How do students with different achievement goal orientation profiles perceive error climate in the mathematics classroom?

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Jussi Järvinen
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Instructors: Markku Niemivirta
and Anna Rawlings

UNIVERSITY OF HELSINKI

Faculty	Department
Faculty of Educational Sciences	

Author
Jussi Järvinen

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Abstract

Aims. The aim of the present study was to examine the effects of students' achievement goal orientations on their perceptions of error climate in the mathematics classroom. Achievement goal orientations refer to relatively stable tendencies to favor certain goals and outcomes in achievement-related situations. Five orientations were included in this study: Mastery-intrinsic refers to a focus on learning, mastery-extrinsic to striving for absolute success, performance-approach to the aim of relative success, performance-avoidance to a focus on avoiding mistakes, and work-avoidance to the aim of minimizing effort. Previous studies suggest that achievement goal orientations affect the way students perceive and evaluate their learning environment, as well as how they respond to errors. Different combinations of orientations (i.e., achievement goal orientation profiles) have also been linked to distinct outcomes. This work examines the role students' achievement goal orientation profiles have in their perceptions of error climate, that is, practices and discourses related to dealing with errors in their classroom. This holds importance for educational research and practice, as error climate has been linked to the adaptivity of students' reactions to their mistakes.

Methods. 169 students (aged 13–14) from four secondary schools completed an electronic questionnaire during their school day about their achievement goal orientations and perceptions of error climate in the mathematics classroom. Five distinct achievement goal orientation profiles were identified using SPSS TwoStep cluster analysis: mastery-oriented, success-oriented, indifferent, performance-and-avoidance oriented, and avoidance-oriented. The mean differences between the groups in perceptions of error climate were analyzed using ANOVA.

Results and conclusions. As expected, the mastery- and success-oriented students perceived the error climate more positively in comparison to both performance-and-avoidance- and avoidance-oriented students. Indifferent students did not differ significantly from other groups. These findings highlight the significance of students' motivational mindsets on their perceptions of the learning environment and practices related to error climate. These differences should be recognized and taken into account when designing instructional practices, in order to ensure a safe and non-judgmental environment, where students with different goals and needs can learn from their mistakes.

Keywords
Achievement goal orientations, achievement motivation, error climate, learning environment

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Tekijä

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Työn nimi

Miten oppilaiden erilaiset tavoiteorientaatioprofiilit ovat yhteydessä virheilmapiirin kokemiseen matematiikan tunneilla?

Oppiaine

Yleinen ja aikuiskasvatustiede

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Tiivistelmä – Abstrakt – Abstract

Tavoitteet. Tämän tutkielman tarkoituksena on tutkia oppilaiden tavoiteorientaatioden vaikutuksia heidän kokemuksiinsa matematiikan oppituntien virheilmapiiristä. Tavoiteorientaatiot viittaavat suhteellisen pysyviin taipumuksiin suosia tiettyjä koulunkäyntiin liittyviä päämääriä ja lopputulemia. Tutkimuksessa tarkasteltiin viittä orientaatiota: oppimisorientaatio viittaa oppimisen tavoitteluun, suoritusorientaatio absoluuttisen menestymisen tavoitteluun, suoritus-lähestymisorientaatio suhteellisen menestymisen tavoitteluun, suoritus-välttämisorientaatio pyrkimyksiin välttää virheitä ja välttämisorientaatio vaivannäön minimoimiseen. Aiempien tutkimusten perusteella tavoiteorientaatiot vaikuttavat siihen, kuinka oppilaat kokevat ja arvioivat oppimisympäristöään sekä kuinka he reagoivat virheisiin. Orientaatioiden erilaisten yhdistelmien (so. tavoiteorientaatioprofiilen) on myös havaittu olevan yhteydessä erilaisiin, oppimisen kannalta merkityksellisiin tekijöihin. Tämä työ tarkastelee tavoiteorientaatioiden roolia oppilaiden kokemuksissa virheilmapiiristä, eli virheiden käsittelyyn liittyvistä käytänteistä ja keskustelutavoista. Näiden erojen tarkasteleminen tärkeää, sillä virheilmapiiri on yhdistetty oppilaiden virhereaktioiden adaptiivisuuteen.

Meenetelmät. 169 oppilasta (13–14 vuotta) neljästä eri koulusta vastasi koulupäivän aikana verkossa kyselyyn tavoiteorientaatioista ja virheilmapiiristä. Viisi erillistä tavoiteorientaatioprofiilia tunnistettiin käyttäen SPSS TwoStep -ryhmittelyanalyysiä: oppimisorientoituneet, menestysorientoituneet, välinpitämättömät, suoritus- ja välttämisorientoituneet sekä välttämisorientoituneet. Näiden ryhmien välisiä eroja analysoitiin yksisuuntaisella varianssianalyysillä (ANOVA).

Tulokset ja johtopäätökset. Oppimis- ja saavutusorientoituneet oppilaat kokivat virheilmapiirin positiivisemmin suoritus- ja välttämisorientoituneisiin ja välttämisorientoituneisiin oppilaisiin verrattuna. Välinpitämättömien oppilaiden ja muiden profiilien välillä ei löydetty tilastollisesti merkitseviä eroja. Nämä löydökset korostavat tavoiteorientaatioiden merkitystä heidän kokemuksilleen oppimisympäristöstä sekä virheiden käsittelyyn liittyvistä käytännöistä. Yksilölliset erot oppilaiden motivationaalisissa taipumuksissa tulisikin tunnustaa ja ottaa huomioon opetusta suunniteltaessa, jotta oppilaille, joilla on erilaisia tavoitteita ja tarpeita, voidaan taata turvallinen ja tuomitsematon ympäristö oppia virheistään.

Avainsanat

Tavoiteorientaatiot, motivaatio, virheilmapiiri, oppimisympäristö

Säilytyspaikka

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Content

1. Introduction

When it comes to learning, errors are both important and unavoidable. While engaging in a challenging task, mistakes are a natural by-product and a part of the learning process. The constructivist learning theory suggests that learners actively construct their own meanings about what is being learned (Rauste-von Wright & Wright, 1994, pp. 50–54). Errors provide students with feedback on their misconceptions and gaps in knowledge thus enabling more efficient learning (see e.g., Metcalfe, 2017). The role of mistakes for learning and their unavoidability is also recognized in the National Core Curriculum for Basic Education (2014) which emphasizes a safe, encouraging, and inspiring social learning environment that promotes students' trying and learning from their mistakes. Surprisingly, however, there is little research on how different aspects of learning environments promote or hinder learning from errors (cf. Steuer, Rosentritt-Brunn, & Dresel, 2013; Tulis, 2013).

There are many important individual and situational factors that determine how an individual is able to handle mistakes and learn from them (see Tulis, Steuer, & Dresel, 2016). In an optimal situation, detecting errors and misconceptions leads to the learner reflecting and trying to explain their conceptions, and contrasting them with the correct answers, which facilitates the forming of accurate mental models (Tulis et al., 2016). The availability of these important cognitive and metacognitive strategies and the ability to persist in the learning activity is, however, affected by concurrent affective and motivational processes and self-regulation (Boekaerts & Niemivirta, 2000). There are individual differences regarding students' patterns of cognition, emotion, motivation, and behavior in response to challenges in achievement situations, such as errors (Grassinger & Dresel, 2017), but they can also be affected by external, situational factors such as instructional characteristics of the task or certain aspects of the social learning environment (Kaplan, Middleton, Urdan, & Midgley, 2002; Steuer et al., 2013).

There is a considerable amount of evidence emphasizing the effects of learning environment on such achievement-related factors and outcomes as students' goals, emotions, and performance (for reviews, see Fraser, 1998; Meece, Anderman, & Anderman, 2006). Adding to this understanding is the recently established research on error climate, which is an approach to examining how certain aspects of the learning environment (e.g., teacher support following errors or communication and analysis of

errors) affect learning from errors (Steuer et al., 2013). It is postulated that these instructional practices and discourses related to dealing with errors promote students' adaptive responses to errors which may lead to more stable knowledge, positive emotions, and better performance (Steuer & Dresel, 2015). Most of the research on the relationships between learning environment and individual differences, however, fails to take into account the reciprocal nature of the relationship between situation and person (cf. Pulkka & Niemivirta, 2013a). It can be argued that individuals' perceptions of the learning context and, consequently, their psychological effects on the individual, vary in accordance to dispositional individual differences, such as their motivational beliefs and orientations (cf. Mischel, 2004). Thus, the perceptions of classroom practices and, consequently, their potential to support students' ability to deal with and learn from errors can vary from student to another. Research on achievement goal orientations suggests that differences in students' tendencies to favor certain goals and outcomes has an effect on their coping and emotions in challenging achievement situations as well as on their perceptions of the learning context itself (e.g., Niemivirta, 2002b; Pekrun, Elliot, & Maier, 2006; Pulkka & Niemivirta, 2013a; Tapola & Niemivirta, 2008; Tuominen-Soini, Salmela-Aro, & Niemivirta, 2008; 2011).

In this study, students' perceptions of error climate in mathematics classroom is examined. It is suggested that these perceptions are affected by the patterns of achievement goal orientations students endorse. Previous work on goal orientations and dealing with errors has focused on the effects of goal orientations on emotional and regulative reactions to errors (Grassinger & Dresel, 2017; Tulis & Ainley, 2011). This research is important and it has yielded interesting results. For example, students' goals of mastery and learning have been linked to more positive emotions and adaptive error reactions. However, in order to design effective instructional practices to promote adaptive responses to errors, it is also necessary to examine how these different motivational mindsets affect how students perceive the instructional practices and social interaction related to these situations.

2. Achievement goal orientations

Achievement goal theory represents an approach to examining achievement motivation that emphasizes achievement-related goals (Ames, 1992; Dweck, 1986; Nicholls, 1984). Two distinct approaches can be distinguished in this research: *Achievement goals* refer to

situated competence-related goals and purposes for achievement behavior, whereas *achievement goal orientations* refer to more stable dispositions, that is, generalized tendencies to favor certain kinds of outcomes in achievement-related situations (Kaplan & Maehr, 2007; Niemivirta, 2002b; Pulkka & Niemivirta, 2013a). Despite the differences, these approaches share a common origin and much of the research has yielded similar results.

Achievement goal orientations are thought to explain students' behavior in achievement situations as well as their perceptions and appraisals of the situations themselves (Dweck & Leggett, 1988). Goal orientations produce patterns of cognition, affect, and behavior influencing students' adaptive and maladaptive reactions to challenging situations. In other words, while some students perceive challenges as opportunities to learn, in others they might evoke fear of failure with associated withdrawal behavior (cf. Niemivirta, 2002b).

The majority of research has focused on two types of goals: mastery and performance goals (Ames, 1992; Dweck, 1986; Nicholls, 1984). Mastery goals refer to an individual's desire to gain competence, and students with mastery goals focus on learning, understanding, gaining knowledge and developing skill. Performance goals, in turn, refer to individual's purpose of demonstrating competence, and students with performance goals focus on making the impression of high ability and avoiding the impression of the lack of it. While results show mastery goals to be positively related to adaptive patterns of coping and emotions, the results concerning performance goals have been more inconsistent. For example, performance goals have been linked, on one hand, to negative emotions and avoidance of challenging tasks, but on the other hand, to positive emotions and performance (for reviews, see Hulleman, Schrager, Bodmann, & Harackiewicz, 2010; Kaplan & Maehr, 2007; Urdan, 1997). It has been argued that a distinction should be made between approach and avoidance performance goals (Elliot & Harackiewicz, 1996; Skaalvik, 1997). Performance-approach goals refer to a focus on showing ability and the possibility of relative success compared with other students, while performance-avoidance goals reflect the aim of avoiding failure and showing lack of ability in front of others.

Similar efforts have been made to elaborate on the reasons students have for pursuing learning and gaining competence. An approach-avoidance distinction has been suggested also for mastery goals (Elliot, 1999; Elliot & McGregor, 2001). While mastery-approach goals reflect striving for learning and gaining ability, mastery-avoidance goals reflect the

avoidance of losing one's skills and abilities. Other conceptualizations aiming to grasp the diversity behind students' mastery behavior are mastery-intrinsic and mastery-extrinsic orientations (Niemivirta, 2002b), and outcome goals (Grant & Dweck, 2003). Dividing mastery goal orientations to intrinsic and extrinsic highlights the criteria students have for learning that may be either intrinsic (e.g., the feeling of learning or understanding) or extrinsic (e.g., in the form of good grades) (Tuominen-Soini et al., 2008). Mastery-extrinsic goals differ from performance-approach goals in whether success is defined in terms of absolute or relative criteria. Students with mastery-extrinsic goals strive for good grades, whereas students with performance-approach goals focus on getting better grades than others. Grant and Dweck (2003) make a similar distinction dividing performance goals into separate ability-linked (i.e., concerns about one's ability), normative (i.e., performing better than others), and outcome (i.e., getting good grades) goals.

While all the aforementioned goals deal with either gaining competence or the appearance of competence, work-avoidance goals have been suggested to account for the fact that not all students' achievement-related behavior has to do with these competence-related aims (Nicholls, Patashnick, & Nolen, 1985). Work-avoidance goals reflect the students' strivings to minimize their school-related effort and avoiding challenges.

The endorsement of certain achievement goals have been linked to different cognitive, affective, and behavioral outcomes (for reviews, see, e.g., Kaplan & Maehr, 2007; Maehr & Zusho, 2009; Urdan, 1997). Mastery (and mastery-intrinsic) goal orientations have been consistently found to be related to adaptive outcomes, such as more positive patterns of emotion, deep learning strategies, self-efficacy, interest, effort, persistence, and school achievement (Elliot, McGregor, & Gable, 1999; Elliott & Dweck, 1988; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Kaplan & Maehr, 1999; Tuominen-Soini et al., 2008). Adopting mastery goals has also been found to predict more positive and less negative emotions (e.g., interest, joy, and pride, as opposed to anger, boredom, shame; Tulis & Ainley, 2011) as well as more adaptive responses following errors (Grassinger & Dresel, 2017). A growing body of research on mastery-extrinsic goals indicates that endorsing these goals may lead to both positive outcomes, such as school achievement, as well as negative outcomes, such as stress and exhaustion (Tuominen-Soini et al., 2008; 2012).

Performance-approach goals are linked with mixed pattern of outcomes such as both positive emotion and negative emotion, high self-efficacy, persistence and effort, fear of failure, and surface learning strategies (Elliot & Church, 1997; Harackiewicz et al., 2000; Pekrun et al., 2006; Skaalvik, 1997). However, performance-avoidance goals have consistently been found to be related to negative outcomes, such as lower self-efficacy, negative emotions (e.g., anxiety, hopelessness and shame), fear of failure, less refined learning strategies, and lower achievement (Elliot & Church, 1997; Elliot et al., 1999; McGregor & Elliot, 2002; Nolen, 1988; Pekrun et al., 2006; Skaalvik, 1997). Further, performance-avoidance goals have predict less adaptive motivational and emotional responses (Grassinger & Dresel, 2017) and more negative pattern of emotions following errors (Tulis & Ainley, 2011). Similarly, work-avoidance goals have been found to be related to mostly maladaptive outcomes, such as lower self-efficacy, anxiety, low school satisfaction, academic withdrawal, less refined learning strategies, and lower achievement (Nicholls et al., 1985; Niemivirta, 2002b; Nolen, 1988; Skaalvik, 1997).

According to the multiple goals framework, students have several simultaneous achievement goal orientations, and different combinations of orientations can lead to unique effects and outcomes (Barron & Harackiewicz, 2001; Pintrich, 2000b). Person-centered research on achievement goal orientations has discovered achievement goal profiles (i.e., homogenous groups of students) that are relatively similar across different grades and age groups (Niemivirta, 2002b; Pulkka & Niemivirta, 2013a; Tapola & Niemivirta, 2008; Tapola, Jaakkola, & Niemivirta, 2014; Tuominen-Soini et al., 2008; 2011; 2012). In these studies, from three to six profiles have been found depending on the number of participants and their level of education. Profiles highlighting the aims of mastery, success, and avoidance, respectively, have consistently been found. Mastery-oriented students show relatively high mastery-intrinsic and mastery-extrinsic orientations and appear low on other orientations. Mastery-oriented students have found to value and perform well in school and show higher self-esteem, commitment, and effort coupled with lower level of depressive symptoms and negative emotions (Tuominen-Soini et al., 2008; 2011; 2012). Success-oriented students differ from mastery-oriented in that they show considerably higher performance-approach orientation and also slightly higher performance-avoidance orientation. While sharing the positive outcomes related to focusing on learning and understanding rather than avoiding schoolwork, success-oriented students also exhibit exhaustion, stress, and fear of failure which may be due to higher

need of self-affirmation (Tuominen-Soini et al., 2008; 2011; 2012). Compared with the other profiles, avoidance-oriented students typically show very low mastery-intrinsic and mastery-extrinsic orientations and high avoidance orientation. This pattern of orientations is connected with less valuing of school and lower levels of commitment, self-esteem, and school achievement, as well as more feelings of cynicism and inadequacy and higher levels of depressive symptoms (Tuominen-Soini et al., 2008; 2011; 2012).

Some studies have also found a group of students described as indifferent, which has also been the biggest of the groups identified in these studies. This profile shows near to mean scores on every orientation. That is, indifferent students seem to represent the typical students in these studies that seem to value learning and good grades somewhat, but are not keen on putting effort in acquiring them (Tuominen-Soini et al., 2008). Compared with avoidance-oriented students, indifferent students have been found to value school more and report less feelings of cynicism but display more fear of failure (Tuominen-Soini et al., 2008; 2011; 2012). Few studies have also identified a performance-oriented profile in which performance-approach, performance-avoidance and mastery-extrinsic orientations are emphasized (e.g., Tuominen-Soini et al., 2008). These students have found to report relatively low self-esteem, as well as relatively high levels of depressive symptoms, cynicism and inadequacy.

2.1. The conceptualization and antecedents of achievement goal orientations

Achievement goal orientations do not refer only to specific goals but to more generalized tendencies to favor certain achievement-related goals (Kaplan & Maehr, 2007). As such, they represent more higher-order goals, and thus can serve to organize lower-level goals and behavior (Maehr & Zusho, 2009; Pintrich, 2000a). For example, a student might aim for high grades because it indicates learning, while another student strives to outperform their classmates. Both students focus on getting good grades, but for different reasons.

Early work on achievement goals emphasized the relationships between students' goal orientations and their beliefs about ability and intelligence and definitions of success and failure. Dweck's studies suggest that students' achievement goals originate from their beliefs about intelligence (Dweck, 1986; Dweck & Leggett, 1988). If a student believes intelligence to be malleable (an "incremental" theory of intelligence), they are likely to adopt mastery goals and focus on gaining knowledge and improving their abilities.

Whereas, if a student believes intelligence to be fixed (an "entity" theory), they are more likely to be concerned by how others perceive their competence and adopt performance goals. Nicholls (1984) argued that conceiving ability as being undifferentiated from effort is likely to lead to task-involvement (mastery orientation), whereas conceiving them to be differentiated may result in ego-involvement (performance orientation). If ability and effort are conceived as differentiated, it follows that the effort poured into mastering a task indicates the level of one's ability, and that the proper criteria for one's ability is in relation to others. That is, managing to complete a challenging task with less effort than their classmates proves the student's ability.

In the dispositional approach to achievement goal research, goal orientations are conceived as knowledge structures (Pintrich, 2000a). They incorporate around them a set of interrelated beliefs and meanings as well as cognitive, affective and behavioral outcomes and other relationships (Dweck & Leggett, 1988; Elliott & Dweck, 1988). Knowledge structures can become chronically accessible for an individual, in the sense that they are more easily activated. That is to say, certain goal orientations can be activated more readily in achievement-situations. Research on the stability of achievement goal orientations suggests that they are relatively stable during academic term and even through academic transitions (Tuominen-Soini et al., 2011; 2012). Students' achievement goal profiles have been found to remain stable around 60 % of the time. Further, the students were far more likely to adopt a similar profile than to move into a completely different one (e.g., from mastery-oriented to avoidance-oriented).

2.2. Relationships between achievement goal orientations and learning environment

The relationships between factors of the learning environment and student motivation have been widely studied from the achievement goal framework (for review, see Meece et al., 2006). Research on classroom goal structures focuses on exploring the instructional practices and messages in the classroom (or school) that serve as cues for triggering students' personal mastery or performance goals (Ames, 1992; Anderman & Midgley, 2002). Ames (1992) identified several such aspects of classroom practices, including the nature of the tasks, autonomy given to the students, grouping and collaboration, and evaluation procedures. The Patterns of Adaptive Learning Survey (PALS; Anderman & Midgley, 2002) – developed on the basis of Ames' work – also takes into account the goal-

related messages teachers communicate to their students. For example, a teacher might point out successful and unsuccessful students in front of the class and convey to students that correct answers and good grades are most important, thereby emphasizing performance goals. Another teacher might recognize students for effort and communicate to students that understanding is the main goal and, in this way, emphasize mastery goals.

Mastery and performance goal structures have been found to be related to endorsement of corresponding personal goals among students (Roeser, Midgley, & Urdan, 1996). In addition, mastery goal structures have also been found to be related to positive affect and coping (Kaplan & Midgley, 1999), as well as lower levels of avoidance (Turner et al., 2002), self-handicapping (Midgley & Urdan, 2001), avoidance of help-seeking (Ryan, Gheen, & Midgley, 1998), and disruptive behavior (Kaplan, Gheen, & Midgley, 2002). Performance goal structure, in contrast, has been found to be related to negative affect and coping (Kaplan & Midgley, 1999), higher levels of self-handicapping (Midgley & Urdan, 2001) and avoidance of help-seeking (Ryan et al., 1998).

Recently, studies on the relationships between individual motivational tendencies have examined the effects of students' achievement goal orientations on their perceptions and evaluations of their learning environment (Pulkka & Niemivirta, 2013a; 2013b; 2013c; Tapola & Niemivirta, 2008). The authors argue that students' motivation and their perceptions of the context are interdependent, and that students with different motivational tendencies might perceive their environment differently. In their longitudinal study in the Finnish National Defence University, Pulkka and Niemivirta (2013a) found that students' achievement goal orientation profiles remained stable over the duration of a course, and that the students' evaluations of their learning environment were different between the profiles. The students' perceptions reflected their motivational tendencies in the sense that mastery- and success-oriented students evaluated their course-related activities more positively in comparison to indifferent and avoidance-oriented students. Although the differences proved small, results in cross-sectional (Pulkka & Niemivirta, 2013b) and variable-centered settings (Pulkka & Niemivirta, 2013c) have yielded similar results. In another study, differences were found between elementary-school students with different goal orientation profiles in their perceptions of elements of the learning environment, such as learning focus, task variety, and individualistic work (Tapola & Niemivirta, 2008).

In summary, achievement goal orientations represent dispositional motivational tendencies that are related to appraisals and perceptions of the learning context as well as patterns of cognition, affect, and behavior in these situations. In addition, students' orientations also seem to affect their reactions following errors (Grassinger & Dresel, 2017). These responses are, however, also dependent on several other factors, such as the learning environment.

3. Perceived classroom error climate

3.1. Dealing with errors in achievement situations

Errors can be defined as discrepancies between outcomes and desired states or criteria (e.g., Frese & Zapf, 1994). However, not every error is a failure. Failure reflects the inability to achieve goals and the negative outcomes linked to this (see Tulis et al., 2016). Errors can offer information about current knowledge and misconceptions, and further, provide opportunities to learn. Learning from errors can be seen as an effortful process that includes analysis of the causes and underlying misconceptions, as well as self-evaluation and modification of relevant knowledge (Tulis, Steuer, & Dresel, 2015). How individuals learn from their errors is influenced by self-regulation processes as well as several other contextual and individual factors (cf. Tulis et al., 2015; Tulis et al., 2016), including achievement goal orientations. For example, for students with mastery orientation, errors might represent opportunities to learn (cf. Dweck & Leggett, 1988) and evoke more positive emotions (Tulis & Ainley, 2011), whereas performance-avoidance goals explicitly deal with avoiding failure (e.g., Tuominen-Soini et al., 2008).

Theoretical frameworks and research on self-regulated learning suggest that processes regulating emotion, motivation, and cognition are necessary for learning from errors (Boekaerts & Niemivirta, 2000; Kuhl, 2000; Winne & Hadwin, 1998). Errors pose a possible threat to students. In a social learning situation, where students' performances become under evaluation, anticipated threats and negative consequences as well as errors or error feedback may evoke negative emotions, such as worry, anxiety, and shame (Pekrun et al., 2006; Tulis & Ainley, 2011). Threats on an individual's self-worth may lead to activity directed towards emotions and well-being rather than the task at hand (Boekaerts & Niemivirta, 2000). This is presumed to be more likely if the individual is

more concerned about the threat than about attaining task-related goals, and if they do not feel competent in completing the task. However, persistence in task-related activities may be achieved with successful self-regulation. As negative emotions are assumed to hinder cognitive activities, for an individual to be able to concentrate on the task at hand, intrusive thoughts and other distractions must be kept at bay (Kuhl, 2000). Reappraisal of negative emotions and the situations that cause them frees resources (Richards & Gross, 2000) that can then be directed towards task-related cognitive and metacognitive activities, such as detecting the errors and identifying their causes and underlying misconceptions (Tulis et al., 2015). Accordingly, supporting emotional regulation and metacognitive activities in error-management training has been found to affect students' performance (Keith & Frese, 2005).

Studies on students' responses to errors have identified individual patterns of affective-motivational and action (cognitive-behavioral) reactions (Grassinger & Dresel, 2017). Affective-motivational adaptivity refers to the degree to which students are able to maintain positive affect and motivation for learning after an error. Action adaptivity, in turn, refers to the cognitive processes and behavior directed towards possible misconceptions that underlie the error. These reactions are found to be predicted by individual differences in students' achievement goals, self-concept, and attributions (Grassinger & Dresel, 2017), as well as classroom error climate (Steuer et al., 2013).

3.2. Error climate in classroom

Error climate refers to how errors are handled in a social learning environment (Steuer et al., 2013; Tulis, 2013). In particular, it refers to what kind of practices are used to manage mistakes and how they are communicated about and utilized to promote learning. The practices around error management and error climate (or error culture) have already been studied in the field of organizational research (e.g., Baumgartner & Seifried, 2014; Cannon & Edmondson, 2001; Rybowiak, Garst, Frese, & Batinic, 1999; Van Dyck, Frese, Baer, & Sonnentag, 2005), but even though the significance of errors for learning is widely recognized, the topic has only recently started to gain interest in an educational context.

Steuer and her colleagues (2013) define a positive error climate as evaluating errors and using them as an integral part of the learning processes. A key assumption also supported by preliminary empirical evidence is that error climate promotes learning from errors by

supporting students' adaptive affective-motivational and cognitive-behavioral reactions to errors (Steuer et al., 2013).

Error climate is suggested to comprise the quality and quantity of verbal and nonverbal communication (Steuer & Dresel, 2015). The behavior of a teacher plays the most central role in the error management culture of a classroom, but the behavior of classmates also contributes to the climate. Based on theory and previous research on learning from errors and error management practices in organizations and educational context, Steuer and her colleagues (2013) argued that there are several contextual factors that affect students' dealing with mistakes and learning from them in a classroom. They found that students' perceptions of classroom error climate consisted of eight distinct but interrelated sub-dimensions.

Four of these sub-dimensions concern the behavior of the teacher. (1) *Error tolerance by the teacher* refers to the teacher's general attitude towards mistakes by the students. The students can observe this from teacher's verbal statements on whether mistakes are acceptable or to be avoided. (2) *Irrelevance of errors for assessment* reflects the degree in which students' mistakes affect the teacher's evaluations about them. If students believe their errors to affect their grades, it might lead to error avoidance. (3) *Teacher support following errors* refers to the amount of help and support students receive after mistakes. This includes, for example, the teacher's willingness to explain the subject patiently to the students. (4) *Absence of negative teacher reactions* refers to the verbal and nonverbal reactions of the teacher to students' mistakes. It is important that the teacher doesn't, even unintentionally, reject, embarrass, or punish students for their mistakes.

The next two dimensions of Steuer and her colleagues (2013) model involve the behavior of the students. (5) *Absence of negative classmate reactions* refers to the reactions of other students in the classroom. Embarrassing, ridiculing, and laughing may easily evoke negative emotions that hinder learning. (6) *Taking the error risk*, in turn, refers to the degree in which students are willing, for example, to try and answer the teacher's question without being certain of the correct answer. Students may be apprehensive about taking chances if they anticipate negative outcomes to follow.

The last two sub-dimensions of the model deal with more general practices related to dealing with errors (Steuer et al., 2013). (7) *Analysis of errors* refers to the degree to which errors are analyzed and communicated about in the learning environment. Open

communication about mistakes is thought to add to the collective knowledge about errors and, therefore, foster learning (cf. Van Dyck et al., 2005). (8) *Functionality of errors for learning* refers to the degree in which errors are conceived to initiate learning. It is suggested that several other aspects of the learning environment must precede for errors to be truly functional for learning in a classroom (Steuer et al., 2013).

Classroom error climate has been found to be related to students' adaptive affective-motivational and action responses to errors, as well as self-regulation of effort and performance (Steuer et al., 2013; Steuer & Dresel, 2015). However, the relationship with performance is weak and may reflect the inclination of higher-performing students to evaluate their learning environment positively, rather than the effect of positive error climate on school achievement (e.g., Griffin, 2004). In addition, a correlation between error climate and mastery goals has been found (Steuer et al., 2013). Error climate and individual reactions to errors have also been found to be related in vocational training (Baumgartner & Seifried, 2014). Interestingly, in contrast with previous findings, trainer's error tolerance was found to predict lower cognitive-behavioral error reactions.

The relationships between error climate and teachers' error management behavior in classroom have also been studied (Tulis, 2013). In a series of studies, Tulis (2013) found that adaptive (e.g., emphasizing learning potential after an error) and maladaptive (e.g., redirecting the question to another student) error management behavior by the teacher after students' mistakes were found to be related to students' positive and negative perceptions of error climate, respectively. In addition, error tolerance by the teacher was found to predict students' attitudes towards making mistakes. A relationship between the adaptivity of teachers' reactions and students' emotional reactions was also observed. However, despite the similarities between Tulis' (2013) conceptualization of the error climate and that of Steuer and her colleagues (2013), the differences in measuring the construct must also be acknowledged. The questionnaire used by Tulis comprised scales measuring error tolerance by the teacher and error communication (somewhat comparable to analysis of errors), but also covering up errors, error strain/fear of mistakes, rule clarity, and students' attitudes towards errors.

Research on error culture and error attitude in work organizations has yielded similar results. For example, analyzing and communicating about errors has been found to help achieving goals and increase performance (Van Dyck et al., 2005), and cooperative

problem solving and open communication has been found to be related to learning from mistakes (Tjosvold, Yu, & Hui, 2004). Coaching to deal with errors by supervisors has also been found to foster employees' learning approach to errors (Cannon & Edmondson, 2001).

Classroom goal structures and error climate are somewhat similar approaches to studying learning environment, as they both deal with classroom-level practices that are expected to predict students' adaptive and maladaptive reactions in achievement-related situations. Further, the teacher's learning approach to errors is also an integral part of mastery goal structure (Anderman & Midgley, 2002), which is found to be related to several adaptive motivational outcomes, such as lower levels of avoidance behavior (Turner et al., 2002). However, the research on classroom goal structures is not focused on dealing with errors in itself but to more general motivational outcomes. Steuer and her colleagues (2013) found that perceived positive classroom error climate correlated positively with mastery goal structure and negatively with performance-approach and performance-avoidance goal structures. Similar, small or intermediate correlations were found between the goal structures and most of the individual sub-dimensions of error climate. The results also suggested that error climate had a unique effect on students' reactions to errors after controlling classroom for goal structures, as well as personal mastery goals and academic self-concept.

4. Present study

Both achievement goal orientations and error climate are central factors in how students perceive error-related achievement situations and maneuver through them by dealing with the emotional, motivational, and cognitive challenges that arise. More specifically, achievement goal orientations predict individual differences in reacting to challenging situations (Niemivirta, 2002b), while at the same time, students' reactions to errors can be supported by a positive error climate (Steuer et al., 2013; Tulis, 2013). However, there are differences in how students perceive the error climate, which can affect its effects on students' reactions to errors (Steuer et al., 2013). These differences and their possible causes remain largely unexplored.

In social-cognitive research on learning environments, a typical approach has been to investigate the effect of contextual factors on students' motivational and learning outcomes

(e.g., Fraser, 1998; Meece et al., 2006). Most studies on the relationships between goal orientations and the learning environment also adopt this view of focusing on how certain contextual features affect the endorsement of different personal goals (e.g., Ames & Archer, 1988; Roeser et al., 1996). This approach has been criticized for failing to take into account the interactional nature of the relationships between person and environment (Pulkka & Niemivirta, 2013a).

According to the interactional (or interactionistic) approach to personality, behavior is the outcome of continuous interaction between an individual and their environment (Endler, 1975; Endler, 2000). An individual's prevalent mental structures affect the cues they scan for in an environment and to which they are sensitive (Mischel, 2004). Kuhl (2000) calls this kind of monitoring of environment "congruence sensitive", because the cues in the environment to which an individual is sensitive get amplified. Concurrently, these mental structures have an effect on an individual's interpretations and appraisals of the situations (Endler, 1975). Thus, it can be argued that prevalent mental structures moderate the perceptions of the environment and its psychological meaning to an individual. An individual's mental representations can also become chronic (i.e., more accessible) when activated regularly (Mischel, 2004). For example, in the context of achievement goal orientations, entering an achievement situation may activate certain goal orientations and related knowledge about classroom norms and practices (Pintrich, 2000c), which in turn can affect how an individual perceives their environment (Boekaerts & Niemivirta, 2000). It should also be noted that students in the same classroom do not share entirely the same environment. For example, teachers' behavior towards students varies, and this may be affected by how the teachers perceive students' motivation (Skinner & Belmont, 1993). Therefore, there may be several pathways for students' motivational mindsets to affect their perceptions of the learning context.

The effect of achievement goal orientations on students' perceptions of their classroom environment and course-related activities has been examined in a series of longitudinal (Pulkka & Niemivirta, 2013a) and cross-sectional studies (Pulkka & Niemivirta, 2013b; Tapola & Niemivirta, 2008). The results suggest that perceptions differ between different achievement goal orientation profiles. Leaning on this previous research, it is assumed that students' perceptions of their social learning environment are filtered by their goal orientations. These orientations are assumed to be relatively stable tendencies that are habitually activated in achievement situations and act as moderators of the students'

experiences (Niemivirta, 2002b; Tuominen-Soini et al., 2011; 2012). Students' evaluations of instructional practices and discourses of the learning context are assessed by adopting a multidimensional approach to measuring classroom error climate (Steuer et al., 2013), which takes into account multiple relevant factors, including the behavior of other students (cf. Tulis, 2013).

The aims of this study are to examine (1) what kind of achievement goal profiles can be identified among secondary school students, and (2) whether differently oriented students perceive the error climate in mathematics classroom differently. To tap into the individual differences in students' achievement goal orientations and perceptions of classroom error climate, a person-centered approach is adopted (Niemivirta, 2002a). As opposed to examining the relationships between isolated variables, the focus is on differences between groups of individuals. This allows examining the effects of different combinations of achievement goal orientations the students might have. The combinations may reveal unique effects that are left unnoticed with a variable-centered approach.

Accordingly, students are first profiled into groups based on their achievement goal orientations. Based on previous research (Niemivirta, 2002b; Pulkka & Niemivirta, 2013a; Tuominen-Soini et al., 2008; 2011; 2012), from three to five groups with different motivational profiles are expected to be identified. In line with this work, profiles emphasizing mastery, success, performance, and avoidance, as well as a profile near the scale mean in all orientations (named "indifferent" in previous work; e.g., Tuominen-Soini et al., 2008), are anticipated.

The mean differences of these profiles in the perceptions of error climate are then examined. The differences are anticipated to be in accordance to those found in previous work on achievement goal profiles and perceptions of learning environment (Pulkka & Niemivirta, 2013a; Tapola & Niemivirta, 2008). Also results on relationships between goal orientations and their relationships to dealing with errors and failure (Dweck & Leggett, 1988; Tulis & Ainley, 2011), as well as on the adaptivity (e.g., well-being, effort, and academic withdrawal; Tuominen-Soini et al., 2008; 2011; 2012) of the motivational profiles are considered. It is anticipated that mastery-oriented students hold more positive perceptions compared to other profiles. Such results would be in accordance with previous findings on students' perceptions of learning environment and the pattern of adaptive outcomes related to focusing on learning, understanding, and self-growth. As focusing on

achievement has been linked mostly with positive, but also some negative outcomes (e.g., fear of failure; Tuominen-Soini et al., 2011), the success-oriented are anticipated to perceive the error climate quite positively. In contrast, performance-oriented students are expected to perceive the error climate more negatively, as they may be sensitive to cues reflecting the possibility to failure. Avoidance-oriented students are anticipated to hold more negative perceptions of the error climate due to their more negative attitude towards school. However, these students do not necessarily fear failure, which may undermine the effect.

The students are asked about their perceptions of error climate in the mathematics classroom, which is the subject previous studies in error climate have also focused on (Steuer et al., 2013; Steuer & Dresel, 2015). A specific subject was selected, as the error climate varies from one teacher's class to another's (Steuer & Dresel, 2015). There might also be differences in how errors are handled in different school subjects (Tulis, 2013). In mathematics, problems and tasks as well as the answers are often more straightforward, and therefore, also the errors are more clear and explicit. It is also a subject that causes anxiety for some students (Wigfield & Meece, 1988), which indicates that emotions might arise in the course of learning. Overall, achievement goal orientations have been, in turn, conceived as a more general orientation to achievement situations, and are mostly presumed to affect students' perceptions and behavior similarly in different domains, although some results have also suggested between-domain differences (e.g., Bong, 2001; Tuominen-Soini & Salmela-aro, 2015).

5. Method

5.1 Participants

The participants were 269 (133 girls) 7th and 8th grade students (aged 13–14 years) from four secondary schools in southern and southwestern Finland. The students were asked to fill an electronic questionnaire. This was done during a school day and participation was voluntary. Permission from the parents was also requested, as the students were under 15 years old. Students and their parents were informed about the study and its purpose beforehand, and assured that all information would be handled confidentially.

5.2 Measuring

Achievement goal orientations were measured using scales developed by Niemivirta (2002b). The five theoretically predicted orientations were measured with three items each. The scale for *mastery-intrinsic orientation* comprised items reflecting students' focus on learning and gaining knowledge (e.g., "*For me, an important goal in studying is to acquire new knowledge*"). The scale for *mastery-extrinsic orientation* comprised items assessing students' aspiration to get good grades and succeed in school (e.g., "*It is important to me that I get good grades*"). The scale for *performance-approach orientation* comprised items assessing the students' desire to perform better than other students (e.g., "*For me, an important goal school is to do better than other students*"). The scale for *performance-avoidance orientation* comprised of items reflecting students' focus on avoiding public failure (e.g., "*I try to avoid such situations in which I may fail or make mistakes*"). The scale for *work-avoidance orientation* comprised of items assessing the students' concerns to minimize school-related effort and work ("*I try to get off with my schoolwork with as little effort as possible*"). The students responded on a scale of 1 ("*not at all true*") to 5 ("*completely true*").

A shortened version of Steuer, Rosentritt, and Dresel's (2013) scales was used to measure perceived error climate. The original scale was translated to Finnish and shortened by four items. The wording was also changed to so that explicit mention of the school subject was left out of the items, and instead, the students were asked to think specifically about mathematics when answering to the scales. The accuracy of the translations was verified using back-translations. The scales comprised 24 items, three measuring each of the eight theoretically predicted dimensions of error climate: *error tolerance by the teacher* (e.g., "*Our teacher doesn't like it when assignments are done incorrectly*"), *irrelevance of errors for assessment* (e.g., "*If someone in our class says something wrong, it has an effect on their grade*"), *teacher support following errors* (e.g., "*If someone doesn't know how to solve an assignment correctly the teacher will help them*"), *absence of negative teacher reactions* (e.g., "*If mistakes are made in class, the teacher gets annoyed*"), *absence of negative classmate reactions* (e.g., "*If someone in our class fails to do an assignment correctly their classmates will mock them*"), *taking the error risk* (e.g., "*A lot of students in our class would rather say nothing than say something wrong*"), *analysis of errors* (e.g., "*If mistakes are done in assignments, they are discussed in detail during lessons*"), and *functionality of errors* (e.g., "*Mistakes made by students are used to understand the subject*

better"). The same 5-point scale was used to respond to the scales. Items indicating negative error climate (e.g. "*If someone in our class does an assignment incorrectly, they will get very little help from the teacher*") were reversed before the analysis.

5.3. Analyses

The statistical analysis were conducted with IBM SPSS statistics version 24 with the exception of confirmatory factor analysis (CFA) which was conducted with Mplus statistics software (Muthén & Muthén, 1998–2015). CFA were performed to test the structural validity of the constructs. CFA tests a hypothesized model where observed variables and their relations to underlying factors (i.e., constructs) are specified (Byrne, 2012). Chi squared, root mean squared error of approximation (RMSEA), Comparative Fit Index (CFI), and standardized root mean squared residual (SRMR) were used to assess how the factor model fit the data. A cutoff value close to .95 with CFI, a cutoff value close to .08 with SRMR, and a cutoff value close to .06 with RMSEA were deemed acceptable for a relatively good fit (Hu & Bentler, 1999).

After testing the factor structure, composite scores were calculated. Cronbach's alphas were calculated to evaluate the internal consistencies and reliabilities of the variables, and correlations were examined to view the relations between the variables. Intra-class correlation coefficients (ICCs) were computed for error climate using variance components to examine how much of the variance of error climate was explained by the students' class, in other words, how homogenic their perceptions of the classroom error climate were.

Following the person-centered approach, the students were classified into homogenous groups according to their achievement goal profiles using TwoStep cluster analysis. Following the clustering, ANOVA was used to test the between-group differences of achievement goal profiles on error climate.

6. Results

6.1. Preliminary results

Before proceeding to further analysis, the descriptive statistics of the data were examined. Four of the items were found to exhibit rather high kurtosis ("*If someone in our class says something wrong, it has an effect on their grade*" $K = 2.97$, "*If one does something incorrectly in class, they may be mocked by the teacher*" $K = 5.02$, "*If mistakes are made in class, the teacher gets annoyed*" $K = 2.47$, "*If someone says something wrong the teacher might embarrass them in front of the entire class*" $K = 4.10$). However, this was not deemed a problem, as CFA with maximum likelihood estimator has been found to perform relatively well with non-normal data, and challenges in rejecting the correct factor model have been found to arise only with kurtosis values approaching 7.0 (Curran, West, & Finch, 1996). All other variables were found to be normally distributed.

The CFA on achievement goal orientations was found to have a good fit, χ^2 (80, $N = 269$) = 100.95, $p = .057$, RMSEA = .054 (90% CI .000, .084), CFI = .962, SRMR = .076. The initial CFA on perceived error climate had an acceptable fit, χ^2 (224, $N = 269$) = 513.51, $p < .001$, RMSEA = .070, CFI = .904, SRMR = .063. However, one item ("*It is okay with our teacher if the assignments are not done correctly*") did not load to any of the factors. This might be due to poor translation and/or wording, the vagueness of the item, or the fact that the content of the item was hard for the students to grasp. Hence, the item was removed. After the removal, the fit indices were χ^2 (202, $N = 269$) = 476.50, $p < .001$, RMSEA = .071, CFI = .908, SRMR = .06. The factor loadings and effect sizes of the items can be viewed in Tables 1 and 2.

After confirming the structural validity, composite scores were calculated accordingly. All descriptive statistics and Cronbach's alphas are given in Table 3. One of the composite score variables, *absence of negative teacher reactions*, was found to exhibit some kurtosis ($K = 3.14$). Otherwise the composite variables were found to be distributed normally. Cronbach's alphas of the variables were calculated to test the cohesion of the measures (Table 3). As the *Teacher's error tolerance* with only two items had an alpha of .49, the variable was left out from further analysis. The alphas of the rest of the variables were .69–.89, and thus, considered acceptable.

Table 1.
Standardized factor loadings, and explained variance of items for five-factor model of achievement goal orientations

Factors and items	1.	2.	3.	4.	5.	R^2
1. MASTERY-INTRINSIC						
For me, an important goal in school is to learn as much as possible.	.91					.83
For me, an important goal in studying is to acquire new knowledge.	.85					.72
I study in order to learn new things.	.65					.42
2. MASTERY-EXTRINSIC						
An important goal for me is to do well in school.		.95				.90
It is important to me that I get good grades.		.83				.68
My goal is to succeed in school.		.82				.67
3. PERFORMANCE-APPROACH						
I feel that I have achieved my goal when I get better grades than most other students.			.74			.55
For me, an important goal school is to do better than other students.			.69			.48
It is important to me that others think I'm able and competent.			.52			.27
4. PERFORMANCE-AVOIDANCE						
I try to avoid such situations in which I may fail or make mistakes.				.94		.87
I try to avoid situations in which I may appear dumb or incompetent.				.76		.58
It is important to me that I don't fail in front of other students.				.44		.20
5. WORK-AVOIDANCE						
I try to get off with my schoolwork with as little effort as possible.					.85	.72
I always try to do nothing more than just the required schoolwork.					.64	.41
I am particularly satisfied if I don't have to work much for my studies.					.46	.21

Table 2.

Standardized factor loadings, and explained variance of items for eight-factor model of error climate

Factors and items	1.	2.	3.	4.	5.	6.	7.	8.	R^2
1. TEACHER'S ERROR TOLERANCE									
Our teacher doesn't like it when assignments are done incorrectly.[1]	.71								.50
It is not at all bad for our teacher is someone answers incorrectly.	.47								.23
2. IRRELEVANCE OR ERRORS TO ASSESMENT									
If someone makes mistakes during a lesson, they will get a bad grade.[1]		.90							.82
If someone in our class says something wrong, it has an effect on their grade.[1]		.78							.61
If someone in our class doesn't do assignments correctly, they will get a bad grade.[1]		.72							.52
3. TEACHER'S SUPPORT									
If someone in our class does an assignment incorrectly, they will get very little help from the teacher.[1]			.77						.60
If someone doesn't know how to solve an assignment correctly the teacher will help them.			.75						.57
If someone in our class says something incorrect, the teacher will patiently explain the problem.			.56						.31
4. ABSENCE OF NEGATIVE REACTIONS BY TEACHER									
If mistakes are made in class, the teacher gets annoyed.[1]				.76					.58
If one does something incorrectly in class, they may be mocked by the teacher.[1]				.75					.56
If someone says something wrong the teacher might embarrass them in front of the entire class.[1]				.65					.42
5. ABSENCE OF NEGATIVE REACTIONS BY CLASSMATES									
If someone in our class fails to do an assignment correctly their classmates will mock them.[1]					.85				.73
If someone in class answers incorrectly, they will hear from it afterwards from their classmates.[1]					.80				.64
If someone makes mistakes in class they might be ridiculed by others.[1]					.77				.59
6. TAKING THE ERROR RISK									
A lot of students in our class hope they will not be called on because they are afraid they will answer incorrectly.[1]						.89			.79
A lot of students in our class would rather say nothing than say something wrong.[1]						.79			.62
In our class a lot of students don't dare to say anything because they are afraid they will say something wrong.[1]						.71			.50
7. ANALYSIS AND COMMUNICATION OF ERRORS									
If mistakes are done in assignments, they are discussed in detail during lessons.							.79		.63
Assignments that are done incorrectly are thoroughly discussed during lessons.							.79		.63
Incorrect answers are discussed in detail during lessons.							.73		.53
8. FUNCTIONALITY OF ERRORS									
Incorrect answers are used for learning during lessons.								.82	.68
Mistakes made by students are used to understand the subject better.								.70	.49
In our lessons we learn a lot from assignments that errors were made in.								.62	.38

[1] Item scores reversed.

Intra-class correlation (ICC) was calculated for perceived error climate variables to test how much of the variance in perceived error climate was explained by the students' class, and therefore how much is left to be explained by individual differences (e.g. goal orientations). ICC can be interpreted as the percentage of variance in perceived error climate explained by the students' class (Bliese, 2000). 0–22% of the variance in the perceived error climate was found to be explained by the students' class (see Table 3).

Correlations within achievement goal orientations and within error climate dimensions as well as between them (see Table 3) were consistent with expectations and previous research (Steuer et al., 2013; Tuominen-Soini et al., 2008; 2011; 2012), which provided support for construct validity. The relationships between mastery-intrinsic, mastery-extrinsic, and performance-approach orientations were all positive, as were the relationships between performance-approach, performance-avoidance and work avoidance orientations. Mastery-intrinsic and mastery-extrinsic orientations were found to be negatively related to work-avoidance, and a small positive correlation was found between mastery-extrinsic and performance-avoidance orientations. Most of the sub-dimensions of error climate were positively related to each other. Some of the relationships were, however, non-significant, but this was also in line with previous research on error climate (Steuer et al., 2013). The only exception to this was the non-significant correlation between irrelevance of errors for assessment and analysis of errors, which has in previous research found to be positive. Both mastery orientations correlated positively with all aspects of error climate except taking the error risk, to which the relationships were nonsignificant. In a similar manner, both performance orientations were positively related to analysis of errors and functionality of errors, but their relationships with taking the error risk were negative. While performance-approach and performance-avoidance orientations were both negatively related to absence of negative student reactions, the former relationship was only nearly significant ($p = .071$). Work-avoidance orientation was negatively related to irrelevance of errors for assessment, as well as absence of negative teacher and student reactions.

Table *3*.

Variable correlations, descriptive statistics, internal consistencies and intra-class correlations.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Achievement goal orientations												
1. Mastery-intrinsic												
2. Mastery-extrinsic	.70**											
3. Performance-approach	.25**	.35**										
4. Performance-avoidance	.08	.15*	.40**									
5. Work avoidance	-.21**	-.19**	.15*	.19**								
Error Climate												
6. Irrelevance of errors for assesment	.17**	.18**	-.09	-.06	-.17**							
7. Teacher support following errors	.25**	.31**	.04	.07	-.11	.45**						
8. Absence of negative teacher reactions	.24**	.29**	.00	-.04	-.17**	.69**	.65**					
9. Absence of negative classmate reactions	.14*	.20**	-.11	-.13*	-.17**	.41**	.35**	.52**				
10. Taking the error risk	.07	.00	-.14*	-.29**	-.03	.24**	.11	.21**	.27**			
11. Analysis of errors	.15*	.18**	.15*	.20**	-.07	.08	.47**	.18**	-.01	-.10		
12. Functionality of errors	.19**	.23**	.19**	.18**	-.08	.10	.55**	.28**	.05	-.10	.69**	
M	3.59	4.00	2.94	3.26	3.12	4.28	4.13	4.47	4.23	3.00	3.04	3.36
SD	.86	.88	.89	.91	.94	.83	.87	.80	.89	1.06	.97	.90
α	.86	.89	.69	.70	.69	.85	.74	.75	.85	.83	.81	.74
ICC	-	-	-	-	-	.00	.22	.06	.13	.06	.11	.14

* $p < .01$, ** $p < .05$

6.2. Achievement goal orientation profiles

The results of the TwoStep cluster analysis showed a four-class solution to have the best fit with the data (see Table 4 for fit indices). However, a qualitative consideration of the profiles showed that the five-class solution was more in line with the findings in previous studies (e.g., Pulkka & Niemivirta, 2013a; Tuominen-Soini et al., 2008; 2011; 2012). The five groups were named (1) *mastery-oriented*, (2) *success-oriented*, (3) *indifferent*, (4) *performance-and-avoidance oriented*, and (5) *avoidance-oriented* (see Figure 1).

Table 4.

Bayesian Information Criterion values for different class solutions

Number of classes	BIC
1	982.225
2	878.288
3	827.822
4	820.537
5	831.602
6	858.055
7	886.780

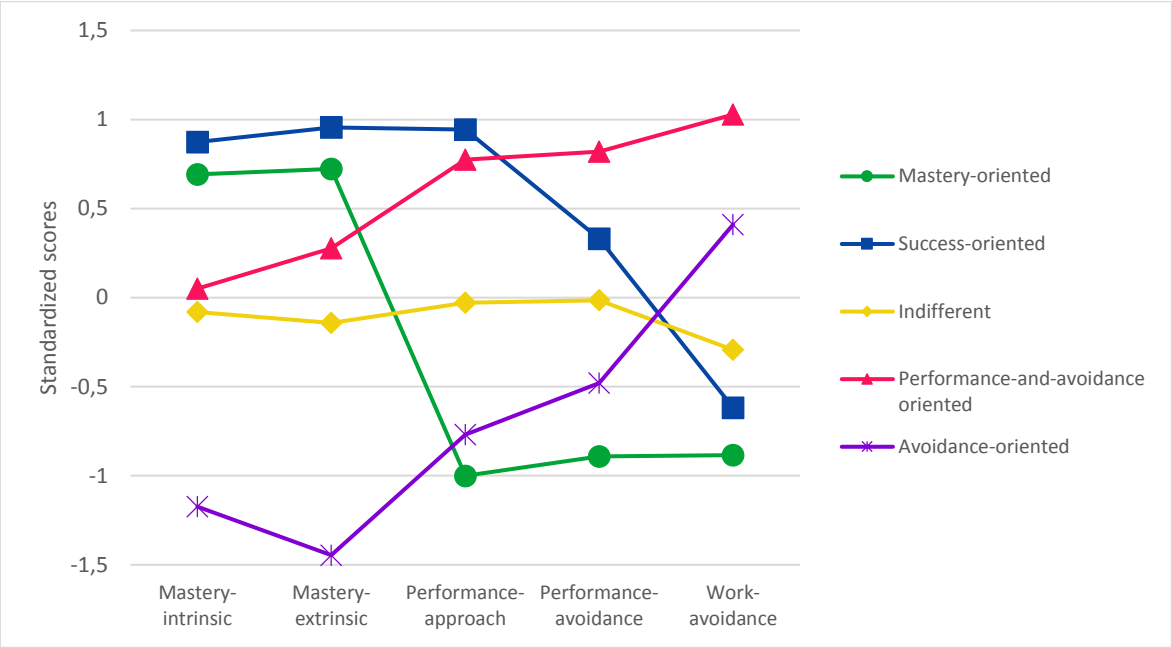

Figure 1. Students' standardized mean scores on achievement goal orientation scales as a function of group membership

As Figure 1 illustrates, *mastery-oriented* students (16 %) had high scores on mastery-intrinsic and mastery-extrinsic orientations, but the lowest scores on other orientations (see Table 5 for pairwise comparisons on raw mean values). *Success-oriented* students (15 %) had high scores on mastery-intrinsic, mastery-extrinsic, and performance-approach orientations, but lower scores in performance-avoidance orientation and even lower in avoidance orientation. *Indifferent* students (26 %) were the largest group, and they had scores close to the mean in every orientation. *Performance-and-avoidance oriented* (23 %) students had high scores on performance-approach, performance-avoidance, and avoidance orientations, and close to mean scores on other orientations. The last group, *avoidance-oriented* students (20 %), had above mean scores in avoidance and low scores in other orientations.

Table 5. Mean differences in achievement goal orientations between goal orientation groups

Orientation group	Mastery-oriented		Success-oriented		Indifferent		Performance-and-avoidance oriented		Avoidance-oriented				
	N = 43		*N* = 40		*N* = 70		*N* = 62		*N* = 53				
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*F(4, 263)*	*p*	η^2
Mastery-intrinsic[1]	4.19_{ab}	.74	4.34_{cd}	.54	3.52_{ac}	.52	3.63_{bd}	.68	2.58_{abc}	.70	57.33	< .001	.47
Mastery-extrinsic	4.64_{a}	.38	4.84_{a}	.27	3.87_{a}	.46	4.24_{a}	.61	2.72_{a}	.70	127.09	< .001	.66
Performance-approach	2.05_{ab}	.62	3.78_{ac}	.55	2.91_{abc}	.50	3.62_{b}	.61	2.25_{bc}	.72	8.21	< .001	.55
Performance-avoidance[1]	2.44_{ab}	.69	3.56_{ac}	.74	3.24_{bd}	.69	4.01_{abc}	.64	2.81_{cd}	.95	34.68	< .001	.35
Work-avoidance	2.29_{a}	.83	2.54_{b}	.63	2.85_{a}	.54	4.09_{ab}	.48	3.51_{ab}	.87	63.63	< .001	.49

Means within a row sharing the same subscripts are significantly different at the $p < .05$ level (with Games-Howell, [1] with Bonferroni correction)

6.3. Differences in perceived classroom error climate

The differences of achievement goal orientation profiles in perceived classroom error climate was analyzed using a one-way ANOVA. The results showed that the students with different goal orientation profiles differed significantly in their perceptions of all aspects of error climate, with the exception of taking the error risk (see Table 6 for all mean differences and effects).The pairwise comparison of means revealed that mastery-oriented students reported the highest scores on most of the sub-dimensions and avoidance-oriented students the lowest scores on all of the sub-dimensions of error climate, except for the above-mentioned taking the error risk, indicating a positive and a negative perception of classroom error climate, respectively. The differences were statistically significant in students' perceptions of irrelevance of errors for assessment, as well as absence of negative teacher and student reactions. Success-oriented students evaluated the error climate mostly positively, reporting more teacher support and functionality of errors in comparison to the avoidance-oriented. The perceptions of performance-and-avoidance oriented students were discordant, including both positive and negative evaluations. They reported higher scores on analysis and functionality of errors in comparison to avoidance-oriented, but lower scores on irrelevance of errors and absence of negative classmate reactions compared to mastery-oriented students. Most of the differences in mean scores between the groups were small, and in most cases, non-significant. In the case of indifferent students, the mean scores did not differ from any of the other profiles with regard to any of the sub-dimensions.

Table 6. Mean differences in perceptions of error climate between goal orientation groups

Orientation group	Mastery-oriented		Success-oriented		Indifferent		Performance-and-avoidance oriented		Avoidance-oriented	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Irrelevance of errors for assesment	4.62_{ab}	.68	4.26	.83	4.33	.64	4.16_{a}	.88	4.08_{b}	1.03
Teacher support following errors	4.26	.91	4.37_{a}	.76	4.13	.74	4.19	.85	3.79_{a}	1.03
Absence of negative teacher reactions	4.74_{a}	.55	4.62	.60	4.50	.72	4.41	.82	4.19_{a}	1.05
Absence of negative classmate reactions	4.53_{ab}	.68	4.33	.98	4.28	.76	4.06_{a}	.98	4.02_{b}	.97
Taking the error risk[1]	3.21	1.13	2.91	.98	2.94	.88	2.80	1.19	3.21	1.06
Analysis of errors[1]	3.03	1.05	3.11	.98	3.12	.79	3.27_{a}	.96	2.63_{a}	1.02
Functionality of errors[1]	3.33	.95	3.61_{a}	.96	3.37	.70	3.57_{b}	.98	2.96_{ab}	.85

Means within a row sharing the same subscripts are significantly different at the $p < .05$ level (with Games-Howell, [1] with Bonferroni correction)

7. Discussion

The aim of this study was to examine how students with different achievement goal orientations perceive the error climate in their mathematics classroom. To achieve this, the students were classified into homogenous groups according to their achievement goal orientations, and differences in students' perceptions of classroom error climate between these achievement goal orientation profiles were examined. It was anticipated that from three to five achievement goal profiles would be found, and that they would be similar to those found in previous research (Niemivirta, 2002b; Pulkka & Niemivirta, 2013a; Tuominen-Soini et al., 2008; 2011; 2012). Further, it was expected that achievement goal orientation profiles would differ in students' perceptions of the classroom error climate. Mastery- and success-oriented students were expected to perceive classroom error climate as more positive and performance- and avoidance-oriented more negative. Indifferent students' perceptions were anticipated to be relatively average.

The results indicated partial support for these expectations in two ways. Firstly, five achievement goal orientation profiles were identified: learning-oriented, success-oriented, indifferent, performance-and-avoidance oriented, and avoidance-oriented. The profiles were for the most part quite similar to those found in previous research studies on lower and upper secondary school (Tuominen-Soini et al., 2008; 2011; 2012) with the exception of performance-and-avoidance oriented profile. For *mastery-oriented* students (16%), learning and gaining knowledge as well as getting good grades were important aims in school. They did not, however, seem to be concerned about relative success or outperforming others. They also displayed low levels of avoiding failures and situations where one would be exposed to them as well as avoiding schoolwork. *Success-oriented* students (15%) demonstrated similar focus on learning and achieving absolute success, but also seemed to aim for relative success. They also displayed more concern regarding failure in comparison to mastery-oriented. The largest of the groups, *indifferent* students (26%), displayed scores near to the scale mean in all achievement goal orientations with a slight emphasis on mastery orientations. Tuominen-Soini and her colleagues (2008) named these students indifferent as they seem to value learning and school achievement but are somewhat reluctant to invest on these goals. *Performance-and-avoidance oriented* students (23%) represented the second largest group in this study. These students were characterized by avoidance of failure and schoolwork as well as focus on normative

success. This kind of profile with concurrent strong emphasis on both performance and work-avoidance has not, to my knowledge, been identified in previous studies. Several factors may have affected this discrepancy. The participants in this study were a little younger in comparison to, for example, the studies of Tuominen-Soini and her colleagues (2008; 2011; 2012) and, hence, there may be some differences due to age and maturation. It should also be noted that the sampling of this study may not be representative, as a non-systematic sampling method was implemented. Also, the method of clustering is different from previous work on achievement goal orientation profiles (e.g., Tuominen-Soini et al., 2008). This might have an influence on the identified profiles, due to their slightly different criteria for defining the groups. Further, a shorter scale is employed in this study, which might have an effect on the habits of answering the items in the questionnaire. The last profile, *avoidance oriented* (20%), is characterized by emphasis on avoiding school-related work and trying to minimize the time and effort poured into it. However, this focus is not as pronounced as with performance-and-avoidance oriented students.

Secondly, as expected, students with different achievement goal orientation profiles perceived the classroom error climate differently. These perceptions were in line with their motivational tendencies in the sense that mastery- and success-oriented perceived error climate more positively than performance-and-avoidance oriented and avoidance-oriented. Mastery-oriented students believed errors to be less relevant for teachers' evaluations, and also thought negative classmate reactions to be less frequent in comparison to the two profiles emphasizing avoidance. They also perceived less negative teacher reactions than the avoidance-oriented. In addition, success-oriented students had a more supportive notion of their teacher, and thought that errors were used to initiate learning processes more frequently than avoidance-oriented. This pattern of results is in line with findings linking emphasizing mastery goal orientations to more positive evaluations of learning environment and perceiving environment more learning-oriented (Pulkka & Niemivirta, 2013a; Tapola & Niemivirta, 2008). To these students, errors may seem less of a threat, but represent feedback about learning process and opportunities to learn (Dweck & Leggett, 1988). In this sense, these findings corroborate previous findings linking students' focus on learning and self-growth to adaptive outcomes regarding errors or possibilities of failure (e.g., Grassinger & Dresel, 2017; Niemivirta, 2002b; Tulis & Ainley, 2011; Tuominen-Soini et al., 2011).

Performance-and-avoidance oriented students seemed to perceive error climate somewhat inconsistently. They believed errors to be relevant for assessment and reported more negative classmate reactions than mastery-oriented students. This is consistent with the ability concerns and worrying about normative evaluation and failure in front of classmates inherent in adopting performance goals (see Hulleman et al., 2010). Surprisingly, they also reported more communication and analysis of errors, as well as using them more frequently to promote learning in classroom, in comparison to avoidance-oriented students. This may, however, be due to the sensitivity to environmental cues indicating possibilities of failure also linked with performance goals (Dweck & Leggett, 1988), which can lead to these students noticing and remembering certain events and situations more readily. In this sense, perceiving more frequent analysis and functionality of errors in classroom may not be unequivocally an indication of positive error climate, if they are not accompanied with an experience of a safe and non-judgmental climate and discourses about the mistakes.

Avoidance-oriented students held consistently more negative perceptions of the error climate. This is in accordance with previous findings emphasizing the negative evaluations of learning environment (Pulkka & Niemivirta, 2013a; Tapola & Niemivirta, 2008) as well as other negative outcomes (e.g., Nicholls et al., 1985; Niemivirta, 2002b; Tuominen-Soini et al., 2008; 2011; 2012) linked to focusing on minimizing effort and avoiding school-related work. While these student are not notably concerned about avoiding failure, they do not value learning and high achievement very highly, either. Previous research has linked this kind of motivational profile to a pattern of low commitment and effort coupled with high cynicism and experiences of inadequacy (Tuominen-Soini et al., 2008).

It should also be noted that no differences were found between differently oriented students with regard to perceptions of taking the error risk. While students' reports of risk-taking was found to correlate negatively with both performance-approach and performance-avoidance orientation, this effect did not transfer to significant differences between achievement goal profiles. This may be due to students having several simultaneous goal orientations, and that the effects of singular goal orientations might cancel each other out somewhat when combined.

The findings of this study seem to indicate that students' motivational tendencies affect how they perceive the learning environment. However, the differences between goal orientation profiles were few and small. This may be due to the fact that while students'

perceptions may be affected by these individual differences, they are nonetheless able to perceive the classroom practices somewhat objectively, independent of how they feel about them (cf. Pulkka & Niemivirta, 2013a). The results should, in any case, be considered with caution for several reasons. Firstly, the study design is cross-sectional and therefore no conclusions can be drawn as to the direction of the relationships. The data was collected via self-report questionnaire, which may induce social desirability bias in the form of over-reporting desirable and under-reporting undesirable behavior. Also, as noted, the sample was not randomized and may not therefore be representative. The measurement error was not taken into account, as the analyses were conducted with compound variables, which might affect the reliability of the findings. Secondly, the observed differences may be at least partly due to differences in performance, as high-performing students are more likely to evaluate their learning environment more positively (e.g., Griffin, 2004), and endorsing mastery goals has been linked to higher achievement (e.g., Tuominen-Soini et al., 2008). Finally, this study concerned error climate only in mathematics classroom, and therefore, the results cannot be generalized into other subjects. These limitations should be addressed in future research. Further research in different domains is needed to examine the generalizability of these results. As the focus of this study was on how students perceive the error climate, its possible effects on motivational outcomes as well as achievement should also be examined. These outcomes might vary as the function of person-situation interaction (Endler, 1975). This is to say, similar error climate might affect students with different motivational tendencies in a different way. Thus, also the effects of these different error climate and achievement goal orientation interactions would make an interesting topic of future research.

In conclusion, the present study contributes to the research on relationships between students' achievement goal orientations and their perceptions of the learning environment, as well as to the emerging research on error climate. These results highlight the significance of individual differences in students' motivational tendencies, not only for their motivated behavior, but also for how they perceive, appraise, and evaluate the social learning environment of the classroom. Recognizing these differences among students is essential when designing instructional practices in schools to ensure well-suited surroundings for learning for every student. For example, students who are more sensitive to failure or aim to minimize effort instead of striving for learning, seem also to be more sensitive to negative reactions and lack of support following errors. These students may

deserve special attention in order to establish a safe and motivating environment that promotes learning from mistakes. Thus, teachers have to be aware of both personal and contextual factors when designing their pedagogy and learning environments.

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