



# Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science



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## ARTICLE INFO

### Article history:

Received 15 July 2014

Received in revised form

29 September 2014

Accepted 22 October 2014

Available online 10 November 2014

### Keywords:

Teacher professional development

Classroom discourse

Self-determination theory

Interest

Intervention

## ABSTRACT

Student interest and motivation in STEM subjects has dropped significantly throughout secondary education, for which teacher–student interactions are named as a central reason. This study investigated whether a video-based teacher professional development (TPD) intervention on productive classroom discourse improved students' learning motivation and interest development over the course of a school year. The teachers' intervention group (IG;  $n = 6$ ) was compared with a control group (CG;  $n = 4$ ) who participated in a traditional TPD programme on classroom discourse. The teachers showed a significant increase in constructive feedback and decrease in simple feedback as a function of the treatment. Pre- and post-tests revealed that students in the IG ( $n = 136$ ) significantly increased their perceived autonomy, competence and intrinsic learning motivation as compared with those in the CG ( $n = 90$ ). They also showed significantly greater interest changes in the subjects compared with their peers in the CG.

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## 1. Introduction

Motivational concepts such as interest in the subject are important outcomes of educational processes (Krapp & Prenzel, 2011) and are key elements regarding the young generations' preparedness for life-long learning as a core-skill in knowledge-based societies. Motivation and interest development, especially in science, technology, engineering and mathematic (STEM) subjects, also determine adolescents' willingness to choose STEM-related career paths (Organisation for Economic Co-operation and Development, 2007).

Therefore, developing students' interest has to be a main educational objective for schools as well as individual teachers. Interested learners develop more differentiated domain-specific knowledge (Renninger, Hidi, & Krapp, 1992), are more focused and have better attention (Ainley, Hidi, & Berndorff, 2002), pursue mastery rather than performance goals (Harackiewicz, Durik, Barron, & Linnenbrink, 2008) and receive better grades than

uninterested learners (Schiefele, Krapp, & Winteler, 1992). However, interest in the subjects decreases significantly throughout secondary education (Eccles et al., 1993; Maulana, Opdenakker, & den Brok, submitted for publication). One reason frequently cited for this decrease is the mismatch between students' needs and classroom practices, especially during secondary education (Eccles et al., 1993).

For positive outcomes of motivated learning, it is the quality of motivation that is decisive (Ryan & Deci, 2000). Interest-based, self-determined forms of learning motivation provide the most favourable learning outcomes (Krapp, 2002; Krapp & Ryan, 2002). Yet, classroom interactions are often dominated by close-formatted classroom discourse (Jurik, Gröschner, & Seidel, 2013; Walshaw & Anthony, 2008; Wells & Arauz, 2006), with negative effects both on students' situational experiences of self-determined learning motivation and their long-term development of more stable orientations (e.g. interest in STEM subjects).

Despite debates about enriching teaching through diverse didactical methods, classroom discourse and verbal teacher–student interactions remain dominant in mathematics and science education (Roth et al., 2006). Typical for practices of classroom discourse is a questioning-developing teaching style in which the teacher dominantly steers the interactions. However, if teachers can actively engage their students in classroom discourse, they are likely to engage them in more meaningful and sustained learning experiences (Walshaw & Anthony, 2008). Therefore, changing

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students' classroom experiences into meaningful ones that develop their interests by changing the prominent routines of classroom interactions and discourse is important. Productive classroom discourse is a key aspect for students' development of interest in the subject.

To improve productive classroom discourse, video examples of classroom interactions are a promising tool for supporting teachers' analysis and reflection on classroom practices and interaction patterns (Tripp & Rich, 2012). Using video in TPD facilitates teachers' (emotional) involvement and makes them more invested in the learning process by activating prior knowledge, building practical knowledge and bridging the theory–practice gap (Santagata & Guarino, 2010).

### 1.1. Theoretical background

This study focuses on a video-based teacher professional development (TPD) intervention to foster teachers' skills leading to productive classroom discourse, which is compared with traditional TPD in the German context. We investigated the extent to which a newly developed intervention (Gröschner, Seidel, Kiemer, & Pehmer, 2014) positively affected teachers' practices as well as students' experiences of self-determined learning motivation and their development of interest in the subject. Thus, this study sheds light on the benefits of video-based TPD in comparison to more common practices of professional development in the German context (Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011), as well as on the importance of meaningful classroom discourse (specifically, teacher questioning and feedback) for students' situational and long-term motivational orientations.

#### 1.1.1. Classroom discourse and the role of questioning and feedback

Verbal teacher–student and peer interactions are major means to construct meaning (Mercer, 2010; Oliveira, 2010; Webb, 2009). Language use and interaction quality have important implications for students' learning processes and outcomes (Lipowsky, Rakoczy, Pauli, Reusser, & Klieme, 2007), active engagement, learning motivation and interest (Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009).

Walshaw and Anthony (2008) differentiate two major teaching strategies in productive classroom discourse: *clarifying discourse participation rights and responsibilities between the teacher and students*, where the objective is to engage students in classroom conversation, and *scaffolding students' ideas*, e.g. by giving individual feedback, in a productive way to move thinking forward. Several studies on mathematical argumentation and science inquiry point out the relevance of these activities in creating productive classroom discourse (Furtak, Seidel, Iverson, & Briggs, 2012; Kovalainen & Kumpulainen, 2005). The two activities can particularly be conceptualised through productive forms of teacher questioning and meaningful feedback (Jurik, Gröschner, & Seidel, 2014).

*Teacher questioning*: Meaningful patterns of teacher questioning leave room for students to explore and express their own understanding. Generally, questioning strategies such as using open questions have been shown to support student motivation and engagement through verbal discourse (Jurik et al., 2014).

*Teacher feedback*: Teacher feedback is deemed supportive of learning and motivation, not just when it informs students about the correctness ('yes', 'right') of a response, but especially when it includes information about what aspects of the response are correct ('You did a good job on that graph') or incorrect and how any flaws can be mended ('Try concentrating more closely on the transfer of electrons') or generally supports the learning process ('No problem. We will get everyone to understand that concept today') (Hattie & Timperley, 2007).

TPD programmes focussing on productive classroom discourse in STEM subjects are rare. By testing the effectiveness of an innovative TPD programme including its effects on students' motivation and interest (Desimone, 2009; Wilson, 2013), the present study breaks new ground in this line of research.

#### 1.1.2. Classroom discourse and learning motivation

To investigate whether an innovative TPD programme focussing on productive classroom discourse can affect students' motivation to learn, we draw on self-determination theory (Deci & Ryan, 1985, 2004) and person–object theory of interest (Krapp, 2002; Krapp & Prenzel, 2011) to frame the importance of productive classroom discourse for students' learning motivation. Interest is defined as a person's repeated engagement or focused attention on an object, determined by a specific relationship between person and object and shaped by interactions and the environment (Krapp, 2000; Renninger & Hidi, 2011). In self-determination theory (SDT) it is important that students perceive fulfilment of their basic psychological needs during instruction. In this situation, they are more likely to experience self-determined, intrinsic-learning motivation, and over time, these experiences are closely connected with a positive development of interest in the subject (Krapp & Prenzel, 2011). Even though the potential for interest lies within the person, content and interaction define the development of situational and individual interests (Hidi & Renninger, 2006). Thus, significant others, the organisation of the environment and a person's inner motivational resources can support interest development (Renninger & Hidi, 2002; Sansone & Smith, 2000).

SDT proposes that a person's motivation depends on the fulfilment of three basic psychological needs: autonomy, competence and social relatedness. The fulfilment of these needs depends on a person's interpretation of the social context—whether the functional significance of a situation is controlling or informational (Ryan & Deci, 2002). Motivation is conceptualised as a situational construct dependent on a person's moment-to-moment experiences and the interpretation. By changing students' moment-to-moment classroom experiences, e.g. through productive classroom discourse, their need for autonomy, competence and social relatedness is repeatedly fulfilled, leading to self-determined-learning motivation. Thus, teachers can create repeated instances of triggered situational interest (Hidi & Renninger, 2006; Krapp, 2005; Renninger & Hidi, 2011) using teaching strategies that promote productive classroom discourse.

Grounded in the situational beneficial effects of productive classroom discourse on students' self-determined-learning motivation, we presume that prolonged positive experiences with basic psychological need support and the resulting motivational outcomes (intrinsic learning motivation) will crystallise in the more enduring motivational orientation of interest in the subject (Fig. 2). The TPD programme in this study aims at improving teachers' skills of creating productive classroom discourse, which should lead to positive changes in self-determined-learning motivation through repeated instances of basic need fulfilment and thus to positively developing students' interest in the subject.

In conceptualising a study design that measures students' situational experiences at multiple points in time as well as their overall development over the course of a school year, we aim to combine these two stances on students' learning motivation to shed more light on the importance of day-to-day classroom experiences and the learning environment for students' development of self-determined-learning motivation and interest in the subject. Furthermore, we investigate whether TPD programmes can help teachers counter students' decreases in learning motivation and interest throughout secondary school (Turner, Warzon, & Christensen, 2011).

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