# Chapter 27
# Fostering Pupils' Deep Learning and Motivation in the Norwegian Context: A Study of Pupils' Perceptions of Mathematics Instruction and the Link to Their Learning Outcomes

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**Abstract** Recent international research has highlighted deep learning as an essential prerequisite for pupils to meet the global challenges of the future. This focus has drawn attention to Norwegian challenges, indicating that instruction leaves little room for pupils to engage intensively in tasks over time and to foster deep-learning processes. Thus, a new curriculum was implemented in the Norwegian educational system in the autumn of 2020 to emphasize deep learning throughout all content areas.

This study investigates how teachers provide learning conditions fostering learning and motivation processes to support pupils' learning during mathematics lessons. After their mathematics lesson, 144 pupils from 9 classes (grades 7–9) in seven schools in Norway completed a questionnaire. It consisted of items measuring their perception of the relevance of the content taught, the quality of the instruction given, the teacher's interest and enthusiasm, and the extent to which the instruction fulfilled their psychological needs for social relation, autonomy, and feeling competent.

On average, the pupils reported that they applied surface-level learning strategies rather than deep-level strategies in their mathematics lessons. They also lacked intrinsic motivation. To a large degree, pupils reported that they hardly recognised the content's relevance. The results support the focus on deep learning in the 2020 curriculum reform in Norway. Additionally, they reveal conditions worth investigating when aiming to foster pupils' deep learning and motivation.

**Keywords** Motivation · Deep learning · Mathematics · Curriculum · School-in

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R. Maulana et al. (eds.), *Effective Teaching Around the World*,
https://doi.org/10.1007/978-3-031-31678-4_27

## 1 Introduction

Building on international research by authors such as Fullan et al. (2018), who pointed out that deep learning allows pupils to gain the skills necessary to tackle rapid changes in society, Norway has seen an increased interest in deep learning. The national curriculum in Norway thus far has been too extensive to stimulate and enable deep learning. In autumn 2020, the Norwegian government reduced the curriculum's content to facilitate deep learning and avoid curriculum overload (Norwegian Ministry of Education and Research, 2015). The new curriculum aims to foster pupils' abilities for broad, transferable skills and knowledge applicable to different subjects and tasks. Deep learning requires pupils to be actively engaged, reflect on their learning, and connect what is learned with what they already know (Norwegian Ministry of Education and Research, 2015). This constructivist view of learning considers learning as occurring in an active and communicative process. Although limiting the amount of content may be helpful, it is not guaranteed to lead pupils to engage in deeper learning processes or improve their learning outcomes. Investigating the communicative process in which learning occurs will illuminate how educators can support and stimulate learners to become actively involved, reflect, and connect their existing knowledge to new knowledge, thereby engaging in deep learning.

Despite widespread agreement that deep learning is appropriate for the school of the future, researchers have divergent understandings of the term 'deep learning' (Gilje et al., 2018). Fullan et al. (2018) argued for six global competencies that foster deep learning: character, citizenship, collaboration, communication, creativity, and critical thinking (p. 16). Others have criticized this framework for failing to consider a theory-based understanding of how pupils learn in a cognitive, social, and emotional way. Gilje et al. (2018) called for research on instruction that provides examples of how deep learning can be realized. Thus, this chapter considers cognitive and sociocultural views on deep learning and combines relevant theories to contribute to this perspective.

Our theoretical framework builds on Self-Determination Theory (SDT; Deci & Ryan, 1985) and Interest Theory (Krapp, 1999; Prenzel, 1995), which have focused on supportive learning conditions relevant for learning and motivational processes. Teachers impact pupils' learning by providing supportive learning conditions (Seidel, 2003). Nevertheless, the pupils must determine to which degree they use the supportive learning opportunities provided (Seidel et al., 2007). The way pupils experience the supportive learning conditions influences their motivation and learning processes. Moreover, pupils' perceptions of the classroom environment are positively related to their learning outcomes (de Jong & Westerhof, 2001; Seidel & Shavelson, 2007). In this chapter, we draw on data from 144 pupils' perceptions of the supportive learning conditions in their mathematics class and their cognitive and motivational learning outcomes. We aim to understand how educators can support and stimulate learners to engage in deep learning processes. The following research questions frame our study:

*Research question 1: How do pupils perceive (a) supportive learning conditions, (b) their learning processes, and (c) their intrinsic motivation?*

*Research question 2: How do pupils' perceptions of supportive learning conditions impact (a) their perceived learning processes and (b) motivation?*

In the following, we will describe the educational situation in southern Norway and the study's context, which builds the backdrop of our study. Next, we will briefly tap into deep learning, motivation, and supportive learning conditions before presenting the methods used and reporting on and discussing our findings.

## 2 The Need for a New Curriculum That Fosters Deep Learning

The Norwegian school system is free, public, and compulsory and lasts from grade 1 to grade 10. School is mandatory for all 6- to 16-year-old children. Following primary school, most pupils attend secondary school (grades 11–13). As 'one school for all' aiming at equal learning opportunities for all pupils, the Norwegian school has a diverse composition and an inclusive function. Norway prioritizes education and spends 6.4% of the gross domestic product (GDP) on educational institutions from primary to tertiary levels, which is the highest amount registered by the organisation for economic co-operation and development (OECD). Norway is also among the top three when it comes to the total expenditure on educational institutions per full-time equivalent pupil from primary to tertiary education (OECD, 2020). Socioeconomic factors play a minor role in pupils' achievement compared to many other countries, according to several large-scale assessment studies. The Norwegian government considers education to be highly important and has overseen frequent changes of curricula and school reforms throughout the years to ensure educational quality. Thus, the new curriculum initiated by the government focusing on deep learning (Norwegian Ministry of Education and Research, 2015) has achieved great attention and cost great effort in the educational system.

Southern Norway has, in some regions, special challenges related to living conditions and learning outcomes. These are characterized by, on average, a lower level of education and below average results on national standard achievement tests. (Statistics Norway, 2021; https://www.ssb.no/).

Our findings are based on data from a larger project (School-In, 2017–2020) funded by the Research Council of Norway (project 260,539). The project was initiated by five municipalities in southern Norway and was operationalized in cooperation with the University of Agder. The project aimed to investigate the role of local school development processes (Midtsundstad, 2019) related to inclusion in 1st- to 10th-grade schools. The project supplemented the region's focus on an inclusive learning environment, implying that children in kindergarten and schools should experience an inclusive learning environment that not only fosters children's social relatedness, but also strengthens their academic outcomes (Knutepunkt Sørlandet, 2015). In the School-In project, pupils answered questions regarding their perceptions of supportive learning conditions in their classroom and their learning processes and motivation. These questions also ask whether the pupils experienced a focus on deep learning. A meta-analysis about the effects of teaching on learning processes (Seidel & Shavelson, 2007) showed that research has more frequently investigated cognitive aspects than motivational-affective aspects. This meta-analysis also showed that domain-specific factors are most relevant for learning processes, regardless of domain, and for both cognitive and motivational-affective processes. Our study refers to the domain of mathematics instruction, which is frequently addressed within large-scale assessment and didactics studies. Thus, our findings will supplement current studies about mathematics instruction.

## *2.1 Deep Learning*

Traditional theories distinguish between various learning processes (see Vermunt & Vermetten, 2004, for a review on patterns in pupil learning). While often overlapping, these theories distinguish between learning activities on different cognitive levels. For instance, Marton and Säljö (1976) focused on surface-level processing and deep-level processing. Other research has considered further aspects of learning processes; for example, Vermunt (1998) distinguished between a deep processing strategy, a stepwise processing strategy, and a concrete processing strategy. Others have broadened the perspective to include other domains. Pellegrino and Hilton (2012, as cited in Pellegrino, 2017) considered intra- and interpersonal domains alongside the cognitive domain. Research has shown that meaningful, deeper learning supports the transfer of knowledge and skills to other contexts, whereas surface knowledge and knowledge acquired through rote learning does not (Mayer, 2010). In a study with student teachers, Gordon and Debus (2002) showed that deep learning approaches positively impacted student teachers' self-efficacy. Research in higher education has been equivocal regarding whether students develop their learning approaches over time from surface to deeper approaches (see Asikainen & Gijbels, 2017).

Our research distinguishes between basic and deep elaborations based on research about teaching and learning processes in physics instruction (Seidel, 2003; Seidel et al., 2005). Basic elaborations include the core elementary topics that pupils must understand, constituting surface learning. Other forms of learning aim at deep elaborations, requiring pupils to know when, how, and why to apply the learning content. Those forms also expect pupils to reflect on how different aspects of a topic are connected, signalling deep learning.

## 2.2 Intrinsic Motivation

Motivation is a situational construct that can initiate and maintain learning processes (Prenzel, 1995; Ryan & Deci, 2017). Various theories address motivation, such as achievement goal theory (Ames, 1992) and expectancy-value theory (Wigfield & Eccles, 2000). Research has indicated that intrinsic motivation, in which the learning drive originates in the person, is essential for learning processes. We consider intrinsic motivation to be a continuum, in line with SDT (Deci & Ryan, 1985) and in relation to Interest Theory (Prenzel, 1995). On this continuum, motivation ranges from controlled motivation, in which action is driven and controlled by external rewards, to autonomous motivation, in which action and intent come from within the actor. Additionally, these theories mention amotivation, where little or no intention or action is present.

Numerous studies have shown the benefits of autonomous motivation over extrinsic or controlled motivation. Attaining extrinsic goals, such as rewards or popularity, leads to a lower degree of wellbeing than attaining intrinsic goals, such as personal growth and contributing to the community (Fryer et al., 2014; Kasser & Ryan, 1996; Unanue et al., 2014). Rump et al. (2017) observed that autonomous motivation types are negative predictors of pupils' intention to drop out of school. In a longitudinal study, Janke (2020) concluded that students in higher education who were intrinsically motivated for enrolment demonstrated a learning goal orientation. These students were also more satisfied with their choice of major. Students with extrinsic motivation for enrolment had more thoughts about dropping out and were less satisfied with their study over time (Janke, 2020). Studies have demonstrated that intrinsic motivation is related to the use of deep learning strategies (Krapp, 1999; Seidel, 2003). Thus, supportive learning conditions strengthening pupils' intrinsic motivation may also positively impact pupils' use of deep learning strategies. Questions remain about how teachers may create supportive learning conditions in their classroom to help pupils engage in deeper learning by elaborating on topics, enabling them to know when, how, and why to apply the learning content.

## 2.3 Supportive Learning Conditions

SDT and Interest Theory suggest various learning conditions to support learning and intrinsic motivation. SDT postulates that the extent to which three basic needs are fulfilled influences the degree to which intrinsic motivation is supported (Deci & Ryan, 1985). Interest Theory builds on SDT but adds a more specific focus and takes the person–object relationships into account (Krapp, 1999). An object can include a particular learning content, an abstract idea, or an action. Prenzel (1995) extended SDT with aspects from Interest Theory and related the theories to a class teaching situation. Our study builds on both perspectives. Below, we elaborate on the supportive learning conditions proposed by SDT (Deci & Ryan, 1985) and the extended Interest Theory (Krapp, 1999; Prenzel, 1995).

### 2.3.1 Basic Needs – Self Determination Theory

Strengthening and supporting autonomous forms of motivation requires three basic psychological needs to be met, namely a sense of (1) autonomy, (2) competence, and (3) social relatedness (Ryan & Deci, 2017). Experiencing autonomy positively impacts learners' motivation (Tilga et al., 2020) and commitment to the learning process (Zhang et al., 2020). In class, pupils might experience **autonomy support** when provided with opportunities to make their own choices or when independent learning is supported. Experiencing that their competence is supported positively impacts learners' self-determination and motivation (Kiemer et al., 2018). Pupils experience **competence support** when they perceive their teacher trusting their skills, such as being given challenging but solvable tasks. Achieving **social relatedness** involves learners experiencing the class as a safe learning environment, characterized by unity and a friendly attitude towards each other. Higher levels of experienced social relatedness are positively related to pupils' psychological well-being, retention, and satisfaction with experiences during study (Boyd et al., 2020). Research has shown that these three psychological needs are unique and cannot be averaged into a single measure of 'satisfaction' (Van den Broeck et al., 2016). They are important for motivation, but also for learning processes (Seidel, 2003).

### 2.3.2 The Role of Person–Object Relationship – Interest Theory

The Interest Theory describes interest as a relation between a person and an object. It aims to explain how individuals develop from having situated to more persistent preferences for an object or activity. Prenzel (1995) argues for supplementing the SDT with elements from the Interest Theory and emphasizes that three aspects can foster the relation to an object (the content or activity) in class: (1) the relevance of the content, (2) the quality of instruction, and (3) the teacher's interest. **Relevance of content**, which helps pupils experience the content as meaningful, can be achieved by using authentic examples, content, or events that matter to the pupils. **Quality of instruction** provides structure and coherence of the content and clarifies how pupils are expected to approach a problem. The **teacher's interest** influences pupils' attitudes towards the content. A teacher showing interest in the content can ignite a spark of interest and motivation among pupils (Prenzel, 1995). These aspects have proven relevant in areas such as physics instruction (Seidel et al., 2007) and vocational education (Prenzel et al., 2002).

# 3 Method

## *3.1 Sample and Design*

The data were collected as part of the School-In project, which ran from 2017 to 2020 (funded by the Research Council of Norway, project 260539) and focused on inclusion in a systemic manner. The Norwegian Centre for Research Data, which protects the privacy and rights of potential research participants, granted us permission to conduct our study. Participation in this study was voluntary and anonymous. The project was designed as a mixed methods study with an intervention in seven rural schools. For this chapter, we use data from the quantitative questionnaire, which was distributed before the intervention. One school was visited per semester (see Table 27.1). In total, 144 pupils responded to the questionnaire directly after their mathematics lesson. Pupils' ages ranged from 12 to 15 years ($M$ = 12.96; $SD$ = .84), with 48.6% being male, 47.2% being female, and 4.2% of the pupils not indicating their gender. The classes varied in size from 5 to 37 pupils (see Table 27.1).

## *3.2 Data Collection*

To ensure we used high-quality analytical tools, we adapted items and scales from the IPN-Video Study in Physics instruction (Seidel et al., 2005). In total, we used 32 items. These items asked pupils about their *perception of supportive learning conditions* (Deci & Ryan, 1985; Prenzel, 1995), which consist of the three basic needs from SDT (Deci & Ryan, 1985): autonomy (4 items), competence (3 items), and social relatedness (5 items), as well as additional concepts from Interest Theory (Prenzel, 1995): relevance of content (3 items), quality of instruction (3 items), and teacher's interest (3 items). The items also asked pupils about *their perceived learning outcome* (Seidel, 2003) during the lesson: the extent to which they experienced basic elaborations (4 items), deep elaborations (4 items), and intrinsic motivation (3 items). The scales were translated into Norwegian and reformulated for the context

**Table 27.1** Distribution of the sample across the schools

| School | Class level | | | |
|---|---|---|---|---|
| | Grade 7 | Grade 8 | Grade 9 | Total |
| School 1 (2017, Spring) | 0 | 10 | 5 | 15 |
| School 2 (2017, Autumn) | 0 | 0 | 23 | 23 |
| School 3 (2018, Spring) | 0 | 8 | 0 | 8 |
| School 4 (2018, Autumn) | 0 | 9 | 0 | 9 |
| School 5 (2019, Spring) | 37 | 0 | 0 | 37 |
| School 6 (2019, Autumn) | 0 | 19 | 14 | 33 |
| School 7 (2020, Spring) | 19 | 0 | 0 | 19 |
| Total | 56 | 46 | 42 | 144 |

and purpose of this study. Pupils replied on a 6-point Likert scale ranging from 0 (*totally disagree*) to 5 (*totally agree*). Table 27.2 offers a description of the questionnaire's scales with item examples. All scales are internally consistent with Cronbach's alpha values ranging from .70 for teacher's interest to .95 for intrinsic motivation. The School-In project technical report offers complete documentation of the scales and items (Dalehefte & Midtsundstad, 2022).

## *3.3 Analysis*

To answer our first research question, we calculated the descriptive values for each scale. We conducted a hierarchical linear regression analysis with two models to answer the second research question investigating the impact of learning conditions on pupils' learning outcomes. The first model shows the impact by considering the basic needs from SDT. The second model shows the added value of considering additional scales related to Interest Theory.

**Table 27.2** Descriptives of the questionnaire's scales, including item examples

| Scale | Number of items | Item example *Intro: During the lesson …* | α | Mean | *SD* |
|---|---|---|---|---|---|
| *Learning conditions* | | | | | |
| Autonomy | 4 | … I had the opportunity to make my own choices. | .805 | 4.15 | .88 |
| Competence support | 3 | … the teacher gave trust that we were able to complete the tasks. | .775 | 4.15 | .82 |
| Social relatedness | 5 | … we had a good atmosphere in the class. | .791 | 4.05 | .89 |
| Relevance of content | 3 | ... it became apparent that the learning content was important for us pupils. | .714 | 2.78 | 1.43 |
| Quality of instruction | 3 | ... I was informed what goals we should reach in the lesson. | .753 | 3.77 | 1.06 |
| Teacher's interest | 3 | … I had the impression that the teacher thought the topic was interesting. | .699 | 4.08 | .92 |
| *Learning outcomes* | | | | | |
| Basic elaboration | 4 | ... the essential points were evident to me. | .821 | 4.08 | .92 |
| Deep elaboration | 4 | ... I thought about how different things are connected to each other. | .811 | 3.43 | 1.11 |
| Intrinsic motivation | 3 | … I wanted to work more with the topic. | .947 | 2.40 | 1.53 |

# 4 Results

The results presented below focus on pupils' perceptions of their learning outcomes, particularly the extent to which they engaged in basic or deep elaborations and felt intrinsically motivated. Additionally, we present the extent to which the pupils experienced supportive learning conditions in their class. Lastly, we present our findings on the degree to which these supportive conditions have a predictive impact on the pupils' learning outcomes.

## *4.1 Pupils' Perceptions of Elaboration and Supportive Learning Conditions*

The pupils in our sample reported experiencing basic elaborations to great a degree ($M$ = 4.08; $SD$ = .92; see Table 27.2), but they experienced deep elaborations during their lesson only to a slight extent ($M$ = 3.43; $SD$ = 1.11). The pupils slightly disagreed with having experienced intrinsic motivation during their lesson ($M$ = 2.40; $SD$ = 1.53).

The pupils experienced supportive learning conditions related to basic needs to a high degree (see Table 27.2). They experienced autonomy ($M$ = 4.15; SD = .88) and competence support ($M$ = 4.15; SD = .82) to a similar degree, closely followed by social relatedness ($M$ = 4.05; SD = .89). Pupils also perceived their teacher to be interested ($M$ = 4.08; $SD$ = .92), but the average for instructional quality was lower ($M$ = 3.77; $SD$ = 1.06). The perceived relevance of the learning content ($M$ = 2.78; $SD$ = 1.43) showed the lowest mean value, indicating that pupils did not experience that the lesson was relevant to them.

Altogether, the pupils' responses showed that they mainly experienced basic elaboration but little deep elaboration and little intrinsic motivation. While their basic needs were fulfilled and they perceived their teacher as being interested, they perceived to a lesser degree the other conditions related to instruction (i.e., instructional quality and relevance of content).

## *4.2 Predictive Value of Supportive Learning Conditions on Pupil Outcomes*

First, when examining predictors for the dependent variable *basic elaboration*, which refers to the most elementary learning outcomes, it becomes clear that including basic needs as predictors (Model I) allows competence support and social relatedness to predict basic elaborations. Adding conditions related to Interest Theory (Model II) considerably reduces the influence of basic needs. Of the basic needs, only competence support is a significant predictor ($\beta$ = .20, $p$ < .10). From Interest

Theory, quality of instruction is the single significant predictor ($\beta = .21$, $p < .05$). Model II predicts 23% of the variance of pupils' perception of having engaged in basic elaboration during their lesson.

Findings related to the dependent variable *deep elaboration*, which refers to the experience of perceiving deeper learning strategies, show that competence support and social relatedness predict deep elaborations in Model I ($\beta = .26$, $p < .01$, $\beta = .22$, $p < .01$ respectively, see Table 27.3). When considering the conditions related to Interest Theory (Model II), only content relevance has a significant impact ($\beta = .21$, $p < .10$) on the perception of deep elaborations. This model explains 32% of the variance in pupils' perceptions of deep elaborations.

Lastly, when considering *intrinsic motivation* as the dependent variable in Model I, competence support is the single significant predictor ($\beta = .46$, $p < .01$). When conditions related to Interest Theory are added to Model II, relevance of content also has a significant impact on pupils' experienced intrinsic motivation ($\beta = .39$, $p < .01$). In Model II, the impact of competence support is reduced to $\beta = .27$ ($p < .01$). Model II explains 47% of the variance in pupils' experienced intrinsic motivation.

## 5 Conclusion and Discussion

Currently, Norway focuses on implementing a curriculum with a great emphasis on deep learning (Norwegian Ministry of Education and Research, 2015). Gilje et al. (2018) emphasised that various international research and trends have influenced the term *deep learning*, which has multiple meanings. Above all, Fullan et al. (2018) have influenced how the term *deep learning* is understood in Norway. Gilje et al. (2018) noted that deep learning concerns pupils' ability to develop their understanding of concepts within a subject area and be able to work in and across subject areas through problem-solving strategies and reflection. They also identified a need to understand how deep learning can be realised in instruction. In response, we applied a sociocultural perspective considering both cognitions and social interaction as essential for pupils' learning in our investigation of mathematics lessons. We studied both cognitive and motivational outcomes, as recommended by Seidel and Shavelson (2007). Thereby, we focused on supportive learning conditions based on two relevant theories about interest and motivation (Deci & Ryan, 1985; Prenzel, 1995).

First, our findings reveal that the pupils in our sample mainly experienced basic elaborations and some deep elaborations in mathematics instruction during the lesson studied. These pupils also showed little intrinsic motivation during the studied lesson. Thus, these findings are in line with the Norwegian government's recent initiatives related to the necessity of implementing a curriculum with a focus on deep learning (Norwegian Ministry of Education and Research, 2015). Second, we stated that the pupils in our sample reported perceiving supportive learning

**Table 27.3** Regression coefficients of supportive learning conditions on basic elaborations, deep elaborations, and intrinsic motivation

| Variable | Model I | | | Model II | | |
|---|---|---|---|---|---|---|
| | B | SE B | β | B | SE B | β |
| *Basic elaborations* | | | | | | |
| Constant | 2.08 | .42 | | 1.86 | .42 | |
| 1. Autonomy | −.02 | .11 | −.02 | −.11 | .12 | −.11 |
| 2. Competence support | .32 | .12 | .30*** | .22 | .13 | .20* |
| 3. Social relatedness | .19 | .09 | .19 ** | .12 | .09 | .13 |
| 4. Relevance of content | | | | −.03 | .06 | −.04 |
| 5. Quality of instruction | | | | .18 | .09 | .21** |
| 6. Teacher's interest | | | | .17 | .11 | .18 |
| $R^2$ ($\Delta R^2$) | .17 | | | | .23 (.06) | |
| Adjusted $R^2$ | .15 | | | | .20 | |
| F | 8.81*** | | | | 6.41*** | |
| *Deep elaborations* | | | | | | |
| Constant | .28 | .48 | | .26 | .49 | |
| 1. Autonomy | .17 | .13 | .13 | .09 | .13 | .07 |
| 2. Competence support | .35 | .14 | .26** | .18 | .14 | .14 |
| 3. Social relatedness | .26 | .11 | .22** | .16 | .11 | .13 |
| 4. Relevance of content | | | | .12 | .07 | .15* |
| 5. Quality of instruction | | | | .11 | .10 | .10 |
| 6. Teacher's interest | | | | .18 | .12 | .15 |
| $R^2$ ($\Delta R^2$) | .26 | | | | .32 (.06) | |
| Adjusted $R^2$ | .24 | | | | .29 | |
| F | 15.34*** | | | | 10.16** | |
| *Intrinsic motivation* | | | | | | |
| Constant | −2.18 | .65 | | −1.84 | .60 | |
| 1. Autonomy | .11 | .17 | .07 | .04 | .16 | .03 |
| 2. Competence support | .86 | .19 | .46*** | .50 | .18 | .27*** |
| 3. Social relatedness | .14 | .14 | .08 | −.10 | .13 | −.06 |
| 4. Relevance of content | | | | .41 | .09 | .39*** |
| 5. Quality of instruction | | | | .11 | .13 | .07 |
| 6. Teacher's interest | | | | .22 | .15 | .13 |
| $R^2$ ($\Delta R^2$) | .31 | | | | .47 (.16) | |
| Adjusted $R^2$ | .29 | | | | .44 | |
| F | 19.45*** | | | | 18.96*** | |

Note. $N = 144$. We examined the impact of supportive learning conditions on basic elaborations, deep elaborations, and intrinsic motivation. In Model I, we entered the basic psychological needs to predict our dependent variables. In Model II, we entered content relevance, quality of instruction, and teacher's interest as predictors
*$p < .10$, **$p < .05$, ***$p < .01$

conditions related to all three basic needs (autonomy, competence, and social relatedness) and they recognized the teacher's interest during the lesson. These are positive findings for the region, which has been working towards an inclusive learning environment for several years (Knutepunkt Sørlandet, 2015). Unfortunately, the pupils in our sample also reported perceiving less instruction quality and finding little relevance in the content of the lesson. Because these two aspects show an added value in predicting learning outcomes, as our analyses show, this finding should be treated as a cause for concern that should receive more attention in the future. Fullan et al. (2018) also emphasised the importance of content being meaningful to pupils for achieving deep learning.

This study also corroborates that both theories provide an added value in reflection about learning conditions in class. SDT (Deci & Ryan, 1985) combined with the Interest Theory elements (Krapp, 1999; Prenzel, 1995; particularly relevance of content and quality of instruction) gives valuable insight into how conditions in instruction coexist and to what degree they support pupils' intrinsic motivation and basic and deep elaborations, so that deep learning can be fostered. This theoretical background may help teachers develop their instruction towards deep learning by considering pupils' needs as well as the quality of instruction and the relevance of the content. Our results show that findings may differ depending on the use of a single theory or a combination of theories as a lens to study education. Therefore, researchers and policymakers may want to consider combining theories in their work to improve education.

Although the sample size was relatively small and restricted to mathematics instruction in grade 7 to 9, the findings provide initial insights into the potential of directing the attention towards making the content relevant to pupils within the new curriculum that aims at enhancing deep learning processes. Content relevance was a highly pertinent predictor for deep learning and intrinsic motivation in our sample. In the School-In project, which this study is a part of, we argue that linking a school's local context to instruction has great potential for both inclusive and learning processes. The local context means something to all pupils and is easy to relate to (Dalehefte & Midtsundstad, 2019). We claim that the use of examples and content from the local context has an untapped potential to improve the perception of content relevance. Further research including larger sample sizes and involving multiple regions is needed to investigate the extent to which our findings are generalizable. Other researchers have previously presented some similar findings (e.g., Frymier & Shulman, 1995; Schrodt, 2013). Furthermore, although we used a well-established and well-studied instrument (Seidel et al., 2005) to collect our data, this study marked the first time this instrument was used in mathematics in a Norwegian context. Readers should be aware that, to meet the given time frame for the pupils to complete the questionnaire, we narrowed down the constructs addressed (i.e., quality of instruction was restricted to clarity and coherence) and selected a limited number of items per scale. This cost-benefit balance may have influenced this study's validity. Nevertheless, we believe the instrument is suitable and valid for this context based on our choice of items. Studies with more items per scale and a broader view on the studied constructs may investigate this claim more thoroughly.

Additional opportunities for further research lie in combining different data sources to paint a fuller picture of the situation at hand (see Kunter & Baumert, 2006). As we surveyed pupils from different schools, classes, and grades on different topics in mathematics, we could not use a mathematics test as an outcome measure to investigate the cognitive impact of the lesson because of bias in the comparisons. Additionally, pupils would be at risk of fatigue in either answering the survey or completing the mathematics test. Fortunately, as mentioned in the introduction, other research has shown that a positive relationship exists between pupils' perceptions of the classroom environment and their learning outcomes related to tests (de Jong & Westerhof, 2001; Seidel & Shavelson, 2007). Another valuable avenue for further exploration could be including teachers' perspectives (Kunter & Baumert, 2006; van der Schaaf et al., 2008).

All in all, the findings reveal that, in our sample, pupils' basic needs were met, but the pupils lacked motivation, experienced little deep learning, and struggled to see the relevance of the lesson content. The findings point into the direction of the need for a focus on deep learning in the 2020 curriculum reform in Norway. Additionally, they reveal conditions worth taking a closer look at when aiming to foster pupils' deep learning and motivation in class.

## References

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261–271.

Asikainen, H., & Gijbels, D. (2017). Do students develop towards more deep approaches to learning during studies? A systematic review on the development of students' deep and surface approaches to learning in higher education. *Educational Psychology Review, 29*(2), 205–234.

Boyd, N. M., Liu, X., & Horissian, K. (2020). Impact of community experiences on student retention perceptions and satisfaction in higher education. *Journal of College Student Retention: Research, Theory & Practice*. https://doi.org/10.1177/1521025120916433

Dalehefte, I. M., & Midtsundstad, J. H. (2019). Linking school's local context to instruction: An important characteristic of the in-service teacher professionalisation in school-in. In I. M. Dalehefte & S. Zehetmeier (Eds.), *Supporting teachers: Improving instruction. Examples of research-based teacher education* (pp. 77–88). Waxmann.

Dalehefte, I. M., & Midtsundstad J. H. (2022). *A systemic approach to school development – Technical report on the project school-in*. Waxmann. https://www.waxmann.com/index.php?eID=download&buchnr=4502

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Plenum Press.

De Jong, R., & Westerhof, K. J. (2001). The quality of student ratings of teacher behaviour. *Learning Environments Research, 4*, 51–85.

Fryer, L. K., Ginns, P., & Walker, R. (2014). Between students' instrumental goals and how they learn: Goal content is the gap to mind. *British Journal of Educational Psychology, 84*(4), 612–630.

Frymier, A. B., & Shulman, G. M. (1995). "What's in it for me?": Increasing content relevance to enhance students' motivation. *Communication Education, 44*(1), 40–50.

Fullan, M., Quinn, J., & McEachen, J. (2018). *Deep learning – Engage the world – Change the world*. Corwin Press.

Gilje, Ø., Flygt Landfald, Ø., & Ludvigsen, S. (2018). Dybdelæring -historisk bakgrunn og teoretiske tilnærminger [Deep learning – Historical background and theoretical approaches]. *Bedre Skole, 4*(30), 22–27.

Gordon, C., & Debus, R. (2002). Developing deep learning approaches and personal teaching efficacy within a preservice teacher education context. *British Journal of Educational Psychology, 72*(4), 483–511.

Janke, S. (2020). Prospective effects of motivation for enrollment on Well-being and motivation at university. *Studies in Higher Education, 45*(12), 2413–2425.

Kasser, T., & Ryan, R. M. (1996). Further examining the American dream: Differential correlates of intrinsic and extrinsic goals. *Personality and Social Psychology Bulletin, 22*(3), 280–287.

Kiemer, K., Gröschner, A., Kunter, M., & Seidel, T. (2018). Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support—Findings from teacher professional development. *European Journal of Psychology of Education, 33*(2), 377–402.

Knutepunkt Sørlandet. (2015). *Rammeverk for satsingen 'Inkluderende Læringsmiljø' [Framework for the initiative 'Inclusive Learning Environment']*. Knutepunkt Sørlandet.

Krapp, A. (1999). Interest, motivation and learning: An educational-psychological perspective. *European Journal of Psychology of Education, 14*(1), 23–40.

Kunter, M., & Baumert, J. (2006). Who is the expert? Construct and criteria validity of student and teacher ratings of instruction. *Learning Environments Research, 9*(3), 231–251.

Marton, F., & Säljö, R. (1976). On qualitative differences in learning: I-outcome and process. *British Journal of Educational Psychology, 46*(1), 4–11.

Mayer, R. (2010). Applying the science of learning to instruction in school subjects. In R. J. Marzano (Ed.), *On excellence in teaching* (pp. 93–111). Solution Tree Press.

Midtsundstad, J. H. (2019). *Lokal skoleutvikling. Sammenhengen mellom sted, roller og undervisning* [Local school development. The connection between place, roles and instruction]. Fagbokforlaget.

Norwegian Ministry of Education and Research. (2015). *The school of the future – Renewal of subjects and competences*. Official Norwegian Report (NOU 2015:8). https://www.regjeringen.no/contentassets/da148fec8c4a4ab88daa8b677a700292/en-gb/pdfs/nou201520150008000engpdfs.pdf

Organisation for economic co-operation and development. (2020). *Education at a glance 2020: OECD-indicators*. OECD Publishing.

Pellegrino, J. (2017). Teaching, learning and assessing 21st century skills. In S. Guerriero (Ed.), *Pedagogical knowledge and the changing nature of the teaching profession* (pp. 223–251). OECD Publishing. https://doi.org/10.1787/9789264270695-12-en

Prenzel, M. (1995). Zum Lernen bewegen. Unterstützung von Lernmotivation durch Lehre [Movement towards learning. Supporting learning motivation through instruction]. *Blick in die Wissenschaft, 4*(7), 58–66.

Prenzel, M., Kramer, K., & Drechsel, B. (2002). Self-determined and interested learning in vocational education. In K. Beck (Ed.), *Teaching-learning processes in vocational education: Foundations of modern training programmes* (pp. 43–68). Peter Lang.

Rump, M., Esdar, W., & Wild, E. (2017). Individual differences in the effects of academic motivation on higher education students' intention to drop out. *European Journal of Higher Education, 7*(4), 341–355.

Ryan, R. M., & Deci, E. L. (2017). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Publications.

Schrodt, P. (2013). Content relevance and students' comfort with disclosure as moderators of instructor disclosures and credibility in the college classroom. *Communication Education, 62*(4), 352–375.

Seidel, T. (2003). *Lehr-Lernskripts im Unterricht* [Teaching and learning scripts in instruction]. Waxmann.

Seidel, T., & Shavelson, R. J. (2007). Teaching effectiveness research in the past decade: The role of theory and research design in disentangling meta-analysis results. *Review of Educational Research, 77*(4), 454–499.

Seidel, T., Prenzel, M., & Kobarg, M. (2005). *How to run a video study*. Waxmann.

Seidel, T., Prenzel, M., Rimmele, R., Herweg, C., Kobarg, M., Schwindt, K., & Dalehefte, I. M. (2007). Science teaching and learning in German physics classrooms–findings from the IPN-video study. In M. Prenzel (Ed.), *Studies on the educational quality of schools. The final report on the DFG priority Programme* (pp. 79–99). Waxmann.

Statistics Norway. (2021). *Tabell 08921: Utdanningsnivå etter fylke, alder og kjønn* [Table 08921: Educational level by county, age, and gender]. https://www.ssb.no/statbank/table/08921/

Tilga, H., Kalajas-Tilga, H., Hein, V., Raudsepp, L., & Koka, A. (2020). How teachers' controlling behaviour can ruin students' intrinsic motivation in a physical education lesson: Test of a conditional process model. *International Journal of Sport Psychology, 51*, 81–99.

Unanue, W., Dittmar, H., Vignoles, V. L., & Vansteenkiste, M. (2014). Materialism and Well-being in the UK and Chile: Basic need satisfaction and basic need frustration as underlying psychological processes. *European Journal of Personality, 28*(6), 569–585.

Van den Broeck, A., Ferris, D. L., Chang, C.-H., & Rosen, C. C. (2016). A review of self-determination theory's basic psychological needs at work. *Journal of Management, 42*(5), 1195–1229.

Van der Schaaf, M. F., Stokking, K. M., & Verloop, N. (2008). Teacher beliefs and teacher behaviour in portfolio assessment. *Teaching and Teacher Education, 24*, 1691–1704.

Vermunt, J. D. (1998). The regulation of constructive learning processes. *British Journal of Educational Psychology, 68*(2), 149–171.

Vermunt, J. D., & Vermetten, Y. J. (2004). Patterns in student learning: Relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review, 16*(4), 359–384.

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology, 25*(1), 68–81.

Zhang, D., Bobis, J., Wu, X., & Cui, Y. (2020). The effects of an autonomy-supportive teaching intervention on Chinese physics students and their teacher. *Research in Science Education, 50*(2), 645–671.

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