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# Students' Perceptions of Teacher Support, Numeracy, and Assessment for Learning: Relations with Motivational Responses and Mastery Experiences

Roger Andre Federici[1], Joakim Caspersen[1] & Christian Wendelborg[1]

[1] NTNU Social Research, Trondheim, Norway

Correspondence: Roger Andre Federici, NTNU Social Research, 7491 Trondheim, Norway. Tel: 471-959-366-231. E-mail: roger.federici@ntnu.no

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**Abstract**

We explored a theoretical model of relations between students' perceptions of emotional support, numeracy, and assessment for learning and their perceptions of relevance of schoolwork, motivation, persistence, and mastery experiences. We also investigated possible differences between students in lower- and upper secondary school. Participants were 44 702 students in 8th to 13th grade in Norway. The data was analyzed by means of structural equation modeling. The results revealed moderate to strong correlations between the three aspects of the learning environment. In general, they related positively to the outcome variables. However, the relations were almost entirely mediated through relevance and motivation. The present study adds to our understanding of how to work with the learning environment.

**Keywords:** emotional support, numeracy, assessment for learning, motivation, learning environment

## 1. Introduction

In recent years, Norwegian educators at different levels have focused especially on three aspects of the learning environment in order to promote student motivation and learning; teacher support, promotion of basic skills, and assessment for learning. A number of studies provide strong evidence that teacher support is predictive of student engagement and motivation, adaptive learning strategies, and achievement (e.g., Furrer & Skinner, 2003; Niehaus, Rudasill, & Rakes, 2012; Pianta, Hamre, & Stuhlman, 2003). Furthermore, promotion of basic skills (see, Norwegian Directorate for Education and Training, 2012), such as literacy and numeracy, are stressed because they are regarded as necessities for lifelong learning and active participation in work and civic life. For instance, studies show that numeracy is related to community participation, engagement in lifelong learning, and health (OECD & Statistics Canada, 2000; Roberts & Fawcett, 1998). Numeracy is also linked to different educational outcomes such as motivation (e.g., Green, Nelson, Martin, & Marsh, 2006) and increased likelihood for entering higher education (Marks, Fleming, Long, & McMillan, 2000). Finally, assessment for learning is a method for promoting effective and meaningful instruction to improve teaching and subsequent student learning experiences (Black & Wiliam, 1998b; Tannehill, Mars, & MacPhail, 2013; Wiliam, 2011). Studies indicate that successful implementation of assessment for learning increase student learning and achievement (Black & Wiliam, 2010; Wiliam, 2011) and motivation (McMillan et al., 2010; Yin et al., 2008).

The purpose of the present study was to explore a theoretical model of relations by using data from the national Norwegian Pupil Survey. We investigated relations between students' perceptions of the three aspects of the learning environment presented above and their perceptions of relevance of schoolwork, motivation, persistence, and mastery experiences. An important research question for the study was whether and to what degree perceptions of school relevance, motivation, and persistence mediated the relation between the aspects of the learning environment and mastery experiences. In addition, we wanted to investigate the correlations between the three aspects of the learning environment. Another purpose of the study was to explore whether the testing of the theoretical model supported the specification of equal structural weights for students in lower secondary school and upper secondary school. The comparison of the model was included to investigate the relative impact of the aspects of the learning environment on the motivational and behavioral outcomes.

## 2. Theoretical Perspectives

Initially we present the theoretical frameworks related to the three aspects of the learning environment. In our theoretical model of relations, we consider these as correlated exogenous variables. We then present theoretical perspectives related to the outcome variables; relevance of schoolwork, motivation, persistence, and mastery experiences, respectively.

### *2.1 Aspects of the Learning Environment*

#### 2.1.1 Emotional Support

A commonly measured aspect of the multidimensional construct of teacher social support is emotional support (see, House, 1981; Malecki & Demaray, 2003; Suldo et al., 2009). Definitions of emotional support typically include students' perceptions of their teachers' communications of empathy and care, as well as trust, warmth, and respect (Langford, Bowsher, Maloney, & Lillis, 1997; Patrick, Ryan, & Kaplan, 2007; Wang & Eccles, 2012). Theoretically, one may distinguish between general and specific emotional support. General emotional support refers to students' general perception of teachers' communications of empathy and care, whereas specific emotional support refers to support in particular situations, for instance, when a student is struggling with schoolwork or is being bullied. A review of some of the measures of emotional support indicates that the construct has almost entirely been measured as students' general perception of the teachers (e.g., De Wit, Karioja, Rye, & Shain, 2011; Wentzel, Battle, Russell, & Looney, 2010).

Similar to perceptions of emotional support are the students' feelings of belonging or relatedness at school (e.g., Deci & Ryan, 2000; Marchand & Skinner, 2007). Even though emotional support and relatedness are theoretical distinct constructs, one may assume that they are related. That is, one may regard feeling of relatedness as consequences of emotional support, partially explaining the impact of emotional support on students' motivational responses (e.g., Federici & Skaalvik, 2014a, 2014b; Marchand & Skinner, 2007). For instance, self-determination theory stress that relatedness is a basic need that when fulfilled provide the required emotional security that individuals need to actively explore and effectively address their worlds, thus increasing intrinsic motivation (Deci & Ryan, 2000; Martin & Dowson, 2009; Ryan & Deci, 2000).

Previous research consistently reveals that students' perceptions of the teachers as emotionally supportive are associated with a range of adaptive motivational and behavioral outcomes such as intrinsic motivation (E. M. Skaalvik & S. Skaalvik, 2013; Wentzel, 1994), engagement (Patrick, Kaplan, & Ryan, 2011), and academic initiative (Danielsen, Wiium, Wilhelmsen, & Wold, 2010). Also, increased perceptions of social support are positively related to effort (Goodenow & Grady, 1993), self-efficacy (Skaalvik, Federici, & Klassen, 2015), and academic achievement (Federici & Skaalvik, 2014a). Based on these studies we expected a positive relation between the students' perceptions of emotional support and the motivational and behavioral constructs included in the present study.

#### 2.1.2 Basic Skills–Numeracy

The curriculum in Norway is defined on a national basis and emphasizes the promotion of five basic skills across all subjects and grades (Ministry of Education and Research, 2004). These consists of oral, reading, writing, digital, and numeracy skills, and are being considered as basic for learning in school and for participation in work and social life. Furthermore, the acquisition of the skills is regarded as fundamental to learning in all subjects, as well as a prerequisite for students to show their competence and qualifications (Norwegian Directorate for Education and Training, 2012; Ministry of Education and Research, 2004).

The present study focus on numeracy skills also referred to as mathematical literacy in the research literature (e.g., Jablonka, 2003; OECD, 2013). Definitions of numeracy typically include the ability of applying mathematics in different situations and across contexts. For instance, the Programme for International Students Assessment (PISA) defines mathematical literacy as "an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena" (OECD, 2013, p. 28). According to Bussière et al. (2001) an important aspect of numeracy is that it includes wider uses of mathematics in people's lives, rather than just mastering them within a school curriculum. Thus, numeracy is not a synonym for school mathematics, but mathematics in school has an important role in providing the foundation for young children and adolescents to develop adequate numeracy skills (Jablonka, 2003; OECD, 2013; Rothman & McMillan, 2003). Willis (1998) therefore argue that one way to promote numeracy or mathematical literacy is by letting students solve real-world problems and assignments across subjects as a mean to bridge the gap between school mathematics and the real world.

Research indicate positive associations between numeracy and different motivational outcomes such as intrinsic and extrinsic motivation (Thompson, Wylie, Mulhern, & Hanna, 2015; Thomson, Cresswell, & De Bortoli, 2004), engagement (Green et al., 2006), and self-efficacy (Ozgen, 2013; Stevens, Olivárez, & Hamman, 2006). As the present study defined numeracy as an aspect of the learning environment, we wanted to explore how students' perceptions of teachers' implementation of mathematics across subjects related to their perceptions of relevance, motivation, persistence, and mastery experiences. Based on previous studies, we anticipated perceived numeracy to relate positively to the motivational and behavioral constructs. Especially, we expected that higher levels of perceived numeracy would increase the students' perceptions of relevance of schoolwork.

#### 2.1.3 Assessment for Learning

Assessment for learning is typically described as a process where both teachers and students recognize and respond to student learning in order to enhance learning, during learning (e.g., Cowie & Bell, 1999; Wiliam, 2011). For instance, the Assessment Reform Group (ARG) defines assessment for learning as "any assessment for which the first priority in its design and practice is to serve the purpose of promoting pupils' learning. It thus differs from assessment designed primarily to serve the purposes of accountability, or of ranking, or of certifying competence" (Black, Harrison, Lee, Marshall, & Wiliam, 2004, p. 10).

In the literature, a number of instructional principles are suggested for promoting and improving assessment for learning, both at the school and classroom level (see, Black, Harrison, Lee, Marshall, & William, 2010; Wiliam, 2011). As the measures in the present study focus on teacher feedback and explanation of goals, most relevant for the present study is the principles concerning feedback (Black et al., 2010). According to the ARG, feedback should have an informative and descriptive form focusing on the purposes and the goals of learning. Furthermore, feedback should include the initial criteria in order for both students and teachers to gain a clear understanding of the progress towards the goals and to identify strategies to reach the desired learning goals (Black et al., 2010; Florez & Sammons, 2013). Such feedback promotes a learning-centered environment, compared to practices were assignments are marked as right or wrong (Florez & Sammons, 2013). The latter promoting social comparison and competition between students.

A vast number of studies reveal that assessment for learning relates to adaptive educational outcomes. For instance, Black and Wiliam (1998a, 1998b) examined 580 articles and concluded that assessment for learning had a positive impact on students' learning, their self-regulation, as well as on students' motivation (Black & Wiliam, 1998a, 1998b). In addition, studies that are more specific have shown that assessment for learning (feedback) relates to perceptions of relatedness and intrinsic motivation (Pat-El, Tillema, & van Koppen, 2012).

Based on previous findings, we anticipated assessment for learning to promote the students' perceptions of relevance of schoolwork, as well as the motivational and behavioral outcomes measured in the study. Furthermore, since assessment for learning theoretically overlap with conceptualizations of instrumental support (see, Federici & Skaalvik, 2014b) an interesting question for the study was if and to what degree assessment for learning correlated with the students' perceptions of emotional support.

### *2.2 Motivational Responses and Mastery Experience*

We employed four measures related to or indicative of the students' achievement motivation: relevance of schoolwork, motivation, persistence, and mastery experience. The Pupil Survey defines relevance as the students' perceptions of the importance of schoolwork at the present and its relevance for future work and future goals in general. The formulation of the questions parallels with the constructs of utility value and importance value as described in expectancy-value theory (e.g., Eccles & Wigfield, 2002; Wigfield & Eccles, 1992). Utility value, or usefulness, refers to how a task relates to current or future goals, for instance career goals, whereas importance value (also called attainment value) refers to how important it is to the individual to succeed on a task (Eccles & Wigfield, 2002; Wigfield, Tonks, & Klauda, 2009). Studies exploring task values reveals that students' perceptions of utility and importance value predict motivation, effort, persistence and academic performance (e.g., Eccles, 2007; Harackiewicz, Rozek, Hulleman, & Hyde, 2012; Wang & Eccles, 2012). Furthermore, teacher support has been shown to be positively associated with task values (Federici & Skaalvik, 2014a).

The questions tapping students' motivation focus on interest and liking for schoolwork, a conceptualization of motivation found in the theoretical framework of self-determination theory. The theory defines intrinsic motivation as the inherent pleasure and satisfaction derived from engaging in an activity (Deci & Ryan, 1985) and a main postulate is that social factors promote intrinsic motivation via satisfaction of individuals' basic needs for autonomy, competence, and relatedness (Deci & Ryan, 2000; Ryan & Deci, 2006). By stimulating these needs, teachers may increase the students' motivation for schoolwork. Recent studies show that teacher support is positively associated with intrinsic motivation (e.g., Federici & Skaalvik, 2014a; Federici & Skaalvik, 2014b;

E. M. Skaalvik et al., 2015). Furthermore, previous research consistently reveals positive relations between intrinsic motivation and adaptive outcomes, such as increased effort, persistence, and academic performance (e.g., Cecchini et al., 2001; S. Skaalvik & E. Skaalvik, 2004; Yildirim, 2012).

Related to intrinsic motivation is persistence, or effort, which is as a behavioral indicator of motivation. The Pupil Survey defines it as the students' persistence when encountering difficult tasks and to what degree they give priority to schoolwork. Previous research reveals that persistence is positively associated with aspects of the learning environment and motivational responses, for instance teacher support and intrinsic motivation (Federici & Skaalvik, 2014b; S. Skaalvik & E. Skaalvik, 2004). Moreover, persistence relates to self-efficacy, a key construct in social cognitive theory (Bandura, 1997, 2006a; Schunk & Pajares, 2009). The primary development of efficacy beliefs mainly occurs by obtaining information from four primary sources (Bandura, 1986; Pajares, 2002), with the most influential and efficient source being mastery experience. Thus, the present study explores how aspects of the learning environment and motivational responses relates to the students' mastery experiences measured as their perceptions of actual mastery of assignments and unfamiliar material at school.

## 3. The Present Study

One purpose of the present study was to test a theoretical model of relations between students' perceptions of three different aspects of the learning environment and investigate how these relates to their perceptions of relevance of schoolwork, motivation, persistence, and mastery experiences (see, Figure 1). We based the theoretical model on the analyses and predictions presented in the theoretical framework. We expected emotional support, numeracy, and assessment for learning to relate positively with the students' perceptions of relevance, as well as with motivation, persistence, and mastery experiences. In addition, we expected increased relevance to be positively associated with motivation, persistence, and the students' mastery experiences. Finally, we expected both persistence and motivation to relate positively with mastery experiences.

Another purpose of the study was to investigate if and to what degree there were differences between the students in lower secondary school and upper secondary school. We explored possible differences by comparing the structural weights for each group when we tested the theoretical model.

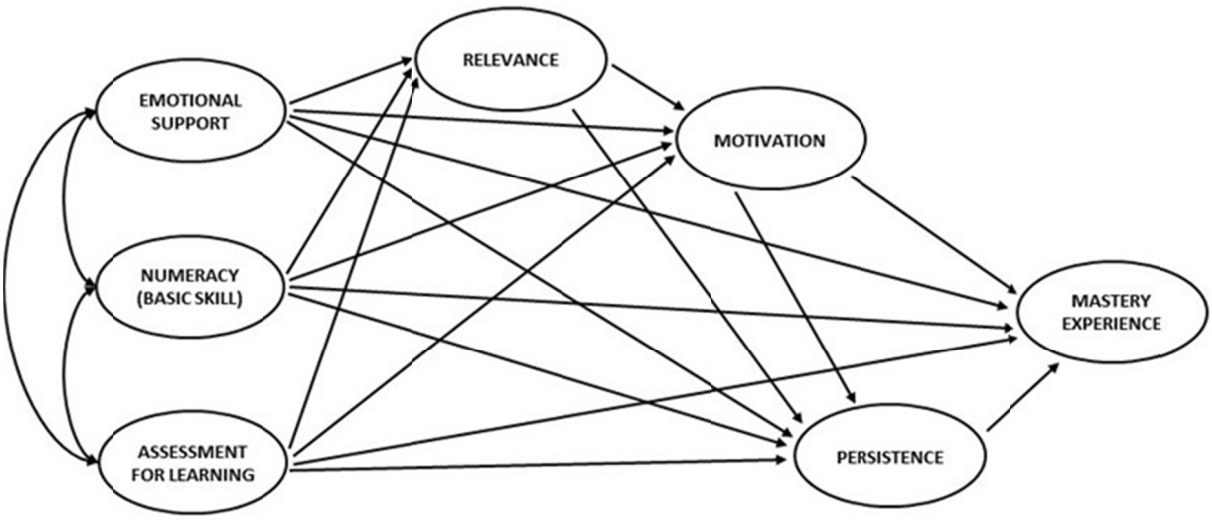


Figure 1. Theoretical model of the relations between the constructs

## 4. Method

### *4.1 Participants and Procedure*

The respondents in the present study were students participating in the Norwegian Pupil Survey in the autumn 2014. The Norwegian Directorate for Education and Training administrate the survey, implementing it two times each academic year (autumn and spring). It is compulsory in the autumn for 7th, 10th, and 11th grade. However, all schools with students from 5th to 13th grade are encouraged to include all students (grades) in the survey and the decision whether to participate or not is usually taken at the municipal level or school level. The total number of respondents in the autumn 2014 amounted to 405 916 students, which constitutes approximately 71.2% of the

total population (see, Wendelborg, Røe, Federici, & Caspersen, 2015). The main purpose of the survey is to give students an opportunity to express themselves about key aspects of the school environment affecting learning and well-being (e.g., goal structures, instructional methods, social support, motivation, bullying). Another purpose of the survey is to provide an empirical basis that can inform the municipal authorities, school owners, and principals in their continuous work with developing the learning environment at schools. The survey consists of both compulsory questions, that vary between the levels (e.g., upper primary level, lower secondary level, and upper secondary level), and add-on questions. The latter, if chosen, are included at the school level.

The sample in the present study consisted of 44 702 students from 243 lower secondary schools (8th to 10th grade) and 36 secondary schools (11th to 13th grade) in Norway. There were 50.4% males and 49.6% females. The number of respondents differs from the total sample because the instrument for measuring numeracy (basic skill) is an add-on package. In addition, only students from 8th to 13th grade are opted to answer these questions. Table 1 shows the total number of respondents by grade and gender.

Table 1. Participants in the present study by grade and gender

| Variable | Males | | Females | | Total | |
|---|---|---|---|---|---|---|
| Lower secondary school | | | | | | |
| 8th grade | 4 917 | 21.8 % | 4 868 | 22.0 % | 9 785 | 21.9 % |
| 9th grade | 5 125 | 22.7 % | 5 024 | 22.7 % | 10 149 | 22.7 % |
| 10th grade | 6 909 | 30.7 % | 6 803 | 30.7 % | 13 712 | 30.7% |
| Total | 16 951 | 75.2 % | 16 695 | 75.4 % | 33 646 | 75.3 % |
| Upper secondary school | | | | | | |
| 11th grade | 2 456 | 10.9 % | 2 162 | 9.8 % | 4 618 | 10.3 % |
| 12th grade | 1 997 | 8.9 % | 1 761 | 7.9 % | 3 758 | 8.4 % |
| 13th grade | 1 135 | 5.0 % | 1 545 | 7.0 % | 2 680 | 6.0 % |
| Total | 5 588 | 24.8 % | 5 468 | 24.7 % | 11 056 | 24.7 % |
| Grand total | 22 539 | 100.0% | 22 163 | 100.0% | 44 702 | 100.0% |

*Note*. Percentages represents number of respondents by grade (columns).

### *4.2 Instruments*

The present study used established measures from the Pupil Survey (see, Federici & Wendelborg, 2015; Wendelborg et al., 2015). As the survey is administrated in Norwegian, the examples of items represent translations into English. We would like to highlight that the primary objective of the Pupil Survey is to inform relevant actors and stakeholders in the educational system of aspects concerning the learning environment. The measures have been utilized since the last revision of the Pupil Survey in 2012 and therefore been subjected to both exploratory (EFA) and confirmatory (CFA) factor analyses, in addition to inspections of face validity and discriminant/convergent validity.

Three items measured the students' perceptions of the teachers as emotionally supportive. Examples of items are "I feel that my teachers care about me", and "I feel that my teachers treat me with respect". These items indirectly tap students' feeling of being liked and respected, which Goodenow and Grady (1993) recognizes as important requirements of feeling of belonging or relatedness. Thus, the scale may function as an indicator of teacher emotional support as experienced by the students. Cronbach's alpha for the scale was .87 and responses were given at a 5-point scale ranging from "None of the teachers" (1) to "All of the teachers" (5). Note that the response categories do not ask the respondents to rate the degree of perceived emotional support, but the number of teachers that provide such support. This measure therefore functions as an indicator of the learning environment or school culture by accounting for the number of teachers that provide social support. Also, one may hypothesize that the measure provides a less biased picture of the learning environment in that it asks the respondents to rate all the teachers in general and not a specific teacher.

Numeracy (basic skill) asks whether the students use mathematics in different subjects and contexts at school. Three items measured this construct. Examples of items are "We use mathematics in different subjects at school"

and "I use mathematics to understand information in most subjects". The participants gave their responses on a 5-point scale ranging from "Not at all" (1) to "To a large degree" (5). Cronbach's alpha for the scale was .87.

We measured assessment for learning by means of four items. The instrument taps the students' perceptions of the degree to which teachers explain the learning goals and provide informative feedback, for instance related to assessments. The measure addresses aspects of instrumental support (e.g., Federici & Skaalvik, 2014a, 2014b). Examples of items are "Do the teachers explain in an understandable manner the objectives in different subjects?", "Do the teachers explain in a way that you understand how your work is evaluated?", and "Do the teachers tell you how you should work to improve your results?" The scale had a Cronbach's alpha of 0.84. Responses were given on a five-point scale ranging from "Not in any subjects" (1) to "In all subjects" (5).

Three items measured the students' perceptions of relevance of schoolwork. This measure parallels with the conceptualization of utility value and intrinsic value in expectancy-value theory (e.g., Wigfield & Cambria, 2010; Wigfield et al., 2009). The scale had a Cronbach's alpha of 0.85. Examples of items are "What we learn at school is important", "The things I learn at school will be beneficial for me later in life", and "What I learn at school is important, regardless of what kind of job I get". The response categories were a 5-point scale ranging from "Absolutely disagree" (1) to "Absolutely agree" (5).

The students' motivation was measured by means of three items and focus on general feelings or attitudes toward schoolwork. Examples of items are "I am interested in learning at school" and "I like schoolwork". The scale had a Cronbach's alpha of 0.77 and the response categories were a 5-point scale ranging from "Not in any subjects/Not at all" (1) to "In all subjects/To a large degree" (5). Note that this measure is a composite of questions with different response categories. Therefore, one may question to what degree it functions as a scale or an index. Previous analyses (Wendelborg, Røe, & Federici, 2014; Wendelborg et al., 2015) indicate that the measure function as a scale indicative of students' motivation.

Two items measured the students' perceptions of persistence. This measure is similar to common conceptualizations of effort (e.g., Federici & Skaalvik, 2014a). The items are "I continue to work, even though the schoolwork is difficult" and "I prioritize to spend time on schoolwork, both at school and when I do homework". The participants gave their responses on a 5-point scale ranging from "Absolutely disagree/Not in any subjects" (1) to "Absolutely agree/In all subjects" (5). The internal consistency of the scale, measured as Cronbach's alpha, was .72.

Three items measured the students' perceptions of mastery experience. These items are related to Bandura`s conceptualizations of mastery experiences, the primary source of efficacy beliefs (e.g., Bandura, 1997, 2006b). Examples of items are "When you get assignments at school that you are told to do on your own, how often do you manage these assignments at your own?" and "When the teacher present and explains unfamiliar material at school, how often do you understand what the teacher is explaining?" The Cronbach's alpha for the scale was .74. The participants gave their responses on a 5-point scale ranging from "Never" (1) to "Always" (5).

*4.3 Data Analyses*

The data in the present study were analyzed by means of descriptive statistics, zero order correlations, confirmatory factor analyses (CFA), and structural equation modeling (SEM) for latent variables. Initially, we descriptively explored the observed variables. We then tested a measurement model consisting of the constructs presented in Figure 1 by means of CFA. Finally, we investigated a model of the hypothesized relations between the variables by means of SEM. A key element of SEM is to assess whether the covariance matrix estimated is consistent with the sample covariance matrix. This consistency is investigated through different measures of goodness of fit statistics such as CFI, IFI, TLI, RMSEA, and the chi-square test (Hoyle, 2012; Kline, 2011; Tabachnick & Fidell, 2007). For the CFI, IFI, and TLI indices, values above .90 are typically considered as acceptable, whereas values greater than .95 indicate a good fit (Hoyle, 2012; Hu & Bentler, 1999; Kline, 2011). For well-specified models, a RMSEA of .06 or less reflects a good fit (Byrne, 2010; Tabachnick & Fidell, 2007). Furthermore, since AMOS 23 does not provide standard errors (SE) and confidence intervals (CI) for all estimates, we performed a bootstrap analysis to estimate approximate SE and CI for the indirect and total effects. As the bootstrap method requires complete data (Arbuckle, 2009), we used an imputed dataset (Table 4) which we obtained by using the Expectation Maximization (EM) imputation option in IBM SPSS Statistics 23. There were no practical differences in the estimates when we compared the original dataset with the imputed dataset.

## 5. Results

### *5.1 Correlations and Descriptive Statistics*

Table 2 shows zero order correlations between the study variables as well as the possible maximum scores, statistical means, standard deviations, and Cronbach's alphas. The scales measuring aspects of the learning environment (emotional support, numeracy, and assessment for learning) were low to moderate correlated (from .290 to .580). They were also moderate correlated with the motivational variables (relevance, motivation, and persistence) and the students' perceptions of mastery experiences (from .259 to 508). In general, numeracy has the weakest correlations with the other variables in the study. Furthermore, the correlations indicate a weak decline in all variables with increasing grade (age). Finally, there were only weak correlations between gender and the other variables. The strongest and negative correlations were with numeracy (-.151) and assessment for learning (-.113) indicating that males tend to score higher than females on these variables.

To further explore the relations between the variables in the study and investigate possible differences in structural weights between lower and upper secondary school (group comparison), we tested the theoretical model presented in Figure 1 by means of confirmatory factor analysis and structural equation modeling.

Table 2. Pearson correlations and descriptive statistics of the study variables

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Emotional support | - | | | | | | | | |
| 2. Numeracy (basic skill) | .290 | - | | | | | | | |
| 3. Assessment for learning | .580 | .382 | - | | | | | | |
| 4. Relevance | .453 | .365 | .458 | - | | | | | |
| 5. Motivation | .508 | .325 | .436 | .561 | - | | | | |
| 6. Persistence | .432 | .283 | .364 | .433 | .622 | - | | | |
| 7. Mastery experience | .438 | .259 | .420 | .331 | .480 | .531 | - | | |
| 8. Grade ($8^{th}$ to $13^{th}$) | -.152 | -.161 | -.166 | -.191 | -.084 | -.162 | -.080 | - | |
| 9. Gender | -.030 | -.151 | -.113 | .019 | .033 | .077 | -.042 | .009 | - |
| Maximum possible score | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 13 | 0/1 |
| Number of items | 3 | 3 | 4 | 3 | 3 | 2 | 3 | 1 | 1 |
| Mean | 4.07 | 3.00 | 3.80 | 3.85 | 3.68 | 4.01 | 3.96 | - | - |
| Standard deviation | .76 | .97 | .82 | .92 | .80 | .86 | .67 | - | - |
| Cronbach's alpha | .87 | .87 | .84 | .85 | .77 | .72 | .74 | - | - |

*Note*. Observed variables. All correlations are significant at $p < .001$. Boys = 0, girls = 1.

### *5.2 Confirmatory Factor Analysis and the Structural Model*

The confirmatory factor analysis included the students' perceptions of emotional support, numeracy, assessment for learning, relevance, motivation, persistence, and mastery experiences. None of the error variances were allowed to correlate. The model had good fit to the data ($\chi 2$ (84, N = 44 702) = 18 673.11, $p < .001$, CMIN/DF = 111.149, RMSEA = 0.050, IFI = 0.962, TLI = 0.947, and CFI = 0.962). All factor loadings were significant at $p < .001$. Table 3 shows the correlations between the latent variables.

The correlations between the latent variables shows similar pattern as those in Table 2. As expected, the correlations in Table 3 are stronger than those obtained using the observed scales. This is due to the removal of error variance when modeling latent constructs (Byrne, 2010; Tabachnick & Fidell, 2007).

Table 3. Correlations between the latent variables in the measurement model

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Emotional support | - | | | | | | |
| 2. Numeracy (basic skill) | .317 | - | | | | | |
| 3. Assessment for learning | .675 | .421 | - | | | | |
| 4. Relevance | .516 | .405 | .536 | - | | | |
| 5. Motivation | .605 | .383 | .533 | .678 | - | | |
| 6. Persistence | .544 | .346 | .467 | .545 | .844 | - | |
| 7. Mastery experience | .532 | .317 | .524 | .404 | .630 | .711 | - |

*Note*. All correlations are significant at $p < .001$.

We further tested the theoretical model displayed in Figure 1 by means of structural equation modeling. As with the measurement model, none of the error variances were allowed to correlate. The model had good fit to the data ($\chi 2$ (166, N = 44 702) = 19 208.11, $p < .001$, CMIN/DF = 56.829, RMSEA = 0.035, IFI = 0.961, TLI = 0.947, and CFI = 0.961). Furthermore, we analyzed the structural model by means of multiple group analysis. Such analyses allow the testing of whether groups meet the assumption that they are equal by examining whether different sets of path coefficients are invariant. In the present study, the testing concerned whether the structural weights in the model were equal for lower and upper secondary school students. The analyses revealed a significant chi-square value ($\chi 2$ (33, N = 44 702) = 668.76, $p < .001$), indicating that imposing restrictions of equal structural loading across groups contributed to a significant worsening of overall model fit.

Figure 2 shows estimate of the standardized regression weights and the squared multiple correlations for lower secondary school and upper secondary school, respectively, whereas Table 4 shows the standardized indirect and total effects. Furthermore, the initial analysis showed that some of the regression weights between the variables were not significant for both lower and upper secondary school ($p < .05$). These regression coefficients were not included in Figure 2.

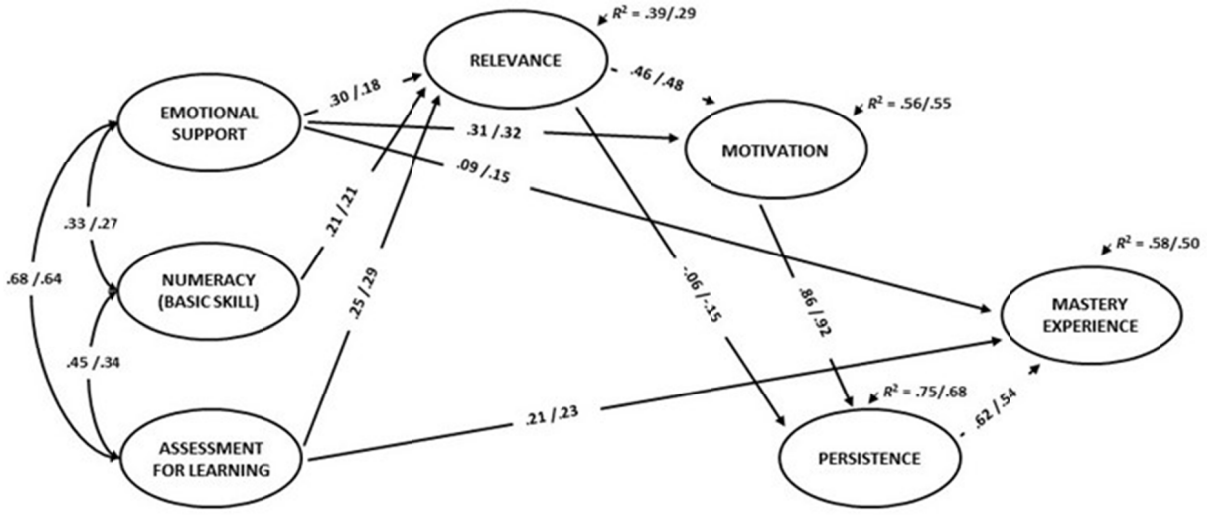


Figure 2. Structural model of the relations between the constructs (lower secondary school/upper secondary school)

Figure 2 shows that the three variables measuring aspects of the learning environment positively predicted the students' perceptions of relevance. For students in lower secondary school the strongest relation was between emotional support and relevance of schoolwork ($\beta = .24$, $p < .001$), whereas the strongest relation for upper

secondary students was between assessment for learning and relevance (β = .29, p < .001). Emotional support positively and directly predicted motivation (β = .31 and .32, p < .001) and mastery experiences (β = .09 and .15, p < .001), whereas assessment for learning was directly related to mastery experience (β = .21 and .23, p < .001). For numeracy, there was only a direct relation to relevance (β = .21 and .21, p < .001). Furthermore, there was a moderate to strong relation between relevance and motivation for both lower and upper secondary students (β = .46 and .48, p < .001) and a negative weak relation from relevance to persistence. There was a strong relation from motivation to persistence (β = .86 and .92, p < .001). Finally, persistence predicted mastery experience with β = .62 and .54, p < .001. Taken together, the exogenous variables explained 58% (lower secondary school) and 50% (upper secondary school) of the variance in mastery experience, respectively.

As shown in Table 4, similar patterns as with the direct relations appear (Figure 2). The bias-corrected bootstrap procedure indicates that all indirect and total effects are significant at p < .01. The strongest indirect effects are from motivation to mastery experiences and from relevance to persistence. Indicating that motivation indirectly affects mastery experiences through persistence, and relevance through motivation, respectively.

Table 4. Standardized indirect and total effects in the structural model

| Latent variable | Standardized indirect effect | | Standardized total effect | |
|---|---|---|---|---|
| | Lower secondary school | Upper secondary school | Lower secondary school | Upper secondary school |
| Relevance | | | | |
| Emotional support | - | - | .302** | .179** |
| Numeracy (basic skill) | - | - | .211** | .207** |
| Assessment for learning | - | - | .253** | .293** |
| Motivation | | | | |
| Relevance | | | .458** | .485** |
| Emotional support | .138** | .087** | .445** | .411** |
| Numeracy (basic skill) | .096** | .100** | .182** | .179** |
| Assessment for learning | .116** | .142** | .163** | .177** |
| Persistence | | | | |
| Motivation | - | - | .857** | .915** |
| Relevance | .392** | .444** | .333** | .292** |
| Emotional support | .364** | .349** | .416** | .384** |
| Numeracy (basic skill) | .143** | .132** | .160** | .171** |
| Assessment for learning | .125** | .118** | .138** | .054** |
| Mastery experiences | | | | |
| Persistence | - | - | .621** | .540** |
| Motivation | .533** | .494** | .533** | .494** |
| Relevance | .207** | .158** | .097** | .065** |
| Emotional support | .225** | .191** | .313** | .336** |
| Numeracy (basic skill) | .076** | .073** | .116** | .070** |

| | | | | |
|---|---|---|---|---|
| Assessment for learning | .058** | .002 | .272** | .233** |

*Note.* * $p < .01$. A bias-corrected bootstrap procedure was employed to estimate two-tailed significance of the indirect and total effects using 2000 samples.

## 6. Discussion

The present study explored a theoretical model of relations between students' perceptions of aspects of the learning environment and their perceived relevance of schoolwork, motivation, persistence, and mastery experience. The correlations between the three contextual aspects varied from moderate to strong, with the strongest correlation being between emotional support and assessment for learning. Furthermore, and in accordance with our expectations, the three aspects of the learning environment were positively related to the outcome variables included in the study. However, the relations were almost entirely indirect, mediated through relevance and motivation.

An interesting finding from both the descriptive analyses and model testing was the strong correlation between emotional support and assessment for learning. As previously noted, assessment for learning parallel definitions of instrumental support, typically conceptualized as students' perceptions of their teachers' provision of instrumental resources, practical help, and feedback directed towards their learning goals (House, 1981; Malecki & Demaray, 2003). Previous studies indicate moderate to strong correlations between emotional and instrumental support (e.g., Federici & Skaalvik, 2014b). One interpretation of the correlation between emotional support and assessment for learning may therefore be that teachers who care the most for the individual students tend to provide both emotional support and instrumental feedback. That is, these teachers care for both the individual student's well-being and their progress in school. Such an interpretation represents an explanation in terms of teacher characteristics. An alternative interpretation in terms of student perception is that teachers who facilitate for assessment for learning are also perceived as emotionally supportive. By helping the students understand and providing them with guidance towards learning goals, the teachers may facilitate for students to gain mastery experiences. This may lead the students to perceive the teachers as warm, friendly, and caring, which characterizes emotional support. Such an interpretation also contributes to explain the direct relation from assessment for learning to mastery experiences in the structural model.

There were direct relations from the students' perceptions of the three aspects of the learning environment to perceived relevance of schoolwork, respectively. A reasonable assumption is that teacher emotional support and successful implementation of principles related to assessment for learning facilitate student understanding and interest for school tasks. For instance, one could expect that students receiving support and guidance gain more mastery expectations, which is a major source of motivation (Bandura, 2006a). Thus, adaptive support and assessment for learning may result in increased enjoyment of working with school assignments, promoting the students' perceptions of relevance, motivation, and their mastery experiences. However, despite the moderate correlation between assessment for learning and motivation, the testing of the theoretical model only revealed an indirect relation between these concepts. This may be due to task specific nature of assessment for learning and indicate that teacher instrumental and informative feedback is especially valuable for students' motivation if it promotes their perceived relevance of schoolwork. On the other hand, emotional support both directly and indirectly predicted motivation and mastery experiences, indicating that teachers' general provisions of warmth and respect promote adaptive functioning in a more general manner.

Numeracy, conceptualized as the students' perceptions of the degree to which they use mathematics across different contexts, were directly related to relevance but only indirectly related to motivation, persistence, and mastery experience. In general, these indirect effects were small. One interpretation of the direct relation is that the measure taps the students' perceptions of the degree to which teachers implement the use of mathematics across subjects, an aspect of the learning environment at the school. Successful implementation may lead to increased perceptions of relevance of schoolwork. An alternative interpretation is that the questions tap the students' numeracy skills. That is, it measures the students' capacity to formulate, employ, and interpret mathematics in different contexts, regardless of actual characteristics of the learning environment. We believe that both interpretations are plausible and suggest an investigation of the validity of the instrument in future research. Regardless of this uncertainty concerning validity, the results reveal a moderate correlation between numeracy, relevance, and the motivational constructs, respectively, indicating that teachers should strive to promote students acquisition of this skill.

As expected, there were moderate to strong correlations between the outcome variables. However, a surprising result from the model testing was the negative relation between relevance and persistence. A possible reason for this finding may be due to the strong mutual correlation between relevance, motivation, and persistence, respectively. When controlling for the shared variance in the structural model, relevance primarily affected motivation whereas the remaining unexplained variance in relevance affected persistence, the latter considered as noise. An interpretation may therefore be that relevance exerts its primary influence on persistence and mastery experiences mediated through motivation. Theoretically, this is a logical causal ordering of the constructs since persistence and mastery experiences are indicators or related to motivated behavior. Thus, this may also explain the lack of a direct effect from motivation to mastery experiences.

The multiple group analysis indicated that the imposing of restrictions of equal structural weights across the groups contributed to a significant worsening of overall model fit. Thus, the strength of the coefficients between the constructs in the structural model differed between lower secondary school and upper secondary school. In general, an inspection of the weights indicates small differences, with the most notable difference being the relation between emotional support and relevance. This finding is similar of those found in previous studies, indicating that with increasing grade level, students perceive their teachers as less emotional supportive or less important for achievement related outcomes (e.g., E. M. Skaalvik & S. Skaalvik, 2013). Paradoxically, increasing age is associated with assignments that are more demanding and a more realistic perception of academic self-concept. Thus, older students should theoretically need even more support. An explanation of this decrease may be due to organizational differences between lower secondary school and upper secondary school. For instance, students in upper secondary school have to relate to a greater number of teachers compared to students in lower secondary school. Another explanation may be that adolescents with increasing age seek peer support rather than teacher support. However, these are merely speculations and should be investigated in future research

The present study adds to our understanding of how to work with the learning environment. In general, the study demonstrates that students' perceptions of emotional support, numeracy, and assessment for learning relate to how they perceive the relevance of schoolwork, their motivation, and their achievement related behaviors. These finding supports a range of recent research that shows the importance of teachers' behaviors and instructional practices, such as providing support. Moreover, the study indicates that implementation of assessment for learning directly promotes students' perceptions of relevance and mastery experiences. A practical implication of the study is that schools should promote teacher practices focusing on meaningful aspects of the learning activities and let students solve real-world assignments, promoting adaption of basic skills. In addition, teachers should provide both emotional support and adaptive feedback tied to learning goals. Such practices may increase students' perceptions of the usefulness of working with schoolwork and thus increasing their motivation and mastery experience.

We used cross-sectional data in the present study. Thus, the regression coefficients merely reveal relations between the constructs when controlling for all of the variables in the model. Of note, the data do not support interpretations of the results in causal terms, even though our interpretations are based on theoretical analyses. Longitudinal studies of the same constructs should be conducted. Moreover, the three aspects of the learning environment represent students' perceptions. In future studies, such measures should be combined with data collected in a more objective manner, for instance observations of teachers' behaviors and instructional practices. Finally, the concepts investigated in this study do not operate in isolation from other determinants of students' motivational and behavioral responses. In future research, other constructs should be explored in relation to those included in the current study.

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