the example choice condition; however, according to Patall et al. (2008), the optimal number of options to promote intrinsic motivation is between two and four. It is therefore possible that other outcomes that are even more encouraging could be achieved by reducing the number of topics.

Interest-based context personalization, although applicable by manually creating customized texts, may be more suitable for use in electronic or web-based learning platforms. Learning using information and communication technology (ICT) is now common in schools (Krumsvik, 2008). By implementing context personalization based on interests, an evidence-supported practice can be applied to encourage students' situational interest as well as effort in learning. For the current research, context personalization was implemented using an online platform (SurveyXact) that was not primarily developed for learning purposes; however, with little effort, the tool used to administer online surveys provided participants with a learning unit and customized the text instantly. For those who develop learning programs, interest-based context personalization, and example choice for that matter, can be appropriate approaches to implement to increase situational interest when learning; however, due to the detrimental effect for those high in interest and perceived competence, screening should be performed to determine whether the intervention is appropriate for the learner.

5.2.3 Methodological contributions

A methodological contribution of this research is the demonstration of how the Student Interest Survey can be used within a single learning session to assess situational interest (SIS: Linnenbrink-Garcia et al., 2010). Prior research that employed the SIS has primarily used the instrument to measure situational interest in hindsight to more general courses rather than isolated learning events (Linnenbrink-Garcia et al., 2010; Linnenbrink-Garcia et al., 2013). An advantage of using the SIS is that it distinguishes between the different facets of situational interest (triggered, maintained based on affect and value), which is often overlooked in studies on experience (e.g. Reber et al., 2009; Tsai et al., 2008). Including different facets of situational interest allows for an investigation of not only the effects but where the effect occurs and perhaps also what should be done to make an intervention even more efficient for "making things interesting."

A second methodological contribution is the use of an experimental approach on a relatively large sample of the target recipients of an intervention. Many experimental studies that aimed to identify interest-enhancing interventions among adolescents tested interventions in a different population of participants (e.g. Durik & Harackiewicz, 2007; Hulleman, Godes, Hendricks, & Harackiewicz, 2010). The current research demonstrates that survey methods using online tools and an experimental approach can be combined to ease the implementation and testing of experimental effects.

5.3 Shortcomings of the research

Chapter 4 highlights several strengths of this research related to the concept of validity. Figure 10 summarizes these strengths and shortcomings; however, there are several limitations to this research that this section explains further. This section supplements the limitations section in each of the three articles.

Internal validity + Control over extraneous variables + Control in intervention testing + Comparison to control condition - Less control over time for testing	**External validity** + Natural setting + Relatively large sample size + Participants are target users of intervention - Limited range of settings - Limited mathematics content - Participants geographically limited
Construct validity + Real-time assessment + Theorized relationship between variables - Construct underrepresentation - Intervention alteration	**Statistical validity** + Sample size + Inclusion of (some) relevant moderators + Timing of assessment + Acceptable treatment fidelity

Figure 10 *Strengths (+) and shortcomings (-) of the current research*

First, for construct validity, there are limitations in the operationalization of example choice. In the original design, example choice includes a variety of examples students can choose from, often related to everyday contexts, such as pregnancy, gambling, colors, vision, and becoming a crime victim (Reber et al., 2009); however, for the current research, the operationalization of example choice was influenced by the design of context personalization using fill-in-the-blanks to make the conditions comparable. To this end, this research employed a more simplistic design to example choice than the original layout. This is beneficial for the practical use of example choice; however, it does not capture the intended complexity that example choice allows because it uses ready-made learning materials rather than customized materials (i.e., context personalization).

A second limitation is related to internal validity. The data collection for each experiment extended over several months, following the participating schools' schedules. Consequently, the participants did not participate in the experiment at the same time with the same level of experience in mathematics. Also, the experiment was conducted at different times during the day. Consequently, some participants

took part in the experiment at the first hour of their school day, whereas others participated during the last hour; however, given the random assignment of participants to the different conditions, it can be assumed that this lack of control over timing did not influence the results. Nevertheless, it is important to acknowledge that all participants did not participate in the experiment simultaneously, as should be the case for optimal control.

Third, the overall design of the experiments may lead to an inconsistent comparison of conditions. Ideally, the two experiments should have been designed so that context personalization was investigated in one experiment (interest-based context personalization, preference-based context personalization, and group personalization) and example choice in a second experiment (example choice, example choice with preselection, and group personalization); however, some of the interventions were dependent on the data for the design, such as group personalization and example choice with preselection. Therefore, the ideal design would not have been possible. Still, a comparison between the different approaches seems applicable given the identical design, procedure, and sample of the experiments.

Fourth, for construct validity, the assessment of interest only included experiential measures that are measurable by surveys. Aspects such as concentration or behavioral measures were not captured in this approach to assessments. The inclusion of effort can confirm the experimental effect on situational interest to some extent, as participants' efforts would be expected to increase when situational interest is increased (Hidi & Renninger, 2006); however, other behavioral measures were not taken into account, such as seeking-behaviors. For example, individual interest can be assessed through students' behaviors. Would the participants read the instructions for probability calculus while they waited for the experiment to begin? The observation of such behaviors could be used to validate interest.

A final limitation of all three articles is the lack of a follow-up test of interest after the study. This would have allowed for observing interest in different contexts (Article I) or observing the long-term and temporary effects of the different phases of situational

interest (Article II and III); however, the practice used to ensure participants' anonymity made it impossible to perform any follow-up tests of interest.

The findings from Article I could benefit further research that examines the discrepancy between individual and situational interest for different content and various settings (e.g., classroom learning, test taking, homework, group assignments). This research might shed light on common trends in individual interest, how they arise, and more importantly, how educators can counter gender gaps and decline in mathematics interest in school.

The findings on context personalization and example choice could benefit future studies as well. The proposed distinction between interests and preferences could be examined using designs other than fill-in-the-blanks based on the principles outlined by Walkington and Bernacki (2014). More elaborate designs than fill-in-the-blanks can be used at the expense of practicality, such as personalization to topic interest (Walkington et al., 2013); however, with the increasing use of technology in schools and the developments in computer programming, practicality might be a less significant issue in the future. Furthermore, interests other than popular culture can be examined, such as vocational interests. Vocational interests are believed to be an important topic for middle school students (Wigfield et al., 2015) and may therefore support both triggered and maintained situational interest in mathematics. Similar recommendations can be made for example choice, but because the approach is probably more practical than context personalization, more elaborate designs with more depth and customization may be useful to study; however, additional insights into their effects on interest and learning are needed, especially as mathematics based on everyday experiences is underlined as an important way to promote interest and motivation (Botten-Verboven et al., 2010).

Finally, the field of interest could benefit from more basic research. What is the difference between the two levels of individual interest (emerging versus well-developed)? How can they be operationalized? Under what conditions is the psychological state of interest triggered? The latter question is attracting increasing

attention in the field of research. Rotgans and Schmidt (2014) have claimed that situational interest can only be triggered when there is a gap between what the student already knows and what needs to be known about a certain task or activity. The current project seems to contradict this assumption, suggesting that several conditions may encourage situational interest. Perhaps one of the more important questions in the field of education is: how can educators differentiate between those who have low or high levels of individual interest? Because effective interest-enhancing interventions, such as those examined, follow a "one-size-fits-some" principle (Harackiewicz et al., 2016), teachers may need tools to assess which students may benefit most from which environmental intervention to engage in learning based on interest. One approach would be applying survey methods in teaching; however, a less intrusive and time-consuming solution may be more beneficial in a classroom setting, such as observational methods. Observational tools used to identify learners' levels of individual interest and situational interest can be helpful for educators to determine which interventions might benefit the students and how it affects the experience of interest. These observational tools have not been developed yet, and little is known about teachers' competence in assessing their students' levels of academic interest. Finally, there is a continuing need to identify and test ways to encourage situational interest during learning in subjects other than mathematics as well.

Throughout this dissertation, the focus has been the tendency for mathematics interest to decline as students age. Thus, the question remains: can these interventions help reverse this trend? The findings from Article I suggest that interest-enhancing interventions may be effective in countering age-related interest decline in mathematics; however, context personalization and example choice alone may not promote individual interest long-term. Because eliciting situational interest requires capturing attention, often through novelty and surprise (Renninger & Hidi, 2015; Silvia, 2006), using the same interventions may become habitual and mundane. Nevertheless, interest-based context personalization and example choice offer concrete guidelines for designing text materials in mathematics to encourage situational interest in specific learning moments among those who may need this type

of encouragement most. Furthermore, along with other interest-enhancing interventions, such as problem-based learning, relevance interventions, and attention-grabbing settings, context personalization and example choice can be part of a "toolbox" of evidence-supported practices teachers can use to encourage interest in the classroom. Consequently, individual interest may follow.

Context personalization and example choice can assist educators in designing learning activities to cultivate students' interests while learning. The importance of these practices is highlighted by Dewey (1913):

> *"interest is obtained not by thinking about it and consciously aiming at it, but by considering and aiming at the conditions that lie back of it, and compel it (...) The problem of educators, teachers, parents, the state, is to provide the environment that induces educative or developing activities, and where these are found the one thing needful in education is secured"* (p. 94-95).

As demonstrated by this dissertation, interest-based context personalization and example choice can assist in developing activities for students to learn from texts, which can be a significant step in countering age-related declines in mathematics interest.

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Appendices

Appendix I: Instructional unit (in Norwegian)

Screen 1

Hva er sannsynlighetsregning?

Vi snakker om sjansen eller sannsynligheten for at noe kommer til å skje. Man kan ofte høre noen si: *Det er stor sjanse for regn idag.* Dette er et eksempel på hvordan vi i hverdagen gjør vurderinger ut fra sannsynlighet. Noen ganger sier vi at sjansen er stor, og noen ganger sier vi at sjansen er liten.

Å regne ut muligheten for at noe kan skje, kaller vi **sannsynlighetsregning**.

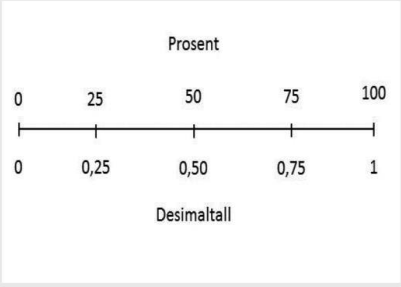
Screen 2

Hvordan kan vi tallfeste sannsynlighet?

Sannsynlighet blir ofte uttrykt som prosent. Prosent går fra 0 til 100, der 0 er ingen sjanse for at noe kommer til å skje og 100 er helt sikkert på noe kommer til å skje.

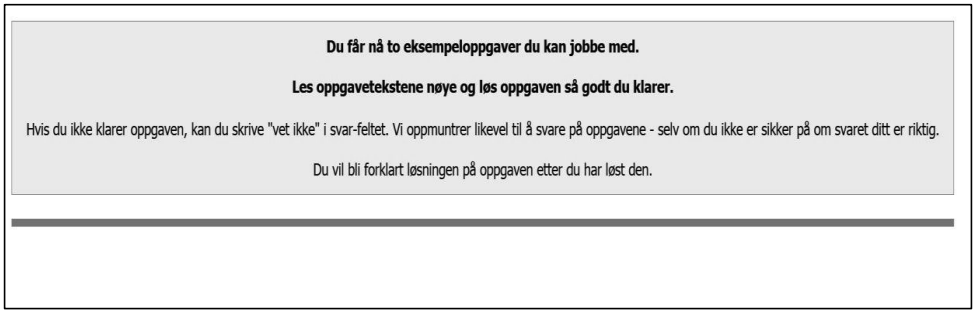
Når vi skal regne ut sannsynlighet, derimot, kan det være enklere om vi bruker desimaltall. Desimaltall går fra 0 til 1, der 0 betyr at noe ikke kommer til å skje og 1 betyr at det er helt sikkert at noe kommer til å skje.

Dersom vi får sannsynlighet oppgitt i prosent og vil vite hva er det er i desimaltall, kan vi dele prosenten på 100. For eksempel, så er 50% omgjort til desimaltall: 50/100 = 0,50.

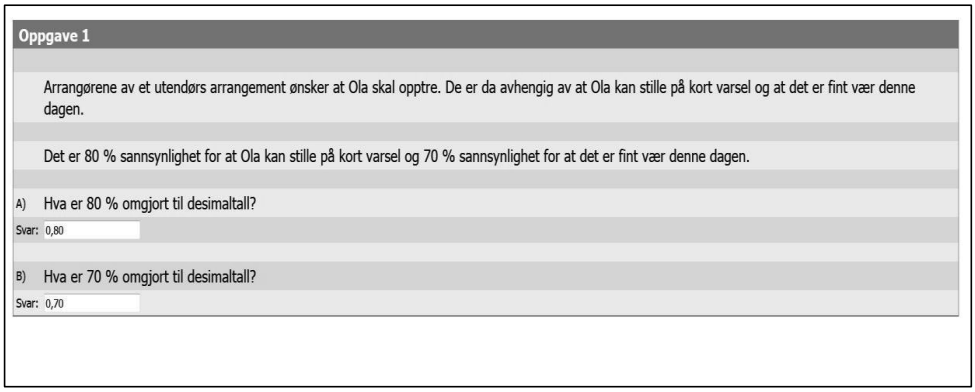


Vi kan også uttrykke sannsynlighet som brøk, men vi fokuserer på prosent og desimaltall i denne presentasjonen.

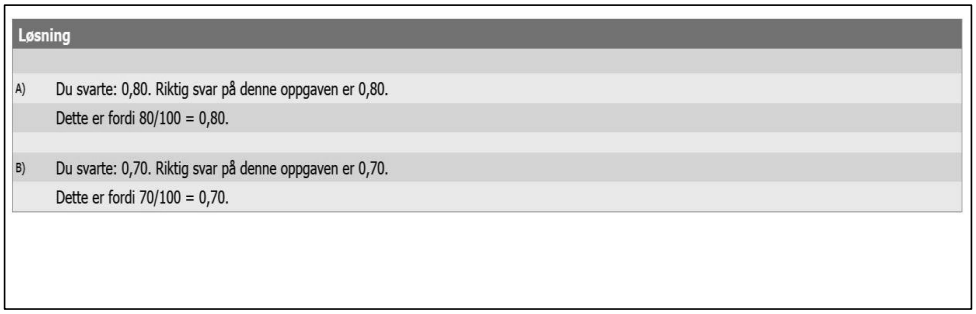
Screen 3



Screen 4



Screen 5



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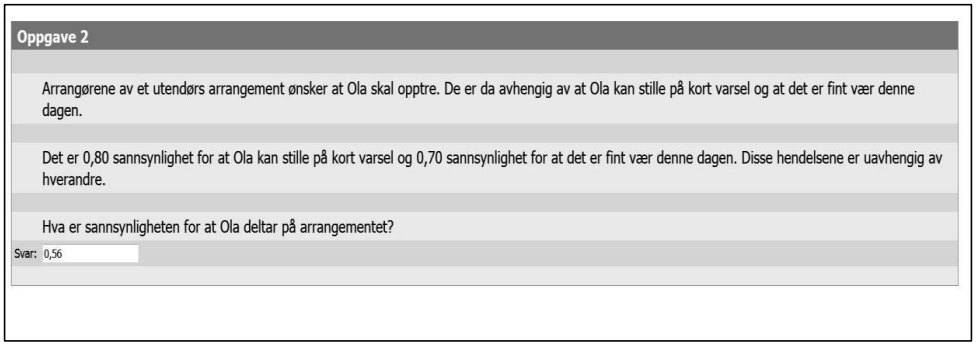

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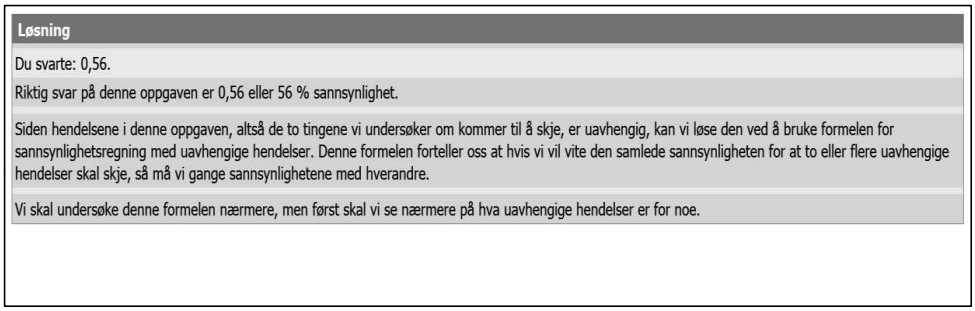
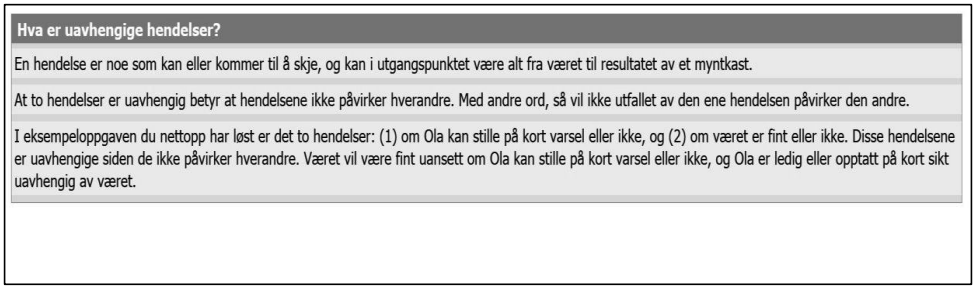


Screen 8



Screen 9

Formelen for uavhengige hendelser

Formelen for sannsynlighetsregning med uavhengige hendelser ser slik ut:

P(A og B) = P(A) * P(B)

P står for det engelske ordet for sannsynlighet - probability - og A og B står for ulike hendelser.

Denne formelen forteller oss at hvis vi vil finne sannsynligheten for flere hendelser skjer, så vi må gange sannsynlighetene med hverandre. Og dette kan vi bare gjøre dersom de to hendelsene er uavhengig – altså ikke påvirker hverandre.

I eksempeloppgaven så vi at det er 0,80 sannsynlighet for at Ola kan stille på kort varsel og 0,70 sannsynlighet for at det er fint vær.

Sannsynligheten for at både Ola kan stille på kort varsel og det er fint vær blir dermed: 0,80 * 0,70.

Slik kommer vi altså fram til at det er 0,56 sannsynlighet for at Ola deltar på arrangementet.

Vi skal nå se nærmere på hvordan formelen fungerer.

Screen 10

Hvordan virker formelen for uavhengige hendelser?

For å forklare hvordan formelen virker, kan vi illustrere de ulike hendelsene.

Vi tar utgangspunkt i eksempeloppgaven du har jobbet med, og hendelsene vi skal se nærmere på er: (1) om Ola kan stille på kort varsel, og (2) om været er fint.

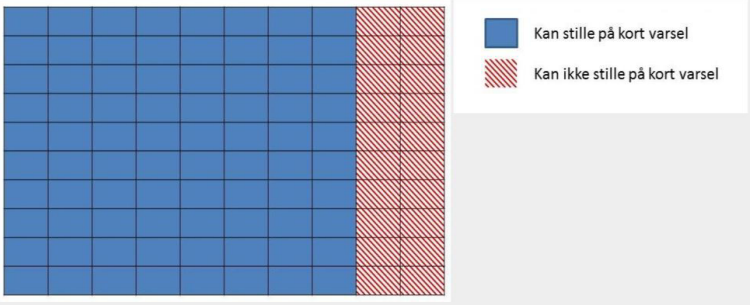
Hver hendelsene blir illustrert med en tabell med 100 felt, der hvert felt viser til 0,01 sannsynlighet - eller 1 % sannsynlighet.

Screen 11

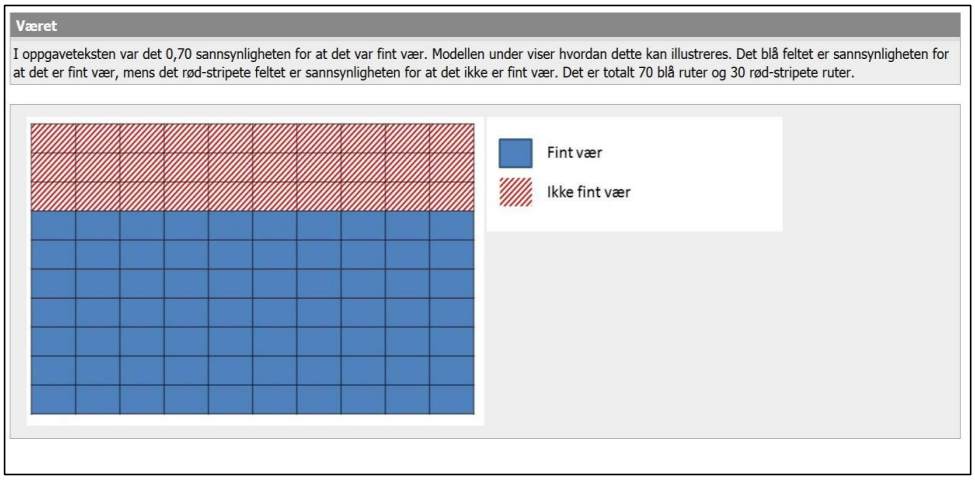
Ola

I oppgaveteksten så vi at det er 0,80 sannsynlighet for at Ola kan stille på kort varsel. Modellen under viser hvordan dette kan illustreres. Det blå feltet er sannsynligheten for at Ola kan stille på kort varsel, og det er totalt 80 blå ruter. Det tilsvarer 0,8 eller 80 % sannsynlighet. Det er også 20 rød-stripete ruter, som viser sannsynligheten for at Ola ikke kan stille på kort varsel.

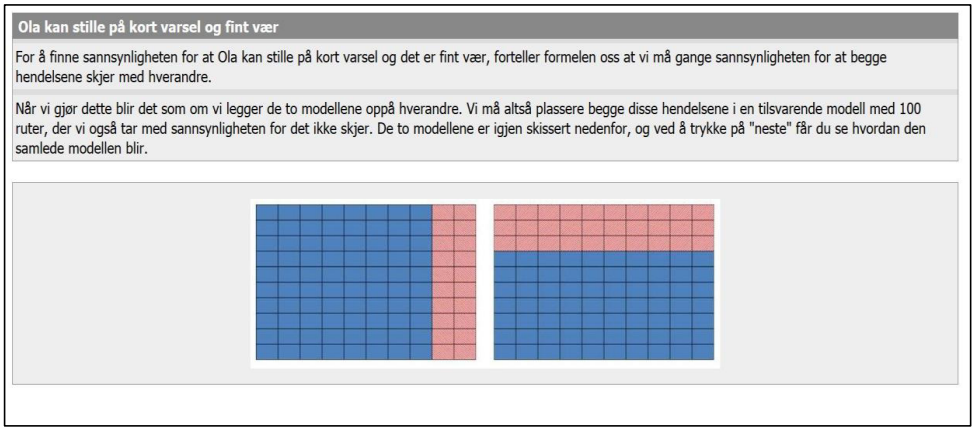
Man kan finne sannsynligheten for at noe ikke skjer ved å ta 1 minus sannsynligheten for at hendelsen skjer. Her blir det: 1 - 0,80 = 0,20.



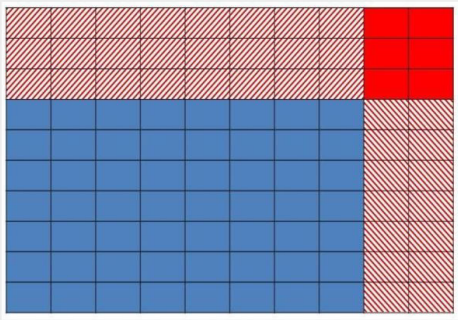
Screen 12



Screen 13



Screen 14



Når vi tar utgangspunkt i både om Ola kan stille på kort varsel og om det er fint vær , blir modellen seende slik ut.

Som vi ser i modellen, vil 56 ruter få fargen blå dersom vi legger modellene oppå hverandre. Dette er fordi vi ikke kan ta vekk de rød-stripete feltene. Hvis vi ganger 0,80 med 0,70, så blir svaret 0,56.

Det som skjer når vi ganger sannsynligheten for at to uavhengige hendelser kommer til å skje, er at vi finner den samlede sannsynligheten for at bare disse skjer - og dette kan vi bare gjøre fordi de ikke påvirker hverandre.

Modellen viser også tre andre utfall som vi ikke har regnet ut. Dette er feltene som er markert med fargen rød. Dette er andre mulige utfall dersom begge hendelsene skjer, men som ikke er tatt med i det regnestykket vi har gjort – men som viser seg i modellen. Vi kan finne den samlede sannsynligheten for alle de røde feltene ved å ta 1 - 0,56, som da er 0,44.

Screen 15

Vi skal nå se nærmere på et annet eksempel på uavhengige hendelser.

Ett vanlig eksempel på uavhengige hendelser er myntkast. Hvis du kaster en mynt to ganger, vil ikke første myntkast påvirke utfallet av det andre - og derfor er dette uavhengige hendelser.

Dersom man kaster en mynt to ganger, hva er sannsynligheten for at vi får mynt på begge kastene?

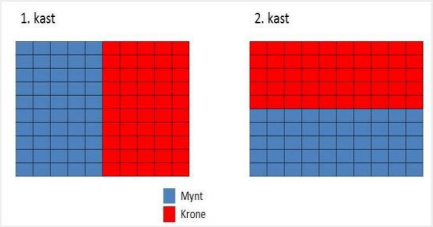
Hvert myntkast har to mulige utfall: mynt (M) eller krone (K). Det er like stor sjanse for å få mynt eller krone på hvert kast - nemlig 0,50 sannsynlighet.

Sannsynligheten for å få mynt på begge kastene kan skrives slik:
Sannsynligheten for M og M = Sannsynligheten for M * Sannsynligheten for M
= 0,50 * 0,50
= 0,25.

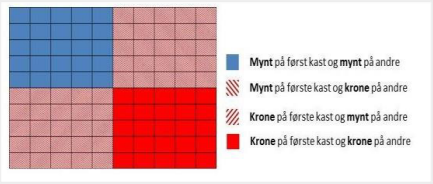
Sannsynligheten for å få mynt på begge myntkastene er 0,25 - eller 25 %.

Screen 16

Vi kan illustrere myntkastene med lignende modell som tidligere. På hvert myntkast er 0,50 sannsynlighet for mynt og 0,50 sannsynlighet for krone. Dette kan illustreres slik:



Når vi skal finne sannsynligheten for å få mynt på begge kastene, blir det som om vi legger modellene oppå hverandre. Modellen for begge myntkastene vil se slik ut:



Som vi ser i bildet, så er det 25 blå ruter, som viser sannsynligheten for å få mynt på begge kastene.
Men hva er så sannsynligheten for **ikke** å få mynt på begge kastene?
Dette er sannsynligheten for å få alle de røde feltene. En måte dette kan gjøres på, er ved å ta 1 - (sannsynligheten for M og M). Det blir:
1- 0,25 = 0,75. Det er altså 0,75 sannsynlighet for ikke å få mynt på begge kastene.

Screen 17

Dette må du ha i tankene når du skal løse en oppgave:

(1) Les oppgaveteksten nøye og tenk gjennom hva oppgaven spør om.

(2) Finn sannsynligheten for de ulike hendelsene som er aktuelle. Dersom sannsynligheten er oppgitt i prosent, kan du fortrinnsvis omgjøre prosent til desimaltall. Dette gjøres ved å dele prosenten på 100.

(3) Bruk formelen for sannsynlighetsregning med uavhengige hendelser for å finne sannsynligheten for at to eller flere hendelser kan skje.

Appendix II: Scales (in Norwegian)

Individual interest in mathematics

For meg er matematikk meningsløst (R)

Siden matematikk er gøy, vil jeg ikke slutte med det

Matematikk er viktig for meg

Jeg har lenge syntes matematikk er kjedelig (R)

Perceived competence in mathematics

Matematikk er vanskelig for meg (R)

Jeg er håpløs i matematikk (R)

Jeg har alltid gjort det bra i matematikk

Jeg er god i matematikk

Jeg anser meg selv som flink i matematikk

Triggered situational interest

Du kan nå si din mening om læringsmaterialet (presentasjon og oppgavene)

Jeg likte læringsmaterialet

Læringsmaterialet var gøy å jobbe med

Jeg syntes læringsmaterialet var kjedelig (R)

Læringsmaterialet fanget oppmerksomheten min

Jeg syntes læringsmaterialet var engasjerende

Maintained situational interest

Du kan nå si din mening om sannsynlighetsregning slik du har lært det her.

Affect

Jeg syntes det var kjedelig (R)

Jeg likte det jeg lærte her

Jeg syntes det jeg lærte var interessant

Jeg syntes det var spennende

Jeg likte ikke det jeg lærte her (R)

Value

Det jeg lærte var nyttig for meg

Jeg syntes dette er viktig å lære

Det jeg lærte er helt unyttig for meg (R)

Jeg kunne gjort dette igjen siden det er nyttig for meg

Jeg ser nytten av det jeg lærte her

Innsats

Jeg anstrengte meg for å løse oppgavene

Jeg prøvde så hardt jeg kunne når jeg jobbet med oppgavene

Jeg la ikke mye energi i å løse oppgavene (R)

Jeg jobbet så hardt jeg kunne med oppgavene

Note. Items marked with (R) are negatively worded items that were reverse coded for the analyses.

Appendix III: NSD Approvals (in Norwegian)

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Harald Hårfagres gate 29
N-5007 Bergen
Norway
Tel: +47-55 58 21 17
Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Rolf Reber
Institutt for pedagogikk
Universitetet i Bergen
Christies gate 13
5020 BERGEN

Vår dato: 16.01.2013 Vår ref:32508 / 3 / HIT Deres dato: Deres ref:

TILBAKEMELDING PÅ MELDING OM BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til melding om behandling av personopplysninger, mottatt 21.12.2012. All nødvendig informasjon om prosjektet forelå i sin helhet 15.01.2013. Meldingen gjelder prosjektet:

32508	*Intervensjoner for å øke interesse i matematikkundervisningen*
Behandlingsansvarlig	*Universitetet i Bergen, ved institusjonens øverste leder*
Daglig ansvarlig	*Rolf Reber*

Personvernombudet har vurdert prosjektet og finner at behandlingen av personopplysninger er meldepliktig i henhold til personopplysningsloven § 31. Behandlingen tilfredsstiller kravene i personopplysningsloven.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i meldeskjemaet, korrespondanse med ombudet, eventuelle kommentarer samt personopplysningsloven og helseregisterloven med forskrifter. Behandlingen av personopplysninger kan settes i gang.

Det gjøres oppmerksom på at det skal gis ny melding dersom behandlingen endres i forhold til de opplysninger som ligger til grunn for personvernombudets vurdering. Endringsmeldinger gis via et eget skjema http://www.nsd.uib.no/personvern/meldeplikt/skjema.html. Det skal også gis melding etter tre år dersom prosjektet fortsatt pågår. Meldinger skal skje skriftlig til ombudet.

Personvernombudet har lagt ut opplysninger om prosjektet i en offentlig database, http://pvo.nsd.no/prosjekt.

Personvernombudet vil ved prosjektets avslutning, 30.06.2015, rette en henvendelse angående status for behandlingen av personopplysninger.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Hildur Thorarensen

Hildur Thorarensen tlf: 55 58 26 54
Vedlegg: Prosjektvurdering

Norsk samfunnsvitenskapelig datatjeneste AS
NORWEGIAN SOCIAL SCIENCE DATA SERVICES

Harald Hårfagres gate 29
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Fax: +47-55 58 96 50
nsd@nsd.uib.no
www.nsd.uib.no
Org.nr. 985 321 884

Rolf Reber
Institutt for pedagogikk
Universitetet i Bergen
Christies gate 13
5020 BERGEN

Vår dato: 07.05.2013 Vår ref: 32508 HIT/LR Deres dato: Deres ref:

ENDRET HJEMMELSGRUNNLAG FOR BEHANDLING AV PERSONOPPLYSNINGER

Vi viser til endringsmelding mottatt 25.04.2013 for prosjektet:

32508 *Intervensjoner for å øke interesse i matematikkundervisningen*

Personvernombudet har vurdert prosjektendringen og finner at behandlingen av personopplysninger nå er ikke meldepliktig i henhold til personopplysningsloven. Prosjektet er tidligere vurdert som meldepliktig jf. § 31.

Det oppgis at metode for gjennomføring av spørreundersøkelse endres til at alle elevene fyller ut spørreskjema på skolens maskiner og uten personlig innlogging. Personvernombudet kan dermed ikke se at det i prosjektet behandles personopplysninger med elektroniske hjelpemidler, eller at det opprettes manuelt personregister som inneholder sensitive personopplysninger.

Personvernombudets vurdering forutsetter at prosjektet gjennomføres i tråd med opplysningene gitt i korrespondanse med ombudet.

Ta gjerne kontakt dersom noe er uklart.

Vennlig hilsen

Vigdis Namtvedt Kvalheim

Hildur Thorarensen

Kontaktperson: Hildur Thorarensen tlf: 55 58 26 54

Appendix IV: Letters to schools (in Norwegian)

Universitetet i Bergen
Institutt for Pedagogikk
Christiesgate 13
5015 BERGEN

Til rektor,

Vi vil gjerne invitere skolen deres til å delta i et Utdanning2020-prosjekt, finansiert av Norsk Forskningsråd, gjennomført av forskere ved Institutt for Pedagogikk, Universitetet i Bergen. Vårt prosjekt har som formål å øke elevenes interesse i matematikkundervisningen med bruk av ulike undervisningsstrategier som skal være et bindeledd mellom læringsmaterialet og elevens liv utenfor skolen. I rammen av dette prosjektet gjennomfører vi en studie med elever fra alle trinn i ungdomsskolen.

Skolen kompenseres med 100 kroner per elev som deltar i undersøkelsen. Denne studien varer i omtrent 30-45 minutter per elevgruppe og handler om elevinteresse i matematikk. Undersøkelsen er en elektronisk spørreundersøkelse som inneholder ulike spørsmål knyttet til elevenes interesse og motivasjon i matematikkfaget, samt en læringspresentasjon om sannsynlighetsregning. Etter presentasjonen vil elevene bli gitt oppgaver å løse. Undersøkelsen gjennomføres på skolens datamaskiner, og det er også nødvendig med et brukernavn/passord for å logge på datamaskinene. Dette er for å sikre elevenes anonymitet i undersøkelsen. Utenom dette trenger ikke skolen eller lærerne å stille opp med ytterlige materiell eller tjenester.

Oppgavene i denne undersøkelsen vil ikke bli brukt som et mål på evner eller bli gjenstand for sammenligning mellom skoler. Etter undersøkelsen vil elevene ha lært seg grunnleggende begreper om sannsynlighet med uavhengige hendelser og skulle være i stand til å løse enkle oppgaver. Presentasjonen i undersøkelsen er utviklet i samarbeid med både fagpersonell innen generell pedagogikk, realfagsdidaktikk og psykologi.

På vegne av forskningsgruppen vil datamaterialet bli behandlet konfidensielt og alle navn være anonyme. For elevene vil undersøkelsen tilby en måte å øke deres akademiske ferdigheter på en gøy måte, men deltakelse i undersøkelsen er frivillig og hver elev har rett til å trekke seg fra undersøkelsen når som helst (dette vil elevene bli informert når undersøkelsen starter). Denne studien har gjennomgått etisk godkjenning fra Norsk Samfunnsvitenskapelig Databasetjeneste (NSD). Hvis du har spørsmål eller ønsker å diskutere dette ytterligere, kan dere kontakte oss: Sigve Høgheim (e-post: sigve.hogheim@psybp.uib.no; tlf: 55 58 47 66) eller professor Rolf Reber (e-post: rolf.reber@psysp.uib.no; tlf: 55 58 31 81), for flere detaljer.

Med vennlig hilsen
Sigve Høgheim
PhD-kandidat
Universitetet i Bergen

Appendix V: Letters to parents (in Norwegian)

Universitetet i Bergen
Institutt for Pedagogikk
Christiesgate 13
5015 BERGEN

Kjære foreldre/verge,

Vi vil gjerne invitere deres barn til å delta i et Utdanning2020-prosjekt, finansiert av Norsk Forskningsråd, gjennomført av forskere ved Institutt for Pedagogikk, Universitetet i Bergen. Dette prosjektet tar for seg interesse i matematikkfaget på ungdomsskoletrinnene. Elevenes faglige interesse kan ha betydning for en rekke aspekter ved deres læring, som for eksempel motivasjon, målsetting, affektive holdning til faget og ikke minst prestasjoner. Vårt prosjekt har som formål å undersøke elevenes interesse i matematikkundervisningen med bruk av ulike undervisningsstrategier som skal være et bindeledd mellom læringsmaterialet og elevens liv utenfor skolen. I rammen av dette prosjektet gjennomfører vi en studie med elever fra ulike trinn i ungdomsskolen.

Denne studien varer i omtrent 1-2 timer og handler om elevinteresse i matematikk. Undersøkelsen er en elektronisk spørreundersøkelse som inneholder ulike spørsmål knyttet til elevenes interesse og motivasjon i matematikkfaget, samt en læringspresentasjon om sannsynlighetsregning. Etter presentasjonen vil elevene bli gitt oppgaver å løse.

Oppgavene i denne undersøkelsen vil ikke bli brukt som et mål på evner eller bli gjenstand for sammenligning mellom skoler. Etter undersøkelsen vil elevene ha lært seg grunnleggende begreper om sannsynlighet med uavhengige hendelser og skulle være i stand til å løse enkle oppgaver. Presentasjonen i undersøkelsen er utviklet i samarbeid med både fagpersonell innen generell pedagogikk, realfagsdidaktikk og psykologi.

På vegne av forskningsgruppen vil datamaterialet bli behandlet konfidensielt og alle navn være anonyme. For elevene vil undersøkelsen tilby en måte å øke deres akademiske ferdigheter på en gøy måte, men deltakelse i undersøkelsen er frivillig og hver elev har rett til å trekke seg fra undersøkelsen når som helst (dette vil elevene bli informert når undersøkelsen starter). Denne studien har gjennomgått etisk godkjenning fra Norsk Samfunnsvitenskapelig Databasetjeneste (NSD). Hvis du har spørsmål eller ønsker å diskutere dette ytterligere, kan dere kontakte oss: Sigve Høgheim (e-post: sigve.hogheim@psybp.uib.no; tlf: 55 58 47 66), Marina Stibric (e-post: marina.stibric@psybp.uib.no; tlf: 55 58 39 76) eller professor Rolf Reber (e-post: rolf.reber@psysp.uib.no; tlf: 55 58 31 81), for flere detaljer.

The articles

Article II

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Supporting interest of middle school students in mathematics through context personalization and example choice

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Adolescence
Interest
Personalization
Choice

ABSTRACT

An experimental study examined the effect of context personalization and example choice on situational interest in mathematics of adolescent students. Middle school students (N = 736) learned about probability calculus and were assigned to one of four instructional conditions. Individual interest and perceived competence in mathematics was examined as moderator on three measures of situational interest: triggered situational interest, maintained situational interest, and perceived value. Context personalization promoted triggered and maintained situational interest, and perception of value among students with low individual interest and perceived competence in mathematics. Similar results were observed for example choice, with the exception of perceived value. Although context personalization and example choice promoted effort for students with low individual interest, we observed no effect on performance. We discuss the theoretical and practical implications of the findings.

1. Introduction

Students' affective and cognitive reactions toward the learning environment play an important role in their choice to reengage in similar activities (Eccles & Wigfield, 2002), as well as for the opportunity to develop and sustain interest in the specific content (Hidi & Renninger, 2006; Renninger & Su, 2012). Situational interest captures this instant reaction, referring to the likelihood that features of the immediate learning environment will trigger a response that may or may not last (Renninger & Su, 2012).

Although situational interest arises from students' interaction with the environment, this state is shaped by their individual interest and perceived competence related to the content at hand (e.g. Durik, Shechter, Noh, Rozek, & Harackiewicz, 2015; Linnenbrink-Garcia, Patall, & Messersmith, 2013). In contrast to situational interest, individual interest is a relative enduring predisposition to reengage in a particular content, which results in experiences of positive affect and value of engagement (Renninger & Su, 2012; Schiefele, 1991). Perception of competence is often related to individual interest (Eccles & Wigfield, 2002; Skaalvik & Skaalvik, 2008), suggesting that these constructs co-occur in learning situations (Köller, Baumert, & Schnabel, 2001). Individual interest tends to decrease with age (Hidi & Harackiewicz, 2000; Wigfield, Eccles, Roeser, & Schiefele, 2008), particularly in the domain of mathematics during the middle years (e.g. Fredricks & Eccles, 2002; Frenzel, Goetz, Pekrun, & Watt, 2010; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Watt, 2004). As inner engagement decreases when learning mathematics, educators of middle school students encounter the challenge to elicit situational interest by adapting situational factors. The present study addresses this challenge by examining interventions to increase situational interest in middle school students. To boost situational interest does not only contribute to increase immediate engagement but also to the maintenance and development of a more enduring individual interest (Renninger & Su, 2012).

In the present study, we hypothesize that the written learning material can provide the external support needed to elicit situational interest, especially among students with low individual interest and perceived competence. In an experimental study on learning mathematics, we examined two text-based interventions among middle school students: context personalization and example choice. Context personalization refers to an instructional strategy that involves customization of features of an academic text to the learners' out-of-school interests or preferences (Walkington & Bernacki, 2014). Example choice is an instructional approach that offers students a choice between predefined topics for an academic text, prior to learning something new. Students can then select the topic they find most interesting and work a subject matter in a self-chosen context that they may find exciting (Reber, Hetland, Chen, Norman, & Kobbeltvedt, 2009). Context personalization and example choice bridge school mathematics with students' out-of-school interests, which is supposed to stimulate interest in content (Walkington & Bernacki, 2014). These authors note that current

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0361-476X/

evidence for such an effect is mostly based on indirect inferences, and in the present study we directly address this assumption.

1.1. Situational interest

Situational interest refers to an immediate state during learning, and is associated with engagement, task involvement, motivation, and performance (Hidi & Renninger, 2006; Linnenbrink-Garcia et al., 2010, 2013). However, the experience of situational interest is also regarded as a central construct in the development and maintenance of individual interest (Hidi & Renninger, 2006; Linnenbrink-Garcia et al., 2013; Renninger & Su, 2012), making it particularly relevant for the challenge of declining interest in middle school.

According to Hidi and Renninger (2006), situational interest represents the first two phases in a four-phased, sequential development that may lead to an enduring individual interest (see also: Renninger & Su, 2012). This development is initialized by something in the environment catching the attention of the learner and eliciting a short-term affective response (Phase 1: triggered situational interest: Hidi & Renninger, 2006). If the external factors sustain the learner's attention, triggered situational interest can in turn develop into maintained situational interest (Phase 2) which increases positive affect and encourages a connection between the learner and content to be learned (Hidi & Renninger, 2006; Renninger & Su, 2012). These experiences of situational interest may lead to an emerging individual interest (Phase 3), and in turn to a well-developed individual interest (Phase 4). This theoretical framework posits a development of individual interest that is initialized by an emotional response toward the learning environment, but as interest develops, the perception of value as well as knowledge develops concurrently, while affect continues to be a central characteristic (Renninger & Hidi, 2011; Renninger & Su, 2012).

In their research on situational interest in education, Linnenbrink-Garcia et al. (2010) operate with a similar distinction between triggered and maintained situational interest; however, they differentiate between maintained situational interest based on the affective and value-based connection to content (see also: Linnenbrink-Garcia et al., 2013). Perceiving a content as meaningful and useful (Eccles & Wigfield, 2002; Linnenbrink-Garcia et al., 2010) is thought to be important for the development of interest, especially in the transition between Phase 2 and Phase 3. In the present study we use the term *perceived value* for students' situations-specific value perception of content; however, we acknowledge that this state represent a stage of maintained situational interest, in line with Linnenbrink-Garcia et al. (2010). As shown in Linnenbrink-Garcia et al. (2013), triggered situational interest as well as both types of maintained situational interest contributed to the development of interest, as posited by Hidi and Renninger (2006).

1.2. Interventions and situational interest

Renninger and Su (2012) emphasize the need for instructional support in order to trigger and maintain situational interest. Indeed, several instructional and textual features have been found to influence situational interest, some related to the interventions examined in the current study. Prior research on context personalization in mathematics education has revealed more positive attitudes toward customized rather than generic material (e.g. Ku, Harter, Liu, Thompson, & Cheng, 2007; Ku & Sullivan, 2000, 2002; López & Sullivan, 1992), suggesting a possible effect on triggered situational interest. In one of the few studies examining context personalization and situational interest, Bernacki and Walkington (2014) observed that context personalization had an effect on triggered but not maintained situational interest, supporting the assumption that context personalization has an effect on situational interest (Walkington & Bernacki, 2014), at least at the initial level. However, in a study of elementary school students, Renninger, Ewen, and Lasher (2002) examined whether interests from other domains could serve as context in mathematics in order to motivate learners to work on a topic in which they did not initially show interest. They found that interest-based contexts, compared to generic contexts, both enabled students to focus on the meaning in tasks and offered students with low individual interest in mathematics an opportunity to make a more personal connection with the subject matter to be learned. The context to which mathematics is embedded appears to be able to help students in forming a connection to the content to be learned (see also: Ainley, Hidi, & Berndorff, 2002). Research on an instructional approach labeled *relevance interventions* showed that conveying the value of mathematic content, either directly by stating why this may be relevant for learners' lives or indirectly by encouraging learners to generate relevance of content, can influence learners' maintained situational and perception of value (Durik & Harackiewicz, 2007; Durik et al., 2015; Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Hulleman & Harackiewicz, 2009).

The opportunity of choice in the learning environment has repeatedly been associated with situational interest and intrinsic motivation (Cordova & Lepper, 1996; Patall, 2012, 2013; Patall, Cooper, & Robinson, 2008; Patall, Cooper, & Wynn, 2010; Patall, Sylvester, & Han, 2014; Reber et al., 2009), and is often related to the need for autonomy within the theoretical framework of self-determination theory (e.g. Deci & Ryan, 2000). Krapp (2005) posited that the need for autonomy, as well as the remaining psychological needs in self-determination theory, may play a crucial part for the experience of situational interest, the affective reactions in particular. Linnenbrink-Garcia et al. (2013) observed that the perception of choice during a three-week residential summer program made a significant contribution to triggered and affect-based maintained situational interest, but not perceived value. According to Patall (2012), the effect of choice on intrinsic motivation and interest is not only based on the feeling of control and autonomy, but also the absence of external control in a choice situation (see also: Patall et al., 2008 for review).

Studies have shown that students' individual interest and perceived competence moderate how they experience interventions targeted at increasing situational interest, and even the effect of choice in learning activities (Patall, 2013; Patall et al., 2014). For example, collative features (e.g. varied fonts and vivid pictures) have been found to trigger situational interest only among those with low individual interest, whereas directly communicating the relevance of mathematics to students' lives was more effective in maintaining situational interest among students with high individual interest in the domain (Durik & Harackiewicz, 2007). These results were interpreted to suggest that collative features may have been perceived as irrelevant for students with a well-developed individual interest in the core content, but stimulated those with low interest.

Like individual interest, perceived competence in mathematics has been found to moderate the effect of interest-based interventions. Studies indicate that self-generated value interventions might be most efficient for students with low perceived competence (Hulleman et al., 2010; Hulleman & Harackiewicz, 2009) whereas passively receiving value information may benefit those with high perceived competence (Durik et al., 2015). These data suggest that students with low perceived competence benefit from interventions that encourage them to generate reasons for why contents are valuable and enjoyable instead of receiving the same reasons from an external source. Furthermore, competence perception and interest are often strongly related (Eccles & Wigfield, 2002; Fortier, Vallerand, & Guay, 1995); therefore, students with low perceived competence might respond like those with low individual interest in the core content.

Although the opportunity of choice in learning is associated with situational interest and intrinsic motivation (Deci & Ryan, 2000; Patall, 2012), individual interest and perceived competence have been found to moderate the effectiveness of choice. Patall (2013) observed that choice was more beneficial for those with high rather than low individual interest in the core content across three experimental studies. Similarly, results were more beneficial for students with high rather than low perceived competence (Patall et al., 2014).

1.3. Interventions to increase situational interest and learning

According to Walkington and Bernacki (2014), context personalization may promote learning by eliciting situational interest and connecting subject matter to students' knowledge from within other interest areas (see also: Walkington, Sherman, & Howell, 2014). However, when it comes to performance, research results are mixed. Context personalization positively influence performance, especially among weaker students, in some studies (Anand & Ross, 1987; Ku et al., 2007; Ku & Sullivan, 2002; Walkington, Petrosino, & Sherman, 2013; Walkington et al., 2014) whereas other studies did not observe such beneficial effects (Bates & Wiest, 2004; Cakir & Simsek, 2010; Ku & Sullivan, 2000). Furthermore, example choice as well as the opportunity of choice in instructions was not associated with increased performance (Flowerday, Schraw, & Stevens, 2004; Reber et al., 2009).

Although context personalization has shown varied results with regard to performance in addition to no effect of example choice, performance is an important indicator of the usefulness of these interventions. Context personalization and example choice may appear to operate as *seductive details*, which are segments that learners might perceive as highly interesting, but are irrelevant in understanding the core topic of the text (Lehman, Schraw, McCrudden, & Hartley, 2007). Seductive details can actually have a detrimental effect on performance (Harp & Mayer, 1998; Park, Flowerday, & Brünken, 2015), especially among weaker students (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014) and when no warning is given that the information is irrelevant (Peshkam, Mensink, Putnam, & Rapp, 2011).

1.4. The present study

To examine the effect of context personalization and example choice on situational interest during mathematics learning, we conducted an experimental study that assessed different facets of interest and performance on mathematics tasks. Administrating the learning material electronically allowed for the immediate measurement of students' affective and cognitive responses during the learning activity. Middle school students were randomly assigned to one of four instructional conditions. In the personalization condition, the learning material was customized to students' individual interest in popular culture. Participants in the example choice condition could choose one of twelve topics for the learning material, all referring to popular culture. Participants in the example given condition were randomly given one of the twelve examples for the learning material. Finally, participants in the control condition received generic learning materials without references to popular culture or choice. Besides the experimental manipulations, the questionnaires were identical.

There are several different approaches to context personalization (see Walkington & Bernacki, 2014, p. 161 for outline). In the present study, we utilized an approach labeled "Fill-in-the-gaps", which is considered a feasible, but shallow form of personalization. In addition to the classification of specificity proposed by Walkington and Bernacki, we suggest a further distinction in the personalization methodology. Based on the literature on context personalization (e.g. Bates & Wiest, 2004; Bernacki & Walkington, 2014; Ku et al., 2007; Ku & Sullivan, 2000, 2002; Walkington & Bernacki, 2014), we distinguish between approaches based on the dimensions of *preferences* and *interests*, pertaining to the information from the learner that is used for personalizing instructions or problems. To the best of our knowledge, this distinction has not yet been made and examined systematically in research on context personalization. In our distinction, preferences refer to comparisons of two or more options on the basis of affective feelings (see Reber, 2015) and therefore to the likings of persons or objects by the learner, such as drinks, foods, or friends—low level inclinations from everyday life that do not need exploration or sustained engagement. Interest, on the other hand, refers to the learner's wish to explore and engage in specific contents (see Dewey, 1975/1913) which in our study were contents pertaining to popular culture, such as music, gaming, or literature. The proposed distinction bears resemblance to Schraw's (1998) distinction between context-independent (i.e. details that are interesting also outside the particular context) and context-dependent (i.e. details that are interesting only when appearing in context) seductive details (see also: Schraw & Lehman, 2001); with the former referring to the dimension of interest and the latter to preferences. These dimensions are illustrated in Fig. 1.

"Low preference-low interest" refers to instructions and problems as they usually are represented in textbooks, with little references to the individual learners' interests or preferences. "High preference-low interest" refers to a mode of context personalization utilizing students' everyday preferences often situated in everyday contexts (e.g. Bates & Wiest, 2004; Ku et al., 2007; Ku & Sullivan, 2000, 2002). "High preference-high interest" is an approach to context personalization that incorporates students' interest into contexts that draws on everyday experiences and preferences (Bernacki & Walkington, 2014; Walkington et al., 2013). In the current study, we examine an approach as illustrated by "low preference-high interest", namely with emphasis on learners interests, but not situated in everyday contexts or situations. We believe that this distinction between preference and interest in the practice of context personalization can contribute to the field of research on the

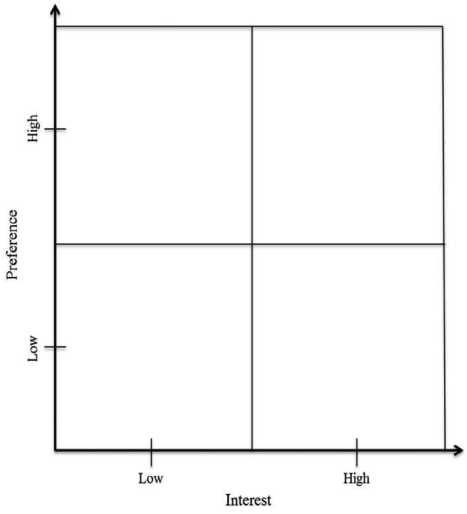

Fig. 1. Different approaches to context personalization based on preference and interest.

instructional format, and accompany the different level of specificity as proposed by Walkington and Bernacki (2014). In the present study we hypothesize that the interest dimension in context personalization is important in stimulating interest by means of context personalization.

Based on the theoretical backdrop, we predict that context personalization and example choice can trigger and maintain students' situational interest and value perception during the learning activity, compared to a generic learning material (Reber et al., 2009; Walkington & Bernacki, 2014). However, individual interest and perceived competence moderated the effects of interventions in opposite directions, making clear predictions difficult. While some relevance interventions were beneficial for students with low interest and perceived competence in mathematics (Durik & Harackiewicz, 2007; Durik et al., 2015; Hulleman et al., 2010; Hulleman & Harackiewicz, 2009), studies on choice found beneficial effects for those high in interest and perceived competence (Patall, 2013; Patall et al., 2014). Finally, the example given condition examines whether using popular culture examples increases situational interest, compared to generic textbook instruction and tasks.

In addition to situational interest, we included a measure of task effort and task performance. Based on the notion that situational interest is associated with immediate engagement (Linnenbrink-Garcia et al., 2013; Renninger & Su, 2012), we expect context personalization and example choice to enhance task effort. Given the mixed results reviewed in the last section, it is difficult to make predictions on performance. Our study adds to the corpus of research on effects of interventions on effort and performance. Still, student performance might give an indication whether the intervention operated as seductive detail that impairs performance and should not be applied in educational practice.

2. Method

2.1. Participants

Participants were recruited from five public middle schools that were informed that the study has obtained ethical approval by the Norwegian Social Science Data Services (NSD).

Eight hundred students from Norwegian public middle school without special needs education in either mathematics or reading completed the online survey. Sixty-four participants were excluded from the final sample based on three criteria: (1) They wrote "I don't know" as favorite subject, object or city in the initial interest questions (n = 43), (2) answered the mathematical tasks with something else besides numbers or the agreed upon "I don't know" (n = 17), or (3) stated a grade level not included in the study (n = 4).

The final sample consisted of 736 (50.4% female) middle school students. Among these, 384 students were from the eighth grade (age 12–13; 185 female) and 352 students from the tenth grade (age 14–15; 186 female). These grade levels were chosen because they represent the first and last grades in the Norwegian middle school system. The final sample included 183, 177, 192, and 184 participants in the personalization, example choice, example given, and control conditions, respectively. Experimenters were unaware of the condition participants were assigned to.

2.2. Procedure and materials

Groups of 15 to 50 students worked simultaneously in the computer labs of their respective schools, with one or two experimenters present during the testing sessions. Each student worked individually on the online questionnaire at a computer, and was told they were participating in a study concerning mathematics learning.

All materials and instruments were developed and administered in Norwegian; all materials presented in this article are translated to English for the purpose of presentation. We developed four online questionnaires corresponding to four instructional conditions using *SurveyXact*. The questionnaires were identical in structure, content and appearance, but differed in how information was customized in the learning materials, depending on the experimental condition.

All questionnaires started with leisure time interest questions. Participants could choose one of six interest areas from popular culture that interested them the most: Movies, Music, Gaming, Sports, Literature, and Internet. After selecting an interest area, participants wrote their favorite subject (e.g., actor, singer) and object (e.g. movie, album) from the respective interest area, with one exception: Participants who selected gaming wrote their favorite game and console. Participants also wrote the name of a favorite city they would like to visit or had had visited. After the interest questions, participants answered pre-test measures, such as individual interest in mathematics. After the pre-test measures, participants were presented with learning materials about probability calculus with independent events.

The introductory presentation to probability calculus (two screens) started with an elementary explanation of what probability calculus is and how it is expressed numerically. We focused on probability expressed as decimal number. Participants could then try to solve an *example task*. The example task was a two-step mathematical word problem concerning probability calculus with independent events. After converting a probability expressed as percentage into a decimal number, participants were asked to solve for the joint probability of two independent events. The different interventions were implemented in the example task and the subsequent presentation. The second part of the example task for the personalization group referred to the favorite subject (here: music), the favorite artist (Rihanna), and the favorite city (London) the participant wrote down at the beginning of the study:

> "Organizers of an outdoor **music**-event **in London** want **Rihanna** to make an appearance. Then **Rihanna** must be available on short notice and the weather **in London** must be nice.
>
> It is 0.80 probability that **Rihanna** is available on short notice and 0.70 probability that the weather **in London** is nice on that day.
>
> What is the probability of **Rihanna** making an appearance at the **music**-event **in London**?"

Participants in the personalization condition received the expressions they entered in the initial interest questions (highlighted in the example above; not highlighted in the study). Participants in the example choice condition, prior to the example task, were given a choice between twelve domains for the task and further presentation (two examples for each of the six interest areas), containing information corresponding to the highlighted words in the example task. In contrast to the personalization group, the interest areas, subjects and objects in the example choice group were not based on the information participants entered at the beginning. Participants in the example given condition were randomly given one of twelve examples. In the control condition, the highlighted words were removed, and the subject was replaced by a common Norwegian first name, as often encountered in Norwegian middle school textbooks on mathematics.

The subsequent presentation was based on probability calculus with independent events. This presentation (11 screens) explained the concept of independent events and how to compute the joint probability for such events. The explanation was embedded in a situation similar to the example task, with the information collected at the beginning for the personalization group, with examples for the example choice and example given groups, and with Norwegian first names for the control group. After working with

Table 1
Zero-order correlations and descriptive statistics.

	1	2	3	4	5	6	7	8
1 Individual interest	–							
2 Perceived competence	.63**	–						
3 Triggered SI	.32**	.21**	–					
4 Maintained SI	.44**	.29**	.65**	–				
5 Perceived value	.40**	.25**	.51**	.72**	–			
6 Task effort	.15**	.02	.22**	.31**	.32**	–		
7 Intervention tasks	.21**	.28**	.17**	.34**	.35**	.10**	–	
8 Generic tasks	.25**	.34**	.17**	.34**	.35**	.07	.81**	–
M	3.36	3.28	3.39	3.38	3.68	3.04	1.45	2.12
SD	.99	1.11	.90	.91	.88	.87	1.21	1.58
Cronbach's α	.80	.92	.90	.87	.85	.72	–	–

Notes: SI = Situational Interest.
** $p < .01$. All values could range from 1 (*low*) to 5 (*high*) with the exception of intervention and generic tasks.

the presentation, triggered situational interest was measured. Then the participants worked with seven mathematical problems: three with conditional information like in the example task, and four generic problems that were identical for the four conditions. Maintained situational interest and utility value was measured after the mathematical word problems.

2.3. Measures

Response on all items was given on a five-point Likert scale ranging from 1 – "Totally disagree" to 5 – "Totally agree". Negatively worded items were reverse-coded. Scale reliabilities are reported in Table 1. *Individual interest in mathematics* was measured by a single scale reflecting respondents' affective experiences and perceived value of mathematics ["I think mathematics is meaningless" (reversed), "Since math is fun, I do not want to give it up", "For a while now, I have found math to be boring" (reversed), and "Math is important to me"]. *Perceived competence in mathematics* was measured by five items ["Math is hard for me" (reversed), "I am hopeless in math" (reversed), "I have always performed well in math", "I am good at math", and "I regard myself as competent in math"].

Three scales measured situational interest, inspired by the Student Interest Survey (SIS: Linnenbrink-Garcia et al., 2010; Linnenbrink-Garcia et al., 2013). The scale *Triggered situational interest* measured participants' opinion of the learning materials ["I liked the learning material", "The learning material caught my attention", "I found the learning material boring" (reversed), "The learning material was fun to work with", and "I found the learning material engaging"]. After working with the seven mathematical word problems, *maintained situational interest* was measured; participants rated affective experiences related to the learning material ["I found it to be boring" (reversed), "I liked what I learned here", "I thought it was interesting", "I found it intriguing", and "I did not like what I learned here" (reversed)] and *perceived value* ["What I learned here was useful for me", "I think this is valuable to learn", "What I learned here is completely useless" (reversed), "I could have done this again since it is valuable to me", and "I see the value of what I learned here"].

Four items measured *task effort* ["I made an effort solving the tasks", "I tried as hard as I could when I worked with the problems", "I did not put much effort into solving the tasks" (reversed), and "I worked as hard as I could on the tasks"]. We measured task performance by two sum scores. *Intervention tasks* represent the number of correct answers given on the three word problems subject to experimental condition, whereas *generic tasks* is the number of correct answers on the remaining four word problems. Each correct answer was given the score of 1 and each wrong answer a score of 0. A score of 0.5 was given if the participant had performed correctly half of a two-step problem.

3. Results

3.1. Overview

To test our hypotheses on instructional interventions, multiple regression analyses were conducted. Six models were examined: three for the facets of situational interest, and one each for task effort, intervention tasks and generic tasks. Dummy coding was used to compare the three instructional interventions to the control condition (1 and 0). With dummy coding it is possible to compare the interventions by means of intercept, which refers to the estimated value of dependent variable when other linear terms are 0. The coefficient b_0 refers to the intercept; in order to obtain an interpretable coefficient, the continuous independent variable was centered on the means. Zero-order correlation and descriptive statistics for study variables are presented in Table 1.

As shown in Table 1, there was a high correlation between individual interest and perceived competence in mathematics. To avoid suppressed effects, two sets of models were examined, first with individual interest as moderator, and then with perceived competence. To test our hypotheses on moderating effects of individual interest and perceived competence, interaction terms between moderator and instructional interventions were added. This measure, referred to as coefficient b_1, represent the effects of this interaction and can be interpreted as the influence of moderator and instructional intervention on dependent variable. Where theoretically relevant significant effects were observed, values for low (–1 SD) and high (+1 SD) on moderator were estimated based on the regression equation to illustrate the results.

3.2. Individual interest models

Table 2 summarizes the regression analyses with individual interest in mathematics, instructional intervention and their interaction. As can be seen, context personalization had a significant positive effect on triggered and maintained situational interest, perception of utility value, and task effort, compared to the control condition (see b_0). However, these effects were qualified by a significant negative interaction term (see b_1), indicating that the advantage of context personalization faded with higher individual interest in the core content. Comparably, example choice had a positive effect on triggered and maintained situational interest, as well as task effort (b_0); however, for maintained situational interest and task effort, the effect was qualified by a significant negative interaction term (b_1).

Table 2
Comparison of experimental interventions to control condition based on multiple regression analyses controlling for individual interest in mathematics.

	Triggered SI	Maintained SI	Perceived value	Task effort	Interventions tasks	Generic tasks
Control b_0 (b_1)	3.27 (.41)	3.34 (.55)	3.68 (.45)	3.07 (.29)	1.60 (.29)	2.24 (.47)
Difference b_0 (b_1)						
Personalization	.92** (−.23**)	1.22** (−.35**)	.97** (−.28**)	.72* (−.24**)	−.16 (−.03)	−.09 (−.05)
Example choice	.69* (−.15)	.69* (−.19)	.26 (−.07)	.80** (−.26**)	−.04 (−.02)	.17 (−.07)
Example given	.42 (−.08)	.27 (−.07)	.17 (−.06)	.36 (−.11)	−.01 (−.05)	.40 (−.17)
R^2	.12**	.21**	.17**	.04**	.05**	.07**

Notes: SI = Situational Interest. Values are based on centering of individual interest on mean.
** $p < .01$; * $p < .05$.

These results are illustrated in Fig. 2. Since example given did not yield any significant difference in comparison to control condition, these estimates are not illustrated in the figure. Fig. 2 shows estimates of outcome variables for participants with low (−1 SD) and high (+1 SD) individual interest in mathematics in the different instructional condition.

3.3. Perceived competence models

Table 3 provides a summary of regression analyses with perceived competence in mathematics, instructional interventions, and their interaction. Context personalization had an effect on maintained situational interest and perception of utility value (see b_0);

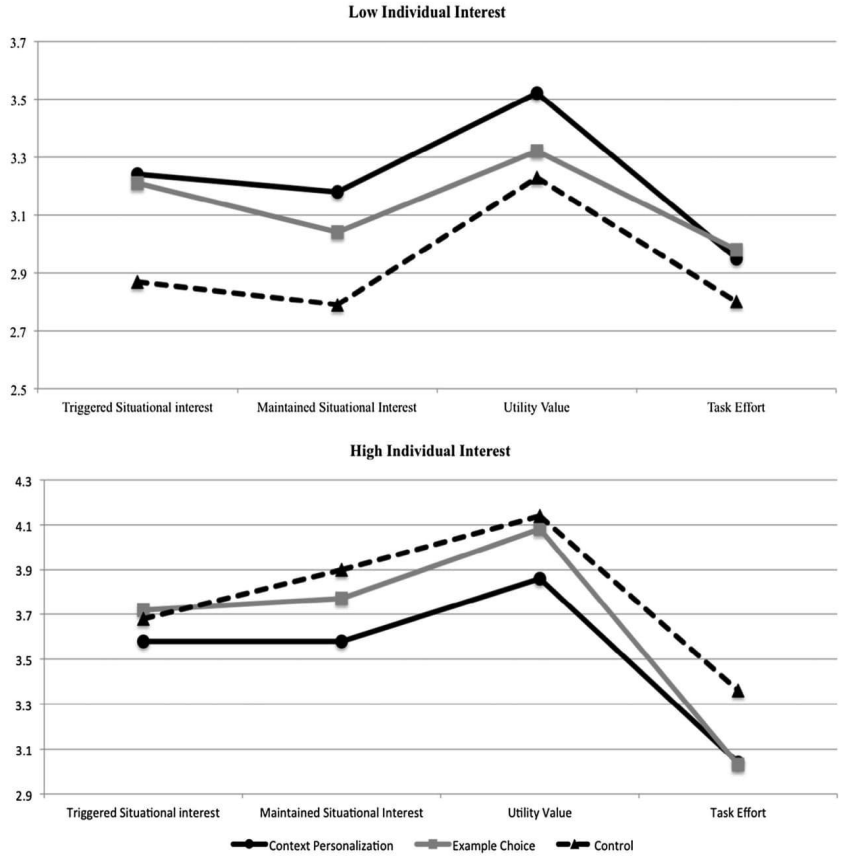

Fig. 2. Estimated values of outcome variables for low individual interest (top panel) and high individual interest (bottom panel).

Table 3
Comparison of experimental interventions to control condition based on multiple regression analyses controlling for perceived competence in mathematics.

	Triggered SI	Maintained SI	Perceived value	Intervention tasks	Generic tasks
Control b_0 (b_1)	3.27 (.20)	3.34 (.31)	3.68 (.21)	1.59 (.33)	2.22 (.57)
Difference b_0 (b_1)					
Personalization	.47 (–.10)	.75** (–.21**)	.56* (–.17*)	.18 (–.14)	.42 (–.20)
Example choice	.19 (.00)	.20 (–.05)	–.25 (.07)	–.12 (.00)	–.04 (.00)
Example given	.15 (.01)	.08 (.00)	–.22 (.07)	–.28 (.04)	.27 (–.12)
R^2	.05**	.10**	.08**	.09**	.12**

Notes: SI = Situational Interest. Values are based on centering of perceived competence in mathematics on mean.
** $p < .01$; * $p < .05$.

however, the effect was qualified by a significant negative interaction effect (b_1). These results suggest that the positive effect of context personalization over the control condition faded with higher perceived competence in mathematics. Differences between remaining instructional intervention and control condition were not statistically significant.

4. Discussion

The purpose of the present study was to examine the effect of context personalization and example choice on adolescent learners' situational interest in mathematics. By means of a randomized experiment conducted in a classroom setting, we demonstrated that the written learning material students interact with in mathematics can enhance situational interest, value perception and task effort; however, the effectiveness of the interventions was moderated by learners' individual interest and perceived competence in mathematics.

Consistent with our assumptions, context personalization and example choice enhanced the experience of triggered and maintained situational interest, as well as task effort; however, the effect was most advantageous for learners with low individual interest, and low perceived competence for context personalization. In line with Durik and Harackiewicz (2007), our findings suggest that context personalization and example choice caught the attention of students with low individual interest in mathematics, and helped them become more engaged in the activity and perceive the content as more interesting. On the other hand, students with high individual interest in core content might have perceived interest-references provided by context personalization and example choice as irrelevant and even annoying. Furthermore, the choices provided by example choice might also have been perceived as less meaningful for those with high individual interest, since they referred to topics that they might perceive as irrelevant for their perception of mathematics. Only context personalization had an effect on learners' perception of value; however, the experimental effect was less beneficial for learners with high individual interest and perceived competence in mathematics. Relating these findings to studies on relevance interventions (Durik & Harackiewicz, 2007; Durik et al., 2015; Hulleman et al., 2010; Hulleman & Harackiewicz, 2009), context personalization might have conveyed value in a way that enabled students to generate relevance of content by relating mathematics with interests from other domains. In turn, this can lead learners to discover the relevance of the materials for themselves. Self-generated value interventions have not been found to benefit those with high perceived competence, which is also evident in the present study.

A vast number of studies have examined the effect of context personalization on performance. Findings from the present study indicate no effect of the instructional format on performance, in line with some earlier findings (Bates & Wiest, 2004; Cakir & Simsek, 2010; Ku & Sullivan, 2000), but in contrast to others that observed improvement of performance (e.g. Ku et al., 2007; Walkington et al., 2013, 2014). Similarly, example choice did not enhance performance, in line with earlier findings (Reber et al., 2009). It is important to notice, however, that the interventions did not negatively influence performance, suggesting that they do not operate as seductive details with a detrimental effect on learning (Harp & Mayer, 1998; Park et al., 2015).

4.1. Theoretical implication

The present findings lead to theoretical implications for three research areas. First, proponents of context personalization have assumed that the instructional format can promote performance by enhancing situational interest (see Walkington & Bernacki, 2014). Our study showed that interest-based context personalization can enhance situational interest among learners with low individual interest and perceived competence in mathematics, but this, in turn, did not result in enhanced problem solving. These observations might suggest that the beneficial effect of context personalization on performance observed in other studies (Ku et al., 2007; Walkington, 2013; Walkington et al., 2013, 2014) do not stem from the impact on situational interest, but rather other aspects of the instructional format. For example, Walkington (2013) proposes that interest-based connections in problems can help to ground abstract mathematical content, making them easier for learners to grasp. This was not evident in the present study; however, we utilized an approach for the instructional format that did not emphasize preferences and everyday situations. This might have caused the mathematical ideas to remain abstract, even though learning was more interesting for the learner.

Second, the applied interventions and results contribute to the body of research examining choice in learning situations. In the current study, the opportunity of choice benefitted students with low individual interest but did not have an effect based on perceived competence in mathematics, as observed by Patall (2013; Patall et al., 2014). The lack of moderation of the effect of choice on interest by perceived competence might either indicate that this moderator is less relevant than individual interest or that our measures were less sensitive than those used by Patall and colleagues. Our study clearly showed, however, that offering choices among options related to popular culture enhanced situational interest among learners with low individual interest in mathematics.

Third, the current findings benefit the area of interest research. The three facets of situational interest emerge in response to different aspects of the textual material. The example given condition did not influence any of the constructs of situational interest. This suggests that merely embedding contexts different from those applied in mathematics textbooks does not influence situational interest. Example choice, the combination of choice and intriguing context, did not enhance perceived value of content. When compared to context personalization, these results support the need for a personal connection to content, which becomes important at later stages of situational interest (Hidi & Renninger, 2006; Linnenbrink-Garcia et al., 2010; Renninger & Su, 2012). An advantage

in the current study was the immediate response to the situational interest questions, providing real-time affective and cognitive assessments in response to the learning activity. Insights into these processes can therefore shed light on the instant interest reactions and their relations to immediate learning behaviors. In addition, our study revealed the moderating effect of individual interest for interest-based personalization and example choice.

4.2. Practical implications

A critical question pertains to what situational interest adds to the learning situation if performance is not improved. Firstly, as shown in the current study, the enhanced situational interest for learners with low individual interest increased task effort, whereas the opposite was observed for learners with high individual interest. Situational interest can therefore help disinterested learners to become more engaged in the learning activity, which in the long run might result in increased performance. However, students might need additional guidance with regard to learning strategies as well as the opportunity to ask questions, which was not provided in the experimental situation.

Nevertheless, as posited in different theoretical perspectives on interest and its development (Hidi & Renninger, 2006; Linnenbrink-Garcia et al., 2010; Renninger & Su, 2012), situational interest is the starting point to the development of a more enduring individual interest. An important outcome of the instructional interventions examined in the present study is that they positively influence situational interest and effort for the students with low individual interest or performance, like self-generated utility interventions (Hulleman et al., 2010; Hulleman & Harackiewicz, 2009), but unlike other interventions prone to the so-called "Matthew effect" (Bakermans-Kranenburg, van IJzendoorn, & Bradley, 2005) benefiting only those who already score high on the dimension to improve (Durik & Harackiewicz, 2007, Study 2; Magner et al., 2014). Context personalization and example choice as utilized here can thus offer an approach to increase situational interest in students with low initial interest, which over time can develop into enduring individual interest. Therefore, we believe that this line of research has several practical implications for mathematics education, particularly for motivating students with low or little interest in the core content of instructions or learning activities. Furthermore, example choice also provide educators with a tool to provide choice in mathematics education, a topic considered challenging (see Flowerday & Schraw, 2000).

The practice of context personalization and example choice may be particularly relevant for educators as well as educational software developers. In many educational systems, among them in Norway where this study was conducted, digitalization of education has increased in the last decades (see Krumsvik, 2008). This digitalization has been associated with the opportunity for educators to adapt education, which means tailoring education for every student. Context personalization and example choice may represent instructional formats suitable for implementation in a digitalized classroom in which the content is adapted to students' interest (see also: National Academy for Engineering, 2008). Finally, insight into the effect of different modes of personalization is important for the development of educational tools, created to meet the needs of the individual learner.

4.3. Limitations

We have to acknowledge several limitations of our research. First, given that this research is based on a single learning session, we cannot generalize findings to mathematical contents probability calculus with independent events. Second, as results only reveal immediate reactions, we cannot make inferences about any eventual long-term effects. Possibly, the effect of context personalization fades over time due to habit. Longitudinal studies and more diverse mathematical topics are necessary to obtain more precise indications of the long-term effects and utility of the instructional formats. Third, students who participated in this experiment did not receive any guidance during the learning session. In a more natural classroom setting, guidance by a teacher may enhance the students' competence and hence their development of interest.

5. Conclusions

This study tested the effect of context personalization and example choice on middle school students' situational interest and perceived utility value during a learning activity in mathematics. We observed that context personalization and example choice can increase triggered and maintained situational interest for students with low initial interest in the domain. In addition, context personalization affected the perception of utility value, again only for students with low initial interest.

Questions about the applicability of the methods in the classroom and the long-term sustainability of the positive effects on interest await further research. Nevertheless, personalization and example choice seem to be promising educational tools that help solve one of the most challenging problems of modern school by increasing interest in mathematics.

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H	Sandbak, Tone, Dr. psychol.	Alcohol consumption and preference in the rat: The significance of individual differences and relationships to stress pathology
	Eid, Jarle, Dr. psychol.	Early predictors of PTSD symptom reporting; The significance of contextual and individual factors.
2001 **V**	Skinstad, Anne Helene, Dr. philos.	Substance dependence and borderline personality disorders.
	Binder, Per-Einar, Dr. psychol.	Individet og den meningsbærende andre. En teoretisk undersøkelse av de mellommenneskelige forutsetningene for psykisk liv og utvikling med utgangspunkt i Donald Winnicotts teori.
	Roald, Ingvild K., Dr. philos.	Building of concepts. A study of Physics concepts of Norwegian deaf students.
H	Fekadu, Zelalem W., Dr. philos.	Predicting contraceptive use and intention among a sample of adolescent girls. An application of the theory of planned behaviour in Ethiopian context.
	Melesse, Fantu, Dr. philos.	The more intelligent and sensitive child (MISC) mediational intervention in an Ethiopian context: An evaluation study.
	Råheim, Målfrid, Dr. philos.	Kvinners kroppserfaring og livssammenheng. En fenomenologisk – hermeneutisk studie av friske kvinner og kvinner med kroniske muskelsmerter.
	Engelsen, Birthe Kari, Dr. psychol.	Measurement of the eating problem construct.
	Lau, Bjørn, Dr. philos.	Weight and eating concerns in adolescence.
2002 **V**	Ihlebæk, Camilla, Dr. philos.	Epidemiological studies of subjective health complaints.

	Rosén, Gunnar O. R., Dr. philos.	The phantom limb experience. Models for understanding and treatment of pain with hypnosis.
	Høines, Marit Johnsen, Dr. philos.	Fleksible språkrom. Matematikklæring som tekstutvikling.
	Anthun, Roald Andor, Dr. philos.	School psychology service quality. Consumer appraisal, quality dimensions, and collaborative improvement potential
	Pallesen, Ståle, Dr. psychol.	Insomnia in the elderly. Epidemiology, psychological characteristics and treatment.
	Midthassel, Unni Vere, Dr. philos.	Teacher involvement in school development activity. A study of teachers in Norwegian compulsory schools
	Kallestad, Jan Helge, Dr. philos.	Teachers, schools and implementation of the Olweus Bullying Prevention Program.
H	Ofte, Sonja Helgesen, Dr. psychol.	Right-left discrimination in adults and children.
	Netland, Marit, Dr. psychol.	Exposure to political violence. The need to estimate our estimations.
	Diseth, Åge, Dr. psychol.	Approaches to learning: Validity and prediction of academic performance.
	Bjuland, Raymond, Dr. philos.	Problem solving in geometry. Reasoning processes of student teachers working in small groups: A dialogical approach.
2003 V	Arefjord, Kjersti, Dr. psychol.	After the myocardial infarction – the wives' view. Short- and long-term adjustment in wives of myocardial infarction patients.
	Ingjaldsson, Jón Þorvaldur, Dr. psychol.	Unconscious Processes and Vagal Activity in Alcohol Dependency.
	Holden, Børge, Dr. philos.	Følger av atferdsanalytiske forklaringer for atferdsanalysens tilnærming til utforming av behandling.
	Holsen, Ingrid, Dr. philos.	Depressed mood from adolescence to 'emerging adulthood'. Course and longitudinal influences of body image and parent-adolescent relationship.
	Hammar, Åsa Karin, Dr. psychol.	Major depression and cognitive dysfunction- An experimental study of the cognitive effort hypothesis.
	Sprugevica, Ieva, Dr. philos.	The impact of enabling skills on early reading acquisition.
	Gabrielsen, Egil, Dr. philos.	LESE FOR LIVET. Lesekompetansen i den norske voksenbefolkningen sett i lys av visjonen om en enhetsskole.
H	Hansen, Anita Lill, Dr. psychol.	The influence of heart rate variability in the regulation of attentional and memory processes.
	Dyregrov, Kari, Dr. philos.	The loss of child by suicide, SIDS, and accidents: Consequences, needs and provisions of help.
2004 V	Torsheim, Torbjørn, Dr. psychol.	Student role strain and subjective health complaints: Individual, contextual, and longitudinal perspectives.

	Haugland, Bente Storm Mowatt Dr. psychol.	Parental alcohol abuse. Family functioning and child adjustment.
	Milde, Anne Marita, Dr. psychol.	Ulcerative colitis and the role of stress. Animal studies of psychobiological factors in relationship to experimentally induced colitis.
	Stornes, Tor, Dr. philos.	Socio-moral behaviour in sport. An investigation of perceptions of sportspersonship in handball related to important factors of socio-moral influence.
	Mæhle, Magne, Dr. philos.	Re-inventing the child in family therapy: An investigation of the relevance and applicability of theory and research in child development for family therapy involving children.
	Kobbeltvedt, Therese, Dr. psychol.	Risk and feelings: A field approach.
2004 H	Thomsen, Tormod, Dr. psychol.	Localization of attention in the brain.
	Løberg, Else-Marie, Dr. psychol.	Functional laterality and attention modulation in schizophrenia: Effects of clinical variables.
	Kyrkjebø, Jane Mikkelsen, Dr. philos.	Learning to improve: Integrating continuous quality improvement learning into nursing education.
	Laumann, Karin, Dr. psychol.	Restorative and stress-reducing effects of natural environments: Experiencal, behavioural and cardiovascular indices.
	Holgersen, Helge, PhD	Mellom oss - Essay i relasjonell psykoanalyse.
2005 V	Hetland, Hilde, Dr. psychol.	Leading to the extraordinary? Antecedents and outcomes of transformational leadership.
	Iversen, Anette Christine, Dr. philos.	Social differences in health behaviour: the motivational role of perceived control and coping.
2005 H	Mathisen, Gro Ellen, PhD	Climates for creativity and innovation: Definitions, measurement, predictors and consequences.
	Sævi, Tone, Dr. philos.	Seeing disability pedagogically – The lived experience of disability in the pedagogical encounter.
	Wiium, Nora, PhD	Intrapersonal factors, family and school norms: combined and interactive influence on adolescent smoking behaviour.
	Kanagaratnam, Pushpa, PhD	Subjective and objective correlates of Posttraumatic Stress in immigrants/refugees exposed to political violence.
	Larsen, Torill M. B. , PhD	Evaluating principals` and teachers` implementation of Second Step. A case study of four Norwegian primary schools.
	Bancila, Delia, PhD	Psychosocial stress and distress among Romanian adolescents and adults.
2006 V	Hillestad, Torgeir Martin, Dr. philos.	Normalitet og avvik. Forutsetninger for et objektivt psykopatologisk avviksbegrep. En psykologisk, sosial, erkjennelsesteoretisk og teorihistorisk framstilling.

	Nordanger, Dag Øystein, Dr. psychol.	Psychosocial discourses and responses to political violence in post-war Tigray, Ethiopia.
	Rimol, Lars Morten, PhD	Behavioral and fMRI studies of auditory laterality and speech sound processing.
	Krumsvik, Rune Johan, Dr. philos.	ICT in the school. ICT-initiated school development in lower secondary school.
	Norman, Elisabeth, Dr. psychol.	Gut feelings and unconscious thought: An exploration of fringe consiousness in implicit cognition.
	Israel, K Pravin, Dr. psychol.	Parent involvement in the mental health care of children and adolescents. Emperical studies from clinical care setting.
	Glasø, Lars, PhD	Affects and emotional regulation in leader-subordinate relationships.
	Knutsen, Ketil, Dr. philos.	HISTORIER UNGDOM LEVER – En studie av hvordan ungdommer bruker historie for å gjøre livet meningsfullt.
	Matthiesen, Stig Berge, PhD	Bullying at work. Antecedents and outcomes.
2006 H	Gramstad, Arne, PhD	Neuropsychological assessment of cognitive and emotional functioning in patients with epilepsy.
	Bendixen, Mons, PhD	Antisocial behaviour in early adolescence: Methodological and substantive issues.
	Mrumbi, Khalifa Maulid, PhD	Parental illness and loss to HIV/AIDS as experienced by AIDS orphans aged between 12-17 years from Temeke District, Dar es Salaam, Tanzania: A study of the children's psychosocial health and coping responses.
	Hetland, Jørn, Dr. psychol.	The nature of subjective health complaints in adolescence: Dimensionality, stability, and psychosocial predictors
	Kakoko, Deodatus Conatus Vitalis, PhD	Voluntary HIV counselling and testing service uptake among primary school teachers in Mwanza, Tanzania: assessment of socio-demographic, psychosocial and socio-cognitive aspects
	Mykletun, Arnstein, Dr. psychol.	Mortality and work-related disability as long-term consequences of anxiety and depression: Historical cohort designs based on the HUNT-2 study
	Sivertsen, Børge, PhD	Insomnia in older adults. Consequences, assessment and treatment.
2007 V	Singhammer, John, Dr. philos.	Social conditions from before birth to early adulthood – the influence on health and health behaviour
	Janvin, Carmen Ani Cristea, PhD	Cognitive impairment in patients with Parkinson's disease: profiles and implications for prognosis
	Braarud, Hanne Cecilie, Dr.psychol.	Infant regulation of distress: A longitudinal study of transactions between mothers and infants
	Tveito, Torill Helene, PhD	Sick Leave and Subjective Health Complaints

	Magnussen, Liv Heide, PhD	Returning disability pensioners with back pain to work
	Thuen, Elin Marie, Dr.philos.	Learning environment, students' coping styles and emotional and behavioural problems. A study of Norwegian secondary school students.
	Solberg, Ole Asbjørn, PhD	Peacekeeping warriors – A longitudinal study of Norwegian peacekeepers in Kosovo
2007 H	Søreide, Gunn Elisabeth, Dr.philos.	Narrative construction of teacher identity
	Svensen, Erling, PhD	WORK & HEALTH. Cognitive Activation Theory of Stress applied in an organisational setting.
	Øverland, Simon Nygaard, PhD	Mental health and impairment in disability benefits. Studies applying linkages between health surveys and administrative registries.
	Eichele, Tom, PhD	Electrophysiological and Hemodynamic Correlates of Expectancy in Target Processing
	Børhaug, Kjetil, Dr.philos.	Oppseding til demokrati. Ein studie av politisk oppseding i norsk skule.
	Eikeland, Thorleif, Dr.philos.	Om å vokse opp på barnehjem og på sykehus. En undersøkelse av barnehjemsbarns opplevelser på barnehjem sammenholdt med sanatoriebarns beskrivelse av langvarige sykehusopphold – og et forsøk på forklaring.
	Wadel, Carl Cato, Dr.philos.	Medarbeidersamhandling og medarbeiderledelse i en lagbasert organisasjon
	Vinje, Hege Forbech, PhD	Thriving despite adversity: Job engagement and self-care among community nurses
	Noort, Maurits van den, PhD	Working memory capacity and foreign language acquisition
2008 V	Breivik, Kyrre, Dr.psychol.	The Adjustment of Children and Adolescents in Different Post-Divorce Family Structures. A Norwegian Study of Risks and Mechanisms.
	Johnsen, Grethe E., PhD	Memory impairment in patients with posttraumatic stress disorder
	Sætrevik, Bjørn, PhD	Cognitive Control in Auditory Processing
	Carvalhosa, Susana Fonseca, PhD	Prevention of bullying in schools: an ecological model
2008 H	Brønnick, Kolbjørn Selvåg	Attentional dysfunction in dementia associated with Parkinson's disease.
	Posserud, Maj-Britt Rocio	Epidemiology of autism spectrum disorders
	Haug, Ellen	Multilevel correlates of physical activity in the school setting
	Skjerve, Arvid	Assessing mild dementia – a study of brief cognitive tests.

	Kjønniksen, Lise	The association between adolescent experiences in physical activity and leisure time physical activity in adulthood: a ten year longitudinal study
	Gundersen, Hilde	The effects of alcohol and expectancy on brain function
	Omvik, Siri	Insomnia – a night and day problem
2009 V	Molde, Helge	Pathological gambling: prevalence, mechanisms and treatment outcome.
	Foss, Else	Den omsorgsfulle væremåte. En studie av voksnes væremåte i forhold til barn i barnehagen.
	Westrheim, Kariane	Education in a Political Context: A study of Konwledge Processes and Learning Sites in the PKK.
	Wehling, Eike	Cognitive and olfactory changes in aging
	Wangberg, Silje C.	Internet based interventions to support health behaviours: The role of self-efficacy.
	Nielsen, Morten B.	Methodological issues in research on workplace bullying. Operationalisations, measurements and samples.
	Sandu, Anca Larisa	MRI measures of brain volume and cortical complexity in clinical groups and during development.
	Guribye, Eugene	Refugees and mental health interventions
	Sørensen, Lin	Emotional problems in inattentive children – effects on cognitive control functions.
	Tjomsland, Hege E.	Health promotion with teachers. Evaluation of the Norwegian Network of Health Promoting Schools: Quantitative and qualitative analyses of predisposing, reinforcing and enabling conditions related to teacher participation and program sustainability.
	Helleve, Ingrid	Productive interactions in ICT supported communities of learners
2009 H	Skorpen, Aina Øye, Christine	Dagliglivet i en psykiatrisk institusjon: En analyse av miljøterapeutiske praksiser
	Andreassen, Cecilie Schou	WORKAHOLISM – Antecedents and Outcomes
	Stang, Ingun	Being in the same boat: An empowerment intervention in breast cancer self-help groups
	Sequeira, Sarah Dorothee Dos Santos	The effects of background noise on asymmetrical speech perception
	Kleiven, Jo, dr.philos.	The Lillehammer scales: Measuring common motives for vacation and leisure behavior
	Jónsdóttir, Guðrún	Dubito ergo sum? Ni jenter møter naturfaglig kunnskap.
	Hove, Oddbjørn	Mental health disorders in adults with intellectual disabilities - Methods of assessment and prevalence of mental health disorders and problem behaviour
	Wageningen, Heidi Karin van	The role of glutamate on brain function

	Bjørkvik, Jofrid	God nok? Selvaktelse og interpersonlig fungering hos pasienter innen psykisk helsevern: Forholdet til diagnoser, symptomer og behandlingsutbytte
	Andersson, Martin	A study of attention control in children and elderly using a forced-attention dichotic listening paradigm
	Almås, Aslaug Grov	Teachers in the Digital Network Society: Visions and Realities. A study of teachers' experiences with the use of ICT in teaching and learning.
	Ulvik, Marit	Lærerutdanning som danning? Tre stemmer i diskusjonen
2010 V	Skår, Randi	Læringsprosesser i sykepleieres profesjonsutøvelse. En studie av sykepleieres læringserfaringer.
	Roald, Knut	Kvalitetsvurdering som organisasjonslæring mellom skole og skoleeigar
	Lunde, Linn-Heidi	Chronic pain in older adults. Consequences, assessment and treatment.
	Danielsen, Anne Grete	Perceived psychosocial support, students' self-reported academic initiative and perceived life satisfaction
	Hysing, Mari	Mental health in children with chronic illness
	Olsen, Olav Kjellevold	Are good leaders moral leaders? The relationship between effective military operational leadership and morals
	Riese, Hanne	Friendship and learning. Entrepreneurship education through mini-enterprises.
	Holthe, Asle	Evaluating the implementation of the Norwegian guidelines for healthy school meals: A case study involving three secondary schools
H	Hauge, Lars Johan	Environmental antecedents of workplace bullying: A multi-design approach
	Bjørkelo, Brita	Whistleblowing at work: Antecedents and consequences
	Reme, Silje Endresen	Common Complaints – Common Cure? Psychiatric comorbidity and predictors of treatment outcome in low back pain and irritable bowel syndrome
	Helland, Wenche Andersen	Communication difficulties in children identified with psychiatric problems
	Beneventi, Harald	Neuronal correlates of working memory in dyslexia
	Thygesen, Elin	Subjective health and coping in care-dependent old persons living at home
	Aanes, Mette Marthinussen	Poor social relationships as a threat to belongingness needs. Interpersonal stress and subjective health complaints: Mediating and moderating factors.
	Anker, Morten Gustav	Client directed outcome informed couple therapy

	Bull, Torill	Combining employment and child care: The subjective well-being of single women in Scandinavia and in Southern Europe
	Viig, Nina Grieg	Tilrettelegging for læreres deltakelse i helsefremmende arbeid. En kvalitativ og kvantitativ analyse av sammenhengen mellom organisatoriske forhold og læreres deltakelse i utvikling og implementering av Europeisk Nettverk av Helsefremmende Skoler i Norge
	Wolff, Katharina	To know or not to know? Attitudes towards receiving genetic information among patients and the general public.
	Ogden, Terje, dr.philos.	Familiebasert behandling av alvorlige atferdsproblemer blant barn og ungdom. Evaluering og implementering av evidensbaserte behandlingsprogrammer i Norge.
	Solberg, Mona Elin	Self-reported bullying and victimisation at school: Prevalence, overlap and psychosocial adjustment.
2011 V	Bye, Hege Høivik	Self-presentation in job interviews. Individual and cultural differences in applicant self-presentation during job interviews and hiring managers' evaluation
	Notelaers, Guy	Workplace bullying. A risk control perspective.
	Moltu, Christian	Being a therapist in difficult therapeutic impasses. A hermeneutic phenomenological analysis of skilled psychotherapists' experiences, needs, and strategies in difficult therapies ending well.
	Myrseth, Helga	Pathological Gambling - Treatment and Personality Factors
	Schanche, Elisabeth	From self-criticism to self-compassion. An empirical investigation of hypothesized change prosesses in the Affect Phobia Treatment Model of short-term dynamic psychotherapy for patients with Cluster C personality disorders.
	Våpenstad, Eystein Victor, dr.philos.	Det tempererte nærvær. En teoretisk undersøkelse av psykoterapautens subjektivitet i psykoanalyse og psykoanalytisk psykoterapi.
	Haukebø, Kristin	Cognitive, behavioral and neural correlates of dental and intra-oral injection phobia. Results from one treatment and one fMRI study of randomized, controlled design.
	Harris, Anette	Adaptation and health in extreme and isolated environments. From 78°N to 75°S.
	Bjørknes, Ragnhild	Parent Management Training-Oregon Model: intervention effects on maternal practice and child behavior in ethnic minority families
	Mamen, Asgeir	Aspects of using physical training in patients with substance dependence and additional mental distress
	Espevik, Roar	Expert teams: Do shared mental models of team members make a difference
	Haara, Frode Olav	Unveiling teachers' reasons for choosing practical activities in mathematics teaching

2011 H	Hauge, Hans Abraham	How can employee empowerment be made conducive to both employee health and organisation performance? An empirical investigation of a tailor-made approach to organisation learning in a municipal public service organisation.
	Melkevik, Ole Rogstad	Screen-based sedentary behaviours: pastimes for the poor, inactive and overweight? A cross-national survey of children and adolescents in 39 countries.
	Vøllestad, Jon	Mindfulness-based treatment for anxiety disorders. A quantitative review of the evidence, results from a randomized controlled trial, and a qualitative exploration of patient experiences.
	Tolo, Astrid	Hvordan blir lærerkompetanse konstruert? En kvalitativ studie av PPU-studenters kunnskapsutvikling.
	Saus, Evelyn-Rose	Training effectiveness: Situation awareness training in simulators
	Nordgreen, Tine	Internet-based self-help for social anxiety disorder and panic disorder. Factors associated with effect and use of self-help.
	Munkvold, Linda Helen	Oppositional Defiant Disorder: Informant discrepancies, gender differences, co-occuring mental health problems and neurocognitive function.
	Christiansen, Øivin	Når barn plasseres utenfor hjemmet: beslutninger, forløp og relasjoner. Under barnevernets (ved)tak.
	Brunborg, Geir Scott	Conditionability and Reinforcement Sensitivity in Gambling Behaviour
	Hystad, Sigurd William	Measuring Psychological Resiliency: Validation of an Adapted Norwegian Hardiness Scale
2012 V	Roness, Dag	Hvorfor bli lærer? Motivasjon for utdanning og utøving.
	Fjermestad, Krister Westlye	The therapeutic alliance in cognitive behavioural therapy for youth anxiety disorders
	Jenssen, Eirik Sørnes	Tilpasset opplæring i norsk skole: politikeres, skoleledereres og læreres handlingsvalg
	Saksvik-Lehouillier, Ingvild	Shift work tolerance and adaptation to shift work among offshore workers and nurses
	Johansen, Venke Frederike	Når det intime blir offentlig. Om kvinners åpenhet om brystkreft og om markedsføring av brystkreftsaken.
	Herheim, Rune	Pupils collaborating in pairs at a computer in mathematics learning: investigating verbal communication patterns and qualities
	Vie, Tina Løkke	Cognitive appraisal, emotions and subjective health complaints among victims of workplace bullying: A stress-theoretical approach
	Jones, Lise Øen	Effects of reading skills, spelling skills and accompanying efficacy beliefs on participation in education. A study in Norwegian prisons.

2012 H	Danielsen, Yngvild Sørebø	Childhood obesity – characteristics and treatment. Psychological perspectives.
	Horverak, Jøri Gytre	Sense or sensibility in hiring processes. Interviewee and interviewer characteristics as antecedents of immigrant applicants' employment probabilities. An experimental approach.
	Jøsendal, Ola	Development and evaluation of BE smokeFREE, a school-based smoking prevention program
	Osnes, Berge	Temporal and Posterior Frontal Involvement in Auditory Speech Perception
	Drageset, Sigrunn	Psychological distress, coping and social support in the diagnostic and preoperative phase of breast cancer
	Aasland, Merethe Schanke	Destructive leadership: Conceptualization, measurement, prevalence and outcomes
	Bakibinga, Pauline	The experience of job engagement and self-care among Ugandan nurses and midwives
	Skogen, Jens Christoffer	Foetal and early origins of old age health. Linkage between birth records and the old age cohort of the Hordaland Health Study (HUSK)
	Leversen, Ingrid	Adolescents' leisure activity participation and their life satisfaction: The role of demographic characteristics and psychological processes
	Hanss, Daniel	Explaining sustainable consumption: Findings from cross-sectional and intervention approaches
	Rød, Per Arne	Barn i klem mellom foreldrekonflikter og samfunnsmessig beskyttelse
2013 V	Mentzoni, Rune Aune	Structural Characteristics in Gambling
	Knudsen, Ann Kristin	Long-term sickness absence and disability pension award as consequences of common mental disorders. Epidemiological studies using a population-based health survey and official ill health benefit registries.
	Strand, Mari	Emotional information processing in recurrent MDD
	Veseth, Marius	Recovery in bipolar disorder. A reflexive-collaborative exploration of the lived experiences of healing and growth when battling a severe mental illness
	Mæland, Silje	Sick leave for patients with severe subjective health complaints. Challenges in general practice.
	Mjaaland, Thera	At the frontiers of change? Women and girls' pursuit of education in north-western Tigray, Ethiopia
	Odéen, Magnus	Coping at work. The role of knowledge and coping expectancies in health and sick leave.
	Hynninen, Kia Minna Johanna	Anxiety, depression and sleep disturbance in chronic obstructive pulmonary disease (COPD). Associations, prevalence and effect of psychological treatment.

	Flo, Elisabeth	Sleep and health in shift working nurses
	Aasen, Elin Margrethe	From paternalism to patient participation? The older patients undergoing hemodialysis, their next of kin and the nurses: a discursive perspective on perception of patient participation in dialysis units
	Ekornås, Belinda	Emotional and Behavioural Problems in Children: Self-perception, peer relationships, and motor abilities
	Corbin, J. Hope	North-South Partnerships for Health: Key Factors for Partnership Success from the Perspective of the KIWAKKUKI
	Birkeland, Marianne Skogbrott	Development of global self-esteem: The transition from adolescence to adulthood
2013 H	Gianella-Malca, Camila	Challenges in Implementing the Colombian Constitutional Court's Health-Care System Ruling of 2008
	Hovland, Anders	Panic disorder – Treatment outcomes and psychophysiological concomitants
	Mortensen, Øystein	The transition to parenthood – Couple relationships put to the test
	Årdal, Guro	Major Depressive Disorder – a Ten Year Follow-up Study. Inhibition, Information Processing and Health Related Quality of Life
	Johansen, Rino Bandlitz	The impact of military identity on performance in the Norwegian armed forces
	Bøe, Tormod	Socioeconomic Status and Mental Health in Children and Adolescents
2014 V	Nordmo, Ivar	Gjennom nåløyet – studenters læringserfaringer i psykologutdanningen
	Dovran, Anders	Childhood Trauma and Mental Health Problems in Adult Life
	Hegelstad, Wenche ten Velden	Early Detection and Intervention in Psychosis: A Long-Term Perspective
	Urheim, Ragnar	Forståelse av pasientaggresjon og forklaringer på nedgang i voldsrate ved Regional sikkerhetsavdeling, Sandviken sykehus
	Kinn, Liv Grethe	Round-Trips to Work. Qualitative studies of how persons with severe mental illness experience work integration.
	Rød, Anne Marie Kinn	Consequences of social defeat stress for behaviour and sleep. Short-term and long-term assessments in rats.
	Nygård, Merethe	Schizophrenia – Cognitive Function, Brain Abnormalities, and Cannabis Use
	Tjora, Tore	Smoking from adolescence through adulthood: the role of family, friends, depression and socioeconomic status. Predictors of smoking from age 13 to 30 in the "The Norwegian Longitudinal Health Behaviour Study" (NLHB)
	Vangsnes, Vigdis	The Dramaturgy and Didactics of Computer Gaming. A Study of a Medium in the Educational Context of Kindergartens.

	Nordahl, Kristin Berg	Early Father-Child Interaction in a Father-Friendly Context: Gender Differences, Child Outcomes, and Protective Factors related to Fathers' Parenting Behaviors with One-year-olds
2014 H	Sandvik, Asle Makoto	Psychopathy – the heterogenety of the construct
	Skotheim, Siv	Maternal emotional distress and early mother-infant interaction: Psychological, social and nutritional contributions
	Halleland, Helene Barone	Executive Functioning in adult Attention Deficit Hyperactivity Disorder (ADHD). From basic mechanisms to functional outcome.
	Halvorsen, Kirsti Vindal	Partnerskap i lærerutdanning, sett fra et økologisk perspektiv
	Solbue, Vibeke	Dialogen som visker ut kategorier. En studie av hvilke erfaringer innvandrerungdommer og norskfødte med innvandrerforeldre har med videregående skole. Hva forteller ungdommenes erfaringer om videregående skoles håndtering av etniske ulikheter?
	Kvalevaag, Anne Lise	Fathers' mental health and child development. The predictive value of fathers' psychological distress during pregnancy for the social, emotional and behavioural development of their children
	Sandal, Ann Karin	Ungdom og utdanningsval. Om elevar sine opplevingar av val og overgangsprosessar.
	Haug, Thomas	Predictors and moderators of treatment outcome from high- and low-intensity cognitive behavioral therapy for anxiety disorders. Association between patient and process factors, and the outcome from guided self-help, stepped care, and face-to-face cognitive behavioral therapy.
	Sjølie, Hege	Experiences of Members of a Crisis Resolution Home Treatment Team. Personal history, professional role and emotional support in a CRHT team.
	Falkenberg, Liv Eggset	Neuronal underpinnings of healthy and dysfunctional cognitive control
	Mrdalj, Jelena	The early life condition. Importance for sleep, circadian rhythmicity, behaviour and response to later life challenges
	Hesjedal, Elisabeth	Tverrprofesjonelt samarbeid mellom skule og barnevern: Kva kan støtte utsette barn og unge?
2015 V	Hauken, May Aasebø	«*The cancer treatment was only half the work!*» A Mixed-Method Study of Rehabilitation among Young Adult Cancer Survivors
	Ryland, Hilde Katrin	Social functioning and mental health in children: the influence of chronic illness and intellectual function
	Rønsen, Anne Kristin	Vurdering som profesjonskompetanse. Refleksjonsbasert utvikling av læreres kompetanse i formativ vurdering

	Hoff, Helge Andreas	Thinking about Symptoms of Psychopathy in Norway: Content Validation of the Comprehensive Assessment of Psychopathic Personality (CAPP) Model in a Norwegian Setting
	Schmid, Marit Therese	Executive Functioning in recurrent- and first episode Major Depressive Disorder. Longitudinal studies
	Sand, Liv	Body Image Distortion and Eating Disturbances in Children and Adolescents
	Matanda, Dennis Juma	Child physical growth and care practices in Kenya: Evidence from Demographic and Health Surveys
	Amugsi, Dickson Abanimi	Child care practices, resources for care, and nutritional outcomes in Ghana: Findings from Demographic and Health Surveys
	Jakobsen, Hilde	The good beating: Social norms supporting men's partner violence in Tanzania
	Sagoe, Dominic	Nonmedical anabolic-androgenic steroid use: Prevalence, attitudes, and social perception
	Eide, Helene Marie Kjærgård	Narrating the relationship between leadership and learning outcomes. A study of public narratives in the Norwegian educational sector.
2015 H	Wubs, Annegreet Gera	Intimate partner violence among adolescents in South Africa and Tanzania
	Hjelmervik, Helene Susanne	Sex and sex-hormonal effects on brain organization of fronto-parietal networks
	Dahl, Berit Misund	The meaning of professional identity in public health nursing
	Røykenes, Kari	Testangst hos sykepleierstudenter: «Alternativ behandling»
	Bless, Josef Johann	The smartphone as a research tool in psychology. Assessment of language lateralization and training of auditory attention.
	Løvvik, Camilla Margrethe Sigvaldsen	Common mental disorders and work participation – the role of return-to-work expectations
	Lehmann, Stine	Mental Disorders in Foster Children: A Study of Prevalence, Comorbidity, and Risk Factors
	Knapstad, Marit	Psychological factors in long-term sickness absence: the role of shame and social support. Epidemiological studies based on the Health Assets Project.
2016 V	Kvestad, Ingrid	Biological risks and neurodevelopment in young North Indian children
	Sælør, Knut Tore	Hinderløyper, halmstrå og hengende snører. En kvalitativ studie av håp innenfor psykisk helse- og rusfeltet.
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