



Technische Universität München
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Productive Classroom Talk and Motivational Learning Outcomes in Students

*A Video-Based Intervention Study on the Effectiveness of a Teacher
Professional Development Programme*

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For my grandma

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Abstract

The teaching script ‘classroom talk’ dominates German mathematics and science classrooms. Despite research for more than four decades attesting to its negative effects on student learning outcomes, teachers more often than not ask questions that foster reproduction of knowledge and provide students only with short, corrective feedback. Such classroom talk is described as tight and narrowly focused. At the other end of the spectrum, *productive classroom talk* is characterised as collective, reciprocal, supportive, cumulative and purposeful, which engages students in a process of ‘thinking aloud’ and shows positive effects on their learning. With this situation in mind – and the aim of changing the status quo in most German mathematics and science classrooms – the Dialogic Video Cycle, an evidence-based teacher professional development programme working strongly with video-based reflection on teaching practices, was developed and implemented during the school year 2011/2012. The programme was compared to traditional forms of professional development.

This dissertation examines how participation in the Dialogic Video Cycle affected teachers’ facilitation of classroom talk A) on the level of *individual talk turns* (open vs. closed questions; simple vs. constructive feedback) and B) on the level of instructional quality in the form of *supportive discourse* (instructionally and motivationally supportive discourse). Furthermore, it examines *learning processes* during such changed classroom talk (perceptions of autonomy and competence support; basic psychological need fulfilment) and *situational* as well as *long-term effects* on student learning motivation (intrinsic motivation; interest in the subject). Within a longitudinal design, teachers’ facilitation of classroom talk was measured repeatedly through video observation, while information on students’ perceptions and motivational orientations were gathered via self-report measures at multiple occasions. The results indicate that participating teachers’ facilitation of classroom talk developed positively compared to the control group. Herein, changes to feedback as a reactive teaching practice are more pronounced than those to teacher questions, which are often seen by teachers as a vital tool to navigate and control the lesson (Essay 1). Teachers’ instructional quality in the form of instructionally and motivationally supportive classroom discourse also significantly benefited from their participation (Essay 2). Overall, students’ response to this changed social context was positive, resulting in significant increases in basic psychological need fulfilment, intrinsic learning motivation and interest in the subject during the school year. Furthermore, results of this dissertation indicate that these positive learning outcomes in students can partially be put down to students’ perception of such classroom talk being more supportive of their basic psychological need for autonomy and competence (Essays 1 and 2).

In summary, this dissertation delivered results regarding systematic effects within a comprehensive examination of the Dialogic Video Cycle. Through a longitudinal mixed-methods approach, the dissertation adds to research on effective teacher professional development and the benefits of productive classroom talk for motivational student learning outcomes.

1. Rationale for the Dissertation

1.1. The Current Situation in German Classrooms

In research on teaching and learning, a relatively new approach has been the description of teaching and learning situations in the form of scripts (Kolodner, 2007; Seidel, 2003a). Scripts refer to internal knowledge structures that have been established through repeated engagement with a certain situation and which influence individuals' understanding of – and behaviour within – that situation. In the context of teaching and learning scripts are representations of typical learning goals, teaching sequences, activities and roles within the teaching and learning process (Kollar & Fischer, 2008).

Since the early findings in the context of TIMSS 1999 (Stigler, Gonzales, Kwanaka, Knoll, & Serrano, 1999; Stigler & Hiebert, 1999; Hiebert, 2003) about dominant teaching scripts in German and Swiss mathematics and science classrooms – a questioning-developing classroom talk – multiple research has been carried out, either mapping the terrain (Hugener, Pauli, Reusser, Lipowsky, Rakoczy, & Klieme, 2009; Jurik, Gröschner, & Seidel, 2013; Lipowsky, Rakoczy, Pauli, Drollinger-Vetter, Klieme, & Reusser, 2009; Pauli & Reusser, 2003; Seidel & Prenzel, 2006; Seidel, 2003a) or conducting attempts to change the current practice (Krammer, Schnetzler, Ratzka, Klieme, Lipowsky, Pauli, & Reusser, 2010; Krammer, Ratzka, Klieme, Lipowsky, Pauli, & Reusser, 2006; Ostermeier, Prenzel, & Duit, 2010).

Such teaching scripts are conceptualised at the level of surface, as well as in deep structures (cf. Pauli & Reusser, 2003; Seidel & Prenzel, 2006). Surface structures are visible to an outsider and relate to aspects such as the organisation of classroom events, teaching methods, and talk format. A surface structure can be enacted in different ways triggering different teaching and learning processes as well as learning outcomes (Kunter & Trautwein, 2013). In the context of this dissertation the surface structure of *classroom talk* was analysed. Different enactments of this surface structure are detailed in Section 3. For the characterisation and assessment of deep structures (teaching and learning processes) multiple frameworks have been put forward (e.g., Chi, 2009; Helmke, 2012; Kunter & Trautwein, 2013). In the context of this dissertation multiple of these frameworks are synthesised to arrive at a deeper understanding of the processes during whole-class discussions and its connection to motivational student learning outcomes. In this synthesis the deep structure of classroom talk is perceived of as layered with visible, *external teaching activities* such as teacher questioning and feedback at the top level. This level – meaning these teaching activities – are indicative of (*internal teaching processes* such as scaffolding students' ideas or activating students (Walshaw & Anthony, 2008). Lastly, these internal teaching processes determine the instructional quality of a lesson in the form of constructive learning support, cognitive activation, and classroom management (e.g. Klieme, Schümer, & Knoll, 2001; Klieme, 2006; Klieme & Rakoczy, 2008).

The dimensions of instructional quality can also be applied to assess the quality of (internal) teaching actions and make assumptions as to their effects on student learning outcomes. Furthermore, external teaching activities like type of questions asked by the teacher (e.g., Jurik, Gröschner, & Seidel, 2013) or the kind of feedback provided by the teacher (e.g., Hattie & Timperley, 2007) are indicators of students' *internal learning processes*. Depending on the teaching activities, internal student learning processes can span from more *passive* activities (like listening to the teacher's instruction) to *interactive* activities (like debating with a classmate and building on shared knowledge; Chi, 2009). Deep structures also indicate teachers' subjective theories and beliefs about teaching and learning (Baumert, Blum, & Neuband, 2004; Knoll, 2003; Pauli & Reusser, 2003).

Despite more than a decade of research, the situation in most German classrooms is more or less unchanged. Recent results from the context of PISA have shown that particularly learning support as a feature of instructional quality is significantly less pronounced in German mathematics classrooms when compared to the OECD mean. Students report receiving feedback only rarely and that the instruction they experience is not very student-centred (Schiepe-Tiska, Reiss, Obersteiner, Heine, Seidel, & Prenzel, 2013). Teacher-student interactions are often tightly focused short exchanges (Jurik, Gröschner, & Seidel, 2013) that seem to mirror teachers' primary concern with completing the lesson and not student understanding (Fischler, 1994; Putnam, 1987). This dominance of the teacher shows in external teaching and learning activities such as closed questions, single-word student answers and very few student questions (Kobarg & Seidel, 2007). The regulation of the conversation is teacher-centred and student-student interactions are rare (Seidel & Prenzel, 2006). Such talk gives only limited opportunity for cognitive activation and constructive learning support – external teaching activities fail to trigger high-quality teaching processes which result in high instructional quality. Yet, research has also shown that similar teaching scripts (on the surface level) can be enacted both unproductively and productively (Dalehefte, 2007).

Given this situation, the promotion of *productive* classroom talk as a different and more effective teaching script becomes a pressing concern for educational research. To provide teachers with a new, *external script* for their teaching (Kollar, Fischer, & Hesse, 2006) and train them in its use, this dissertation took the approach of long-term professional development for teachers in secondary mathematics and science classrooms. In order to do so, state-of-the-art research on teacher professional development (e.g., Desimone, 2009; van Veen, Zwart, & Meirink, 2012; Wilson, 2013) was considered to develop a long-term, evidence-based approach called the *Dialogic Video Cycle*. The Dialogic Video Cycle was developed and empirically tested within the research project 'Dialogue' (Gröschner et al., 2015a, 2015b), funded by the German Research Foundation (DFG, SE 1397/5-1). This dissertation uses data from this project to analyse independently developed research questions.

1.2. The Current Situation of Teacher Professional Development in Germany

Much of the research on professional development in Germany and German-speaking countries is quite dated (see Richter, Kunter, Anders, Klusmann, Lüdtke, & Baumert, 2010); more recent projects are more scarce (e.g. Krammer, Schnetzler, Ratzka, Klieme, Lipowsky et al., 2010; Lipowsky, 2010; Ostermeier, Prenzel, & Duit, 2010; Richter, Kunter, Klusmann, Lüdtke, & Baumert, 2011; Richter, Engelbert, Weirich, & Pant, 2013), hence we know only little about its effectiveness and the learning opportunities teachers engage in throughout their career (Corcoran, 2007). International research endeavours produced evidence regarding effective components for teacher professional development: *content focus, active learning, collective participation, duration and coherence* (Desimone, 2009; van Veen et al., 2012; Wilson, 2013). Moreover, from research on training transfer it is known that the motivation for transfer is essential for practice changes to occur (Gegenfurtner, Veermans, Fenster, & Gruber, 2009) and that transfer is more successful for programmes which are more learner than content-centred (Gegenfurtner, 2011).

In many German states, teachers are not required to attend teacher professional development to develop their practice or renew their licence (Avenarius & Heckel, 2000). Still, most teachers engage in professional development (81.2%); on average for about 35 hours in a 3.5-year period (Richter et al., 2010). Similar findings were also reported in the national PISA teacher sample from 2006 (Frey, Taskinen, Schütte, Prenzel, Artelt, Baumert et al., 2009). In Bavaria (which forms the administrative context for the following research), teachers are required by law to participate in teacher professional development as part of their profession (Art. 20 Abs. 2 BayLBG)¹. The minimum is twelve days in a four-year period (one day consists of at least five hours for 60 minutes). Research shows that while 68% of primary teachers in Bavaria attend five or more professional development activities in a period of two years, there are also 13% attending none in the same period of time (Richter & Klein, 2013). For Bavaria, the median of time spent in professional development activities per year is 17.5 hours (Richter, Kuhl, Reimers, & Pant, 2012). School administrations plan and supervise teacher participation in professional development as part of their school and personnel development activities. Generally, teacher professional development is provided from four ‘directions’: centrally from the federal state, regionally by the districts, locally by school boards or on-site by the school itself. Only in recent years did university-based teacher professional development enter the picture; as a measure to support teachers’ life-long professional learning, as well as to introduce state-of-the-art educational knowledge to practice. Non-university provided teacher professional development most often comes in the form of one-day to full-week workshops (Richter et al., 2011) centering on, for instance, content knowledge, pedagogical content knowledge or pedagogical-psychological knowledge (Shulman, 1986). The uptake of these learning opportunities varies across one’s life span, with a peak around mid-career. High work engagement and additional responsibilities (e.g., guidance councillor, information officer, etc.) predict the engagement in formal learning opportunities positively (Richter et

¹ Art. 20 Abs. 2 Bayerisches Lehrerbildungsgesetz (BayLBG)

al., 2011). Teachers who show high participation in professional development are also characterised by high self-efficacy beliefs and strong cooperation with other faculty members (Richter et al., 2013).

The three-year project within which this dissertation is situated sought to support teachers to redefine their classroom talk towards a more productive teaching script. The approach taken was that of a year-long, video-based professional development programme with secondary mathematics and science teachers. In the design of this teacher professional development programme – the *Dialogic Video Cycle* – effective components of teacher professional development (Desimone, 2009; van Veen et al., 2012; Wilson, 2013) were carefully considered and implemented (Gröschner, Seidel, Kiemer, & Pehmer, 2015). For a rigorous test of its effectiveness and to advance the field of research on teacher professional development, the Dialogic Video Cycle was compared to a more traditional programme (control group), which reflects the common practice of professional development in the federal state of Bavaria.

1.3. The Use of Video as a Tool for Research and Learning

Due to new developments regarding digital technology and software (Pauli & Reusser, 2006) the use of video in educational research has become increasingly common (e.g., Andersen & Nielsen, 2013; Doll & Prenzel, 2004; Goldman, Pae, Barron, & Sharon, 2007; Helmke & Jäger, 2002; Hiebert, 2003; Jurik, Häusler, Stubben, & Seidel, 2015; Klieme & Reusser, 2003; König, Blömeke, Klein, Suhl, Busse, & Kaiser, 2014; Odegaard, Haug, Mork, & Sorvik, 2015; Pfister, Opitz, & Pauli, 2015; Prenzel, Seidel, Lehrke, Rimmel, Duit, Euler, et al., 2002; Roth, Druker, Garnier, et al., 2006; see also Gaudin & Chaviés, 2015 for an overview of video-use in teacher education and professional development). Though demanding in their realisation and analysis, video studies come with specific advantages:

(1) In contrast to large-scale studies which provide information on the macro-level of a school system or a population with the help of student or teacher self-reports, video studies can provide process data from a more objective perspective (Pauli & Reusser, 2006); (2) Video footage, such as that of classroom interactions, is very rich in data and can be analysed from a variety of different perspectives and with different analysis frameworks (Petko, Waldis, Pauli, & Reusser, 2003) and thus (3) integrate micro-analyses (e.g., in the form of case studies; Klieme & Thußbas, 2001; Schindler, Gröschner & Seidel, 2015) and macro-analyses (e.g., in the form of video surveys; Stigler, Gallimore, & Hiebert, 2000). (4) Furthermore, with the separation of observation and analysis (in difference to in situ observations) the complexity of classroom teaching and learning becomes manageable, while data quality is not hampered due to observers limited capacity of attention and concentration. Moreover, measurement quality can be much better monitored in the form of inter-coder agreement analysis (Pauli & Reusser, 2006) or studies on observer agreement and the stability of features of instructional quality (Praetorius, Lenske, & Helmke, 2012; Praetorius, Pauli, Reusser, Rakoczy, & Klieme, 2014). (5) It lends itself to repeated analyses, such as in the form of re-analyses of data from previous studies

(e.g., Jurik, Gröschner, & Seidel, 2013, 2014; Kunter, 2005) with the advantage that data from multiple studies can be integrated and additional comparisons achieved (e.g., Dalehefte, 2007). (6) Video studies allow for the much called for integration of qualitative and quantitative research methods (Johnson & Onwuegbuzie, 2004; Mayring, 2001; Renkl, 1999), as well as innovative approaches like stimulated recall (Clarke, 2001).

In the 'Dialogue' project video footage of classroom teaching and learning was used to describe teachers' facilitation of classroom talk during periods of whole-class discussions, as well as track changes in this behaviour over the course of a school year. Furthermore, due to the simultaneous collection of student self-report data on their perceptions of the classroom environment, learning processes and aspects of learning motivation (such as self-concept of ability, self-efficacy and interest in the subject), these descriptions of teaching processes could be connected to learning processes in students to track relationships between teacher actions and student learning (e.g., Kiemer, Gröschner, Pehmer, & Seidel, 2014). The theoretical backdrop of such examinations are Utilisation-of-Learning-Opportunities Models (cf. Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014), which focus on the processes during classroom instruction that connect teachers' provision of learning opportunities with students' use of such opportunities and the corresponding learning outcomes (Pauli & Reusser, 2006; see Section 7).

The documentation of real-life teaching and learning during classroom instruction is not only a positive development in terms of research; they provide a vast case library (Schank, 1982) that can be used for teacher education and professional development. In this context Pauli and Reusser (2006) outline three functions of videos for teacher learning: (1) videos as a point of reference to develop a shared professional language and transfer findings from research into practice; (2) videos as a tool for professional reflection to build professional knowledge and a critical awareness of quality teaching; and (3) videos as cases as used, for example, in medicine. In recent research on teacher professional development, the use of video (own or other) as a tool for reflection has become prominent and shown as a successful approach to integrate theory and practice (e.g., Borko, Jacobs, Eiteljorg, & Pittman, 2008; Santagata, 2009; Sherin & van Es, 2009; see Section 7.4). During the Dialogic Video Cycle teachers were filmed in their classrooms orchestrating whole-class discussions. The video material was then in subsequent workshops used as tool for reflection (Function 2). Teachers engaged in case-based reasoning (Schank, 1982); with the help of a facilitator they built an understanding on the strategies involved in productive classroom talk and their successful application (Section 7.5).

1.4. Aims and Scope of the Dissertation

Most of the research in the last decades involved with classroom talk has focused on describing dominant teachings scripts and variations therein. In Howe and Abedin's literature review, more than two-thirds of the studies fall into this category (Howe & Abedin, 2013). After establishing this important basis of the status quo concerning classroom talk and definitions and conceptualisations of

future goals (see Section 3.1 and 3.2), it is now time to examine ways through which productive classroom talk can be proliferated more densely in our classrooms. Current research attempts this through a variety of ways (see Resnick, Asterhan, & Clarke, 2015 for an overview); including specific professional development approaches (e.g., Michaels & O'Connor, 2015, Sedova, Sedlacek, & Svaricek, 2016). In addition to a strong focus on descriptive analyses in previous literature on classroom talk, research has also been mostly restricted to reviews looking at the effects of classroom talk in terms of student achievement (Howe & Abedin, 2013). This dissertation takes up this two-fold challenge left by previous research by analysing the effectiveness of a professional development programme (the Dialogic Video Cycle) with the aim to support teachers in redefining their classroom talk on the levels of changed teacher practice and motivational student learning outcomes. To this purpose, the literature on classroom talk and present current approaches to scaling productive classroom talk are reviewed. Furthermore, the theoretical frameworks of Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000) and Person-Object-Theory of Interest (Krapp, 2002) are outlined and connected to productive classroom talk within current frameworks of instructional quality (e.g., Klieme, Schümer, & Knoll, 2001; Kunter, Dubberke, Baumert, Blum, Brunner, & Jordan, 2006; Prenzel, Seidel, Lehrke, Rimmele, Duit, Euler et al., 2002; Seidel, Rimmele, & Prenzel, 2005), and here particularly constructive/process-oriented learning support. Furthermore, the design of the Dialogic Video Cycle as well as its theoretical underpinnings and how it relates to teacher learning are outlined. This is contrasted to other currently available programmes offering professional development on classroom talk.

The empirical part of the thesis examines the effectiveness of the Dialogic Video Cycle in terms of changed teacher practice and motivational student learning outcomes in two studies. To this end, teachers were accompanied through a year-long professional development programme and video-taped multiple times during instruction; careful video analyses of teachers' facilitation of classroom talk were conducted and related to student self-reports. In doing so, the dissertation uses a mixed-methods approach capable of connecting external teaching activities with internal learning activities, as well as analysing underlying processes (Pauli & Reusser, 2006). Based on state-of-the-art research on teacher learning and professional development (e.g., Clarke & Hollingsworth, 2002; Desimone, 2009; Guskey, 2002; van Veen et al., 2012; Wilson, 2013), it was hypothesised that, in comparison to a control group, teachers in the Dialogic Video Cycle would learn more and revise their dominant teaching script as to arrive at a practice more aligned with current research on productive classroom talk (based on the activities delineated in Walshaw & Anthony, 2008: *clarifying discourse participation rights and responsibilities* and *scaffolding students' ideas to move thinking forward*). In Study 1 these changes were connected to students' moment-to-moment (situated) experiences of motivational learning outcomes (basic psychological need fulfilment and intrinsic learning motivation) and their connection to more dispositional outcomes in the form of interest in the subject. For Study 2 students' perceptions of autonomy and competence support were used as indicators for internal student learning processes

Rationale for the Dissertation

(as an element of these deep structures, particularly constructive learning support), and their relationship to situational motivational learning outcomes (experienced self-determination and intrinsic learning motivation) was examined. Through this, the dissertation aims to analyse the deep structures of student learning within productive classroom talk.

Two overarching questions guided the present dissertation and were pursued in these two studies. These guiding questions were:

- *In the course of one school year, to what extent do teachers in the Dialogic Video Cycle (intervention group) change their classroom talk positively, when compared to a control group?*
- *To what extent are motivational student learning outcomes (interest in the subject, intrinsic learning motivation, and basic psychological need fulfilment) affected by teachers' changed classroom talk practice?*

Detailed research questions and hypotheses are provided further down in the summary of the studies (Sections 10 and 11), alongside the theoretical rationale underpinning them. In part, the results presented here have already been published (Kiemer, Gröschner, Pehmer, & Seidel, 2015) or have been submitted for publication (Kiemer, Gröschner, Kunter, & Seidel, accepted). In the following, the theoretical backdrop of these examinations is presented (Sections 2 to 7), as well as a summary of the respective studies (Section 10 and 11), followed by a summary of the results and a general discussion (Section 12).

2. Teaching Scripts in Educational Research

This section aims to describe the typical use of classroom talk in German mathematics and science classrooms. In doing so, it is drawn on the concept of scripts (Schank & Ableson, 1977) in order to provide a comprehensive description of typical teaching patterns. In research on teaching and learning scripts, they have become popular forms of describing common teaching patterns in a holistic and comprehensive way (e.g., Kollar & Fischer, 2008; Seidel & Prenzel, 2006; Seidel, 2003a; Stigler & Hiebert, 1999). Furthermore, a distinction is made between *internal* scripts (held by an individual) and *external* scripts (provided as instructional support; Kollar, Fischer, & Hesse, 2006), drawing on research on collaborative learning and the *Script Theory of Guidance* (Fischer, Kollar, Wecker, & Stegmann, 2013) to describe ways in which external scripts can support change of rigid patterns of teaching and professional learning.

2.1. The Concept of Teaching Scripts

In cognitive psychology the term *script* describes a form of memory structure. It is a schema for events that follow a more or less strict sequence of steps (Schank & Abelson, 1977). Within any given script (e.g., visiting a restaurant, going grocery shopping, conducting a business meeting), subroutines and roles are defined, which help navigate those events. Though providing relatively stereotypical information about situations and events, scripts are dynamic and can be reconfigured in relation to personal experiences with such situations. Scripts can be conceptualised as part of a person's procedural knowledge (Anderson, 1992) and are as such not easily accessible in terms of externalising the knowledge. Their retrieval and application happens mostly automatic and often non-consciously.

In more recent years, the script concept has also been used to describe reoccurring, stereotypical teaching practices (e.g., Gruber, Prenzel, & Schiefele, 2001; Hugener, 2008; Hugener et al., 2009; Kollar & Fischer, 2008; Pauli & Reusser, 2003; Seidel & Prenzel, 2006; Seidel, 2003a; Stigler & Hiebert, 1999). This form of description as a meaningful sequence of subroutines and roles within the script has been helpful for describing the complexities of teaching and learning – instead of only looking at single indicators – and produced an understanding for culture-specific teaching patterns within different countries (Stigler & Hiebert, 1999). It describes teaching in a formalised manner as a sequence of different activities. With the beginning of primary school, students learn how 'doing school' works and what is expected of their role as a student (e.g., to be silent when the teacher or someone else talks, to be attentive, to raise one's hand before speaking, etc.). This forms the basis of their 'school script'. More refined, students acquire a concept of the different kinds of lessons: experiments in chemistry, reading primary sources in history, repeating vocabulary in English or running around the track in physical education. Moreover, with experience, students and teacher establish routines for their teacher and class-specific lessons together. These *teaching scripts* are shared between teacher and students and can be specific to that classroom culture. Furthermore,

teaching scripts also include shared beliefs about teaching and learning, such as valued activities or classroom goal structures, as well as the role definitions of teacher and students.

It is important to note that scripts only describe the different activities that make up an event, such as a mathematics lesson. It has no direct implication for the learning processes within these different steps. The activities within a teaching script can be seen as different opportunities for learning, which vary in quality depending on how they are realised, not because of the activity itself (Dalehefte, 2007; Seidel & Prenzel, 2004). Hence, the same activity, like opening a lesson, can be conducted as a high-quality learning opportunity (e.g., if it requires transferring prior knowledge to new scenarios, asks students to come up with their own ideas or orients students towards a problem) or a low-quality learning opportunity (e.g., if it requires only repetition, leaves some students unattended or fails to provide them with a meaningful explanation as to why students should engage in the topic).

Also, it needs to be noted that though research could show that while teaching scripts describe common, culturally shared teaching patterns, there can be more than one teaching script prevalent within a community (Pauli & Reusser, 2003; Pauli, Reusser, Waldis, & Grob, 2003). Furthermore, it could be shown that the same teaching script can be implemented very differently, depending on the level to which it adheres to different dimensions of teaching quality (Dalehefte, 2007). The teaching script focused upon in the context of this dissertation is that of *classroom talk* (Section 3), for which different implementation forms (productive vs. unproductive) have been established in prior research (e.g., Alexander, 2005, 2008, 2010; Chi & Meneske, 2015; Christoph & Nystrand, 2001; Howe & Abedin, 2013; Kluger & DeNisi, 1996; Kobarg & Seidel, 2007; Lefstein, 2006; Lyle, 2008; Mercer & Dawes, 2014; Michaels, O'Connor, & Resnick, 2008; Resnick, Michaels, & O'Connor, 2010; Walshaw & Anthony, 2008). In order to conceptualise why so-called 'productive' classroom talk is supportive of student learning outcomes, in the following it will be linked to aspects of instructional quality (Section 4).

The term script has also been used in another area of educational research – research on collaborative learning. In this field of study, so-called *collaboration scripts* (Dillenbourg, 2002; Dillenbourg & Jermann, 2007; Fischer et al., 2013; Kollar & Fischer, 2008; Rummel & Spada, 2005; Weinberger, Ertl, Fischer, & Mandl, 2005) have been used successfully to enhance learning in groups. In difference to the scripts mentioned so far, collaboration scripts are seen as *external scripts*, which are not yet shared by the community, but provided from an external source in order to coordinate and regulate the process of learning in groups. As such, external scripts can be seen as prompts or scaffolding methods in as much as they guide the learning process.

2.2. Classroom Talk as a Teaching Script

Research on teaching and learning established characteristic teaching scripts in different countries (e.g., Segal & Lefstein, 2015; Stigler & Hiebert, 1999). For German mathematics and science classrooms, *classroom talk* has been shown as the dominant teaching script (Hiebert, 2003; Seidel & Prenzel, 2006). Within this classroom talk, the teacher-student interchanges have been characterised as tightly focused short exchanges with a strong focus on the teacher that follow a pre-structured design (Alexander, 2005, 2008; Asterhan & Schwarz, 2016, 2007; Graesser & Person, 1994; Kobarg & Seidel, 2007; Mehan, 1979; Lemke, 1990). The purpose of these interchanges is less one of fostering students' understanding than that of propelling the lesson forward to arrive at a pre-planned end (Jurik, Gröschner, & Seidel, 2013). *Productive classroom talk*, on the other hand, is teacher-student or student-student interactions that support learning and reasoning (Emanuelsson & Sahlström, 2008; Kovolainen & Kumpulainen, 2005; Mercer, 2008). Such teaching scripts can be conceptualised, both on the level of *surface structures* as well as on the level of *deep structures* (cf. Pauli & Reusser, 2003; Seidel & Prenzel, 2006).

On the level of surface structures, the dominance of the teacher in traditional classroom talk features in closed questions, single-word student answers and very few student questions (Chin, 2006; Kobarg & Seidel, 2007; Mercer & Howe, 2012). The talk is lacking a *dialogic stance* (Lotman, 1988); instead it is structured as a sequence of teacher test-questions that support reproduction (Reznitskaya, 2012). This teaching script is strongly asymmetrical with the teacher in the role of initiator and controller of the interactions, while at the same time student-student interactions are scarce and mostly perceived as a didactical variation (Howe, 2009; Seidel & Prenzel, 2006). In such classroom talk students have only limited possibility to shape the communication (Wells, 2009).

On the level of deep structures, traditional classroom talk can be described as teacher-centred. As a consequence, the talk becomes monologic (Lotman, 1988), meaning as well that it only represents one opinion or perspective – the teacher's. This also means that students only have a small say in the design and execution of learning processes – hence, they are not equal partners (Wells & Arauz, 2006) but mere stooges (Jurik et al., 2013). In such an environment, scientific argumentation or the co-construction of knowledge is almost impossible to realise, while it would be such learning activities that promote deep-level understanding in students (Alexander, 2005, 2008, 2010; Asterhan & Schwarz, 2016; Chi, 2009; Mercer, Wegerif, & Dawes, 1999; Resnick, Michaels, & O'Connor, 2010; Webb, Franke, Ing, Wong, Fernandes, Shin, & Turrou, 2014). The definition of teacher and student role in traditional classroom talk ascribe them very different responsibility and ownership over the learning process, resulting in asymmetrical power structures; rendering such classroom talk pressuring and controlling for students (Wells, 2009). Research shows that this teaching script has negative effects for students' deep-level learning and conceptual understanding (Alexander, 2008; Mercer, 2010; Reznitskaya, 2012), as well as their learning motivation (Seidel, Rimmel, & Prenzel, 2003).

This dissertation wants to make the argument, that this is the case because on the level of deep structures traditional classroom talk often fails to address dimensions of instructional quality, such as *cognitive activation*, and more so *constructive learning support* (Section 4.1).

Notwithstanding these findings, classroom talk can be facilitated in a high-quality way and provide meaningful learning opportunities that promote positive learning outcomes in students (Alexander, 2005, 2008, 2010; Asterhan & Schwarz, 2016; Chi & Meneske, 2015; Christoph & Nystrand, 2001; Furtak, 2006; Howe & Abedin, 2013; Kluger & DeNisi, 1996; Kobarg & Seidel, 2007; Lefstein, 2006; Lipowsky, Rakoczy, Pauli, Reusser, & Klieme, 2007; Lyle, 2008; Mercer & Littleton 2007; Mercer & Dawes, 2014; Michaels, O'Connor, & Resnick, 2008; Pehmer, 2015; Resnick, Michaels, & O'Connor, 2010; Seidel & Prenzel, 2006; Walshaw & Anthony, 2008). Descriptions of such productive classroom talk vary (see Section 3.1), but they share important core features (e.g., Asterhan & Schwarz, 2016; Resnick, Asterhan, & Clarke, 2015; van der Veen, van Kruistum, & Michaels, 2015). In his seminal work R.J. Alexander (2008) described 'productive' classroom talk as *collective, reciprocal, supportive, cumulative* and *purposeful*. Further important aspects are that students have opportunities to express their own ideas and hypotheses, hear other points of view, argue, reason and receive feedback from their teachers, which engages them in a process of 'thinking aloud' (Dawes, 2004; Myhill, Jones, & Hopper, 2005; van der Veen et al., 2015). Productive classroom talk is not based on a simple prescriptive model but it involves people providing arguments based on validity and not power claims (Alexander, 2005). Hence, in productive classroom talk students' voice is clearly audible and they share in control over the learning process with the teacher, which brings with it ownership and responsibility. All these features of productive classroom talk pertain to the level of deep structures, suggesting that productive classroom talk is less a specific teaching script and more an attitude towards teaching, learning and students. Kachur and Prendergast (1997) conclude that it is the classroom culture of taking students seriously that leads to student engagement and participation in dialogic exchanges and overrides possible negative surface structures such as teacher test questions and single-word answers. In consequence, such surface structures can be implemented productively (or unproductively), depending on the extent to which deep structures are salient (Dalehefte, 2007). Similar findings on the importance of deep structures have been obtained in other research on classroom talk as well (e.g., Boyd & Rubin, 2006; Christoph & Nystrand, 2001).

Research on productive classroom talk shows that verbal interaction between teacher and student as well as between student and student is one of the major ways of constructing meaning during instruction (Mercer, 2010; Michaels, O'Connor, & Resnick, 2008; Webb, 2009). The use of language and the quality of interactions have important implications for students' learning processes and learning outcomes (Lipowsky et al., 2007; O'Connor, Michaels, & Chapin, 2015), and their active engagement (Seidel & Prenzel, 2006). Many studies reporting on the relation between classroom talk and student's learning or development only take student's subject matter knowledge or their reasoning

skills into account (van der Veen et al., 2016). Much remains unknown about the benefits of productively organised classroom talk for the development of students' motivational learning outcomes. Yet, there is initial evidence that such classroom talk is associated with positive outcomes in the domains of intrinsic learning motivation and interest development (Andersen & Nielsen, 2013), as well as achievement behaviours (Turner, Midgley, Meyer, Gheen, Anderman, & Kang, 2002).

According to a recent review on classroom talk by Howe and Abedin (2013), there is a lack of empirical evidence to decide 'whether certain modes of organization are more beneficial than others' (p. 325) as most of the studies on classroom talk are qualitative in nature. Howe and Abedin suggest, 'it is time to take risks' (p. 346) and complement this body of research with quantitative studies. Besides, most studies on classroom talk focus on dialogue in small-group contexts. As many teachers struggle to orchestrate classroom discussion in whole-class settings, it is worthwhile to investigate how productive classroom talk can be transferred to whole-class contexts (van der Veen, de Mey, van Kruistum, & van Oers, 2016). The studies presented in this dissertation address these gaps in research on productive classroom talk by examining motivational learning outcomes during whole-class classroom talk in a longitudinal, quasi-experimental design with a mixed-method approach.

Orchestrating productive classroom talk in whole-group discussions is a complex endeavour in which teachers have to manage many things at the same time (O'Connor, Michaels, & Chapin, under review; van der Veen et al., 2016). Teacher professional development programmes which aim to promote teachers' skills in productive classroom talk and to help them to redefine their teaching scripts are currently growing in number (e.g., Davies, Kiemer, & Meissel, under revision; Higham, Brindley, & van de Pol, 2013; Michaels & O'Connor, 2012; Sedova, Sedlacek, & Svariceck, 2016; van der Veen et al., 2016). In the intervention presented in this dissertation, productive classroom talk was framed according to Walshaw and Anthony (2008): *Clarifying discourse participation rights and responsibilities to set up student verbal engagement and scaffolding students' ideas in order to move thinking forward*. These two teaching activities were appropriated for teachers in the workshops through different teaching activities such as the use of high-quality feedback (Dawes, 2004; Hattie & Timperley, 2007; Myhill, Jones, & Hopper, 2005), using errors as opportunities for learning and understanding students' misconceptions (Furtak, Kiemer, Swanson, De Léon, Circi, Morrison, & Heredia, 2016; Turner et al., 2002), being clear on learning goals (Turner et al., 2002; Seidel, Rimmele, & Prenzel, 2005), activating and encouraging all students to take part in the conversation, and scaffolding their developing ideas (Furtak, Morrison, Iverson, Ross, & Heredia, 2011; Michaels & O'Connor, 2012; Walshaw & Anthony, 2008). The thesis looks at productive classroom talk on a very fine-grained level in the form of teacher questioning and feedback (single-talk turn) and a more qualitative and holistic level, considering the instructional and motivational support of the talk.

2.3. Measuring Teaching Scripts – Advantages of Video Studies

To access individual's scripts, recent research has used the structure formation technique (Scheele & Groeben, 1988) in interview settings (e.g., Beltermann, Wessels, Kollar, & Fischer, 2015). Here, an interviewee is provided with a number of cards that represent different possible steps within a given script. They are asked to choose the ones that apply to their scripts and are given the option to include further steps on blank cards. Once all necessary steps are represented properly, the interviewee is asked to order them and provide explanations and further detail on the steps and sequencing. The interviewer supports this process by probing for further explanations and guiding the interview (Scheele & Groeben, 1988).

A variant of this technique has also been used to extract student teachers' internal scripts of prototypical lesson sequences (Fischer, 2016). Though this approach holds promise for the reconstruction and understanding of individuals' internal scripts, there are also some inherent problems. In most studies an interview setting is used, bringing with it the problem of high time-intensity for data gathering. Furthermore, with scripts being part of a person's procedural knowledge (Anderson, 1992), it can be difficult for them to reconstruct it, providing possibly only partial information. Moreover, there is no guarantee that the internal script in a person's dynamic memory will be the one enacted in the classroom. Consequently, such an approach to teaching scripts is ill-suited if the interactions between classroom events and students' learning outcomes are of interest.

A second approach uses stimulated recall (Bloom, 1953; Clarke, 2001) to enter an individuals' mind. This approach has successfully been used to analyse teachers' cognitions, beliefs and decision-making processes (e.g., Kagan, 1992; Shavelson & Stern, 1981). As 'a method for retrieving memories' (Bloom, 1953, p.161) it seems to be 'a valuable source of information on the teacher's theory of action' (Marland & Osborne, 1990, p. 94). Similarly to the structure formation technique, stimulated recall also depends on the accessibility of teachers' procedural knowledge/memory when prompted and only accesses the *theories of actions* which teachers hold, not their actions themselves. In studies using stimulated recall, different materials have been used as stimuli, such as cues, audio tape – and more recently, video tape (Stough, 2001). Classroom videos as stimuli offer the advantage of providing multiple and interwoven cues for the recall, potentially increasing the chances of retrieving full information. Lyle (2008) successfully used stimulated recall in the context of classroom talk to examine the roots of dialogic meaning making in classrooms.

In difference to the methods described so far, video studies do not rely on an individuals' reconstruction of an internal script; they record the script in action and reconstruct it through careful scientific analysis of the footage (e.g., Dalehefte, 2007; Pauli & Reusser, 2003; Seidel, 2003a). The reconstructive process here is carefully considered and less prone to individual biases and lack of recollection as other approaches. Consequently, video studies provide a more objective and research-informed perspective. Furthermore, they document the necessary complexity of classroom instruction

that is needed to identify patterns of instruction (i.e., teaching scripts) and not only single indicators (Prenzel, Seidel, Lehrke, Rimmel, Duit, Euler, et al., 2002). In video studies, surface structures (behaviours, activities, etc.) are recorded and analysed for indicators of deep structures. Furthermore, they allow for analyses within the theoretical framework of Utilisation-of-Learning-Opportunities Models (cf. Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014) as they provide process information during classroom learning. Other advantages of such approaches have already been mentioned in Section 1.3: quality assurance through determination of inter-coder reliability; analysis from multiple perspectives; sufficient time (Pauli & Reusser, 2006). As with all approaches, there are, of course, also disadvantages: Even with multiple measurement points and additional artefacts from the lesson – like lesson plans, handouts, etc. – video studies can only assess small windows or excerpts of the teaching process. Prenzel and colleagues (2002) argue for a connection of video observation and self-report to arrive at a fully-fledged picture of teaching and learning that adequately represents structural aspects of the instructional setting, as well as learning processes, beliefs and attitudes. The studies reported in this dissertation enact this approach and demonstrate its advantages by reporting on video analyses of whole-class discussions from two different perspectives (see Section 9.2.2 for a full description of the coding) and connecting them to student self-reports on motivational orientations and perceptions of the learning environment.

3. Classroom Talk

Thus far, general features of classroom talk that are deemed productive have been mentioned (Section 1.1). Before going into more detail on the relationship between productive classroom talk and instructional quality, briefly different conceptualisations of ‘productive’ classroom talk that are currently applied in research will be presented. The cornucopia of research on classroom talk becomes evident from the following excerpt from Resnick, Asterhan and Clarke (2015) in the introduction to their book ‘Socializing Intelligence Through Academic Talk and Dialogue’:

We bring together a wide range of bodies of scholarship on dialogue, and its disparate nature is reflected in the use of terminology. Authors use “dialogue,” “dialogic pedagogy,” “dialogic teaching,” “accountable talk,” “deliberation,” and “argumentation,” but all share basic assumptions. For the authors, talk is a privileged form of learning. This kind of talk begins with students thinking out loud about a domain concept: noticing something about a problem, puzzling through a surprising finding, or articulating, explaining, and reflecting upon their own reasoning. Students do not simply report facts they already know for the teacher to evaluate. Instead, with teacher guidance, they make public their half-formed ideas, questions, and nascent explanations. Other students take up their classmates’ statements: challenging or clarifying a claim, adding their own questions, reasoning about a proposed solution, or offering a counter claim or an alternate explanation. This form of talk is orchestrated by a teacher. It may be conducted in whole groups, smaller collaborative groups, or with pairs of students. The key component is the learning power generated by two or more minds working on the same problem together. (p. 6)

3.1. Conceptualisations of ‘Productive’ Classroom Talk

One of the first conceptualisations of classroom talk is that of classroom talk as an *IRE sequence*, a cycle of teacher question (initiation), student response (response) and teacher follow-up (evaluation) (Mehan, 1979; also known as Initiation-Response-Follow-up; Sinclair & Coulthard, 1975). This triadic dialogue (Lemke, 1990) has traditionally been viewed as very rigid and limiting the interaction space between teacher and student or student and student, due to its focus on the ‘correct response’ (Ruiz-Primo, 2011) and the teachers as the primary source of knowledge (Bernstein, 2000). However, Wells (1999) pointed out that such talk is neither in itself good or bad, but it is the quality with which the different moves are carried out (especially the third one) which determine their effect on learning (see also Chin, 2006; Dawes, 2004). Mortimer and Scott (2003; also Mortimer & Machado, 2000) demonstrated that depending on teachers’ initiation and follow-up move classroom talk varies along a dimension from ‘authoritative’ to ‘dialogic’. Yet, research has also shown that often times IRE sequences are enacted rather more ‘authoritative’ than ‘dialogic’ (Howe & Abedin, 2013; Mercer & Dawes, 2014). Most supportive of sustained learning are chains of IRE cycles that establish prolonged interaction, often including incomplete sequences or follow-up moves which give rise to a new response (Mortimer & Scott, 2003). Ruiz-Primo and Furtak (2006, 2007) proposed a more elaborate model of such interaction patterns, in which a teacher elicits information, students respond by giving the information, which is then recognised and used by the teacher (ESRU cycles). In their data they

also repeatedly found incomplete interactions before arriving at a closing of the interaction. As in the research of Mortimer and Scott (2003), such interactions resulted in better understanding on the side of students.

With regard to the quality with which the different teacher-initiated moves of triadic dialogue are carried out, teacher questions and feedback receive great importance. Yet, there has been conflicting evidence about the role of the teacher in promoting productive classroom talk. Dillon (1985) contended that it is not questions from the teacher, but rather statements that generate complex discussions. However, subsequent work has found that the use of teacher questions can increase the number and length of episodes of so-called *dialogic spells* (Boyd & Rubin, 2006; Franke et al., 2009; Graesser & Person, 1994; Nystrand, Wu, Gamoran, Zeiser, & Long, 2003; Oliveira, 2010) because they promote high-level student answers (Chin, 2006). Such high-quality questions challenge students to think profoundly (Alexander, 2005, 2008, 2010; Franke et al., 2009). On the other hand, questions allowing only one correct answer support students' expectations that they will be provided the correct answer anyway. Thus, high-quality initiation questions are open-ended, with multiple answer possibilities, and imply expectations of high-quality student responses (Oliveira, 2010).

At the other end of the interaction pattern the follow-up move can be realised by a variety of teacher actions such as: rephrasing, clarifying, elaborating summarising and repeating, relating a student's response to another student's response, promoting students' questions and comments about a student's contribution, displaying students' responses, responding with a reflective toss, offering explanations, comparing and contrasting students' ideas, modelling, debugging and providing feedback (Ruiz-Primo, 2011). The high value of feedback (both teacher and peer feedback) for student learning and motivation has been shown repeatedly in the literature (e.g., Chen et al., 2011; Chin, 2006; Hattie, 2008, 2012; Hattie & Timperley, 2007; Kluger & DeNisi, 1996; Lu & Law, 2012; Turner, 2014; Urdan & Turner, 2005). Walshaw and Anthony (2008) incorporated feedback as a central element in their Activity 2 of productive classroom talk: *scaffolding students' ideas to move thinking forward*. A classic taxonomy of feedback is the one by Hattie and Timperley (2007), who differentiate different levels of feedback: *feedback about the task*, *feedback about the processing of the task*, *feedback on self-regulation* and *feedback on the self*. These different levels of feedback have been shown to have differential effects on student learning and motivation. With regard to students' learning motivation, not only 'cognitive' information is deemed supportive but also feedback containing 'affective' information (e.g., Henderlong & Lepper, 2002; Ruiz-Primo, 2011; Schunk, Pintrich, & Meece, 2008). In the conceptualisation of Hattie and Timperley (2007) such 'affective' information is contained in feedback on self-regulation, which has been found to positively influence students' self-monitoring and regulation of learning processes, as well as self-efficacy and autonomy. Feedback on the processing of the task has been shown to be the most effective in terms of cognitive learning outcomes (Hattie & Timperley, 2007; Harks, Rakoczy, Hattie, Besser, & Klieme, 2014). It

directs students to re-think and re-use certain strategies or to ask for concrete help. It is regarded as a 'cueing' type of feedback and is likely to enhance students' deep understanding of tasks (Pehmer, 2015). It can also provide students with information on their competence, thereby helping to satisfy this basic psychological need (Deci & Ryan, 1985; Ryan & Deci, 2000). Positive feedback has generally been found to increase intrinsic motivation because it enhances perceived competence (e.g., Blanck, Reis, & Jackson, 1984; Harackiewicz & Larson, 1986; Harks et al., 2014; Vallerand, 1983). Furthermore, positive feedback encourages students to return to or continue with an activity, and they report more interest in the activity (Deci, Koestner, & Ryan, 1999; Harackiewicz & Larson, 1986), as well as positive connections to self-concept (Chen, Thompson, Kromrey, & Chang, 2011). However, feedback will facilitate intrinsic motivation and interest only to the extent that it is accompanied by autonomy supportive rather than controlling social contexts (Deci, Koestner, & Ryan, 1999; Deci, Vallerand, Pelletier, & Ryan, 1991; see Section 5). Studies regarding teacher feedback generally found that feedback does not occur frequently (Kluger & DeNisi, 1996; Schiepe-Tiska et al., 2013; Voerman, Meijer, Korthagen, & Simons, 2012). In physics instruction, for instance, teacher feedback statements hardly occur and represent mostly simple feedback (Kobarg & Seidel, 2007), which provides information on the correctness of the task ('Yes'; 'No'; 'Correct').

Dialogic Teaching (Alexander, 2005; 2008; 2010) – a further conceptualisation of productive classroom talk – builds on the work of Bakhtin (1986) and holds the perspective that talk is supportive of student learning if it is informed by five principles: *collectivity*; *reciprocity*; *support*; *cumulation* and *purposefulness*. Lefstein (2006) added two more principles: *criticality* and *meaningfulness*. Through comparative analysis of classroom discourse in five countries, Alexander (2005) identified five categories of talk:

- *Rote*: the drilling of facts, ideas and routines through constant repetition;
- *Recitation*: the accumulation of knowledge and understanding through questions designed to test or stimulate recall of what has been previously encountered, or to cue pupils to work out the answer from clues provided in the question;
- *Instruction/Exposition*: telling the pupil what to do, and/or imparting information and/or explaining facts, principles or procedures;
- *Discussion*: the exchange of ideas with a view to sharing information and solving problems;
- *Dialogue*: achieving common understanding through structured, cumulative questioning and discussion.

These forms of talk differ in the amount in which they involve the principles of supportive talk mentioned above, with *rote* providing them least and *dialogue* the most. Alexander (2008) constituted a dominance of the recitation script characterised by much teacher talk and little student uptake for most counties under investigation. Teaching and learning is less involved with students' ideas and understanding than with a game of 'guess what the teacher is thinking' (Alexander, 2008, p. 106) and

a quest for the right answer. This teacher centredness has been described by other authors as well (e.g., Jurik et al., 2013; Kobarg & Seidel, 2007; Seidel & Prenzel, 2006).

Based on a Vygotskian theoretical framework and a situated cognition perspective (Collins, Greeno, & Resnick, 1994; Greeno, Collins, & Resnick, 1996), *Accountable Talk* (Michaels, O'Connor, & Resnick, 2008) represents another framework for productive classroom talk, less concerned with specific interaction patterns and more focused on overarching features of the classroom talk. Resnick and colleagues propose three broad dimensions that characterise Accountable Talk: *accountability to community*, *accountability to knowledge* and *accountability to accepted standards of reasoning*. When talk is accountable to community, participants listen to others and build their contributions in response to those of others. It is necessary for such talk to occur that the topics or problems under discussion are interesting, support multiple positions and solution paths (Michaels et al., 2008). By opening up the conversation through a variety of so-called *talk moves* (e.g., 'Who can put into their own words what was just said?' or 'Can you explain what you meant when you said...?' Michaels & O'Connor, 2012) teachers can elicit students' knowledge, thinking and reasoning. This aspect of their framework is comparable to so-called *assessment conversations* in informal formative assessment (Ruiz-Primo & Furtak, 2006, 2007) or Hattie's notion that through dialogue and feedback student learning can be made visible (Hattie, 2008, 2012). Talk that represents accountability to standards of reasoning stresses logical argumentation and conclusions (Michaels et al., 2008). The notion of accountability to standards of reasoning shares features with classroom discourse as scientific argumentation (Asterhan & Schwarz, 2016; Driver, Newton, & Osborne, 2000; Duschl & Osborne, 2002; Fischer, Kollar, Ufer, Sodian, Hussmann, Pekrun, et al., 2014; Shemwell & Furtak, 2010) and includes aspects of learning as conceptual change (Chi, Slotta, & De Leeuw, 1994). Accountability to knowledge refers to talk that is based 'explicitly on facts, written texts or other publicly available information that all individuals can access.' (Michaels et al., 2008, p. 283) One of the aims here is to uncover misconceptions or lack of knowledge by continuously pressing participants for evidence behind their reasoning. Alexander (2010) sees similarities here to his notions of cumulation and purposefulness and states that – like these two – accountability to knowledge is difficult because it requires 'changing the substance as well as the form of learning; in the way that teachers and pupils, working collectively, reciprocally and supportively, actually understand and engage with knowledge' (p. 106).

The SLANT (Spoken Language and New Technology) project (e.g., Mercer, 1994; Wegerif & Mercer, 1997) defined three different types of talk occurring in classroom conversations: *disputational talk*, *cumulative talk* and *exploratory talk*. The different forms of talk demonstrate different effectiveness as 'social modes of thinking' (Wegerif & Mercer, 1997), with *exploratory talk* producing the most positive learning outcomes. In many regards, the conceptualisation shares similarities with Dialogic Teaching and Accountable Talk, when Mercer (2002) wrote:

Exploratory talk is that in which partners engage critically but constructively with each other's ideas. Relevant information is offered for joint consideration. Proposals may be challenged and counter-challenged but, if so, reasons are given and alternatives are offered. Agreement is sought as a basis for joint progress. Knowledge is made publicly accountable and reasoning is visible in the talk. (p. 146)

For talk to be considered *exploratory talk*, a challenge is needed (e.g., by asking high-level questions or posing real-life problems) which, in turn, results in a discussion about this challenge. The challenge is not merely for disputing purposes, but to engage in reasoning and critical analytical thinking (Mercer & Littleton, 2007). In *cumulative talk*, participants build a shared knowledge base by building on what the other one has said – but there is no element of critical engagement with the contributions of the partner. Such a form of talk is similar to the one described by Chi and colleagues resulting from constructive engagement activities (Chi, 2009; Chi & Meneske, 2015; Chi & Wylie, 2014). Disputational talk is characterised by antagonisms and disagreement; resources are not pooled together and constructive criticism is lacking (Wegerif & Mercer, 1997).

In research on science education and formative assessment a different perspective on classroom talk has emerged (Black & Atkin, 2014). Conversations between teacher and students serve the purpose of figuring out what students understand and know in order to adjust instruction. Duschl and Gitomer (1997) define these *assessment conversations* as ‘a specially formatted instructional dialogue that embeds assessment into the activity structure of the classroom.’ (p. 39) Such assessment conversations are discussions that elicit student ideas and make them public in order to build on them and provide the teacher with assessment information. In order to do so, they are structured in a three-step system: *receiving* student ideas, *recognising* student ideas and *using* student ideas (Duschl & Gitomer, 1997; Ruiz-Primo & Furtak, 2006, 2007; Ruiz-Primo, 2011). Teacher questions and feedback are vital constituents for receiving student ideas and recognising them (Furtak et al., 2016).

From the tradition of collaborative learning (e.g., Elbers & Streefland, 2000; Slavin, 1980) another framework, which highlights the positive effects of productive classroom talk emerged. In her ICAP-framework Chi and colleagues (Chi, 2009; Chi & Menekse, 2015; Chi & Wylie, 2014) provide a comprehensive conceptualisation of different engagement activities or dialogue patterns students can pursue during instruction (*passive, active, constructive, interactive*) and highlight the importance of interactive activities – building on other's knowledge and ideas in order to arrive at an new and deeper understanding for all participants – for high-level cognitive processes to occur and deep-level learning to take place. In collaborative settings, where interactions between people take place, it is possible for partners to contribute differently to the talk. One partner might be active (in the terminology of Chi), while the other one shows constructive engagement activities. Those students, who show higher quality engagement activities, also show higher learning gains, while dyads with a higher net sum of engagement activities (*active – constructive vs. active – active*) also show deeper understanding. The most positive outcomes were found in dyads that engage in co-construction (both partners engage in constructive engagement activities), because dyads contributed to the talk in an interactive way. Co-

constructive talk is the most powerful for learning because each partner can benefit from the other partner's perspective, feedback, and knowledge, and they can jointly create new knowledge that neither partner could have created alone (Chi & Wylie, 2014; Menekse, Stump, Krause, & Chi, 2013). In sum, her research suggests that the success of collaborative learning depends on the dialogue patterns in which students engage (Chi & Menekse, 2015). Chi and colleagues' notion of conversation partners being engaged in separate engagement activities without interacting shows resemblance to the conceptualisation of cumulative talk by Mercer and colleagues (Mercer, 1994; Wegerif & Mercer, 1995, 1997), while Chi's co-constructive or interactive talk is similar to exploratory talk in their conception.

Thus far, the focus of conceptualisations of productive classroom talk was on cognitive processes and cognitive learning outcomes. The conceptualisation by Turner and colleagues (2002) broadens the scope by including motivational processes in their framework on productive classroom talk; thereby they differentiate between *instructional* and *motivational supportive discourse*. Both forms of talk are defined along a continuum ranging from non-supportive to supportive. Supportive instructional discourse focuses on transferring the responsibility of the learning process to students. It is characterised by the support of strategic thinking and autonomous learning and holds students accountable for understanding. Supportive motivational discourse has a focus on learning and is achieved by challenging students, viewing errors as constructive, positive emotions during learning, as well as through building collaboration by emphasizing joint goals and shared responsibilities (Turner et al., 2002). In their conceptualisation Turner and colleagues are less concerned with structural aspects such as question type or feedback (as some of the approaches presented so far) but more with procedural aspects, yet great overlap exists, for example, through the idea of 'thinking aloud' or holding students accountable for understanding as part of instructional discourse (e.g., see Myhill et al., 2005; Michaels, O'Connor, & Resnick, 2008). Though not explicitly, by focusing on autonomy, responsibility and feelings of competence, they relate their approach of classroom talk to current theories on student learning motivation (e.g., Deci & Ryan, 1985; Dweck & Legget, 1988; Pintrich, 2000). Specifically, they linked supportive classroom talk to students' goal orientation, self-handicapping and positive affect (Turner, Meyer, Midgley, & Patrick, 2003; Turner et al., 2002). More recently, Andersen and Nielsen (2013) developed a coding framework to examine motivational incidents during classroom talk. This research showed that the teacher's combined use of questions, uptake and high-level feedback was very important for students' learning processes and motivation – especially students' self-efficacy. By coding and analysing video excerpts from science classrooms, they were able to demonstrate that their analytical framework helps to gain new insights into the effect of classroom talk on students' learning motivation. To further address its positive learning outcomes and determine how productive classroom talk can be effective, in the next section the functions which have so far been ascribed to classroom talk will be addressed. Different research perspectives (such as the ones described above) often highlight a single function in their research on and use of productive

classroom talk in education. Simultaneous analysis of multiple functions is still relatively rare, yet given the great overlap in these conceptualisations as presented above, there is grounds for the assumption that multiple functions are realised at the same time through similar methods, such as for example the provision of constructive feedback.

3.2. Functions of Productive Classroom Talk

After arguing what productive classroom talk may look like or rather how it may be conceptualised, we now turn to the question what can be achieved by productive classroom talk. This dissertation aims to go beyond the broad category of ‘positive learning outcomes’ here and look more detailed into specific functions classroom talk can serve. In doing so, it also pulls together different perspectives or research traditions that have looked at classroom talk through somewhat different lenses, but always attributing positive relationships to student learning (Resnick et al., 2015).

Much of the research based on the constructivist tradition has a focus on the positive learning processes occurring during high-quality classroom talk. The co-construction of meaning, reasoning, and knowledge generation through a ‘thinking aloud’ process between teacher and students or students and students are the focus of attention (e.g., Dawes 2004; Mercer, 2010; Michaels, O’Connor, & Resnick, 2008; Myhill et al. 2005; Webb, 2009). Herein, the use of language and the quality of interactions have important implications for students’ learning processes and learning outcomes (Lipowsky et al., 2007), and their active engagement (Seidel & Prenzel, 2006). Similarly, cognitive research in the tradition of cooperative learning (e.g. Chi, 2009; Chi & Menekse, 2015; Gillies, 2004, 2006, 2015) highlights the cognitive processes during interactive learning activities. Along with research on classroom talk stemming from an inquiry-learning tradition (e.g., Kovalainen & Kumpulainen, 2005; Shemwell & Furtak, 2010) this perspective on classroom talk highlights the cognitive aspects of learning, specifically the learning processes taking place. The theoretical basis for such learning processes can be found in *Knowledge Building Theory* (Scardamalia & Breiter, 2003). Central to Knowledge Building Theory is the notion that knowledge is a social product, created by members, that adds value to the community (Scardamalia & Bereiter 2003); in line with research on productive classroom talk it distinguishes *knowledge building* from knowledge acquisition. Another *situated cognition approach* (Greeno, Collins, & Resnick, 1994) applicable here is the perspective of classrooms as *learning communities* (Lave & Wenger, 1991), which provide a social learning environment in which cooperative problem solving and joint reflection can take place. Herein, classroom talk fulfils a *knowledge construction function*.

The aspect of making student thinking explicit by encouraging students to voice their opinions, ideas and hypotheses has also been harnessed by research focusing on formative assessment. In the context of formative assessment classroom talk can be conceptualised as assessment conversations (Ruiz-Primo & Furtak, 2006, 2007, see above). The very early works on classroom talk (e.g., by Lemke, 1990; Mehan, 1979; Sinclair & Coulthard, 1975) already include this aspect of evaluating

students' responses in the form of the third IRE/IRF move the evaluation or follow-up (Mehan, 1979; Sinclair & Coulthard, 1975). Assessment conversations provide teachers with the opportunity to gather information on their students' level of understanding and learning. With this information they can then determine their future course of action in order to attain a certain learning goal. 'The main purpose of assessment conversations is to make students' thinking evident, or to voice their understanding so that teachers can recognize and act on it to promote learning' (Ruiz-Primo, 2011). Similarly, when proclaiming that effective teachers have a frame of mind that makes them see assessment as feedback about their impact and engage in more dialogue than monologue Hattie (2012) pursues the goal to make student learning visible and use it as the basis for adaptive teaching. Seen from this perspective, classroom talk fulfils an *assessment function*.

Thus far, the focus of classroom talk was a cognitive one. Yet, the way people interact with each other has significance regarding the mind frames with which they enter the classroom (Hattie, 2012) and the classroom climate (*authoritative* vs. *dialogic*; Scott, Mortimer & Aguiar, 2006). Only in an environment that values my ideas as a student will I be willing to voice them and open them up for assessment and evaluation. Consequently, classroom talk has implications for the classroom climate and thus the social context of learning and instruction. Research in the constructivist tradition hints at this when declaring that the typical script of classroom talk is pressuring and controlling (Webb, 2009), while high-quality talk is open and non-coercive, and sees teacher and students as equal partners in the learning process (Alexander, 2008; Michaels, O'Connor, & Resnick, 2008; Walshaw & Anthony, 2008; Wells, 2009; Wells & Arauz, 2006). Hence, depending on the way classroom talk is enacted, different roles are assigned to participants and different value is given to their speech. In this, a *social function* of classroom talk is evident.

Based on this social function of classroom talk, I want to make the argument in this dissertation that classroom talk – if conducted productively – also serves a *motivational function*. There are some hints to this in the literature, such as Reeve and colleagues (Reeve, 2006, 2009; Reeve, Bolt, & Cai, 1999; Reeve & Jang, 2006) name non-controlling language as one aspect of an autonomy supportive teaching style fostering basic psychological need satisfaction in the sense of Self-Determination Theory (Deci & Ryan, 1985). Andersen and Nielsen (2013) pursued this line of argumentation in the development of their analysis framework for incidents of motivation support during classroom talk. They specifically conceptualise aspects of teachers' questions and responses as indicators of autonomy supportive behaviour in teachers. Similarly, Stone, Deci and Ryan (2009) argue that building autonomous motivation requires supportive dialogue, and supportive dialogue begins with open questions that invite exploration of an important problem. Furthermore, they include student classroom talk behaviour like generating ideas, content-related questions, help-seeking and student uptake as markers for student motivation. Turner, Meyer, Midgley and Patrick (2003), on the other hand, could show associations between the quality of classroom talk and students' goal orientation and affect. To

activate, maintain, regulate and monitor cognitive learning activities, the quality of learning motivation plays a decisive role. Motivation and interest research has shown that self-determined learning motivation plays an important role for the regulation of cognitive learning processes (e.g., Ainley, Hillman, & Hidi, 2002; Hidi, 1990; Hidi, Berndorff, & Ainley, 2002; Hoffmann, Krapp, Renninger, & Baumert, 1998; Krapp, 2002b; Pintrich & De Groot, 1990; Renninger, Ewen, & Lasher, 2002; Renninger, Hidi, & Krapp, 1992; Schiefele & Wild, 2000). Self-determined learning motivations as well as elaborative and organising learning activities are seen as relevant processes for the construction of knowledge structures (Friedrich & Mandl, 1996; Seidel, Prenzel, Duit & Lehrke, 2003). Given this theoretical perspective as well as the positive outcomes of productive classroom talk on cognitive learning processes and knowledge acquisition, there is ground for the assumption that this form of instruction also affects students' learning motivation – as a prerequisite for such cognitive outcomes – positively.

3.3. Attempts to Scale Up Productive Classroom Talk

After more than 40 years of research into classroom talk, a new focus of current research endeavours – after generating a general understanding of the mechanisms within and the positive effects of productive classroom talk – is the question of how to make such forms of classroom talk accessible to a large number of students. One way to 'make dialogic instruction a reality across contexts, for all populations of learners' (Resnick et al., 2015, p. 17) is to teach the necessary skills and attitudes to (student) teachers. Recently, efforts have been made to design such programmes in the international context. In the following paragraphs approaches on teaching teachers how to pay attention to student ideas, scaffold their emerging ideas (e.g., through constructive feedback) and keep the classroom talk flowing and co-constructive are introduced.

Michaels and O'Connor (2012) highlight the complexity and expertise necessary to orchestrate dialogic instruction effectively. They suggest that professional development should support teachers in conceptualising *talk moves* as tools, a repertoire of utterances that teachers can call on to address particular problems of practice in interaction. With their notion of talk moves, they expand on Mehan's (1979) IRE sequence and suggest that there are a number of specific utterances (talk moves) that open up classroom talk for joint-participation. In their two projects *Classroom Discussions in Math* and *Talk Science* they developed and implemented materials that supported teachers in recognising the relevance of productive classroom talk, delineating the goals of such talk and using specific talk moves to accomplish these goals. In their research they could show this approach of conceptualising talk moves as tools was successful (Michaels & O'Connor, 2015). Van der Veen and colleagues (2016) implemented a professional development programme for pre-school teachers on the basis of Michael and O'Connor's (2012) talk moves, and successfully fostered students' language competencies.

In the CamTalk project – a design-based research project from Cambridge University – a blended learning course, taught online, was developed together with practitioners, focusing on principles of dialogic teaching and learning, classroom impact and dialogic assessment. Higham, Brindley, and van de Pol (2014) worked with teachers to open up their classroom talk so that students could co-construct knowledge rather than having the teacher impose content on them. Over three terms, teachers followed a four-module course, which included a small-scale research project presented at an in-house conference. Also at Cambridge, the epiSTEMe project (Effecting Principled Improvement in STEM Education) pursues a dialogic teaching approach for educational reform (Ruthven et al., 2016). The project designed and trialled a classroom intervention in science and mathematics classrooms together with partnering teachers. The aim was to arrive at an intervention that could be implemented at scale across the UK. Characterising features of the epiSTEMe intervention are the reliance on effective teaching principles (e.g., Seidel & Shavelson, 2007) and a pedagogical approach based on dialogic teaching principles (see Alexander, 2005, 2008, 2010; Mercer & Littleton, 2007). Ruthven and colleagues argued that in order for such attempts to be successful sustained professional development for teachers is of the essence (see also Osborne et al., 2013).

Stein and colleagues (2015) developed a measurement tool, the Analyzing Teaching Moves Guide (ATM), with which they aim to provide a useful indicator of teachers' progress in orchestrating classroom talk. The tool aims to measure the extent to which students receive high-quality opportunities to engage in classroom talk. They highlight five key practices for orchestrating productive mathematics discussions in their framework: *anticipating*, *monitoring*, *selecting*, *sequencing* and *making connections between student responses* (Stein, Engle, Smith, & Hughs, 2008). Thus far, the instrument can help teacher professional development by documenting and describing teachers' practices during classroom talk. Furthermore, it provides clear descriptions of desired teaching practices which can serve as a guideline for teachers who want to implement productive classroom talk in their classrooms, which is important for implementing reform practices (Correnti & Rowan, 2007).

In the recent literature (Resnick et al., 2015) other projects focusing on scaling productive classroom talk are mentioned. While Lampert and colleagues (2015) focused on preparing pre-service teachers 'as sense-makers about mathematics instruction in the same way that dialogic classroom instruction positions students as sense-makers' (Resnick et al., 2015, p. 18), Osborne (2015) took a closer look at obstacles that might hinder the uptake of productive classroom talk, such as teachers not being committed to the values of productive classroom talk and obtrusive beliefs about teaching and learning. In their own attempt of scaling the use of argumentation to make it a common instructional practice in science education in four schools (Osborne et al., 2013) a further point for the uptake of productive classroom talk was the provision of in-school support and professional development (see also Dudley, 2012; Horn & Kane, 2015). He and his colleagues (Osborne, Henderson, MacPherson,

Szu, Wild, & Yao, 2016) also developed a learning progression for scientific argumentation in science in order to support teachers in their use of these practices to meet the goals of the Next Generation Science Standards (NGSS Lead States, 2013).

In connection to formative assessment practices the use of a learning progression in professional development has been shown to support teachers' use of high-quality questions and feedback during whole-class discussions (Furtak et al., 2016). Matsumura and Garnier (2015) take a systemic perspective by reviewing a district-wide professional development programme and identifying features on the district level that might have supported the improvement of teachers' practice. Davies and Meissel (2016) aim to move away from the primary school and science, technology, engineering and mathematics (STEM) focus of most research on classroom talk (Higham, Brindley, & van de Pol, 2014) and implement their professional development programme (based on *Quality Talk*; Wilkinson, Soter, & Murphy, 2010) in secondary English language arts and geography classrooms. Here, teachers are trained to be multipliers of the Quality Talk principles in their own classrooms (see also Davies, Kiemer, & Meissel, under review). Their approach is also more comprehensive inasmuch as it focuses not only on the teachers as trainees in professional development, but also includes the training of students. In doing so, they increase the likelihood of effective classroom talk (Bennett, Hogarth, Lubben, Campbell, & Robinson, 2010) and increase the proliferation of productive classroom talk within a school. Sedova and colleagues (2016) used a video-based approach for teacher professional development on productive classroom talk (see also Chinn, Anderson, & Waggoner, 2001; Lefstein & Snell, 2014). Their programme consisted of several components: (1) four workshops for teachers which included group discussion; (2) documentation of lessons by means of video recordings; and (3) reflective interviews conducted between a researcher and a teacher in which video recordings of individual lessons are discussed, which alternate and build on each other. Video-based reflection (Borko, Jacobs, Eiteljorg, & Pittman, 2008) feature prominently in this approach; teachers are recorded nine times during the programme, followed by individual reflection sessions with a researcher. They found significant effects of teachers' participation in the professional development programme on student talk (Sedova, Sedlacek, & Svaricek, 2016).

In sum, there is a growing body of approaches to support the scaling of productive classroom talk in a variety of contexts, domains and with differing grain-levels. So far, when looking at the effectiveness of such practices, mostly cognitive aspects such as learning gain (e.g., Furtak et al., 2016), deep-level understanding (e.g., Michaels & O'Connor, 2012) or critical thinking (e.g. Davies & Meissel, 2016) have been the focus of attention. To my knowledge, to date no approach has explicitly focused on motivational benefits of teacher learning on productive classroom talk for students. Furthermore, none of the studies reported here looked at the effectiveness of the intervention in the form of a field experiment (comparing it to a control group) or on different levels of effectiveness (Lipowsky, 2010). In the next sections the dissertation follows up on this perspective by making the

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argument that productive classroom talk incorporates dimensions of instructional quality (e.g., Klieme, Schümer, & Knoll, 2001; Kunter & Voss, 2011; Seidel, Rimmele, & Prenzel, 2003, 2005; Prenzel, Seidel, Lehrke, Rimmele, Duit et al., 2002) associated with motivational learning outcomes in students and that aspects of such classroom talk are capable of fulfilling basic psychological needs (Deci & Ryan, 1985; Ryan & Deci, 2000) leading to such motivational learning outcomes. Beginning, models of instructional quality are introduced and related to productive classroom talk (Section 4). Next, two prominent and interrelated theories on learning motivation are outlined (Self-Determination Theory; Deci & Ryan, 1985, Person-Object Theory of Interest; Krapp, 2000) and related to teacher instruction (Section 5). By proposing productive classroom talk as an autonomy and competence supportive social context all these ideas are pulled together providing the integrative perspective of this dissertation (Section 6).

4. Instructional Quality and Classroom Talk

To assess whether or not any teaching script is ‘productive’ – allowing for the co-construction of meaning and results in positive learning outcomes – some form of criterion is needed. In the field of educational research such criterion can be found in the dimensions of instructional quality. This dissertation draws on the concept of these dimensions in order to arrive at a theoretical framework connecting productive classroom talk and motivational student outcomes. In order to do so, it begins by delineating different conceptualisations of instructional quality (Section 4.1) For a synthesis; the last section concentrates on bringing those two perspectives together and explores instructional quality in productive classroom talk.

4.1. Conceptualisations of Instructional Quality

In research on instructional quality different conceptualisations have emerged. In the German context, two of them have received much prominence (e.g., Klieme, Schümer, & Knoll, 2001; Kunter, & Voss, 2011 and Seidel, Rimmel, & Prenzel 2003, 2005; Prenzel, Seidel et al., 2002). Both frameworks overlap in many aspects, yet also contain specific aspects that will be analysed in the following paragraphs. The two frameworks are each made up of three overarching dimensions.

In the conceptualisation used in much research from the *Deutsches Institut für Internationale Pädagogische Forschung* (DIPF) and the *Max-Planck Institut für Bildungsforschung* (MPI) (Klieme, Schümer, & Knoll, 2001; Kunter, Dubberke, Baumert, et al., 2006; Kunter & Voss, 2011), the three dimensions that build the deep structure of teaching and learning are *cognitive activation*, *constructive learning support* and *classroom management*. *Classroom management* goes back to the seminal work of Kounin (1970). Central in this conceptualisation is the preventive aspect; classroom disruptions should be terminated before they even appear. *Cognitive activation* means that the instruction engages students in deep-reasoning processes that have the potential to change students’ conceptions of the content (Posner, Strike, Hewson, & Hertzog, 1982). *Constructive learning support* focuses on a supportive learning environment. It means the recognition of problems and difficulties within the individual learner, followed by explanations and feedback that recognises the learner as capable and autonomous (Cornelius-White, 2007). These aspects are part of the deep structure of instruction (Kunter & Voss, 2011; Kunter & Trautwein, 2013). The positive effects of these dimensions on student learning outcomes have been shown repeatedly (Baumert, Kunter, Blum, Brunner, et al., 2010; Klieme, Lipowsky, Rakoczy, & Ratzka, 2006; Lipowsky, Rakoczy, Pauli, Reusser, & Klieme, 2009). Herein, constructive learning support and to a lesser extent cognitive activation have been predictive of student learning motivation (Kunter, Klusmann, Baumert, Richter, Voss, & Hachfeld, 2013; Rakoczy, Klieme, & Pauli, 2008; Rakoczy, Klieme, Drollinger-Vetter, Lipowsky, Pauli, & Reusser, 2007; Rakoczy, 2006). Recent research also demonstrated that the connection between instructional quality as defined above and the use of metacognitive strategies is mediated by intrinsic learning motivation, which strengthens the position of a supportive learning environment for positive

motivational student learning outcomes (Rieser, Naumann, Decristan, Fauth, Klieme, & Büttner, 2016).

The second framework used in the context of research on instructional quality differentiates the dimensions of *student-centeredness*, *goal orientation* and *process-oriented learning support* (e.g., Bolhuis, 2003; Dalehefte, 2007; Seidel, Rimmele, & Prenzel, 2003, 2005; Seidel & Shavelson, 2007). Variations of this framework have been used in the context of large-scale video analyses of classroom instruction, such as the IPN Video Study conducted by the *Leibniz-Institut für Pädagogik der Naturwissenschaften und Mathematik* (Prenzel, Seidel, et al., 2002). *Student-centred instruction* is characterised by strong student engagement and activity. Student-centeredness lies at the heart of many constructivist, reform-oriented instructional approaches, such as collaborative learning (e.g., Elbers & Streefland, 2000; Slavin, 1980), problem-based learning (e.g., Hmelo-Silver, Duncan, & Chinn, 2007) or inquiry learning (e.g., Abrams, Southerland, & Silva, 2008; Wells, 2001). These approaches report positive effects for student skill acquisition and non-cognitive learning outcomes. *Goal orientation* in the context of instructional quality means that clear learning goals are at the centre of instruction and guide the instructional process. These learning goals are communicated clearly and are transparent for all participants. Instruction which is goal oriented is structured clearly and presents content in a coherent way (Brophy, 2000). *Process-oriented learning support* encompasses different teacher activities (Bolhuis, 2003), which can be used both in more teacher-centred or student-centred modes of instruction (Kobarg, 2004; Kobarg & Seidel, 2007), and which aim to foster students' acquisition of knowledge and understanding. Teachers only support the student as much as is necessary for the student to arrive at a greater understanding without depriving them of the responsibility for the learning process. In student-centred instruction students have more control over the learning process, which offers them more opportunity for active, cooperative and self-regulated learning. In such a learning environment also non-cognitive learning outcomes can be achieved (Gruehn, 1995; Kunter, 2005). Seidel et al. (2005) found evidence that goal clarity is important to students' perception of the learning environment being supportive. Students in classrooms characterised by high goal clarity and coherence of instruction experienced higher levels of self-determined learning motivation than did students from classrooms with less clearly structured lessons. Research has shown that students' perceptions of process-oriented learning support are strongly related to self-determined learning motivation (Prenzel, Kramer, & Drechsel, 2002), interest development (Lewalter, Wild, & Krapp, 2001), the use of deep learning strategies (Schiefele & Wild, 2000) and understanding (Alexander, Murphy, Woods, Duhon, & Parker, 1997).

Both frameworks of instructional quality presented here have been applied in research successfully. Prenzel and colleagues' (2002) notion of goal clarity and coherence overlaps with aspects of classroom management and cognitive activation in Klieme and colleagues' (2001) conceptualisation. Tasks and activities can only unfold their full potential for cognitive activation if

the learning goal is explicit and the full cognitive potential can be used for engaging in the task – not wasting it on the extrinsic load (Kirschner, Sweller, & Clark, 2006) of the task or the instruction. Coherence in instruction – the structured presentation of content, the build-up of tasks, etc. – help making lessons run fluently and reduce the possibility of disruptions and loss of time on tasks (Kounin, 1970).

Similarly, cognitive activation shares aspects with student-centeredness inasmuch that in order to activate students cognitively teachers need to be aware of their students and their learning process, and not just blindly following the curriculum. Within student-centred teaching, the prerogative is not on teaching or covering the content (Fischler, 1994; Putnam, 1987), but learning and understanding for which cognitive activation is necessary. Yet, the biggest overlap in the two conceptualisations is with regard to learning support. It is of great importance for scaffolding student ideas and providing a positive learning climate in the classroom.

The necessity for support structures during instruction for the attainment of learning goals is widely undisputed in educational research (Hmelo-Silver, Duncan, & Chinn, 2007; Kuhn, 2007; Mayer, 2004; Schmidt, Loyens, Van Gog, & Paas, 2007; Sweller, Kirschner & Clark, 2007), yet questions remain with regard to how these support structures should look and how intensive they should be. Prenzel and colleagues (2002) provide a synthesis of supportive conditions during classroom instruction. They differentiated theoretically between six supportive aspects in the learning environment (Prenzel, Kramer, & Drechsel, 2002; cf. Seidel et al., 2005):

- *Support of relevance* (i.e., applicability of contents, proximity of reality, connections to prior knowledge and to other subject domains).
- *Quality of instruction* (i.e., contents that are situated in authentic and meaningful problem contexts, clarity and coherence of instruction, adaptation of instruction to students' prerequisites).
- *Teacher's interest* (i.e., expression of engagement, enthusiasm, commitment).
- *Social relatedness* (i.e., collegiality, empathy, cooperation, relaxed and friendly learning atmosphere).
- *Support of competence* (i.e., feedback on learning objects, informal feedback, individual frame of reference).
- *Support of autonomy* (i.e., possible choices, flexibility, support of self-determined exploration, planning, acting).

Benefits of such supportive environments can be found numerous in the literature, both from a perspective of instructional quality (Harks, Rakoczy, Hattie, Besser, & Klieme, 2014; Klieme & Rakoczy, 2003; Kunter et al., 2006; Lipowsky, Rakoczy, Pauli, Drollinger-Vetter, Klieme, & Reusser, 2009; Seidel, Rimmel, & Prenzel, 2003, 2005) as well as from a motivation research perspective

(Hospel & Galand, 2016; Jang, Reeve, & Deci, 2010; Reeve, 2006; Reeve, Bolt, & Cai, 1999, Ryan & Stiller, 1991; Ryan & Deci, 2000; Vansteenkiste, Sierens, Goosens, Soenens, Dochy, Mouratidis et al., 2012). While Seidel, Rimmelle and Prenzel (2005) provided the theoretical rationale that narrowly-focused classroom talk is lacking of process-oriented learning support as described above (Prenzel, Seidel et al., 2002), in their research they chose to focus only on the direct connection between constrained classroom talk and student learning motivation, documenting negative effects of such instruction of self-determined forms of learning motivation.

In this thesis, this line of investigation is picked up upon and extended by examining intermediate processes connecting classroom talk and student learning motivation. Particularly, this dissertation looks at students' perceptions of autonomy (support), competence (support) and social relatedness during changing classroom talk over the course of one school year and its effects on intrinsic learning motivation and interest in the subject. Furthermore, the present analysis differs from Seidel and colleagues (2005) due to its focus on the positive effects of productive classroom talk on only one form of self-determined learning motivation (intrinsic learning motivation) and its aim to connect it to dispositional motivational student characteristics (interest in the subject). It is also maintained in this dissertation that the supportive conditions as outlined by Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000) are integral parts of the deep structure of instruction and, as such, instructional quality (Prenzel et al., 2002). Furthermore, with regard to these dimensions, productive classroom talk is presented as a high-quality form of instruction with positive relationships to student learning motivation (Andersen & Nielsen, 2013).

4.2. Instructional Quality during Classroom Talk

As mentioned above, earlier research established a characteristic teaching script of a questioning-developing classroom talk in German mathematics and science classrooms (Hiebert, 2003; Seidel & Prenzel, 2006). Due to its tight interaction pattern (IRE sequence, Mehan, 1979), this teaching script is perceived as providing only limited learning support, resulting in mostly other-determined forms of learning motivation (Seidel et al., 2003). On the basis of the national PISA sample 2012 Schiepe-Tiska and colleagues could establish that only about one-fifth of the students report lessons characterised by high cognitive activation, good learning support and classroom management, while about one-fourth of the students reported the opposite (Schiepe-Tiska et al., 2013). Consequently, even after more than a decade of research on teaching scripts and instructional quality, the reality of most students is still the same as it was in 1999 when the first TIMS study was conducted (Hiebert, 2003). In order to break up this pattern and offer our students learning environments conducive to learning, it seems appropriate to target forms of instruction that are already very pervasive in the classroom. Thus, this thesis goes on to explore how classroom talk can fulfil the dimensions of instructional quality if it is used productively. For this purpose, the conceptualisation of Klieme and colleagues (2001) is used as a template, but aspects from other frameworks incorporated where appropriate.

When analysing classroom talk, we look at *external teaching and learning activities*, visible to outside observation. Herein, often times superficial activities pertaining to the organisation of the talk, the amount of time engaged in talk and the activities that elicit that talk (Seidel, Prenzel, Duit, & Lehrke, 2003; Seidel, Dalehefte, & Meyer, 2001) are differentiated from teaching activities relevant for student learning. The type of questions asked by the teacher (e.g., Jurik, Gröschner, & Seidel, 2013) or the kind of feedback provided by the teacher (e.g., Hattie & Timperley, 2007) bear importance for students' learning as their quality determines the *external learning activities* of students. Student learning activities are distinguished as ranging from passive (with little implication for learning) to constructive or even interactive (with large implications for student learning, Chi, 2009). Depending on the quality of external learning activities, *internal learning processes* differ and result in differences in the quality of learning outcomes such as deep-level learning, conceptual understanding and the like (Chi & Meneske, 2014). External teaching activities can be seen as indicators of internal teaching and learning processes and this provide a window into the deep structure of instruction (Figure 1). In the following studies different teaching activities will be used as approximations for the quality of classroom talk and to provide information on internal teaching activities.

Walshaw and Anthony (2008) conducted an extensive review of research on classroom talk in mathematics teaching, synthesising the research into two main internal teaching activities of productive classroom talk: *clarifying discourse participation rights and responsibilities* and *scaffolding students' ideas to move thinking forward*. Clarifying discourse participation rights and responsibilities aims to engage all students into the talk and underscores teacher expectations that everyone is responsible for the success of classroom talk. It is an expression of shared responsibility of the learning process (Alexander, 2008). Scaffolding student ideas to move thinking forward relates to research on inquiry-based learning that stresses the importance of teachers being able to interpret student ideas, instead of evaluating them (Duschl & Gitomer, 1997; Ruiz-Primo & Furtak, 2006, 2007; Ruiz-Primo, 2011) probing for evidence (Alexander, 2008; Mercer, 2010; Michaels & O'Connor, 2012), and providing students with constructive feedback to elaborate on their ideas (Shepard, 2000).

In the view of this thesis productive classroom talk as conceptualised by Walshaw and Anthony (2008) is an effective teaching script because it addresses facets of cognitive activation and constructive learning support (Figure 1). Particularly, through constructive learning support it sees productive classroom talk as a possibility to support students' basic psychological need fulfilment and with this a mechanism to foster students' intrinsic learning motivation (Prenzel et al., 2002; Seidel et al., 2003). Also with regard to other conceptualisations of teaching quality (e.g., Seidel, Prenzel, Duit, & Lehrke, 2003) productive classroom talk presents itself as an effective teaching script, as it is student-centred and offers process-oriented learning support. The favourable cognitive outcomes of productive classroom talk have been shown numerous times (Alexander, 2008; Mercer, 2008; Mercer,

Wegerif, & Dawes, 1999; Resnick, Michaels, & O'Connor, 2010, Webb et al., 2014). On the other hand, research on motivational outcomes has been scarcer (e.g., Andersen & Nielsen, 2013; Chen, Thompson, Kromrey, & Chang, 2011; Turner, Midgley, Meyer, Gheen, Anderman, & Kang, 2002). The present dissertation aims to expand the field of research in this direction. It adds to this field by examining the effects of a newly developed teacher professional development programme with a focus on productive classroom talk on the deep structures of teaching and learning in the form of teachers' changed instruction (external teaching activities) and motivational student outcomes.

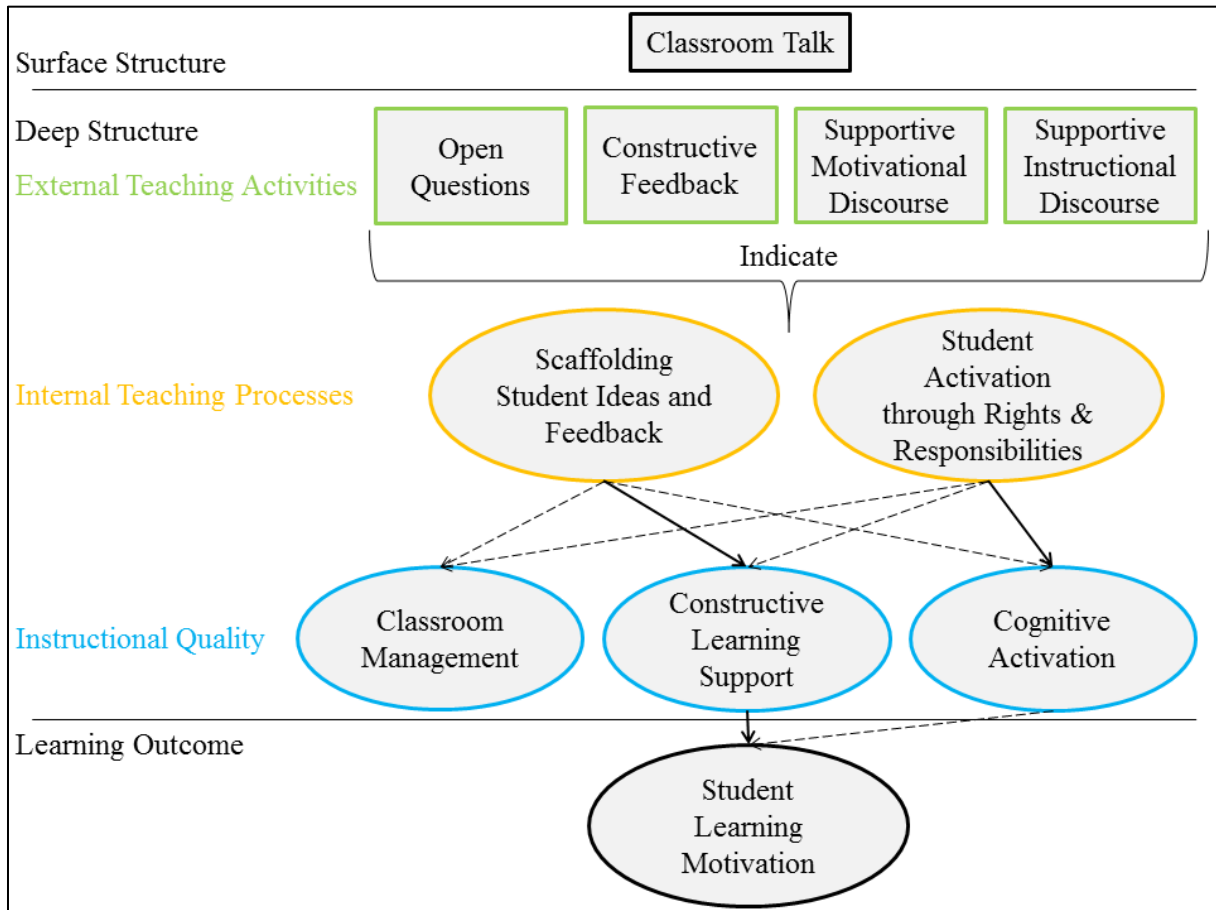


Figure 1. Productive classroom talk and its relationship to dimensions of effective teaching

5. Student Learning Motivation

Besides cognitive outcomes, such as students' competences in mathematics and science, students' learning motivation is both an important prerequisite (Hattie, 2008) as well as a meaningful outcome of learning processes (Kunter, 2005; Prenzel, 2012). This focus on motivation as an objective for teaching and learning has been developed under the heading of multiple goals in education (Bolhuis & Voeten, 2001; Gruehn, 1995; Helmke, 2012; Klieme & Rakoczy, 2003; Kunter, 2005). Numerous analyses could demonstrate the positive effect of student learning motivation on desired educational outcomes (cf. Ainley, Hidi, & Berndorff, 2002; Harackiewicz, Durik, Barron, & Linnenbrink, 2008; Köller, Schnabel, & Baumert, 2001; Renninger, Hidi, & Krapp, 1992; Ryan & Connell, 1989; Schiefele, Krapp, & Winteler, 1992). It has also been linked to students' decisions on career paths (Wang, 2013b). Especially with a view on life-long learning in an information society, learning motivation receives particular prominence (Bolhuis, 2003; McCombs, 1991). Two interlocking frameworks have shown to be especially productive for explaining situated and dispositional developments in students learning motivation: Self-Determination Theory (Deci & Ryan, 1985) and Person-Object Theory of Interest (Krapp, 2000). The two frameworks not only focus on inner motivational resources of the learner (Reeve, 2009), but also on supportive aspects of the social context and with this provide explanations of how teachers can design learning environments which support students' motivational outcomes or more specific; learning opportunities, which are interpreted as supportive and utilised in a meaningful way by students (e.g., Assor, Kaplan, Roth, & Kanat-Maymon, 2005; Ciani, Middleton, Summers, & Sheldon, 2010; Deci, Schwartz, Sheinman, & Ryan, 1981; Jang, Reeve, & Deci, 2010; Kaplan & Assor, 2001; Reeve, 1999, 2006, 2009; Reeve, Bolt, & Cai, 1999; Reeve & Jang, 2006; Schuitema, Peetsma, & van der Veen, 2016; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Skinner, Furrer, Marchand, & Kindermann, 2008; Soenens & Dochy, 2009; Stroet, Opdenakker, & Minnaert, 2013; Vansteenkiste, Sierens, Goossens, Soenens, Dochy, et al., 2012).

5.1. Motivational Learning Outcomes as Objectives for Teaching and Education

When assessing educational success, we often think in terms of grades, test results and other aspects of students' cognitive learning outcomes. Especially in high-stakes contexts, educational quality often comes down to high achievement scores. Also in Germany, in the wake of the first PISA (Programme for International Student Assessment) results and the following educational reforms, a superficial inquiry into the educational system might lead to the conclusion that test results (e.g., PISA, PEARLS), educational standards (Bildungsstandards) or comparisons between students (e.g., VERA) have become ever more present and important and that our students are 'over-tested'. Yet, another result of the so-called 'PISA shock' is an increasingly competence-oriented perspective within the educational system of Germany. Competence sensu Weinert (2003) does not only comprise factual knowledge and skills, but also the motivational, emotional and volitional prerequisites to apply this knowledge in various contexts. As such, motivational outcomes also come into the focus of large-scale

research on the quality of educational systems (OECD, 2013; Prenzel, 2012; Schiepe-Tiska & Schmidtner, 2013; Schiepe-Tiska, Heine, Lüdtke, Seidel, & Prenzel, 2016) and other representative studies (Kunter, 2005, Seidel, Rimmel, & Prenzel, 2003).

As Kunter (2005) points out for mathematics education, competence building in the form of increased factual and conceptual knowledge is only one half of the outcomes sought in education (Figure 2). Besides competence building, motivational concepts such as interest in the subject and intrinsic learning motivation are important outcomes of educational processes as well (Krapp & Prenzel, 2011; Kunter, 2005; Prenzel, 2012). Both reciprocally affect each other. In terms of interest in the subject and learning motivation; successful learners are generally more motivated, while more motivated learners achieve better (Ainley, Hidi, & Berndorff, 2002; Köller, Schnabel, & Baumert, 2001; Ryan & Connell, 1989). Students who are more self-determined in their learning motivation show better use of learning strategies (Ryan & Deci, 2000) and as a result better achievement in school and college ($r = .23$; Schiefele & Schreyer, 1994). 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). Consequently, students' learning motivation and interest has not only importance in terms of personality development, but is also a vital part and prerequisite for capacity building.

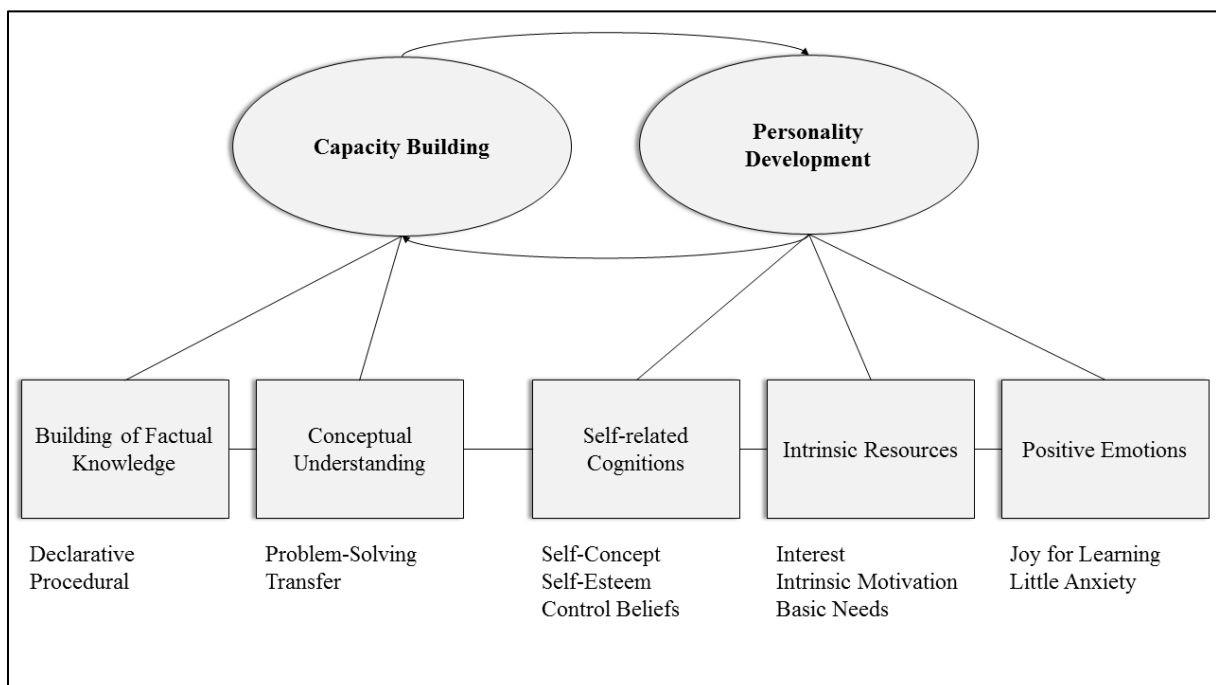


Figure 2. Multiple objectives in educational settings (adapted from Kunter, 2005, own translation).

Furthermore, motivational characteristics are key elements regarding the young generations' preparedness for life-long learning as a core-skill in knowledge-based societies. References to motivation are present in many conceptualisations of self-regulated learning (e.g., Boerkaerts, 1997;

Pintrich, 1999; Zimmermann, 2002), which in turn is a required skill for continuous self-development. The reasons for prolonged, life-long learning are manifold, but can be grouped into three central arguments: (A) economic arguments – in knowledge societies knowledge production and handling are important skills for prosperity, (B) societal arguments – in a globalised society people are commonly confronted with other's perspectives and need to be able to accommodate them, and (C) democratic arguments – democracy can only function if all citizens can form an informed opinion and can equally take part in the decision-making process (Bolhuis, 2003; Darling-Hammond, 1996). As such, motivation to engage with new content, to self-direct the learning process and to engage in learning processes across the lifespan becomes essential for a skilled and well-informed citizenship. Motivation and interest development, especially in STEM subjects, also determine adolescents' willingness to choose STEM-related career paths (OECD, 2007).

Therefore, developing students' interest and intrinsic learning motivation has to be a main educational objective for schools as well as individual teachers (Kunter, 2005). However, student learning motivation and interest in the subjects often decrease significantly throughout education (Baumert & Köller, 1998; Eccles et al., 1993; Gottfried, Fleming, & Gottfried, 2001; Helmke, 1993; Maulana, Opdenakker, & den Brok, 2013; Pekrun, 1993; Spinath & Spinath, 2005). One reason frequently cited for this decrease is the mismatch between students' (basic psychological) needs and classroom practices, especially during secondary education (Eccles et al., 1993). Increased teacher-centeredness of the instruction, less emotional support and close contact with teachers, and a stronger focus on grades with more social comparisons are put forward as conditions of the learning environment which lead to this mismatch. As outlined above, one such teacher-centred instructional practice in German mathematics and science classrooms is that of classroom talk (e.g., Jurik et al., 2013). Prior research on such classroom talk has shown that the common script of tightly focused teacher-student interactions has negative effects on students' learning motivation (Seidel, Rimmel, & Prenzel, 2003). In turn, less teacher-centred instruction could provide more supportive learning environments and, in turn, better students learning motivation. The theoretical framework often evoked in this context is Self-Determination Theory (Deci & Ryan, 1985). In the scope of this dissertation this perspective is expanded by also drawing on Person-Object Theory of Interest (Krapp, 2000) in order to examine both situated and more dispositional effects of productive classroom talk on motivational student learning outcomes. In the following, the scene for the research is set by presenting the frameworks of Self-Determination Theory (Sections 5.2) and Person-Object Theory of Interest (Sections 5.3).

5.2. Student Learning Motivation from the Perspective of Self-Determination Theory

Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000, 2002) is a comprehensive framework for human motivation and action. It provides an integrative perspective, combining aspects of the individual and the context to explain individual differences as well as different effects of the

surroundings on human motivation. It has been applied to many contexts such as education (Reeve, 2002), parenting (Grolnick & Apsostoleris, 2002), environmentalism (Pelletier, 2002) and health (Williams, 2002). Its foundational cornerstones have also been shown to hold true in different cultures (e.g., Chirkov, Ryan, & Willness, 2005; Deci, Ryan, Gagné, Leone, Usunov, & Kornazheva, 2001; Reeve, Vansteenkiste, Assor, Ahmad, Cheon, Jang, et al., 2014). The foundation of Self-Determination Theory is that human beings have an innate tendency for growth and a comprehensive, unified sense of self. In other words, they want to feel self-determined about their actions. But, this innate tendency can either be supported or hindered by the social context. Hence, Self-Determination Theory is concerned with the interactions between an active individual and its social context that either supports or thwarts its natural growth tendencies (Ryan, & Deci, 2002). Consequently, Self-Determination Theory can be categorised as a dynamic personality theory (Krapp, Geyer, & Lewalter, 2014) and represents a person-in-context approach to motivation.

In Self-Determination Theory the interactions between individual and social context are organised by three basic psychological needs that are universal in human beings (Deci & Ryan, 1985; Ryan & Deci, 2000). Along these three dimensions social contexts can be described as supportive of a person's development or aversive to it (Ryan & Deci, 2002). These three basic psychological needs are *autonomy*, *competence* and *social relatedness*. Importantly, it is the individual's perception of their surroundings that is decisive for feelings of basic psychological need fulfilment, not the objective level. Within the Self-Determination Theory literature this is referred to as the *functional significance* of contextual aspects (Deci & Ryan, 1980). Herein, the theory shares similarities with appraisal theories (e.g., Lazarus & Folkman, 1987; Pekrun & Stephens, 2010; Pekrun, 2006), as the individual interpretation of a context or a situation is deemed more significant than its objective description.

Deci and Ryan (1980) proposed two main cognitive processes through which the social context affects people's basic psychological need fulfilment. The first is the *perceived locus of causality*, the second, *perceived competence*. In later works (e.g., Jang, Reeve, & Deci, 2010) perceived competence is also referred to as *perceived control*. Perceived locus of causality expands on notions by deCharms (1968) and Heider (1944) that individuals want to engage in activities out of a sense of volition. They want to feel that the origin of the action lies within themselves. Perceived competence or the pleasure to have an effect on one's environment is a feature of many theories on motivation (e.g., Atkinson, 1964; Bandura, 1977; Dweck & Legget, 1988; Heckhausen, 1985; Nicholls, 1970; Wigfield & Eccles, 2002). The aspect of being in control over the situation is also prominent in approaches on achievement emotions having motivational implications (Pekrun & Stephens, 2010). Perceived locus of causality is the process related to an individual's perceptions of autonomy. *Autonomy* here means the self-perception as the source of one's own behaviour, so that an individual's behaviour becomes the outer sign of her personality, values and beliefs. With regard to the context of schools and education, this means that students can feel autonomous if they recognise themselves in the activities

they are engaged in and feel ownership over them (Ciani, Middleton, Summers, & Sheldon, 2010). Perceived competence/control obviously relates to the basic psychological need for competence. *Perceived competence* is the feeling of having an effect on the environment and being capable to effectively navigate tasks and challenges. It also refers to the need to express one's capabilities (Ryan & Deci, 2002). *Social relatedness* is the feeling of being connected with other people, having meaningful relationships with others and being an integrated part of the community. It also relates to feelings of security within the social group.

The overall Self-Determination Theory framework is organised by different mini-theories. *Cognitive Evaluation Theory* (Deci & Ryan, 1980) focuses on the cognitive processes underlying perceptions of autonomy and competence (mentioned above) and the functional significance of a situation. *Organismic Integration Theory* describes how human beings internalise extrinsic contingencies that regulate their actions and make them part of their sense of self. Depending on the degree to which this internalisation process takes place, different qualities of regulation emerge, differing in the degree to which they are perceived as autonomous (Figure 3). *Causality Orientation Theory* focuses on the individual by describing different motivational orientations. It relates to dispositional differences regarding preferences in regulatory style (autonomous, controlled, and impersonal). *Basic Needs Theory* focuses on the concept of basic psychological needs, its relationship to well-being, life goals and daily behaviour (Ryan & Deci, 2002).

Within the context of this dissertation, Causality Orientation Theory plays a central role as it is focused particularly on the supportive effects of the social context (in the form of productive classroom talk) on students' perceptions of autonomy (Study 2). Also Organismic Integration Theory plays a role, as the project further examines the effects of basic psychological need fulfilment on intrinsic learning motivation (Study 1 and 2). It is analysed whether students internalise the regulation of their behaviour within the context of productive classroom talk and report high levels of intrinsic learning motivation. Different developments between students or classes could potentially to some extent be explained by differing causality orientations which are a function of students' prior experiences and the functional significance they ascribe to their classroom environment.

Within research on Self-Determination Theory some teacher behaviours expected to help students in their fulfilment of basic psychological needs are discussed quite extensively. Very prominently is the use and effect of feedback (e.g., Butler, 1987; Deci & Ryan, 1985; Deci, Koestner, & Ryan, 1999; Katz, Assor, Kanat-Maymon, & Berbey-Meyer, 2006; Ryan & Deci, 2000; Sansone, 1986, 1989; Vansteenkiste & Deci, 2003). If seen as a reward or an extrinsic contingency, feedback could possibly undermine a persons' intrinsic or self-determined learning motivation (Deci & Ryan, 1985; Ryan & Deci, 2000). Yet, feedback that is task-related, informational and contingent could be shown to have positive effects on students' intrinsic learning motivation by fulfilling the need for competence (Deci, Koester, & Ryan, 1999). It is furthermore not interpreted as a reward that limits the individual's

autonomy and as such has no undermining effect. Specifically, need supportive feedback is positive (Deci, Koester, & Ryan, 1999), performance-contingent (Katz et al., 2006; Ryan & Deci, 2000), task-related and non-threatening (Butler & Nisan, 1986). Such feedback is generally referred to as *informational feedback* in the Self-Determination literature (Ryan & Deci, 2000)

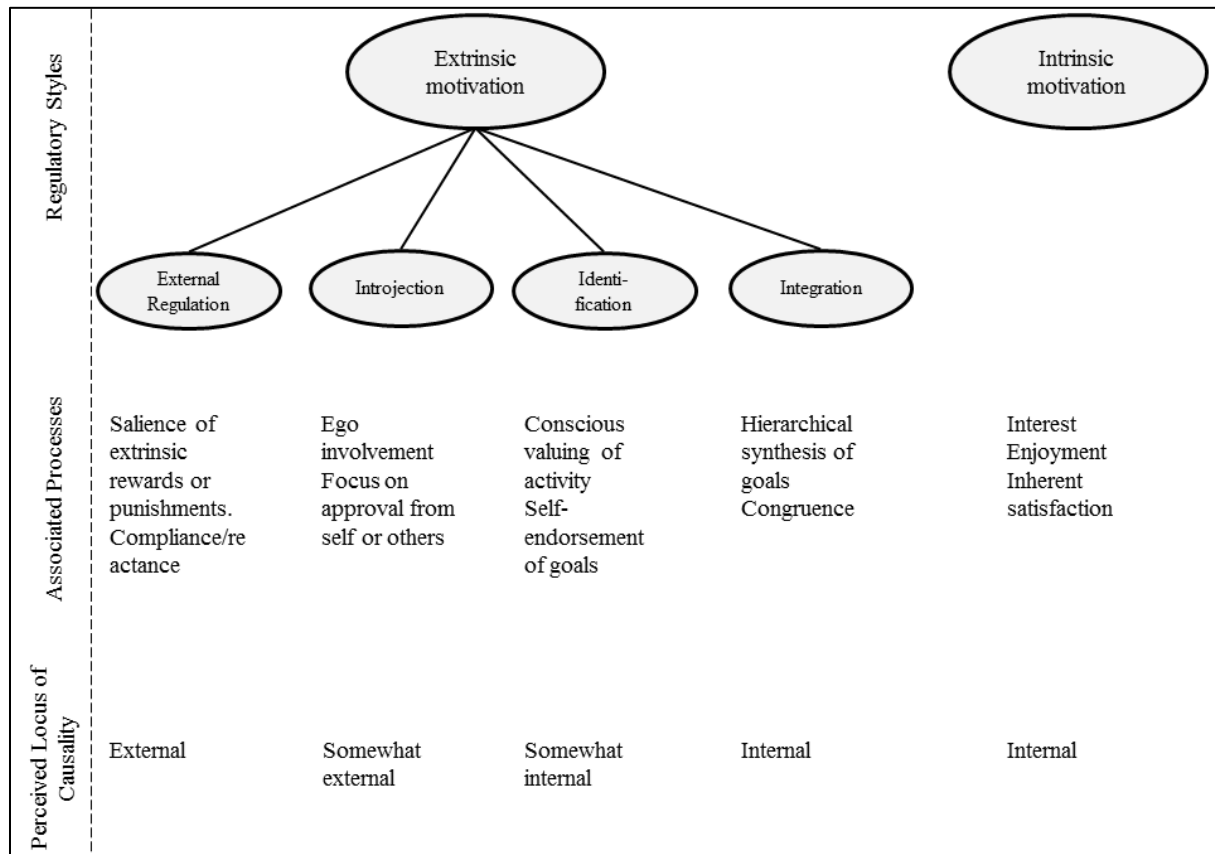


Figure 3. Taxonomy of human motivation (adapted from Ryan & Deci, 2002, p. 61).

Feelings of volition and relevance are important aspects for the fulfilment of the basic need of autonomy (Assor, Kaplan, & Roth, 2002; Reeve, Nix, & Hamm, 2003). The use of authentic problems and questions, which open up debate and discussion, are external teaching actions which can provide these feelings of relevance and volition, as they enable the learner to understand the personal meaning of the learning content and to acquire a sense of ownership over the learning material (Furtak & Kunter, 2012; Stone, Deci & Ryan, 2009). In their research into autonomy supportive teaching behaviours Reeve and Jang (2006) state that it is teacher suggestions that guide rather than provide answers and provocative questions that stimulate independent critical thinking that are important for students to claim their knowledge. Building intrinsic motivation requires supportive interactions, and supportive interactions begin with open questions that invite exploration of an important problem (Stone, Deci & Ryan, 2009). Furthermore, it requires active listening and an appreciation of the others' contributions and perspective (Reeve & Jang, 2006; Stone, Deci, & Ryan, 2009). These forms of questions and feedback are also external teaching activities indicating effective teaching processes and high-quality instruction during classroom talk (see Section 3.1; Figure 1). Other relevant teaching activities and processes include: nurturing students' inner motivational resources, acknowledging

students perspective and feelings, creating time for independent work, and giving students opportunity to talk (Conklin, 2013; Jang, Reeve, & Deci, 2010; Mageau & Vallerand, 2003; Reeve & Jang, 2006)

5.3. Student Learning Motivation from the Perspective of Person-Object Theory of Interest

Though Self-Determination Theory takes into consideration prior experiences of the individual and dispositional aspects such as causality orientation, it is a framework of human action and motivation that is situated in nature. It focuses on the moment-to-moment experiences of the individual within its social context. In difference, Person-Object Theory of Interest (Krapp, 2002a, 2002b, 2007; Krapp & Prenzel, 2011; Krapp & Ryan, 2002) is concerned with more long-term motivational outcomes. Furthermore, in difference to most other conceptualisations of human motivation interest is characterised by subject-specificity (Krapp, 2000, 2002a; Schiefele, 1996). The concept of interest is a cross-over between cognition and affect (Hidi & Renninger, 2006, Renninger & Hidi, 2011; Renninger & Riley, 2013; Renninger, 1990); it 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). The object of interest has great value to the individual (value valence) and produces positive affect (emotional valence; Schiefele, 1996). Furthermore, as a person identifies with the object of interest, it has constitutive value for her personality and is closely connected to the self. Consequently, Person-Object Theory of Interest also falls into the category of dynamic personality theory (Krapp, Geyer, & Lewalter, 2014). The object of interest does not have to be a physical object, but can also be a topic or an activity. Generally, in their domain of interest people accumulate vast amounts of domain-specific content knowledge (Prenzel, 1988).

In recent conceptualisations of interest in the subject (e.g., Ainley, Hidi & Berndoff, 2002; Hidi & Renninger, 2006; Hidi & Baird, 1986; Hidi & Harackiewicz, 2000; Knogler, Harackiewicz, Gegenfurtner, & Lewalter, 2015; Krapp, 2000, 2002, 2007; Schiefele, Krapp, & Winteler, 1992; Rotgans & Schmidt, 2014; Sansone & Thoman, 2005; Schiefele, 2009; Silvia, 2006; Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008) at least two qualitatively different types are differentiated, defined by temporal aspects, as well as the degree to which they have been internalised by the individual. *Situational interest* refers to the interestingness of the situation. It is triggered in the moment, for example by aspects of the learning environment such as the topic, the activity or the instructional style of the teachers. It is the 'focused attention and the affective reaction that is triggered in the moment by environmental stimuli' (Hidi & Renninger, 2006, p.113). This 'focused attention and affective reaction' is referred to as the catch-component (Mitchell, 1993) of situated interest; it orients the person towards the object. If a person additionally ascribes value to the object, the hold-component (Mitchell, 1993) took effect, which forms the basis for the development of individual interests. *Individual interest* is a personality trait or motivational disposition. It can be activated in a specific situation, but exists in the person beyond the situation. Through repeated activation situated interest

can be internalised and eventually integrated into a persons' value system, making it an individual interest (Figure 4).

Herein, interestingness is an aspect of the social context, while dispositional interest is an aspect of the individual (Krapp, Hidi, & Renninger, 1992). Even though the potential for interest lies within the person, content and interaction define the development of situational and individual interests (Hidi & Renninger, 2006). In recent research the situatedness of interest has been highlighted even further (Knogler et al., 2015). Thus, significant others, the organisation of the environment and a person's inner motivational resources can support interest development (Krapp, 2000; Renninger & Hidi, 2002; Sansone & Smith, 2000). An aspect of the environment that has repeatedly been shown to affect a person's interest is the availability of feedback (e.g., Sansone, 1986, 1989). Task-related feedback can address the affective component of interest (curiosity), while positive feedback provides information on competence (Sansone, 1989). As has been pointed out before, the use of such forms of feedback constitutes an external teaching activity indicative of high-quality deep structures during classroom talk; an indicator of productive classroom talk.

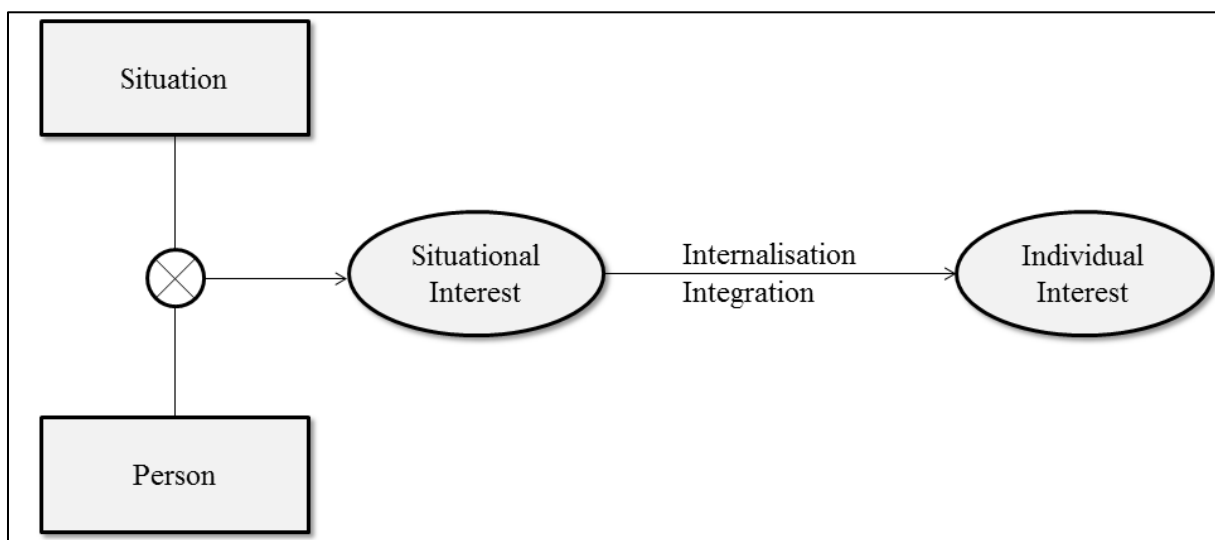


Figure 4. Development of individual interest (adapted from Krapp, Gayer, & Lewalter, 2014, p. 206) .

Repeatedly, the relationship between intrinsic learning motivation and situated interest has been stressed (Krapp, 2002). Person-Object Theory of Interest and Self-Determination Theory share a number of metatheoretical aspects such as their view on man. Both theories stress the dynamic integration of self, the active individual and the interaction of individual and context in the process of personal development. Furthermore, intrinsic learning motivation is conceptualised with explicit reference to the concept of interest. Also, intrinsic learning motivation shares the emotional aspect of enjoyment and positive affect with interest in the subject (Figure 3). Prenzel (1988) went on to differentiate the emotional valence of interest into three components (a) tension, in the sense of positive arousal and activation, (b) content-specific emotional experiences, and (c) perceived competence with regard to the object of interest. As such, interest-oriented actions can fulfil the basic psychological need for competence. Krapp (2002) shows that the integration of external regulations

into the value system of an individual within the framework of Self-Determination Theory can be connected to the value component of interest and thus to the fulfilment of the basic psychological need for autonomy. Finally, Self-Determination Theory and Person-Object Theory of Interest are connected through the intrinsic quality of the motivation: ‘There is no gap between what a person has to do in a specific situation and what the person likes to do’ (Krapp, 2002, p. 415). From the perspective of Self-Determination Theory interest is ‘conceptualized as the core affect of the self — the affect that relates one’s self to activities that provide the type of novelty, challenge, or aesthetic appeal that one desired at the time’ (Deci, 1992, p. 45). Here, the emotional component of an interest is at the centre of attention.

It is the perspective of this thesis that due to their participation in a year-long teacher professional development programme on productive classroom talk, teachers come to increasingly support students basic psychological needs. As Turner and colleagues (2002) point out, supportive classroom talk can fulfil the need for autonomy, while constructive and informational feedback – an essential part of productive classroom talk (Chinn, 2006; Kluger & DeNisi, 1996; Mehan, 1978; van den Bergh, Ros, & Beijgaard, 2013b) – can enhance experiences of competence (Deci & Ryan, 1985; Ryan & Deci, 2000). Furthermore, asking meaningful, authentic questions (as should be the case in productive classroom talk; Alexander, 2005, 2008; Boyd & Rubin, 2006; Graesser & Person, 1994; Nystrand, Wu, Gamoran, Zeiser, & Long, 2003) carries the potential to demonstrate value of and rationale for the learning content to students – both aspects that relate positively to student learning motivation (Deci & Ran, 1985; Pekrun, 2006; Pekrun & Stephens, 2010; Ryan & Deci, 2000; Wigfield & Eccles, 2000). By changing students’ moment-to-moment classroom experiences their need for autonomy, competence and social relatedness can be fulfilled, leading to intrinsic learning motivation. Since the teacher professional development programme implemented in the context of the ‘Dialogue’ project is long-term and aims to result in transfer into teachers’ every day practice (Gröschner et al., 2015a), this thesis acknowledges the possibility for teachers to create repeated instances of intrinsic learning motivation/triggered situated interest which eventually develops into individual interest in the subject (Hidi & Renninger, 2006; Krapp, 2005; Renninger & Hidi, 2011). In conceptualising a study design that measures students’ situated experiences at multiple points in time as well as their overall development over the course of a school year, the aim was to combine the two perspectives of Self-Determination Theory and Person-Object Theory of Interest 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 intrinsic learning motivation and interest in the subject. The learning environment or social context here is focused on classroom talk and its supportive properties if conducted productively.

5.4. Teacher Instruction and Student Learning Motivation – the Need for Supportive Learning Environments

The associations between classroom practices and students' motivation have been analysed from various perspectives. For example, classroom practices have been found to relate to achievement goals (Ames, 1992; Greene, Miller, Crowson, Duke, & Akey, 2004), effective strategies and ability beliefs (Ames & Archer, 1988), self-efficacy (Greene et al., 2004), involvement (Turner, Meyer, Cox, Logan, DiCintio, & Thomas, 1998), and avoidance strategies (Turner et al., 2002). Even more recently, Lerkkanen and colleagues (2012) produced evidence that student-centred teaching positively affects the interest development in mathematics and reading. Herein, constructive learning support and to a lesser extent cognitive activation have been predictive of student learning motivation (Kunter, Klusmann, Baumert, Richter, Voss, & Hachfeld, 2013; Rakoczy, Klieme, & Pauli, 2008; Rakoczy, Klieme, Drollinger-Vetter, Lipowsky, Pauli, & Reusser, 2007; Rakoczy, 2006).

The organisational context of schools sets certain boundaries on students' self-determination (Reeve & Assor, 2011). Though in young infants a love for learning and constant curiosity make learning and the early years of school an autonomous experience, with a mounting number of school years students' learning motivation develops negatively (Anderman & Maehr, 1994; Eccles et al., 1993; Wigfield et al., 2006). While part of this effect comes down to idiosyncratic and ontological developmental effects (Hofer, 2004), others are more related to aspects of instruction and the organisation of schooling: increased social comparisons (Schurtz, Pfof, Nagengast, & Artelt, 2014), a mismatch between students' psychological needs and the requirements of schools (Eccles et al. 1993; Köller, 2000; Wigfield, 1994). While ontological developments are only to a limited degree accessible for interventions, aspects of instruction are open to the like. Given that in many conceptualisations of motivation, not least Self-Determination Theory and Person-Object Theory of Interest, learning motivation is a function of individual prerequisites and aspects of the social context, and hence this decreasing learning motivation – found particularly during secondary education – does not have to be accepted.

Within the limits of the rules and affordances of a particular school system Self-Determination Theory offers recommendations on how to design learning environments that allow for student experiences of autonomy and competence – despite the fact that the system is prescriptive and regulates students' behaviour. Central in this research are two comprehensive questions: (A) How can we support students to internalise external contingencies and (B) How does teaching and learning have to look in order for the functional significance to be autonomy and competence supportive? With regard to the first question, much research went into the direction of the undermining effects of rewards (Deci & Ryan, 2002; Ryan & Deci, 2000). This research centres on Organismic Integration Theory (Ryan & Deci, 2002). The research on the second question often draws on aspects of Cognitive Evaluation Theory (Deci & Ryan, 1980; Ryan & Deci, 2002) and has produced an extensive body of

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literature under the headings of autonomy support and structure. Prenzel and colleagues (2002) provide a synthesis from research on motivation and interest of supportive conditions during classroom instruction that represent aspects of process-oriented learning support. They differentiated between six supportive aspects in the learning environment (see Section 4.1). Two of those aspects are the focus of much research from the perspective of Self-Determination Theory: support of autonomy and support of competence.

Research on autonomy support (cf. Assor, Kaplan, Roth, & Kanat-Maymon, 2005; Kaplan & Assor, 2001; Reeve, 1999, 2006, 2009; Reeve, Bolt, & Cai, 1999; Reeve & Jang, 2006; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009; Schuitema, Peetsma, & van der Veen, 2016; Soenens & Dochy, 2009; Stroet, Opdenakker, & Minnaert, 2013; Vansteenkiste, Sierens, Goossens, Soenens, Dochy, et al., 2012) focuses on the supportive aspects of the social context (Skinner, Furrer, Marchand, & Kindermann, 2008). Similar to Self-Determination Theory, this approach has been applied to a number of domains (e.g., health, psychotherapy, parenting, physical education) and cultures (e.g., individualistic vs. collective societies). In addition to students' inner motivational resource, it is contextual aspects such as a teacher's instructional style that foster or thwart experiences of autonomy (Jang, Reeve, & Deci, 2010; Reeve, 2009; Reeve & Jang, 2006). A social context is autonomy supportive if an individual within this context perceives her actions as stemming from within her. The locus of causality is seen as lying within the person. A teacher's instructional style can be located on a continuum between highly controlling and highly autonomy supportive (Deci, Schwartz, Sheinman, & Ryan, 1981). An instructional style is considered autonomy supportive if teachers provide 'their charges as much choice as possible within the situation. The idea is to help [the students] to connect their sense of self to the activity, so they can do it with a sense of ownership and volition, rather than feeling controlled and coerced by external forces' (Ciani, Middleton, Summers, & Sheldon, 2010, p. 90).

In their synthesis of research on learning motivation and interest Prenzel and colleagues (2002) name possible choices, flexibility in instruction and support of self-determined exploration, planning and acting amongst the features of autonomy support during classroom instruction. Specifically, autonomy supportive teachers (A) nurture students' inner motivational resources, (B) rely on non-controlling, informational language, and (C) acknowledge students' perspective and feelings (Jang, Reeve, & Deci, 2010; Mageau & Vallerand, 2003; Reeve & Jang, 2006). Conklin (2013) specifies these broad categories as the instructional behaviours of: (1) listening, (2) creating time for independent work, (3) giving students opportunities to talk, (4) giving praise as feedback, (5) offering encouragement, (6) offering hints, (7) being responsive to questions and comments, and (8) acknowledging student's perspective and experience.

A further important distinction came from Stefanou and colleagues (2004), who reconciled contradictory findings surrounding the concept of choice within research on autonomy support. The

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researchers reviewed literature on autonomy support and differentiated three subtypes of autonomy support in which teachers engage. *Organisational autonomy support* focuses on the overall organisation of the learning environment, such as seating arrangements, group-work arrangements, etc. It refers to surface structures of instruction. *Procedural autonomy support* is such, in which students are allowed, for example, to choose and handle their own experimental materials. Such external teaching/learning activities have only limited implications for internal teaching and learning processes (Kunter & Trautwein, 2013). In *cognitive autonomy support* students may find multiple solutions to problems, receive informational feedback, and are supported in finding solution strategies and the re-evaluation of errors (Furtak & Kunter, 2012; Stefanou, Perencevich, DiCintio, & Turner, 2004). Practices addressing cognitive autonomy support are of importance for internal teaching and learning processes. Hence, research in this field supposes that cognitive autonomy is more beneficial to student learning than procedural autonomy, which is more beneficial than organisational autonomy. However, it has been argued as well that learning could actually be hindered if students are given too much freedom with materials (Kirschner, Sweller, & Clark, 2006; Mayer, 2004).

A second dimension that defines a teachers' instructional style is structure (i.e., competence support). It is 'the amount of clarity of information that teachers provide to students about expectations and ways of achieving desired educational outcomes' (Jang et al., 2010, p. 589). It gives students a sense of control over classroom environments; the locus of control lies within the student. Its opposite on the continuum is chaos. Looking at the recommendations for teachers to provide structure: (A) present clear, understandable, explicit, and detailed directions, (B) offer a programme of action to guide students' ongoing activities, and (C) offer constructive feedback (Jang et al., 2010) parallels to the concept of scaffolding (Vygotsky, 1978) and goal clarity (Prenzel, Seidel et al., 2002) become apparent. Feedback here should be feedback on learning objectives and also informal feedback that uses an individual frame of reference (Prenzel et al., 2002). Supporting students' perception of competence necessitates a focus on their level of understanding, and as such, their *zone of proximal development* (Vygotsky, 1978); it is thus a student-centred form of instruction (Prenzel, Seidel, et al., 2002). The student or learner is seen as an active constructor of knowledge and understanding, who, with some support from the teacher, can develop in her understanding. Successful learning processes then are those where students are at the centre of the learning process and instruction is adapted to them, not the other way around.

Within the research on autonomy and competence support the concept of control is pivotal. It is looked upon from two sides: teacher control and student control. Autonomy support is a minimum of teacher control, while competence support is high student control. This is not equivalent to a *laissez-faire* teaching style and instruction in which students can do whatever they want, what is meant – in line with the original definitions from above – is that students are given control over the learning process through clear task descriptions, fully articulated expectations and scaffolding procedures which help them accomplish their goals. On the other hand, teacher control is decreased in the sense

that teachers do not prescribe how the learning goals ought to be achieved or by which method a task needs to be fulfilled. Students are given degrees of freedom about how they want to organise the learning process, which procedures to engage in during the learning process and how they cognitively engage in the learning process (Stefanou et al., 2004). Amongst others, instructional approaches such as problem-based learning (e.g., Hmelo-Silver, Duncan, & Chinn, 2007), inquiry-based learning (Abrams, Southerland, & Silva, 2008; Wells, 2001) and in the perspective of this dissertation productive classroom talk are seen to have the capacity to provide this instructional style (high autonomy support and high structure), which is considered optimal for student motivation and engagement (Assor, Kaplan, Roth, & Kanat-Maymon, 2005; Hospel & Galand, 2016; Jang et al., 2010).

Repeatedly, attempts have been undertaken to train and support teachers in the use of autonomy and competence supportive teaching (e.g., Cheon & Reeve, 2015, 2013; Kaplan & Assor, 2013; Reeve, 2009). A meta-analysis ($N = 19$ studies) showed that intervention programmes on autonomy support were overall effective, with a weighted effect size of $d = 0.63$. Further analyses showed that the more effective intervention programmes included multiple elements of autonomy support and were relatively short (1–3 hours) laboratory trainings that focused on skill-based activities and used media to deliver content. Furthermore, teacher trainings were more effective (rather than trainings for other professionals; Su & Reeve, 2011). Also, it could be shown that teachers' causality orientations (Su & Reeve, 2011), as well as their beliefs (Aelterman, Vansteenkiste, van den Bergh, De Meyer, & Haerens, 2014; Reeve & Cheon, 2016; Reeve, Vansteenkiste, Assor, Ahmad, Cheon, Jang, et al., 2013) play an important role as to how readily they incorporate new autonomy supportive practices into their teaching script. Pivotal here is teachers' belief about how easy-to-implement the new practice is.

It is the conjecture of the present thesis that *productive* classroom talk is such a student-centred classroom practice in which teacher control is reduced and the potential for increased student control is present. This creates a social context for the promotion of motivational learning outcomes in students in supporting students' competence and autonomy (Andersen & Nielsen, 2013; Turner et al., 2002). Preliminary findings for this conjecture have been presented from Kaplan and Assor (2012), who implemented a teacher training based on Buber's I-Though Dialogue (1960), demonstrating positive effects on reduced student aggression. Furthermore, it was of interest whether teacher professional development programmes could help teachers counter students' decreases in intrinsic learning motivation and interest throughout secondary education (Turner, Warzon, & Christensen, 2011).

6. Productive Classroom Talk and the Promotion of Motivational Learning Outcomes

Productive classroom talk has been analysed from multiple perspectives; thereby two major lines of inquiry emerged. As described above (Sections 3.1 and 3.3), originating from a constructivist perspective on learning, there is research seeing productive classroom talk as a tool for co-construction of meaning and knowledge in the form of thinking aloud in order to be able to build upon these ideas and elaborate student thinking (e.g., Alexander, 2005, 2008; Howe & Abendin, 2013; Mortimer & Scott, 2003; Wells & Arauz, 2006). Conceptualisations like Accountable Talk (Michaels et al., 2008) and Exploratory Talk (Mercer & Howe, 2012; Mercer, 1994, 2002; Mercer & Littleton, 2007) are examples of classroom talk seen from this perspective. In line with this reasoning, although inspired from different theoretical backgrounds, are examinations looking at classroom talk from an inquiry learning point of view (Furtak, 2006; Kovolainen & Kumpulainen, 2005; Wells, 1999, 2001). The second perspective is one of assessment. Productive classroom talk is (A) a tool for teachers to become aware of students ideas and assess them (Ruiz-Primo, 2011) and (B) has the capacity to make learning visible and provides teachers with feedback on their teaching and how suitable it is for their students (Hattie, 2008, 2012). In summary, productive classroom talk offers potential in terms of the learning processes it can trigger (Chi, 2009), as well as through its capacity to make student thinking explicit (Ruiz-Primo & Furtak, 2006, 2007; Ruiz-Primo, 2011), thereby fulfilling a feedback function for teachers (Hattie, 2012).

In much of this research on classroom talk, cognitive and informational aspects have been the focus (Howe & Abedin, 2013); much less attention has been paid to motivational-affective processes (Andersen & Nielsen, 2013). However, there is some research suggesting that certain forms of teacher-student interaction are supportive of learning motivation and affect (Reeve, 2006; Reeve & Jang, 2006; Turner et al., 2002). In the following, it will be elaborated upon the afore-mentioned function of productive classroom talk as a motivational scaffold by arguing its importance as a social context in which learning motivation can thrive. This argumentation is based on the two interconnected frameworks of Self-Determination Theory and Person-Object Theory of Interest, which follow person-in-context lines of reasoning instead of a dispositional approach to motivational student learning outcomes (Krapp, Geyer, & Lewalter, 2014). In doing so, this dissertation aims to add a third perspective to the research tradition on productive classroom talk and provide a first step towards an explanatory model for positive relationships between classroom talk and student learning motivation (Andersen & Nielsen, 2013). Furthermore, it adds to the body of literature on instructional quality in the form of constructive learning support as outlined by Prenzel and colleagues (2002), and training and professional development programmes that aim to foster this aspect of instructional quality in teachers (e.g., Aelterman, Vansteenkiste, Van Keer, De Meyer, Van den Bergh, & Haerens, 2013; Cheon & Reeve, 2015; for a recent overview, see also Su & Reeve, 2011)

6.1. Productive Classroom Talk as a Need-Supportive Social Context

Learning is a social and interactional process (Vygotsky, 1976) where '[t] eachers and student work together in the rich psychological soup of a classroom, a soup comprised of cognitive, social, cultural, affective, emotional, motivational, and curricular factors' (Shuell, 1996, p. 726). Given its dominance in German classrooms, in my view, it constitutes one of the most central elements of the proximal social context in education – after all, most instruction is done verbally (Kobarg & Seidel, 2007). In conceptualisations of teaching scripts (Kollar & Fischer, 2008) certain roles are assigned to participants, as well as typical activities that these participants engage in. Within the questioning-developing classroom talk script, the role of students is that of a keyword giver (Jurik et al., 2013; Kobarg & Seidel, 2007) and the activity they most commonly engage in is that of single-word answers to teacher questions (Kobarg & Seidel, 2007; Reznitskaya, 2013). Consequently, such classroom talk is a very narrowly defined social context with only limited degrees of freedom for the individual student. Such a social context is pressuring and controlling (Webb, 2009), rendering it detrimental to student motivation and engagement (Seidel, Rimmele, & Prenzel, 2003). For many students such a script of limited constructive learning support defines the social context within which they learn every day (Schiepe-Tiska et al., 2013).

If conducted productively, classroom talk can be an instructional and motivational scaffold (see Sections 3.2 and 4.2). Within such a student-centred teaching script, the prerogative is not on teaching or covering the content (Fischler, 1994; Putnam, 1987), but on learning and understanding. The expectations toward the participants change, as well as their roles and social interactions. In the terms of Walshaw and Anthony (2008), participation in the classroom talk and with this in the learning process is the right *and* the responsibility of every one in the classroom. With this perspective, students' role becomes that of an equal partner, who has a share and stake in the learning process. In other words, they receive ownership over the learning process (Ciani et al., 2010). In alignment with the second aspect of Walshaw and Anthony's review, scaffolding student ideas becomes a priority. This changes the valence of the social context toward one of support. The scaffolding aspect of such talk has been highlighted in the literature (Patrick, Turner, Meyer, & Midgley, 2003; Tharp & Gallimore, 1991; Turner et al., 2002).

References to social context emerge in various research studies on students' motivation and self-regulation (Anderman & Anderman, 2000; Appleton, Christenson, & Furlong, 2008; Meyer & Turner, 2002a; Pintrich, 2000; Urdan, 1999), not least research on Self-Determination Theory (see Section 5.2; Deci & Ryan, 1985; Guay & Vallerande, 1997). Research has provided rich descriptions of learning environments that promote students' motivation (Blumfeld & Meece, 1988; Meece, 1991; Stipek, Salmon, Givin, Kazemi, Saxe, & MacGyvers, 1998), and important connections between teachers' instruction and motivation (see Section 1.1). Aspects of instruction that reoccur in the literature on need support and Self-Determination Theory include the asking of open questions and the provision of

constructive feedback (Conklin, 2013; Furtak & Kunter, 2012; Reeve, 2009; Stone et al., 2009) – indicators of productive classroom talk.

The Self-Processes Model (Connell & Wellborn, 1991; Skinner, Wellborn, & Connell, 1990; Furrer, Skinner, Marchand, & Kindermann, 2006; Appleton, Christenson, Kim, & Reschly, 2006) provides a comprehensive framework linking the social context, the individual, their actions and educational outcomes (Figure 5). The framework integrates research on motivation (in the form of Self-Determination Theory), teacher effectiveness research and student engagement and highlights the importance of the social context as a precursor for student motivation and desirable learning outcomes. Based on the Self-Processes Model, supportive social contexts foster students’ fulfilment of basic psychological needs and increase the quality of students’ learning motivation (Deci & Ryan, 1985; Ryan & Deci, 2000). Such motivation is seen as a prerequisite for student engagement (Furtak & Kunter, 2012; Meece, Blumfeld, & Hoyle, 1988; Pintrich, Marx, & Boyle, 1993).

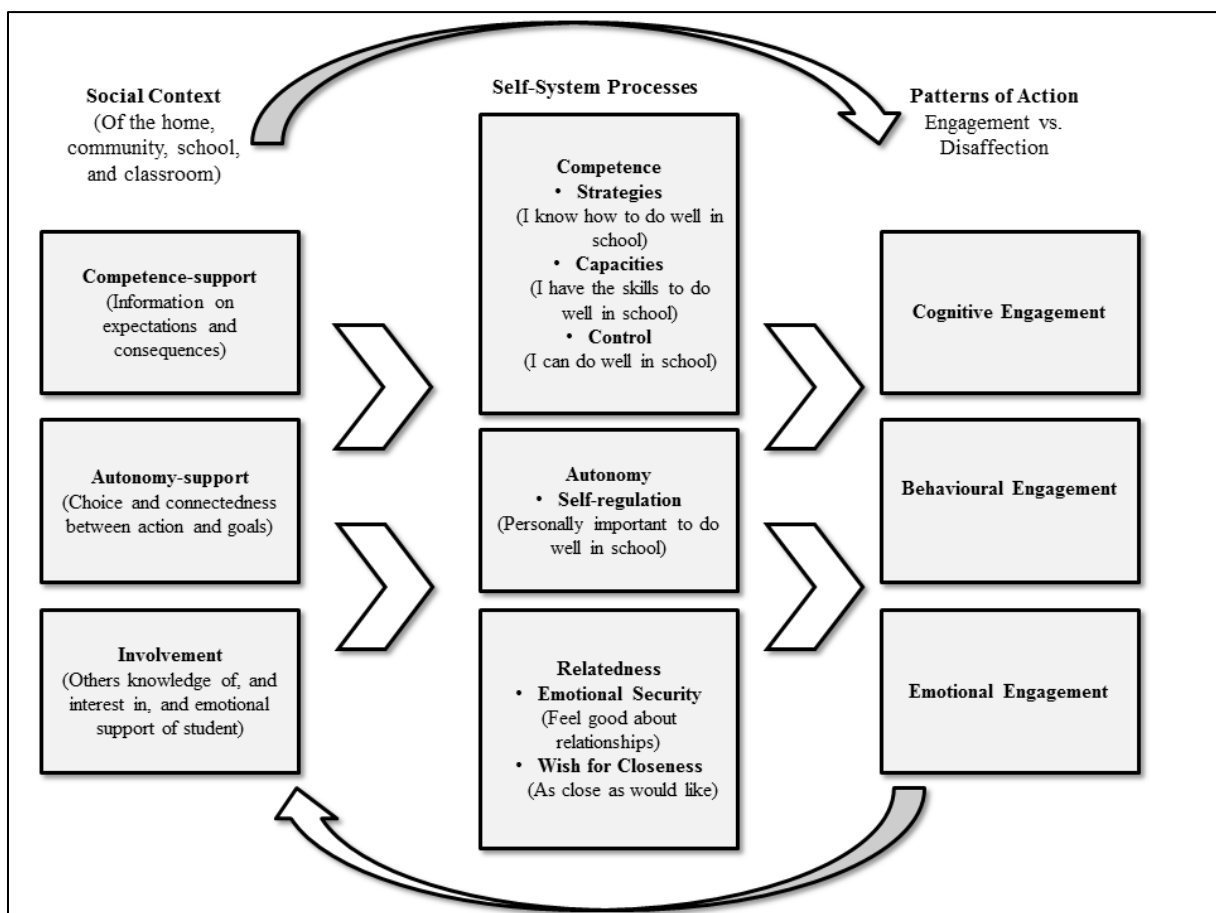


Figure 5. Self-Processes Model applied to educational settings (adapted from Connell & Wellborn, 1991, p. 54).

Going back to research on autonomy support aspects of the social context that support the need for autonomy are: (A) nurturing students’ inner motivational resources, (B) relying on non-controlling, informational language, and (C) acknowledging students’ perspective and feelings (Jang, Reeve, & Deci, 2010; Mageau & Vallerand, 2003; Reeve & Jang, 2006). More specifically even, an autonomy supportive social context is characterised by: (1) listening, (2) creating time for independent student

work, (3) giving students opportunities to talk, (4) giving praise as feedback, (5) offering encouragement, (6) offering hints, (7) being responsive to questions and comments, and (8) acknowledging student's perspective and experience (Conklin, 2013). Offering hints entails suggestions that guide rather than provide answers, as well as provocative questions that stimulate independent critical thinking. In the terminology of research on productive classroom talk, this represents a high-quality teacher initiation in the sense of an IRE/F sequence. Giving student opportunities to talk and being responsive to their questions and comments echoes the R move in the IRE/F sequence. Similarly, listening stresses the need to make room for student contributions and move beyond lecture-style classroom instruction in which only the teacher is talking. Points four (giving praise as feedback) and five (offering encouragement) stress the importance of feedback or evaluation in order to move student thinking forward. In sum, both research perspectives – research on Self-Determination Theory, in the form of autonomy support, and research on productive classroom talk – highlight very similar contextual elements for the promotion of student learning outcomes.

Turner and colleagues (2002) reported specifically on supportive social context in the form of classroom talk. In their study they differentiated between *supportive instructional discourse* focused on understanding and autonomy, and *supportive motivational discourse* focused on effort, affect and collaboration. The instructional discourse that supports students' autonomy focuses on transferring the responsibility of the learning process to students. It is characterised by the support of strategic thinking and autonomous learning and holds students accountable for understanding. Motivational discourse has a focus on learning and is achieved by challenging students, viewing errors as constructive and supporting persistence (Turner et al., 2002). When looking at the recommendations for teachers to provide autonomy support (nurture students' inner motivational resources, rely on non-controlling, informational language, and acknowledge students' perspective and feelings; Jang et al., 2010; Mageau & Vallerand, 2003; Reeve & Jang, 2006) and structure (present clear, understandable, explicit, and detailed directions, offer a programme of action to guide students' ongoing activities, and offer constructive feedback; Jang et al., 2010) similarities between instructional and motivational discourse on the one side and autonomy support and structure on the other become apparent and make clear why a social context of instructional and motivational discourse provides a suitable learning environment for fostering student learning motivation and interest in the subject. Additional parallels can be drawn to the concept of scaffolding (Vygotsky, 1978) and constructive learning support, underscoring the high instructional quality (Baumert & Kunter, 2006; Lipowsky et al., 2009) of such social contexts.

6.2. Shared Responsibility and Control in Productive Classroom Talk

It is the aim of this dissertation to integrate research on classroom talk and supportive social context in the sense of the Self-Determination Theory framework. Though with a focus on inquiry-based and autonomy supportive teaching Furtak and Kunter (2012) articulate this perspective on the potential

relationship between instructional/motivational discourse on the one hand and autonomy/competence support on the other:

A common theme running through both of these theoretical lines is a new perspective on the role of the learner, including a shift away from the teacher as an authoritative figure responsible for delivering instruction to students and a shift toward teachers as providers of guidance and scaffolding for student learning. (Furtak & Kunter, 2012, p. 285).

In many instances research on classroom talk uses a constructivist perspective based on Vygotsky (1978) to account for the benefits of productive teaching for learning outcomes (Halliday, 1993; Reznitskaya & Gregory, 2013; Wells, 2009). This perspective highlights the individuals' responsibility for her learning process (Michaels, O'Connor, & Resnick, 2008). Similarly, Turner and colleagues (2002) speak about shared responsibility and student autonomy as the mechanisms for the supportive nature of instructional discourse. Their conceptualisation of scaffolding in supportive instructional discourse shares many similarities with competence support or structure found in the framework of Self-Determination Theory. In tightly-controlled classroom talk dominated by closed questions and short student answers, this responsibility is taken from students and traded for teacher controlled learning processes (Alexander, 2008; Wells, 2009). High-quality talk is open and non-coercive, as it sees teacher and students as equal partners in the learning process (Alexander, 2008; Michaels, O'Connor, & Resnick, 2008; Reznitskaya & Gregory, 2013; Walshaw & Anthony, 2008; Wells, 2009; Wells & Arauz, 2006). Continuous perspective-taking and the acknowledgement and appreciation of others' ideas, thoughts and understanding are also necessary to facilitate the learning process (Lotman, 1988). Hence, the reduction of teacher control and shared responsibility for the learning process are hallmarks of productive classroom talk in the framework of productive teaching. Moreover, teachers taking perspective supports them in acknowledging their students' need for autonomy (Katz & Assor, 2007).

This perspective seems to be at the heart of the matter when Ryan and Stiller (1991) wrote: 'the more we try to control and pressure learning from without [e.g., through closed questions, evaluative feedback, transmission of knowledge, teacher-centeredness, etc.], the more we obstruct the tendencies of students to be actively involved and to participate in their own education'. The reduction of teacher control is pivot in Self-Determination Theory to promote students' inner motivational resources and facilitate them with autonomy and competence. Autonomy supportive teacher behaviours are geared towards non-control of student behaviours and not pressuring them into certain modes of thinking (Reeve, Bolt, & Cai, 1999; Reeve, 2006, 2009, Reeve & Jang, 2006; Stefanou, Perencevich, DiCintio, & Turner, 2004). On the other hand, competence supportive teachers provide constructive feedback and structure so that within well-defined boundaries students can feel competent and efficacious. Consequently, autonomy and competence support come down to finding equilibrium between teacher and student control in which effective learning can take place. In such need-supportive social contexts there is minimum risk of failure, ideas can be put forward and elaborated on

during discussion. Hence, they allow for the expression of individual ideas and acknowledge them, as is the case in productive classroom talk (Dawes, 2004; Howe, 2009; Myhill, et al., 2005; Seidel & Prenzel, 2006; Walshaw & Anthony, 2008). Students' ownership over the learning process is the conceptual link between this motivation-based research and productive classroom talk. Key in the relationship between productive classroom talk and autonomy support is a leadership style that has been called both dialogic (Scott, Mortimer, & Aguir, 2006) and democratic (Lewin, Lippitt, & White, 1939), which is characterised by shared control over content, decisions and the overall learning process (e.g., Reznitskaya & Gregory, 2013) and is addressed as teachers' instructional style in the framework of Self-Determination Theory (Jang et al., 2010; Reeve, 2009).

In their research on the relationship between instructional discourse and student motivation Meyer and Turner (2002) furthermore draw on the concept of scaffolding for the description of instructional discourse that is supportive of learning and motivation. In their view,

[d]uring instructional scaffolding, the teacher supports student self-regulation, as needed, in three ways: (a) helping students build competence through increased understanding, (b) engaging students in learning while supporting their socioemotional needs, and (c) helping students build and exercise autonomy as learners (Meyer & Turner, 2002a, p. 18).

Herein, instructional discourse becomes a form of autonomy and competence support. Also, both research traditions share an emphasis on teachers' implicit beliefs about the social construction of knowledge, the importance of student ideas and the nature of motivation (Michaels, O'Connor, & Resnick, 2008; Reeve, 2006).

All these considerations refer more to aims of instruction, yet recommendations from the literature also relate to specific external teaching activities that bear importance for students' internal learning processes. The literature on productive classroom talk and autonomy/competence support references similar external teaching activities which they deem productive; elements such as open questions, constructive feedback, scaffolding devices (hints), or sufficient waiting time (Furtak & Kunter, 2012; Mercer, 2010; Reeve, 2006; Reeve & Jang, 2006; Tobin, 1987; Walshaw & Anthony, 2008). These strategies aim to encourage students to take control (i.e., ownership) of and responsibility for their own learning process. Key here is to move beyond procedural autonomy (students being autonomous in their selection of learning materials, presentation modes, etc.) and to provide them instead with cognitive autonomy; the freedom to think without external pressures (Stefanou et al., 2004). As has been outlined in preceding sections, this aspect of thinking in a personal way, arriving at one's own solution path or thinking aloud to arrive at a shared understanding that is not determined by 'the right answer' is a hallmark of productive classroom talk (Alexander, 2005, 2008, 2010; Dawes, 2004; Howe, 2009; Myhill, et al., 2005; Seidel & Prenzel, 2006; Walshaw & Anthony, 2008). In consequence, productive classroom talk carries the potential to foster students' cognitive autonomy.

After outlining in detail different forms and conceptualisations of productive classroom talk, its different functions and the relationship between productive classroom talk and motivational student learning outcomes, the question arises how to make teachers aware of this powerful tool which they use (presumably) without much consideration every day of their practice for large periods of time. Followed by the second question how teachers can be trained and supported to revise and redefine their dominant teaching script of classroom talk to arrive at a more productive form. In the present project, video-based teacher professional development for the duration of one school year was chosen as a possible answer to these two questions. Notwithstanding, before going into explanations on teacher learning (Sections 7.1 and 7.2), effective professional development (Section 1.1) and the programme implemented in the ‘Dialogue’ project (Section 7.5), the theoretical perspective of this dissertation is summarised in the following passage and an integrative model of the relationship between instructional quality, productive classroom talk and motivational student learning outcomes is provided. To do so, a current model in teaching and learning research, the Utilisation-of-Learning-Opportunities model is used as a backdrop (Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014).

6.3. Integrative Perspective of the Dissertation – Productive Classroom Talk as a Supportive Learning Opportunity Characterised by Shared Responsibility and Control

In order to situate this research in the greater context of educational research, this thesis draws on the Utilisation-of-Learning-Opportunities model (Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014; Figure 6). The model highlights the active role of the learner in the learning process by underscoring that learning environments provide learners with chances or opportunities for learning, yet if learning and understanding actually takes place depends on the up-take of these opportunities. It is the learner who is responsible for making use of what is offered. This perspective resonates with the widely held view in present educational research that learners ought to be active, self-regulated and autonomous (Bolhuis, 2003), as well as the view that any learning outcome is a function of the interactions between individual and context. In doing so, it implicitly raises the question what contexts need to look like to allow learners to be active, self-regulated and autonomous and how these aspects can be supported through instructional practices. In consequence, these models also give prominence to the role of the teachers as the facilitator and moderator of learning opportunities (Hattie, 2008, 2012; Lipowsky, 2006) and highlights the importance of providing high-quality instruction through good classroom management, high cognitive activation and constructive learning support (Klieme, Schümer, & Knoll, 2001; Kunter, Dubberke, Baumert, et al., 2006; Kunter & Voss, 2011). In difference to earlier Process-Product models (Brophy & Good, 1986), which examined the relevance of specific teacher characteristics for student learning outcomes, in Utilisation-of-Learning-Opportunities models (or Opportunities-to-Learn models; Seidel & Reiss, 2014) learning processes are complex, multifaceted, and reciprocal (Bolhuis, 2003; Doyle, 1986; Seidel & Shavelson, 2007). It is not the teacher who is at the focus of attention, but the processes and interactions that occur during instruction. Broadly speaking, three levels are distinguished within such Utilisation-of-Learning-

Opportunities models: the level of learning opportunities, the level of utilisation, and the level of learning outcomes (Seidel & Reiss, 2014).

On the level of learning opportunities instructional processes during class time are decisive. In their meta-analysis of teacher effectiveness research Seidel and Shavelson (2007) use Bolhuis' (2003) process-oriented model of teaching and learning components to map distal aspects of teaching such as goal setting, orientation, evaluation, regulation and monitoring, and execution of learning. The enactment of these teaching components can be evaluated based on the extent to which they fulfil aspects of instructional quality, such as classroom management, cognitive activation and learning support (Baumert & Kunter, 2006; Lipowsky et al., 2009). Furthermore, teachers' enactment of these learning opportunities and the quality with which they are applied is dependent on their professional competence (Kunter, Klusmann, Baumert, Richter, Voss, & Hachfeld, 2013). Beside teachers' knowledge (Baumert et al., 2010; Hill, Rowan, & Ball, 2005; Hill, Blunk, Charalambouse, Lewis, Phelps et al., 2008; Kersting, Givvin, Thompson, Santagata, & Stigler, 2012) also their motivation and beliefs (Dubberke, Kunter, McElvany, Brunner, & Baumert, 2008; Holzberger, Philipp, & Kunter; Seiz, Voss, & Kunter, 2015), as well as self-regulation (Klusmann, Kunter, Trautwein, Lüdtke, & Baumert, 2008) as part of professional competence (Baumert & Kunter, 2011) have been shown to influence instructional quality. The class context further affects learning opportunities, such as in the form of class size, heterogeneity, overall achievement and the like. Structural aspects of the school system and the individual school provide the broader societal context. The level of utilisation refers to the individual learning activities of the students during instruction. For educational research, this level poses some problems; the decisive learning activities are internal processes (Friedrich & Mandl, 1992), which need to be reconstructed for analysis and research. Besides cognitive processes, students' prerequisites, like in the form of motivational-affective variables, prior experiences and educational resources fall under this heading (Seidel, 2014). Finally, learning outcomes are the results of the individual learning activities in relationship to student characteristics and instructional activities. As mentioned before, learning outcomes involve a variety of aspects related to capacity building and personality development (Kunter, 2005; Prenzel, 2012), which are interrelated and often serve as prerequisites or mediators for one and another (Köller, Baumert, & Schnabel, 2000). Utilisation-of-Learning-Opportunities models demonstrate that learning is not monocausal and that learning outcomes depend on a complex network of interrelated variables and processes; the actualisation of learning outcomes is dependent on the provision of high-quality learning opportunities, student prerequisites that allow them to use these learning opportunities and high-level learning processes during instruction.

In this dissertation the different levels of the Utilisation-of-Learning-Opportunities model (Helmke, 2012; Seidel, 2014, Seidel & Reiss, 2014) apply as follows: learning outcomes pertain to motivational student outcomes (A) short-term in the form of basic psychological need fulfilment and

intrinsic learning motivation and (B) long-term in the form of interest in the subject. Learning opportunities are examined within the conceptual framework of productive classroom talk under the assumption that it provides students with high-quality learning opportunities – particularly on the dimension of constructive learning support. Teaching activities that signify this learning opportunity are indicators of productive classroom talk such as open questions, constructive feedback (Jurik, Gröschner, & Seidel, 2013), and instructionally and motivationally supportive discourse (Turner et al., 2002). In line with the respective learning outcome variables on the level of utilisation students' perceptions of the learning environment in the form of perceived autonomy and competence support, as well as their experiences of basic psychological need fulfilment are of concern. Furthermore, it conceptualises teachers' instructional style (Jang, Reeve, & Deci, 2010) as part of their professional competence in the form of attitudes and beliefs; hence this teacher prerequisite will influence the way in which teaching activities are enacted and their quality with regard to the support of autonomy and competence. Also, student prerequisites are conceptualised within the frameworks of Self-Determination Theory (Section 5.2) and Person-Object Theory of Interest (Section 5.3); such prerequisites are students' inner motivational resources (Reeve, 2002), as well as causality orientations (Deci & Ryan, 2002) and prior experiences. With these as the backdrop, students perceive the teacher's instruction and appropriate it for their individual learning, consequently there is the possibility that a teaching activity is not interpreted and utilised by all students in the same way. As the unidirectional arrows show (Figure 6) within the scope of this dissertation, we only delve into the effects of the teaching activities or learning opportunities on utilisation and learning outcomes – but given the complexity (Doyle, 1986) and reciprocity (Seidel, 2014; Skinner & Belmont, 1993) of classroom interaction, bidirectional relationships are to be expected (Reeve & Tseng, 2011). Prior research on classroom talk already produced evidence that teachers interact differently with different groups of students depending on their cognitive and motivational-affective prerequisites (Jurik, Gröschner, & Seidel, 2013).

From the review of the relevant literature it is now known that, to a great extent, students in Germany still experience learning opportunities with low degrees of constructive learning support (Schiepe-Tiska et al., 2013). Furthermore, the review highlighted the dominant teaching script in German mathematics and science classrooms and described it as problematic in view of motivational student learning outcomes (Seidel, Rimmele, & Prenzel, 2003). With this in mind, findings of decreasing student learning motivation and interest in the subject are not surprising (Baumert & Köller, 1998; Eccles et al., 1993; Gottfried, Fleming, & Gottfried, 2001; Helmke, 1993; Maulana et al., 2013; Pekrun, 1993; Spinath & Spinath, 2005). Yet, the question arises how research and teacher education can support teachers to move away from teaching activities of low instructional quality. Since teaching scripts are particularly resistant to change (Gruber et al., 2001), the project took the approach of long-term, evidence-based teacher professional development as a way to redefine teachers' scripts and increase the quality of teaching and learning in their classrooms. Professional

development has already been used successfully to proliferate more productive forms of the classroom talk teaching script (see Section 3.3). For professional development to be successful though it needs to be designed carefully and in accord with certain design principles and features mentioned in the literature (e.g., Desimone, 2009; van Veen et al., 2012; Wilson, 2013). By way of reviewing the literature of teacher learning and professional development, in the following the thesis pursues introducing the Dialogic Video Cycle. The Dialogic Video Cycle was developed and implemented as part of the ‘Dialogue’ project. To date, multiple analyses have been carried out within the context of this project, focusing on the implementation of the intervention (Gröschner, Kiemer, Pehmer, & Seidel, 2015a), the role of facilitation during the professional development workshops (Gröschner, Pehmer, Kiemer, & Seidel, 2015b), and changed teacher practice (Pehmer, Gröschner, & Seidel, 2015a), and effects of the intervention on students’ learning strategies and cognitive activation (Pehmer, Gröschner, & Seidel, 2015b). This dissertation now presents two further analyses into the effectiveness of the Dialogic Video Cycle, both on the level of changed teaching practice and on the level of students’ motivational outcomes (Lipowsky, 2010).

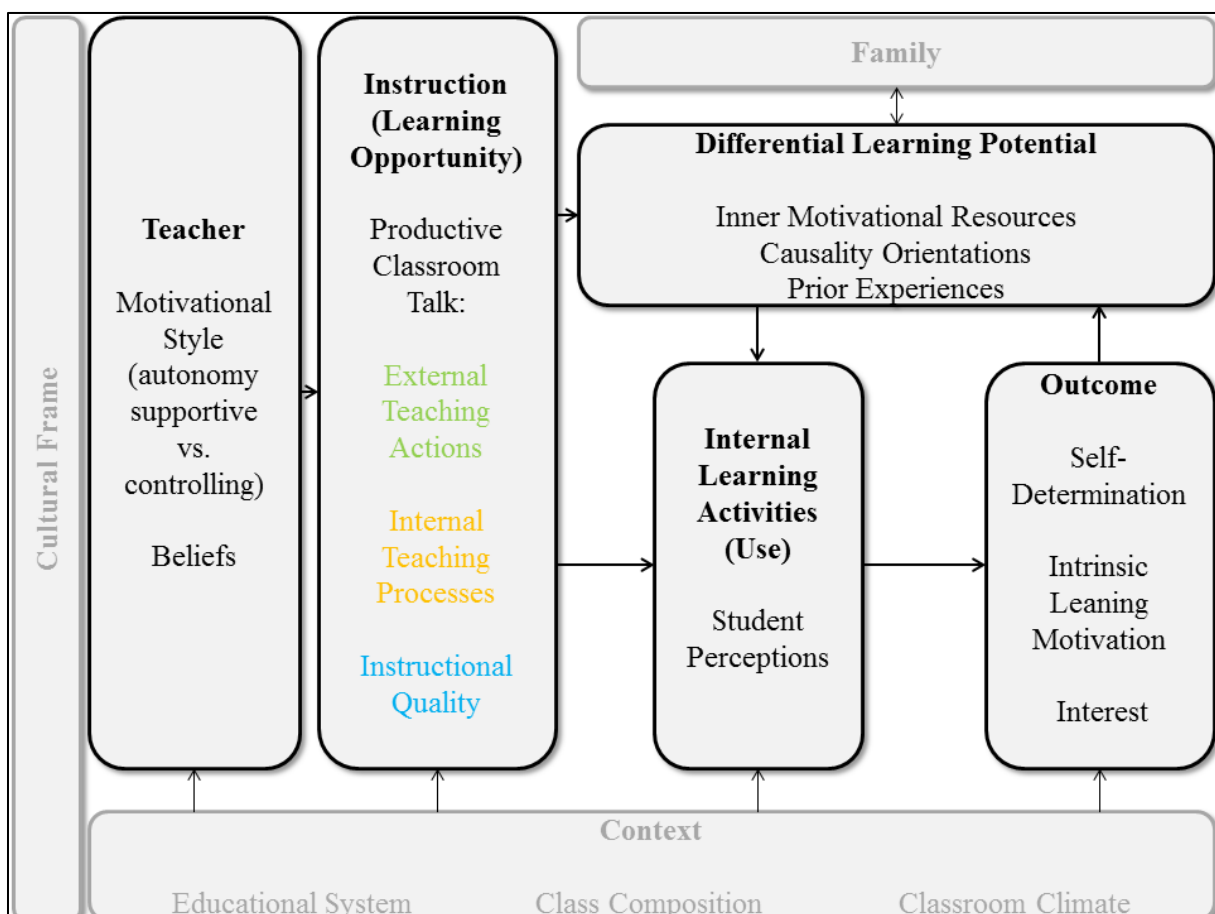


Figure 6. Utilisation-of-Learning-Opportunities Model (Helmke, 2012, p. 71) applied to productive classroom talk and motivational student outcomes.

7. Teacher Professional Development

In their seminal work Clarke and Hollingsworth (2002) provide an overview of theoretical perspectives on teacher learning and professional growth. Their argument to engage in such an endeavour is their assumption that '[t]he application of contemporary learning theory to the development of programs to support teacher professional growth has been ironically infrequent. In particular, models of teacher professional development have not matched the complexity of the process we seek to promote' (p. 947). In the design and application of the Dialogic Video Cycle, care was taken to use a firm evidence base from research on teacher professional development (e.g., Desimone, 2009; van Veen et al., 2012; Wilson, 2013) to arrive at an effective format that avoids mistakes made in the past. By way of reviewing this evidence base and specific components of effective teacher professional development, in the following the Dialogic Video Cycle will be introduced and compared to other attempts to promote productive classroom talk through professional development (see Section 3.3).

In the literature on teacher professional development different perspectives of the teacher in professional development and with it the role of professional development are identified (Clarke & Hollingsworth, 1994):

- *Change as training*: builds on a deficit perspective (Guskey, 1986) and describes professional development that is done to teachers in order to change them
- *Change as adaptation*: teachers change their practice in response to changed conditions
- *Change as personal development*: teachers strive to develop their competencies in order to enhance their performance
- *Change as local reform*: change lies not within the teachers, but in the context
- *Change as systemic restructuring*: teachers implement reform policies
- *Change as growth or learning*: change is inevitable due to the engagement in professional activity; teachers are learners in a professional community

The reality of teacher professional development in Germany is still often that of engaging in 'one shot' workshops to acquire a new skill and remedy a deficit (Richter et al., 2011; Richter, Kuhl et al., 2012). For example, 68% of mathematics teachers asked about their recent professional development activities reported that they engaged in one-day workshops (Jäger & Bodensohn, 2007). Similar findings were also reported in the national PISA teacher sample from 2006 (Frey, Taskinen, Schütte, 2007; see also Gräsel, Fussangel, & Parchmann 2006; Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). This is despite the (research) perspective that teachers are learners in a learning community (e.g., Fullan & Stiegelbauer, 1991; Guskey, 1986; Santagata, 2009; Sherin & van Es 2009) and reflective practitioners (Schön, 1983); as well as that providing professional development that is based on a deficit perspective (Guskey, 1986) is ineffective (e.g., Fullan & Stiegelbauer, 1991; Smith & Gillespie, 2007; Prenzel, Artelt, Baumert et al., 2009).

In Bavaria (which forms the administrative context for the following research) teachers are required by law to participate in teacher professional development as part of their profession (Art. 20 Abs. 2 BayLBG¹). The minimum hereby is twelve days of teacher professional development in four years (one day consists of a minimum of five hours for 60 minutes). Research shows that while 68% of primary teachers in Bavaria attend five or more professional development activities in a period of two years, there are also 13% attending none during that time (Richter & Klein, 2013). For Bavaria, the median of time spent in professional development activities is 17.5 hours (Richter et al., 2012).

In many other federal states, teachers are not required to attend teacher professional development to develop their practice or renew their licence (Avenarius & Heckel, 2000; Richter, Kuhl et al., 2012). The uptake of professional development opportunities among teachers varies across the life span. High work engagement and additional responsibilities (e.g., guidance councillor, information officer, etc.) predict the engagement in formal learning opportunities positively (Richter et al., 2011). Professional development is commonly provided from four 'directions' – centrally from the federal state, regionally by the districts, locally by school boards or on-site by the school itself. Most of those professional learning opportunities do not seem to be grounded in theory or based on evidence.

During the research for this thesis, I was not able to find systematic measures implemented by the federal state of Bavaria or any other government agency to assess the quality of professional development provided to teachers. The only body with some expertise and mission in this direction is the *Staatsinstitut für Schulqualität und Bildungsforschung* (ISB), which rather provides than evaluates professional development. Given this lack in quality assurance, the high hopes put into professional development by the *Bayerisches Staatsministerium für Bildung und Kultus, Wissenschaft und Kunst* seem almost naïve:

Teacher professional development as an instrument for personnel and organisation development includes qualification, the support of professional development processes, and prevention of professional problems. It contributes to the professionalisation of teachers in dealing with all stakeholders, prepares for new tasks and trains new school officials and teacher leaders for the school and administration. It offers support in the form of qualification and training programmes fitting one's professional needs. (<https://www.km.bayern.de/lehrer/fort-und-weiterbildung/staatliche-lehrerfortbildung.html>; own translation)²

Scientifically sound, professional development programmes are commonly offered by universities to support their research activities (e.g., Gräsel, Fussangel, & Parchmann, 2006; Krammer, Schnetzler, Ratzka, Klieme, Lipowsky et al., 2010; Lipowsky, Rzejak, & Dorst, 2011; Möller, Hardy, Jonen,

² Lehrerfortbildung als Instrument der Personal- bzw. Organisationsentwicklung umfasst eine geplante Weiterqualifizierung, Begleitung der beruflichen Entwicklung und Prävention berufsimmanenter Probleme. Sie trägt zur Professionalisierung der Lehrkräfte im Umgang mit allen am Schulleben Beteiligten bei, bereitet sie für neue Aufgaben vor und bildet Funktionsträger und Führungskräfte in Schule und Schulverwaltung aus. Sie bietet Unterstützung in Form von Qualifizierungs- und Trainingsangeboten, die auf die jeweiligen beruflichen Bedürfnisse zugeschnitten sind. (<https://www.km.bayern.de/lehrer/fort-und-weiterbildung/staatliche-lehrerfortbildung.html>)

Kleickmann, & Blumberg, 2006; Ostermeier, Prenzel, & Duit, 2010; Prenzel, Carstensen, Senkbeil, Ostermeier, & Seidel, 2005). The effectiveness of such programmes can be assessed on four levels (Guskey, 2002; Lipowsky, 2010): (1) teachers' satisfaction with and acceptance of the course or workshop, (2) changes to their cognitions, beliefs and attitudes, (3) changes to teachers' classroom practice due to the participation in professional development and (4) benefits for student learning outcomes. Within the 'Dialogue' project, to date we have examined levels one, three and four (Gröschner et al., 2015a, 2015b; Pehmer et al., 2015a, 2015b; Schindler et al., 2015). The studies reported in this dissertation focus particularly on changes in teachers' practice in the facilitation of classroom talk and benefits in terms of students' perceptions of supportive learning environments and motivational learning outcomes. Currently, analyses on the remaining level of teacher cognitions, beliefs and attitudes are on the way (Jerabek, Gröschner, & Seidel, under review).

In order to design effective teacher professional development, first it is important to have a clear idea of the learning processes taking place during professional development, and second, to have a concept of the process of change that accompanies the introduction of reform practices in classrooms. Before going into learning processes during professional development and their consequences for the design and implementation of such programmes, I want to briefly touch upon current ideas on teacher growth to provide a better understanding of how professional development, changes to cognitions and behaviour and student learning outcomes interact.

7.1. Models of Teacher Growth

Currently, three broad models of teacher change can be found in the literature (Clarke & Hollingsworth, 2002; Clarke & Peter, 1993; Guskey, 1986; Teacher Professional Growth Consortium, 1994). Differences between these models pertain to the sequencing of change outcomes (knowledge and beliefs, classroom practice and student learning outcomes) and mediating processes. The consideration of these models can help to understand the effectiveness of teacher professional development programmes, supportive context factors, and differences with regard to uptake, application and change.

In what Clarke and Hollingsworth (2002) refer to as the 'implicit model of teacher growth' teacher change begins by teachers changing their beliefs, attitudes or knowledge due to participation in professional development. With this new set of attitudes and beliefs they enter their classroom and perform and practice differently – meaning better, so that ultimately student learning outcomes rise. Herein, the goal of professional development is not personal growth for the teacher, but improved performance by the student. Guskey (1986) and Clarke (1988) revised this implicit model arguing that sustained changes in teachers' beliefs and attitudes only occur after they saw the effectiveness of new practices in terms of better student learning outcomes. They argue that teachers need to 'field-test' reform practices and reflect on their effects for sustained change to occur. Furthermore, such processes of testing-reflecting-changing are likely to be cyclical (Clarke & Peter, 1993). Lastly, the

Interconnected Model of Professional Growth (Teacher Professional Growth Consortium, 1994) suggests that change in teachers takes place in four domains: the personal domain (knowledge, beliefs, and attitudes), the domain of practice (professional experimentation), the domain of consequences (student learning outcomes) and the external domain (sources of information, and support). These domains are interrelated: change in one is mediated by the processes of ‘enactment’ and ‘reflection’ of change in another. Consequently, change is not seen as a linear or cyclical process, but one of high complexity and interrelatedness. Evidence for the validity of this model has been acquired in empirical research (e.g. Clarke, 2001; Clarke, Carlin, & Peter, 1992; Hollingsworth, 1999).

In difference to older models (reported above), the Interconnected Model of Professional Growth includes the external domain that can be represented by things such as learning materials for home study, workshops, facilitators or a community of learners at the school. As such, it represents a more comprehensive approach to teacher change in the context of professional development programmes such as the Dialogic Video Cycle. As the name suggests, the Dialogic Video Cycle follows a cyclical design (see Section 7.5.1) following the process of testing-reflecting-changing outlined by the Interconnected Model of Professional Growth and also similarly described in other literature on teacher learning (planning-teaching-reflecting; Borko, Jacobs, Eiteljorg, & Pittman, 2008). In our examination into its effectiveness, we only looked at changes in the domains of practice and consequence. Yet, when applying the assumptions from the model, by engaging teachers in the processes of enactment and reflection, possible changes in these two domains may also transpire into changes in the personal domain.

7.2. Models of Teacher Learning

‘Teachers learn best by studying, doing, and reflecting; by collaborating with other teachers; by looking closely at students and their work; and by sharing what they see’ (Darling-Hammond, 2008, p. 93). This quote points out that meaningful teacher learning cannot take place in isolation; neither isolated from other teachers, nor isolated from students. It calls for a form of problem-based approach that looks at both teaching itself and the improvement of teaching as an inquiry process. Ball and Cohen’s (1999) theory of practice-based professional education conceptualises teaching as a profession that must be learned in and from practice. Their theory rests upon four basic requirements: (1) ‘a conception of practice and what it takes to practice well should lie at the foundation of professional education,’ (p. 12), (2) it involves a conception of what is involved in learning to operate in practice and (3) a professional education requires ideas about how to teach teachers that includes a ‘pedagogy of investigation’. Finally, (4) it needs to develop ‘substantial professional discourse and engagement in communities of practice’ (p. 12). Their theory already provides strong implications for the development and design for professional development programmes; what is lacking though is the connection to some coherent theory of learning.

If we apply the Interconnected Model of Professional Growth, learning can take place in multiple domains. It can be the construction of new knowledge in the personal domain or the application of new skills and strategies in the domain of practice. These forms of learning lend themselves to different theories of learning. In the domain of practice: '[g]iven the professional context in which teaching practice is perceived to occur, a situated perspective with associations of apprenticeship offers an appealing theory of teacher learning' (Clarke & Hollingsworth, 2002; p. 955). On the other hand, knowledge construction in the personal domain might be open to more cognitive approaches such as knowledge building (Scardamalia & Bereiter, 2003, 2006) or learning from (worked) examples (e.g., Stark, Kopp, & Fischer, 2011). What I feel is missing from much of the literature on professional learning and development though is an indication as to what learning processes teachers are meant to engage in throughout the learning phase. Generally, professional learning is seen as a self-regulated, experiential and situated process (e.g., Guskey, 2002; Webster-Wright, 2009). Webster-Wright (2009) stresses that professional learning is a process people engage in naturally throughout their career and which is not restricted to professional development. She sees professional development as a formalised version of professional learning.

By stressing the situated and experiential character of professional learning many approaches hint at research on situated learning. Models of situated learning (Lave & Wenger, 1991) or situated cognition (e.g., Collins, Greeno, & Resnick, 1994; Resnick, 1994) stress learning as a situated process and the need to learn new competencies in contexts similar to those in which they will be applied later on. In this context, Reusser (2005) pointed to the fact that lesson videos as part of professional development can serve this purpose. Under the premise that professional learning is situated different design principles for professional development present themselves (Reinmann-Rothmeier & Mandl, 2001): (1) authenticity of the learning environment and relevance for practice, (2) learning from multiple contexts and perspectives, (3) social and cooperative learning environments, and (4) instructional scaffolding and support.

With regard to authenticity and relevance for practice, research has shown that learning occurs more effectively if the learning process occurs during engagement with 'real-life' problems and authentic tasks (e.g., Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990). For the context of teacher professional development this means that teachers should engage in learning that is based on their own teaching and their own classrooms and not decontextualised from their practice. Examples of such teacher professional development programmes can be found in the literature (see Alvalos, 2011 for an overview), and in many cases video examples from participating teachers' classrooms are used for this purpose (e.g., Koellner, Jacobs, Borko, Schneider, Pittman, Eiteljorg et al., 2007; Santagata, 2009; Sherin & van Es, 2009). Including different contexts and perspectives fosters the generation of flexible knowledge and ensures transfer into teachers' classroom practice (instead of inert knowledge; Whitehead, 1929).

The theoretical foundations of this design element are provided by *Cognitive Flexibility Theory* (Spiro, Collins, Thota, & Feltovich, 2003) and *Knowledge Building Theory* (Scardamalia & Breiter, 2003). In the context of teacher learning Cognitive Flexibility Theory appears particularly applicable; it focuses on the nature of learning in complex and ill-structured domains. Spiro and Jehng (1990) state: ‘By cognitive flexibility, we mean the ability to spontaneously restructure one’s knowledge, in many ways, in adaptive response to radically changing situational demands [...] This is a function of both the way knowledge is represented (e.g., along multiple rather single conceptual dimensions) and the processes that operate on those mental representations (e.g., processes of schema assembly rather than intact schema retrieval)’ (p. 165). In view of teachers’ decision-making and judgement during instruction (Shavelson & Stern, 1981) this form of learning and knowledge representation must be seen as essential for professional learning in teachers.

Central to Knowledge Building Theory is the notion that knowledge is a social product created by members of a group, adding value to the community (Scardamalia & Bereiter 2003); it distinguishes knowledge building from knowledge acquisition. Such multiple perspectives and knowledge building can be achieved in learning communities (Lave & Wenger, 1991), which provide a social learning environment in which cooperative problem solving and joint reflection can take place. Learning communities or communities of practice can also provide peer feedback, encouragement and motivational support during professional development. Instructional scaffolding and support during professional learning appear especially important in ill-structured domains such as teaching. Moderation of the group discussions, facilitation of the group process and frequent constructive feedback are examples of such scaffolding and support (Mandl & Kopp, 2006). Structuring teachers’ learning process, providing clear guidance and structure are also important aspects from the perspective of *Cognitive Load Theory* (Kirschner, Sweller, & Clark, 2006).

This situated perspective has particular appeal if we want to move away from the deficit perspective of much of the older literature on professional development and instead embrace teachers as ‘reflective practitioners’ (Schön, 1983) and support them in their own process of life-long professional learning (Webster-Wright, 2009). It furthermore holds appeal for the effectiveness of any professional development programme, since – as Guskey (2002) argued – teachers are pragmatists and engage in professional development to achieve growth in terms of improved student learning. Consequently, professional development that operates close to home (i.e., on authentic problems of a teacher’s every-day practice) is more likely to be engaged in by teachers, seen as meaningful and hence successful. The ways in which the previously described design principles are realised in successful and effective professional development programmes is the focus of the next section.

7.3. Effective Teacher Professional Development

Within the last ten years, educational research has pointed out a number of components that are considered effective in programmes for teacher learning (e.g., Cordingley, Bell, & Thomason, 2003; Fishman, Marx, Best, & Tal, 2003; Kwakman, 2003; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Timperley, Wilson, Barrer, & Fung, 2007; Desimone, 2009; van Veen, Zwart, & Meirink, 2012; Wilson, 2013). Effective here means the ‘perceived relevance and usefulness of the programme with respect to teachers’ daily work’ (van Veen et al., 2012, p.12; cf. Borko, Jacobs, & Koellner, 2010), as well as the empirical finding that sustained learning took place during the teacher professional development and furthermore showed positive effects on student learning outcomes (Lipowsky, 2010). Central features referred to in the literature (Desimone, 2009; van Veen et al., 2012; Wilson, 2013) are generally: *content focus*, *active learning*, *collective participation*, *duration*, and *coherence* (Table 1). Furthermore, effective programmes allow for a connection between phases of input, testing and reflection (Gersten, Dimino, Jayanthi, Kim, & Santoro, 2010; see also Section 7.1 on models of professional growth) and provide feedback that underscores the consequences of changed practice (cf. Interconnected Model of Professional Growth; Clarke & Hollingsworth, 2002).

Table 1. Effective components of teacher professional development (Gröschner, Seidel, Kiemer, & Pehmer, 2015a).

Component	Central research findings
Content focus	<ul style="list-style-type: none"> • Should be related to classroom practice • Focuses particularly on subject content, but also on pedagogical content, and student learning processes of a specific subject • Should be based on theory-based content and well-researched methods and practices (e.g., examples should be powerful and clear, intellectually challenging and exceptional) • Should be permanently accessible to newly developed knowledge and expertise of colleagues
Active learning	<ul style="list-style-type: none"> • Should include learning opportunities that allow transfer of experiences as necessary condition (e.g., reflections) • Is followed by discussion and feedback, or reviewing student work • Contains ‘inquiry-based’ elements in which teachers are actively engaged in order to learn in the teacher professional development programme
Collective participation	<ul style="list-style-type: none"> • Concerns collaborations between teachers to set up potential interaction and discourse • Is characterised by a shared responsibility of the teachers for their own teacher professional development
Duration	<ul style="list-style-type: none"> • Allows teachers to also set goals • Includes span of time over which the teacher professional development activity is spread as well as the number of hours spent in the activity • Long-term interventions with enduring follow-ups (e.g., ongoing facilitation) are more effective than short-term, one-shot interventions
Coherence	<ul style="list-style-type: none"> • Shows consistency of policies, schools and so on with what is taught in professional development • Should be consistent with teachers’ knowledge and beliefs or at least provide examples to ongoing innovations or specific problems that teachers experience in their daily work

Besides effective components, research on (teacher) professional development also examined under which circumstances practice changes get implemented into teachers' every-day practice and what might be obstacles to teacher learning. First, it has been argued that the success of professional development depends (apart from the design features mentioned above) on trainees' attitudes towards the programme (Vermunt & Endedijk, 2001). Moreover, from research on training transfer it is known that the motivation for transfer is essential for practice changes to occur (Gegenfurtner, Veermans, Fenster, & Gruber, 2009). In connection with the Dialogic Video Cycle, prior research could show that generally the attitude towards the programme was positive (Pehmer, 2015) and that the intervention group teachers had high programme satisfaction and fulfilment of basic psychological needs during the intervention (Gröschner et al., 2015a).

Similarly, teachers' beliefs, both about teaching and learning in general, but also about the new teaching practice have important implications for practice changes (Aelterman, Vansteenkiste, Van Keer, & Haerens, 2016). In the context of trainings on autonomy support Reeve and colleagues (2013) demonstrated that teacher' beliefs about how effective autonomy supportive teaching is, how normative it is and how easy it is to implement predicted teachers' instructional style at the end of the training. Other research has also shown that changes in teacher learning are more likely if teachers recognise improvement in their students' learning as a result of their new practices (Clarke & Hollingsworth, 2002; Guskey, 2002; Opfer, Pedder, & Lavicza, 2011). Such practices are then assessed as effective and used more frequently. Transfer is also more successful for programmes focusing more on declarative than procedural knowledge, and that are more learner than content-centred (Gegenfurtner, 2011). This declarative knowledge helps teacher to develop a deeper understanding and theoretical rationale of the new instructional practices, which is necessary for successful implementation (Osborne, Simon, Christodoulou, Howell-Richardson, & Richardson, 2013).

Finally, teacher learning follows the same basic model as student learning (Figure 6). Teachers utilise their learning opportunities individually, depending on personal prerequisites, the learning opportunities offered and context variables. It has repeatedly been shown that learning in the context of professional development is an individual process (e.g., Furtak et al., 2015; Vestico, Ross, & Adams, 2008). Existing research often warrants fluctuation in teacher learning because of teachers grappling with new practices and the time needed to consolidate changes in routine practices (Bakkenes, Vermunt, & Wubbels, 2010). Also, classrooms have been found to constitute individual implementation settings for newly acquired skills and practices (van den Bergh et al., 2014), characterised by different resources and challenges, different administrative constraints and different student bodies. Complementary, more qualitative research on the Dialogic Video Cycle (Pehmer, 2015) already established that teachers in the intervention group were confronted with individual challenges regarding the implementation of productive classroom talk.

7.4. Use of Video in Teacher Professional Development

Even more recently, successful teacher professional development programmes began using videos of teachers' classrooms as a tool for reflections on their own teaching practices (Avalos, 2011; Borko, Jacobs, Eiteljorg, & Pittman, 2008; Chinn et al., 2001; Furtak et al., 2016; Goldman, Pae, Barron, & Sharon, 2007; Krammer, 2006; Krammer et al., 2010; Lefstein & Snell, 2014; Powell, 2005; Santagata, 2009; Sherin & van Es 2009; Harford, MacRuairc, & McCartan, 2010; Sedova et al., 2016; Seidel, Stürmer, Blomberg, Kobarg, & Schwindt, 2011; Tripp & Rich 2012; Zhang, Lundeberg, Koehler, & Eberhardt, 2011). Video encourages teachers to see their teaching from a new perspective, and to feel accountable for changing their practices (Tripp & Rich, 2012). As Timperley and colleagues (2007) point out: 'It is reasonable to expect that new teaching practices will be reinforced when teachers observe that they are having a positive impact on student outcomes. Such reinforcement can only occur, however, when teachers have the assessment tools with which to see these changes in student outcomes, and when they have come to value them' (p. 81). The use of video in professional development can be such an assessment tool. In comparison with other (text-based) formats, video was found to be a more effective tool regarding transfer and the application of theory into practice (Moreno & Valdez, 2007).

In a recent review Gaudin and Chaliès (2015) identified 255 studies in the area of teacher education and professional development that used video. The authors use four aspects of video use in teacher professional development to code their data: (A) What is the nature of teachers' activity as they view classroom videos? (B) What are the objectives of video viewing in teacher professional development? (C) What type of video is viewed during teacher professional development? (D) What are the effects of video viewing on teacher professional development? The Dialogic Video Cycle (Gröschner, Seidel, Kiemer, & Pehmer, 2015a) falls into this conceptualisation as follows:

- a) The nature of teachers' activity as they view classroom videos:
 - *Video viewing and selective attention*: In the workshops, teachers focus on aspects of productive classroom talk (student activation and clarifying discourse rights; scaffolding student ideas and feedback) and by reflecting on *critical incidents* (Griffin, 2003; Tripp, 1994) raise awareness for these concepts (professional vision; Sherin, 2001).
 - *Video viewing and knowledge-based or case-based* (Schank, 1982) *reasoning*: Teachers discuss the critical incidents in the videos and reason together about take-home messages and alternative routes. These descriptions and explanations are linked back to the theory by the facilitator. The video examples serve as anchors in memory, which allow for the build-up of a strategy repertoire (Kolodner, Camp, Crimson, Fasse, Gray, et al., 2003).
- b) Objectives of video viewing:
 - *Video viewing to build knowledge on 'how to interpret and reflect'*: The first workshop of every cycle is in part dedicated to establishing ground rules for shared video reflection and

collaborative practice (Gröschner et al., 2015a). Furthermore, the teachers are exposed to a variety of practice examples that can serve as ‘springboards for analysis and discussion about teaching and learning’ (Borko et al., 2011, p. 184).

- *Video viewing to build knowledge on ‘what to do’*: The different examples of typical classroom practices concerning productive classroom talk help teacher to elaborate their repertoire and gives them new ideas about what to do (case library; Schank, 1982 see above).

c) The nature of classroom videos:

- *Viewing videos of peer activity*: The participating teachers come together as a community of practice (Lave & Wenger, 1991). During each cycle video excerpts of all participants are shown and discussed in the workshops. Viewing others’ practice supports teachers to engage in comparative and critical thinking (Zhang, Lundeberg, Koehler, & Eberhardt, 2011).
- *Viewing one’s own professional practice*: During each cycle teachers see themselves at least once on video, which affects their engagement in the teacher professional development positively (Brouwer, 2012; Seidel et al., 2011). Furthermore, seeing themselves creates distance that allows them to identify aspects of their practice on which to improve (Borko et al., 2008).

d) The effects of viewing on teacher professional development:

- *Video viewing and teacher motivation*: Prior research on the Dialogic Video Cycle (Gröschner et al., 2015a) could show that in comparison to a control group, participating teachers experienced higher levels of basic psychological need fulfilment and intrinsic learning motivation. Also, teachers’ satisfaction with the programme was higher (cf. Moreno, Abercrombie & Hushman, 2009; Moreno & Valdez, 2007).
- *Video viewing and teacher cognition*: Pehmer and colleagues (2015a) provide qualitative data suggesting that teacher cognitions and beliefs changed to some extent as a result of participating in the Dialogic Video Cycle. Other research has shown that video use increases teachers’ ability to interpret classroom situations more effectively (Stürmer, Königs, & Seidel, 2013).
- *Video viewing and teacher classroom practice*: The present dissertation presents evidence that participation in the Dialogic Video Cycle had positive effects on teachers’ facilitation of productive classroom talk (teacher practice) and students’ internal learning activities (see also Pehmer et al., 2015a, 2015b; Pehmer, 2015; Schindler, Gröschner, & Seidel, 2015).

Gaudin and Chaliès (2015) continue to argue that video, as an ‘artefact of practice’ (Borko, et al., 2008), can link theoretical university-based education with classroom practice (Wang, 2013a). Furthermore, they contend that video-based teacher professional development is increasingly used to

implement instructional reforms. The Dialogic Video Cycle is an example of such instructional reform, as it targets teachers' redefinition of classroom talk towards a more open interactional space with shared control and responsibility between teacher and students.

7.5. The Dialogic Video Cycle– a Video-Based Teacher Professional Development Programme

The Dialogic Video Cycle was developed on the basis of the teaching cycle of *planning, teaching and reflecting* (Borko et al., 2008). It aims to support teachers in the re-definition of their classroom talk practices in order to arrive at instruction characterised by high quality and positive student learning outcomes. Within the 'Dialogue' project, the Dialogic Video Cycle was implemented successfully with mathematics and science teachers (Gröschner et al., 2015a). Its effectiveness was examined in a two-group quasi-experimental study, comparing the intervention group (Dialogic Video Cycle) to standard teacher professional development on classroom communication (without the use of video as a tool for reflection).

7.5.1. Design and Implementation of the Dialogic Video Cycle

The Dialogic Video Cycle concentrates on generic aspects of classroom talk as part of general pedagogical knowledge (Shulman, 1986). It implements productive classroom talk in the form of two main activities: *student activation and clarifying discourse rights* and *scaffolding student ideas and feedback* (based on Walshaw & Anthony, 2008; see Figure 7, left-hand side). The Dialogic Video Cycle aims to change teachers' dominant script of classroom talk and their perspective towards student learning processes. Each cycle included three workshops and one lesson videotaping (Figure 7, left-hand side). In the first workshop, teachers received input on productive classroom talk by a facilitator, and together with the facilitator and in collaborative practice, they adapted existing lesson plans by taking concrete activities of productive classroom talk (in accord with Walshaw & Anthony, 2008) into account (Gröschner et al., 2015a). Next, they were videotaped by the research team while teaching the revised lesson. The facilitator chose video excerpts of this footage on the basis of the criteria of productive classroom talk and prepared them as a basis for teacher reflection in workshops 2 and 3. Workshop 2 focused on Activity 1 (student activation), and teachers exchanged ideas about the discursive roles of teachers and students and the ways in which students are engaged. Workshop 3 focused on Activity 2 (scaffolding student ideas), and teachers exchanged ideas about how to take up student responses and elaborations (e.g., right/wrong answers, new ideas, misconceptions, etc.) and give feedback. During the workshops, they watched selected clips, clarified questions about productive classroom talk and jointly reflected on their experiences. During every iteration of the Dialogic Video Cycle it was ensured that each teacher's classroom video served at least once as a reflective prompt. Each video reflection followed the same protocol. The excerpt was screened in full without any comments or questions. Afterwards the teacher who was seen on video provided context information of the lesson, the student and the content and answered any questions from colleagues. Following the clip was shown once again, while the facilitator posed guiding questions (e.g., 'Which

strategies does the teacher in the video clip use to promote student activation?') to focus teachers' attention. Finally, the group discussed what attracted their attention and gave feedback (including solutions and alternatives), or asked more questions. All discussions were chaired and guided by the facilitator. Each workshop contained between three and four video reflections (Gröschner et al., 2015a). The second iteration of the Dialogic Video Cycle followed the same course of action. For results regarding the learning processes of teachers during these workshops see Jerabek and colleagues (under review).

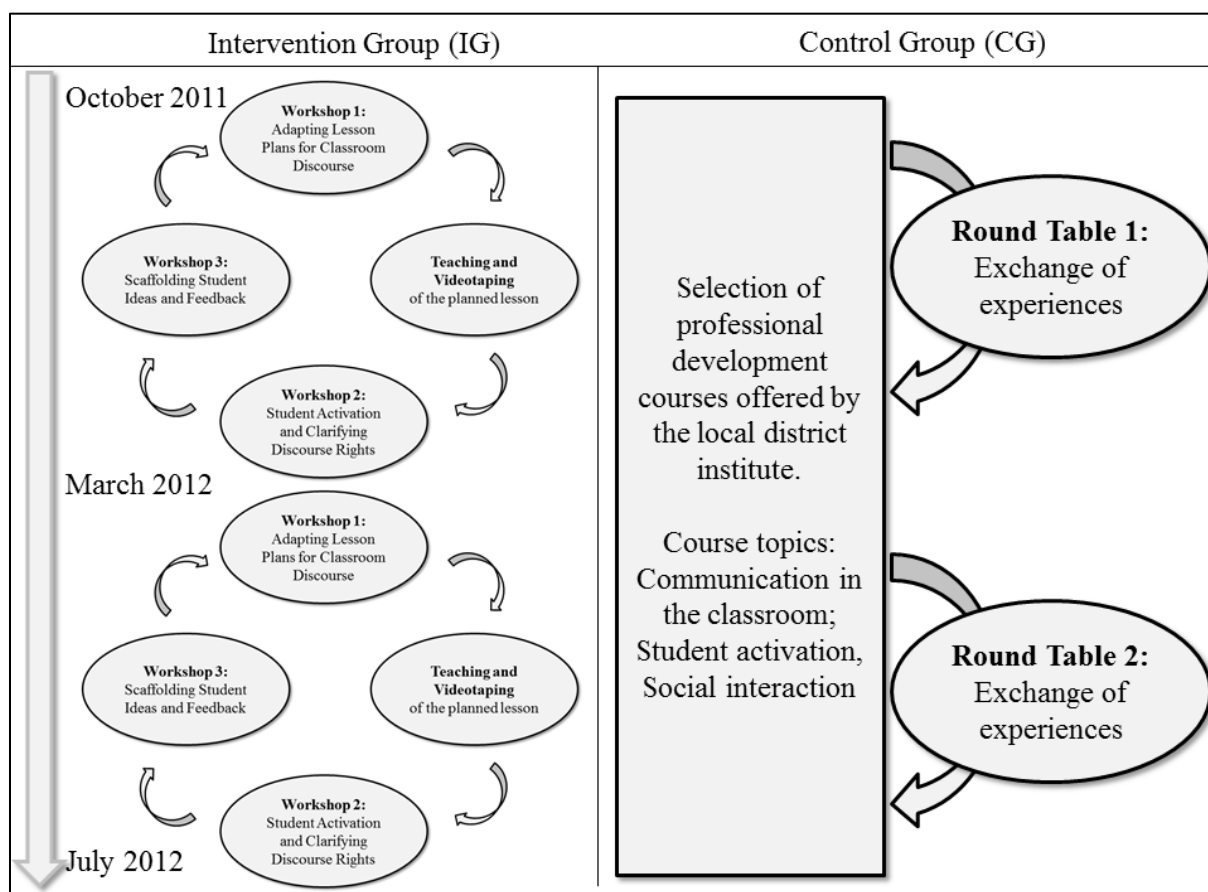


Figure 7. Treatment conditions in Dialogic Video Cycle as intervention (left), and a traditional programme as control group (right) (Adapted from Gröschner et al., 2015a).

Teachers in the control group (CG) participated in more traditional professional development (Richter et al., 2011). They were given a preselection of afternoon or multiple-day workshops offered by the district's professional development institute and chose freely which of them to attend. All workshops on offer related to topics of classroom communication, student activation or teacher-student interactions. Additionally, all teachers in the CG attended a roundtable each semester to discuss their learning experiences and provide opportunity for reflections on new practices and practice changes (Figure 7, right-hand side). These meetings were chaired by the same facilitator as the Dialogic Video Cycle meetings and discussions were prompted by similar guiding questions. Yet, for this group the discussions did not entail video-based reflections – hence, active learning was not equally part of the programme (as compared to the Dialogic Video Cycle). In total, control group

teachers spent the same amount of time in teacher professional development as the intervention group (see Table 2).

The ‘Dialogue’ project was implemented as a year-long teacher professional development programme in 10 mathematics and science classrooms with the aim of comparing the two programmes regarding their improvement of teachers’ classroom talk practices and their students’ motivational outcomes. Table 2 situates the programmes with regard to their adherence to effective components of teacher professional development. For a full description of the treatment conditions and the role of the facilitator see Gröschner, Seidel, Kiemer, & Pehmer, 2015a and Gröschner, Seidel, Pehmer, & Kiemer, 2015b.

Table 2. Description of the teacher professional development programmes with regard to effective components (Gröschner, Seidel, Kiemer, & Pehmer, 2015a).

Component	Intervention Group attending the Dialogic Video Cycle	Control Group attending the traditional teacher professional development
Pedagogical focus	Classroom communication with a focus on (a) student activation and instruction (b) scaffolding student ideas and feedback	Classroom communication: selection of workshops as offered by the local Pedagogical Institute of the district
Active learning	Active involvement in (a) planning and revising a lesson, (b) teaching the lesson, (c) reflecting upon this lesson by means of video examples	Active participation in workshops and in reflecting upon workshop experiences in two roundtable meetings (no video as part of the teacher professional development)
Collective participation	Group of $n = 6$ teachers meeting seven times during the academic year 2011/12	Group of $n = 4$ teachers meeting three times during the academic year 2011/12
Duration	Total: 22 hours Including two Dialogic Video Cycle (each three workshops, one video recording) Workshop duration: each two hours Opening (Dialogic Video Cycle-specific) and closing session (each two hours) Video recording: four lessons	Total: 22 hours Two to three workshops Two roundtable meetings (each two hours) Opening (teacher professional development specific) and closing session (each two hours) Videotaping: two lessons
Coherence	Set of three workshops on planning, acting and reflecting in each Dialogic Video Cycle; facilitator guided processes of lesson planning and reflection, videotaped lessons and selected video examples for reflective workshops	Selection of a set of workshops targeting classroom communication by facilitator; facilitator guided roundtables by relating workshop experiences to own teaching practices and supporting teacher reflection

Note: The description of the program is based on the effective components drawn from the literature (e.g. Desimone, 2008; van Veen et al., 2012; Wilson, 2013).

7.5.2. Teacher Learning During the Dialogic Video Cycle

As has been mentioned before, the Dialogic Video Cycle follows a cyclical model of teacher growth (see Figure 7), similar to the Interconnected Model of Teacher Growth (Clarke & Hollingsworth, 2002). It expands the process of testing-reflecting-changing described in the Interconnected Model by proposing a planning step at the beginning of the change process (Workshop 1; Figure 7). In order for this process to take effect multiple iterations of the Dialogic Video Cycle are necessary; the first iteration can be seen as the testing and reflecting phase, while in the second iteration change can already become visible and be reflected upon in subsequent workshops. By providing teachers with theoretical input on the topic of classroom talk and recent findings from research it addresses the personal domain as outlined by Clarke and Hollingsworth (2002; Section 7.1). Teachers' knowledge, skills, beliefs and attitudes are furthermore target of the entire change process – even if not addressed directly during instruction (Guskey, 2002). The domain of practice was, of course, focused upon during the reflective workshops (Workshops 2 and 3). Herein, the use of video as a tool for reflection on one's own and others' practice is essential. Within these workshops the domain of consequence was also in view as the connection between teacher behaviour (e.g., questioning or feedback) and student response was continuously pointed out and teachers became interested in a new strategy once they saw the results their peers achieved with it on video. In the aftermath of the project the domain of consequence across the school year was provided to the teachers in the form of a written report on the performance of their class in terms of motivational learning outcomes (e.g., interest in the subject, self-efficacy and self-concept of ability).

Looking at the learning processes during the Dialogic Video Cycle, a situated perspective on teacher learning is evident. Going back to the design principles outlined by Reinman-Rothmeier and Mandl (2001), the Dialogic Video Cycle provides authenticity and relevance for practice by working with teachers directly on their classroom practice. It is focused in content and coherent in its build-up of the learning process (Desimone, 2009; see Section 7.5.1). The lessons teachers are asked to work on during Workshop 1 are of immediate relevance to participating teachers as they intend to teach them within a fortnight. The video examples of their practice guarantee authenticity and relevance in a very immediate manner, more so than text-based reflections could (Tripp & Rich, 2012). Participating teachers worked together as a group over the course of a school year; they built a community of learners (Lave & Wenger, 1991) during this process. During the workshops much time was dedicated to collective reasoning and problem solving on concrete video examples. Teachers provided differing perspectives on the examples and analysed videos from different vantage points. All this made it possible to learn from different perspectives (Spiro et al., 2002) and build growing understanding of classroom talk as an instructional strategy as a community (Scardamalia & Bereiter, 2003, 2006). Instructional scaffolding and support was provided by the facilitator. Among the more central tasks of the facilitator was the choosing of suitable video examples, the moderation of group discussions, monitoring of group rules and the provision of feedback. The work with video examples in (pre-

service) teacher education has been reported to be demanding on their cognitive capacities (Syring, Bohl, Kleinknecht, Kuntze, Rehm, & Schneider, 2016). By taking only excerpts from the lessons, the complexity of the domain was broken down in order to reduce the intrinsic load of the learning task teachers were engaging in. Additionally, videos were watched multiple times and with focusing questions to further reduce extraneous load in favour of germane load (Kirschner, Sweller, & Clark, 2006).

The learning occurring during the Dialogic Video Cycle can also be viewed from a case-based learning perspective. Case-based learning is a process-oriented model of learning from experience. Particular case-based reasoning (Schank, 1982) describes knowledge and understanding that is derived from previous experiences (cases) and the indexing of such experiences for a readily accessible knowledge base. At its heart lies the assumption that the solution to a new problem can be found by adapting the solution to an old problem or merging different old solutions. Learning, in case-based reasoning, means extending knowledge by interpreting new experiences and incorporating them into memory, by reinterpreting and reindexing old experiences to make them more usable and accessible, and by abstracting out generalisations over a set of experiences (Kolodner, Camp, Crimson, Fasse, Gray, et al., 2003). In this sense, case-based reasoning is similar to the building of expertise (Berliner, 1994). Experts can retrieve their knowledge easily in appropriate situations, while this knowledge is very well interconnected, helping them see similarities and differences and quickly choose appropriate courses of action (Berliner, 1994). Expertise can only be developed through experience in what Ericsson, Krampe and Tesch-Römer (1993) call *deliberate practice*. Such practice requires repetition, feedback and purposeful engagement (Berliner, 2001), which are design principles of the Dialogic Video Cycle. The high relevance of case-knowledge for teachers' professional competence was also pointed out by Shulman (1986), as this form of highly contextualised knowledge is necessary to apply propositional knowledge (also conceptual knowledge or declarative knowledge) in actual situations. Consequently, case-knowledge is necessary for transfer of practice to occur. Case-based instruction is often used in medical training (e.g., Stark, Kopp, & Fischer, 2011), but has also already been applied successfully in teacher training (e.g., Abell, Bryan, & Anderson, 1998).

By providing teachers with video cases of different situations in which the teaching strategy of classroom talk (in its different forms) was experienced (in *sensu*), the Dialogic Video Cycle has the potential to support teachers in elaborating their case-library and informed them as to when different behaviours in the facilitation of productive classroom talk were appropriate and successful. Furthermore, by focusing on a particular teaching strategy (classroom talk) and asking teachers to repeatedly engage in it with following reflection and feedback from peers and the facilitator the design of the Dialogic Video Cycle engaged them in instances of deliberate practice. In so doing, the programme aimed to redefine teachers' dominant teaching script of classroom talk and to make them more flexible in the arrangement and enactment of this teaching script.

7.5.3. The Dialogic Video Cycle in Comparison to other Professional Development Programmes Fostering Productive Classroom Discourse

In Section 3.3, other interventions designed to make productive classroom talk a more common teaching script have been reviewed. Generally speaking, such attempts report positive results, though the outcome variables by which success or effectiveness are determined differ. After reviewing research on effective teacher learning and professional development, introducing the Dialogic Video Cycle and outlining the ways in which it represents current state-of-the-art research on professional development, the Dialogic Video Cycle is contrasted with other available interventions on classroom talk before moving on to the empirical part of this dissertation.

A point of criticism on much of the literature on professional development in classroom talk is its lack of theoretical grounding in terms of teacher learning processes. The dissertation will elaborate on this point by comparing the Dialogic Video Cycle with three other programmes. The choice of comparison programmes is more pragmatic than systematic. Due to their broad reception in the literature, Accountable Talk (Michaels, O'Connor, & Resnick, 2008; Michaels & O'Connor, 2012, 2015) and Exploratory Talk will be used as comparisons. The programme implemented by Sandoval and colleagues (2016) is used to include a second, recently evaluated intervention. All three approaches provide at least some information in the relevant publications on the professional development activities used.

From the research group around Neil Mercer and Exploratory Talk different approaches to professional development have emerged, one of which is CamTalk. Yet, the development, design, and implementation have thus far barely been published. From the project website it can be deduced that CamTalk is a design-based research project, which together with practitioners aimed at developing a blended learning course on principles of dialogic teaching and learning, classroom impact and dialogic assessment. Over three terms, teachers followed a four-module course that included a small-scale research project presented at an in-house conference. The only publication available from the project group to date (Higham, Brindeley, & Van de Pol, 2014) does not focus on the professional development at all. Also at Cambridge, the epiSTEMe project (Effecting Principled Improvement in STEM Education) was launched (Ruthven, Mercer, Taber, Guardia, Hofman, Ilie, Luthman, & Riga, 2016), designing and trialling a classroom intervention in science and mathematics classrooms. Ruthven and colleagues (2016) argue that in order for such attempts to be successful sustained professional development for teachers is of the essence. The authors (e.g., Ruthven et al., 2016; Ruthven, Hofmann, & Mercer, 2011) state that the design of the professional development used in their project was in line with current research. The professional development activities lasted two days, to reflect the limited time that is available for professional development in the British educational system (while the authors concede that current research argues for long-term professional development). Workshop 1 focused on dialogic teaching, while the second one was a debriefing, after

teachers enacted dialogic teaching with one of their classes – how this was done remains, however, unclear. A video example was used in Workshop 1 to help teachers concretise teaching strategies that would support productive classroom talk (Ruthven et al., 2011). Further video examples as well as written transcripts were used to encourage discussion and reasoning on classroom interaction and student thinking (Ruthven et al., 2016). Additionally, the research team attempted to set up communities of practice in the participating schools by encouraging at least pairs of teachers to take part and facilitate the implementation of reform practice. However, they admit that this idea could often not be realised due to structural obstacles. In sum, their analysis yielded mixed results with regard to implementing more productive classroom talk in participating schools. Reflecting on their findings the authors argue that fostering appropriate forms of in-school support and coaching would probably be more productive than isolated professional development activities (Ruthven et al., 2016). In contrast to the Dialogic Video Cycle, where teachers watched video in the epiSTEMe programme it was not their practice or that of their learning community they reflect upon. While divergent effects for learning with own and other videos have been found (e.g., Seidel, Stürmer, Blomberg, Kobarg, & Schwindt, 2011), the higher emotional and motivational investment of reflecting on own videos is broadly accepted in the research community (e.g., Santagata & Guarino, 2010). Furthermore, it has been argued that watching and reflecting upon other's videos may be too distant for teachers in order to change their beliefs and practice (Abell, Bryan, & Andersen, 1998). The use of one's own videos as a tool for reflection may thus be an advantage of the Dialogic Video Cycle in terms of effective teacher learning. Furthermore, the long-term orientation of the programme, and the resulting learning community have to be noted as positive aspects in comparison to the epiSTEMe professional development activities, while the rather small group size and the responsiveness of the facilitator (see Gröschner, Seidel, Pehmer, & Kiemer, 2015b) made it possible to address individual challenges of the teachers.

Like Exploratory Talk (Mercer, 1994, 2002; Mercer & Littleton, 2007), Accountable Talk is not a professional development programme per se, but a conceptualisation of productive classroom talk (see Section 3.1). Yet, research into Accountable Talk and so-called talk moves has led to the development of professional development materials in the spirit of this conceptualisation (e.g., Anderson, Chapin, & O'Connor, 2011; Michaels & O'Connor, 2012). In their publications, the authors take great care to describe the theory behind Accountable Talk, obstacles one may encounter when trying to implement such forms of talk in schools, and – in contrast to many other programmes – concrete phrases and moves that facilitate this kind of classroom talk (Michaels & O'Connor, 2012, 2015). What is lacking though is a theoretical grounding for the way they deliver the professional development and the kind of learning that should take place there. The Classroom Discussions in Mathematics professional development, which is based on Accountable Talk, includes a study book for teachers along with classroom videos (Chapin, O'Connor, Anderson, 2009, 2013), plus a facilitator's guide with classroom videos (Anderson et al., 2011). These resources can be used as study group texts, while the facilitator's

guide provides support for watching and discussing classroom videos (video-viewing rules, discussion questions, etc.). The programme provides examples of talk move use in different classrooms, content areas and grade levels (Michaels & O'Connor, 2015). While the authors draw on the tool of video for their professional development materials, there is no rationale provided for doing so. The research literature on effective professional development and the use of video in professional development is not reviewed. As with the epiSTEMe professional development activities, an advantage of the Dialogic Video Cycle over the Discussions in Mathematics programme is the use of own videos and the reflection of teachers' own practice. Yet, at the same time this can also be seen as a disadvantage in terms of scaling the programme and the associated costs of time and manpower. Available as a manual with an accompanying DVD, the Classroom Discussions in Mathematics programme potentially reaches a far greater audience and allows for sustained, long-term teacher learning in self-organised learning communities. Nonetheless, with this, the engagement with the learning materials and the learning processes cannot be monitored by a trained facilitator. Especially in video-based professional development programmes, the relationship between participating teachers and a facilitator has been shown to be important for fostering successful teacher learning (Borko, Koellner, & Jacobs, 2014).

Sedova and colleagues (2016) present an incredibly intensive professional development programme they initially implemented with eight teachers. It consists of workshops, video documentation of entire lessons and reflective interviews on the basis of these recordings. In total, there are four workshops and five lesson recordings with accompanying interviews, plus four additional video recordings to establish pre/post-differences. Each workshop had a different topical focus within the Dialogic Teaching framework (Alexander, 2005, 2008; see Section 3.1): (1) introduction to Dialogic Teaching, (2) teacher questions and uptake, (3) student participation and open discussion, (4) debriefing and reflection on the professional development. Between workshops, teachers tried implementing those elements of Dialogic Teaching under discussion during the workshops. Researchers took recordings of the lessons, and then selected sequences from the recording they watched with the teacher, together discussing the lesson. Though without reference to current research on effective professional development and teacher learning, Sedova and colleagues designed a very strong intervention that incorporates many of the aspects mentioned in the literature (Desimone, 2009; van Veen et al., 2012; Wilson, 2013). In many respects their professional development approach is very similar to the Dialogic Video Cycle by including videos of teachers' own practice, intensive reflection of this practice, content focus and coherence, long-term duration, active learning and collective participation. Evaluation also showed very promising results with regard to teacher and student behaviour during classroom talk. In research on professional development the questions 'how long is long enough?' and 'how much learning support is needed?' are still unanswered (Lipowsky, 2004) – but in light of policies and budgets, we might have to settle for a trade-off between cost and usefulness. Here, the Dialogic Video Cycle could possibly present a sort of

middle ground between 2-day workshops (e.g. Ruthven et al., 2016) and very time and personnel intensive interventions, like the one presented by Sedova and colleagues (2016).

Resnitskaya and Gregory (2013) state that productive classroom talk generally advocated by theorists and researchers is difficult for teachers to implement. According to these authors, this is due to the fact that teachers are not able to transform abstract theoretical principles into specific classroom practices that reflect these principles. Teachers generally appear to be, in principle, inclined to use strategies associated with productive classroom talk but fail to do so (Sedova, Salamounova, & Svaricek, 2014). According to Resnitskaya and Gregory (2013), professional development should focus on helping practitioners develop coherent instructional frameworks that integrate both theoretical and practical knowledge. Due to the careful design of the Dialogic Video Cycle, it affords many different learning opportunities from different theoretical perspectives and includes learning from theory as well as practice. Programmes in which teachers received feedback and concentrated directly on the process of their teaching in class (Chinn et al., 2001; Snell & Lefstein, 2011) led to a considerable – or at least partial – change in teachers’ practices. Given the promising results found by Sedova and colleagues (2016) with a similar programme, the Dialogic Video Cycle is likely to be found effective as well. After ensuring the fidelity of implementation (Gröschner, et al., 2015a), this dissertation explores the *effects* of the learning processes during the Dialogic Video Cycle mentioned above. Particularly, it focuses on change in the domain of practice (Clarke & Hollingsworth, 2002) in the form of teachers’ talk practices (questioning and feedback behaviour) and the domain of consequences in the form of students’ intrinsic learning motivation, and the development of interest in the subject in Study 1. Study 2 takes a less fine-grained view on the teacher-student interaction and instead focuses on the internal teaching processes during whole-class discussions in the form of instructional and motivational discourse (Turner et al., 2002) and its relationship with perceptions of autonomy and competence support. In line with Self-Determination Theory, the predictive value of these perceptions for students’ self-determination and resulting intrinsic learning motivation were examined. The thesis closes by exploring the connections between the different forms of talk and the motivational outcomes in students. The specific research questions are presented below.

8. Research Questions

8.1. Teachers' Changed Practice during the Dialogic Video Cycle

Within both studies that comprise this dissertation, teachers' changed practice were analysed – both as a measure for the effectiveness of the Dialogic Video Cycle as well as a prerequisite for changes in student motivational outcomes (Lipowsky, 2010). In Study 1 the focus was on specific structures pertaining to the initiation (I) and follow-up (F) of teacher-student interactions (IRE-sequence; Mehan, 1979; IRF-Sequence, Sinclair & Coulthard, 1975). Specifically, changes in open and closed questions, and constructive and simple feedback were examined (Section 10.4). Study 2 took a more holistic approach, by differentiating productive classroom talk into instructionally and motivationally supportive discourse (Turner et al., 2002) as indicators of high instructional quality (Section 11.4). Again, year-long developments on these variables were reviewed. In both instances, the developments in the intervention group were compared to the control group. The specific research questions were as follows:

- *To what extent does teachers' facilitation of classroom talk become more productive (operationalised through questioning and feedback) in the intervention group in comparison to the control group? (Essay 1)*
- *To what extent does teachers' facilitation of classroom talk become more instructionally and motivationally supportive in the intervention group in comparison to the control group? (Essay 2)*

In both instances, it was hypothesised that teachers in the intervention group would outperform teachers in the control group on the different measures of productive classroom talk in the course of the school year. We also tentatively conjectured that intervention group teachers would increase their performance, while control group teachers would stagnate or decrease.

8.2. Students' Motivational Learning Outcomes during Productive Classroom Talk

In Study 1, group differences between students in the intervention and control group regarding their developments of interest in the subject from pre (T_{pre}) to post-test (T_{post}) were examined. Based on Self-Determination Theory and Person-Object Theory of Interest, the relationship of changes in basic psychological need fulfilment, intrinsic learning motivation and interest in the subject within the intervention group was analysed further. The specific research questions were:

- *To what extent does a one-year Dialogic Video Cycle intervention show positive effects on students' development of interest in the subject in comparison to the control group?*
- *To what extent are the positive changes in interest in the subject systematically related to changes in intrinsic learning motivation, which in turn are systematically related to a change in students' basic psychological need fulfilment?*

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Together, with a team of co-authors, I conjectured that students whose teachers participated in the Dialogic Video Cycle would outperform students in the control group and show higher levels of interest in the subject at the end of the school year. In line with Self-Determination Theory and Person-Object Theory of Interest, we assumed that repeated fulfilment of basic psychological needs would lead to an increase in intrinsic learning motivation. Consequently, the repeated experience of intrinsic learning motivation/situational interest would manifest itself in increased individual interest in the subject at the end of the school year.

Study 2 then picked up on the results of Study 1 and was a more focused analysis targeting only intervention group teachers and their students. The aim was to more fully understand how students perceive productive classroom talk with regard to constructive learning support (autonomy and competence support) and how this affects motivational learning outcomes (self-determination, intrinsic learning motivation). Three research questions were pursued regarding this issue:

- *To what extent do students' perceptions of autonomy support change during the intervention (IG)?*
- *To what extent do students' perceptions of competence support change during the intervention (IG)?*
- *To what extent are the changes in students' perceptions of autonomy and competence support predictive of their changed perceptions of self-determination and furthermore changes in intrinsic learning motivation?*

We expected that in the intervention group students' perceptions of autonomy support would change positively during the intervention, as well as students' perceptions of competence support. These positive changes would in turn predict students' perception of self-determination and intrinsic learning motivation.

8.3. Connections between Changed Teacher Practices and Changed Motivational Student Learning Outcomes

The last research question under review was an exploratory more qualitative one, looking into the relationship between teachers' changed practice and students' perceptions of constructive learning support (autonomy and competence support):

- *What is the relationship between changes in autonomy support, competence support and instructional and motivational discourse in the intervention group?*

To date, the majority of studies targeting productive classroom talk have focused on cognitive learning outcomes, such as the co-construction of knowledge and achievement as outcome variables (e.g., Davies & Meissel, 2016; Mercer, Wegerif, & Dawes, 1999; Lipowsky et al., 2007; van der Veen, de Mey, van Kruistum, & van Oers, 2016; see Howe & Abedin, 2013 for an overview) or qualitative analysis of classroom interactions (Howe & Abedin, 2013; Michaels & O'Conner, 2012). To our

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knowledge, this is the first research endeavour focusing explicitly on teachers' changed practices and students' motivation to learn mathematics and science. It furthermore takes both a situated and dispositional stance on students' learning motivation and brings together state-of-the-art research on productive classroom talk (e.g., Alexander, 2005, 2008, 2010; Asterhan & Schwarz, 2016, 2007; Howe & Abedin, 2013; Mercer & Dawes, 2014; Michaels, O'Connor, & Resnick, 2008; Michaels & O'Connor, 2012; Mortimer & Scott, 2003; Resnick, Asterhan, & Clarke, 2015; Walshaw & Anthony, 2008; Wells & Arauz, 2006; Wilkinson, Murphy, & Binici, 2015) and the role of teachers and teacher professional development in supporting students' learning motivation (e.g. Aelterman et al., 2013; Cheon & Reeve, 2015; Jang et al., 2010; Reeve, 2006; Reeve & Jang, 2006; Turner et al., 2011). The studies reported in this dissertation also move beyond the focus on primary school education that has been noted for much of the work on productive classroom talk (Higham, Brindley, & van de Pol, 2013) and specifically address mathematics and science education in upper secondary schools.

9. Methodological Approach

In the 'Dialogue' project, the Dialogic Video Cycle was implemented as a year-long teacher professional development programme (two cycles, 22 hours of professional development). Fidelity of implementation was examined in a separate study and tested positively. Central components of effective teacher professional development (Desimone 2009; van Veen et al., 2012; Wilson, 2013) were judged as present by two independent raters. Differences between the intervention group and the control group were present regarding *active learning*, (video-based) *reflection* and *transfer* to practice. Also, the intervention group showed more *motivation* towards and *satisfaction* with the professional development at the end of the school year than the control group did. At mid-test, no such differences were evident (see Gröschner et al. 2015a). Data was collected at multiple measurement points: in the intervention group at the beginning of the year (Tpre), once per semester (T2, T3) and at the end of the year (Tpost). In the control group: at the beginning of the year (Tpre) and at the end of the year (Tpost). Students reported on their perceptions via questionnaire directly after class, while teacher' facilitation of classroom talk was videotaped and coded later (Figure 8).

This dissertation is characterised by a longitudinal design using a mixed-method approach. It employs video analysis as well as student self-report and thus brings together data from different perspectives (Mayring, 2001; Renkl, 1999). Video data is gathered on the class level and can be considered more objective, while student self-reports are measured on the individual level and provide the subjective perspective of each student and as an aggregate the mean perceptions of the class (climate indicator; Marsh, Lüdtke, Nagengast, Trautwein, Morin, Abduljabbar, & Köller, 2012). The use of video as an instrument 'represents a complex methodological approach, which enables the employing of a number of various strategies, methods, or techniques for generating, collecting, and analysing video data, i.e. audio-visual data grounded in rich situated contexts' (Janík, Seidel, & Najvar, 2009, p. 7). The combination with student self-reports further enriches this approach and allows for detailed descriptions of classroom interactions and their implications for students' motivational outcomes. Furthermore, it allows for the analysis of both surface and deep structures of teaching and learning, making possible the analysis of learning processes and their interplay with instructional moves (Prenzel, Seidel, et al., 2002) – not only within a single lesson, but also over the course of a school year.

In recent years, video observations have become more frequent in educational research (e.g., Belger-Oberdeck & Bieber, 2003; Clausen, Reusser, & Klieme, 2003; Jurik, Häusler, Stubben, & Seidel, 2015; Pauli & Reusser, 2006; Seidel, 2011) – not least because of dramatic technical improvements concerning camera handling and data storage. Video allows fully capturing 'the rich psychological soup of a classroom' (Shuell, 1996) and watching and analysing it from different theoretical perspectives (Jacobs, Kawanaka, & Stigler, 1999; Pauli & Reusser, 2006). Importantly though, video data is primarily raw data; any information obtained from it can only be as good as the

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analytical tool used to acquire that data (i.e., coding scheme) (Dalehefte, 2007). Therefore, a rigorous development process for these tools is a prerequisite for any video study in order to obtain objective, reliable and valid results (see Section 9.2.2 for the coding systems developed in the context of this dissertation).

To obtain the classroom videos for the following studies, two cameras were used per classroom; one with a boom microphone capturing the sound of the entire classroom and another with a lapel microphone recording specifically the teacher utterances. In prior research on teaching scripts, a 1/3 perspective for the two cameras has been found useful (Dalehefte, 2007; Seidel, 2003a; Seidel, Dalehefte, & Meyer, 2003). One camera is positioned at the window side of the classroom, about 1/3 to halfway down the classroom. This camera is focused on the teacher and moves according to their movements in the classroom. The second camera is positioned in the front of the classroom, facing the students. The best spot is usually the window-side corner, right next to the blackboard. This camera is stationary and films the entire student body as a whole (Seidel, Meyer, & Dalehefte, 2005). This procedure was used for every videotaping in order to obtain comparable footage and ensure data quality. Nonetheless, it needs to be kept in mind that despite the broad scope of video data many – but not all – features of classroom interactions can be captured (Seidel & Prenzel, 2003; Sherin, 2001) and that the data is only as good as the coding. Moreover, recent research showed that some features of instructional quality need multiple videorecordings in order to be assessed reliably (Praetorius, Pauli, Reusser, Rakoczy, & Klieme, 2014). In their study Praetorius and colleagues showed that video observation of aspects of cognitive activation fluctuate strongly between recordings and require thus up to nine observations in order to be assessed reliably. In contrast, classroom management and constructive learning support seem to be more stable features of an instructional style and can be measured effectively with only one observation.

As noted previously, classroom videos were also used as tools for reflection in the teacher professional development programme presented in this thesis. To improve productive classroom talk, video examples of classroom interactions are a promising tool for supporting teachers' analysis and reflection on classroom practices and interaction patterns (e.g., Tripp & Rich, 2012). Using video in teacher professional development 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) (for a fuller description of the benefits of video in teacher professional development research see Section 7.4).

For the mixed-method approach of this dissertation, video data was combined with student self-report. Such approaches are warranted in research (Johnson & Onwuegbuzie, 2004; Meyring, 2001; Renkl, 1999) as the different data sources complement each other and create the possibility for a more comprehensive understanding of teaching and learning (Dalehefte, 2007; Prenzel, Seidel, et al., 2002). Student self-reports are a common instrument in educational and psychological research. Though very

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wide-spread and popular, they are not free of methodological queries. First, they provide a subjective self-image of the respondent that may fall prey to self-serving answers or other response bias (Fan, Miller, Park, Winward, Christensen, Grotevant, & Tai, 2006; Shulruf, Hattie, & Dixon, 2008). Second, the researcher has no control over how the respondents interpret (A) the question and (B) the answer scale (Austin, Deary, Gibson, McGregor, & Dent, 1998). Due to individual differences on these interpretations, which have nothing to do with the actual expression of the psychological trait within these persons, responses may carry a certain extent of error. Overall though, self-report data has shown to be reliable and valid (Chan, 2009) and a tool to access information on constructs that would be difficult to obtain otherwise. Moreover, difficulties with biased answers seem to occur more in lab experiments than in field studies like the present project. To ensure data quality, this dissertation used questionnaires that have been used successfully in prior research and can be seen as established instruments. Furthermore, in this longitudinal study it was possible to compare the reliability of the repeated measures to establish data quality. However, data triangulation from multiple perspectives – which can be the case in some mixed-method approaches – have to be seen as the gold standard.

Analyses of teacher effectiveness call for controlled comparisons. The quasi-experimental design of the ‘Dialogue’ project fulfils this requirement, stressing its scientific rigor. We compared typical forms of teacher professional development in Germany (Richter et al., 2011) with the Dialogic Video Cycle to establish its benefits over ‘one shot’ workshops. Furthermore, as outlined by Lipowsky (2010), analysing the effectiveness of teacher professional development programmes can occur on four levels: (1) teacher satisfaction, (2) changes in teachers’ cognitions, beliefs and attitudes, (3) changes in teachers’ classroom practice, and (4) benefits for student learning outcomes. By combining video observation with teacher and student questionnaires, the ‘Dialogue’ project assessed effectiveness on all of those levels (studies on satisfaction, change in practice, and learning outcomes have already been published, while analyses on teachers’ cognitions are currently underway), providing an in-depth analysis of the effectiveness of the professional development programme under scrutiny. Moreover, the longitudinal set-up can help us to understand both how changes in instruction occur throughout long-term professional development as well as how effective transfer works within the programme. Longitudinal analyses have also been called for in research on need supportive instruction and student learning outcomes (e.g., Schuitema, Peetsma, & van der Veen, 2016; Stroet, Opdenakker, & Minnaert, 2013). Herein, of particular interest are developmental aspects regarding the interaction between teacher and students (Turner, Gray, Anderman, Dawson, & Anderman, 2013). Yet, these particular design elements are not free of certain challenges – especially concerning the statistical analysis (Section 9.3 will go into more detail about these). Other challenges relate to the choice of measurement interval (e.g., Collins & Graham, 2002), sample recruitment and dropout, and systemic barriers due to school holidays, extracurricular activities and other school events.

9.1. Design and Sample

Data used in this dissertation stems from a three-year project funded by the German Research Foundation (under grant SE 1397/5-1), in which the Dialogic Video Cycle was developed and implemented. The implementation phase was one full school year (year 2011/12). The design was a two-group design with intervention and control group. Intervention group teachers took part in two iterations of the Dialogic Video Cycle (one per semester), while control group teachers chose traditional workshop-based professional development without the use of video reflections. In order to supply the control group with the opportunity for collective participation and exchange, they also met once per semester in roundtables (see Section 7.5.1). The effective teacher professional development time was the same in both groups (22 hours; Figure 8).

At the beginning of the school year 2011/12 (approximately six to eight weeks into the semester) one full lesson in mathematics or science instruction was videotaped in both groups to establish a baseline (Tpre). The videorecording followed standardised procedures (Seidel, Dalehefte, & Meyer, 2001b; see Section 9.2.2). Following the videotaped lesson students filled in questionnaires. The same procedure was chosen for the post-test assessment at the end of the school year (Tpost). The intervention group was further videotaped once per semester (totalling four classroom videos for each intervention group class and two videos for each control group class) as part of the Dialogic Video Cycle (T2 and T3). These classroom videos served both as prompts for video-based reflection as part of the teacher professional development workshops, as well as an instrument for capturing classroom interactions. Following these recordings students filled in questionnaires. In total there were four measurement points for the intervention group and two for the control group (Figure 8).

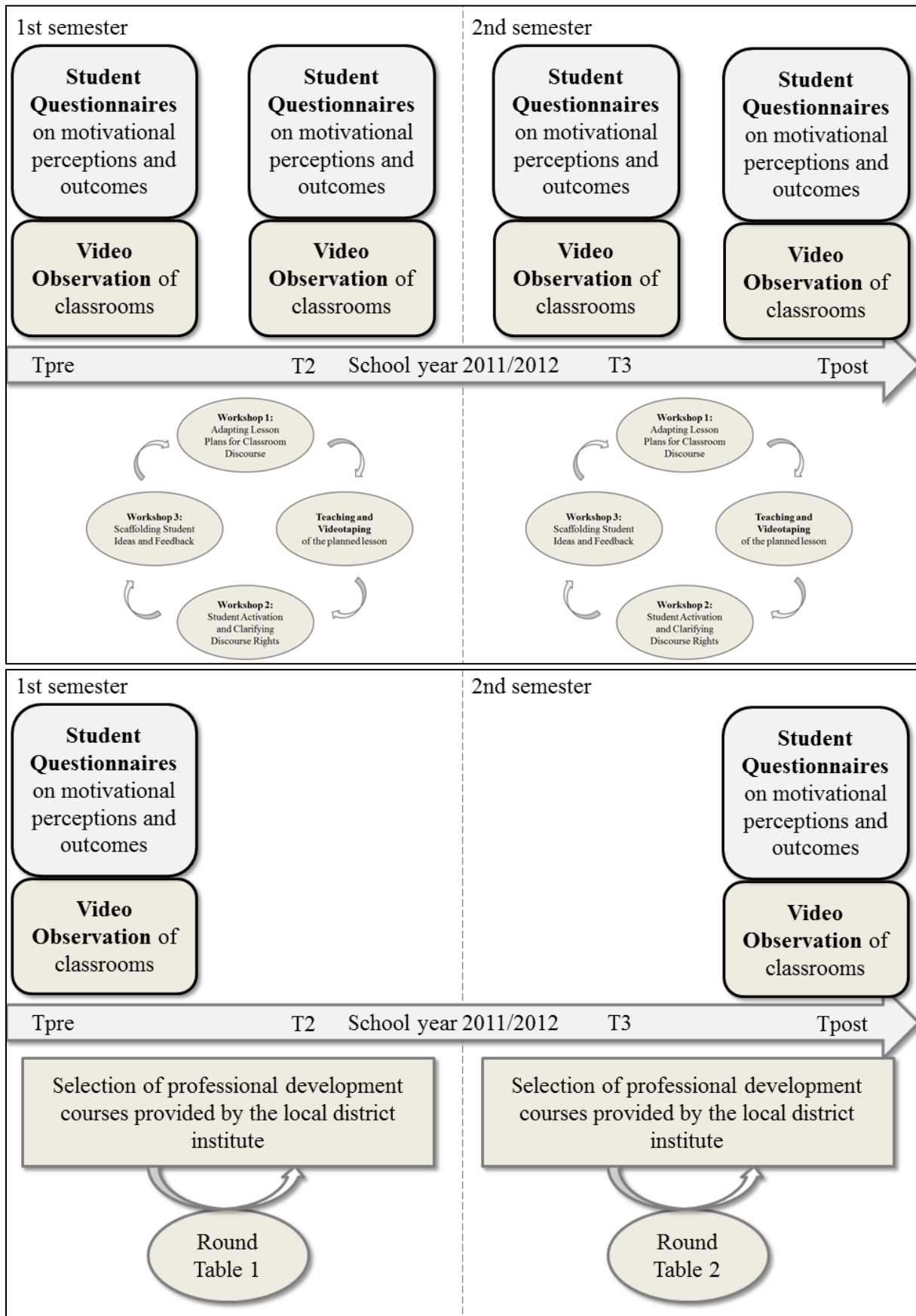


Figure 8. Design of intervention (top) and control group (bottom).

9.1.1. Treatment Implementation

We implemented a feasibility study to examine the scope to which the two different treatments aligned with effective components of teacher professional development (see Table 3) and provided opportunities for teacher learning (Gröschner et al., 2015a). Two independent, trained coders rated the videotaped Dialogic Video Cycle workshops and the roundtables. The raters independently watched video footage of the TPD workshops and scored each workshop for each component on a 3-point Likert scale (0 = ‘not observable’, 1 = ‘partially observable’, 2 = ‘clearly observable’). Spearman’s ρ was used as a measure of agreement. The rater agreement varied between $\rho = .80$ (active learning) and $\rho = 1.0$ (coherence) over the different components. The raters agreed that a pedagogical focus (on classroom talk), comparable duration (22 hours), and coherence were fully implemented in both programmes. Opportunities for collective participation and exchange were observed fully in the Dialogic Video Cycle, and were – to a lesser extent – also observed in the roundtables. Active learning and reflection of teaching practice distinguished the Dialogic Video Cycle workshops from the roundtables. Moreover, aspects of concrete lesson planning and video-based reflection were only implemented in the Dialogic Video Cycle workshops (Gröschner et al., 2015a). The feasibility study ensured that both programmes varied systematically (cf. Table 3) and was an important prerequisite for the present dissertation. Detailed findings are provided in Gröschner et al., 2015a.

Table 3. Treatment implementation for both conditions.

Component of effective teacher professional development	Intervention Group	Control Group
<i>Content focus</i>	+	+
<i>Duration (22 hours)</i>	+	+
<i>Coherence</i>	+	+
<i>Collective participation and exchange</i>	+	0
<i>Active learning and reflection</i>	+	-
<i>Lesson planning</i>	+	-
<i>Video-based reflection</i>	+	-

Note: + = fully implemented; 0 = partly implemented; - = not implemented.

One further result of the feasibility study was that the programme satisfaction and basic psychological need fulfilment was greater in the intervention group, than in the control group. Given that attitudes towards the programme and participant motivation are important prerequisites for teacher change and transfer (Gegenfurtner, Festner, Gallenberger, Lehtinen, & Gruber, 2009; Vermunt & Endedijk, 2001), this finding is the basis for any of the following results on changed practice in the studies reported herein. Furthermore, it provides a first indication for the effectiveness of the Dialogic Video Cycle in comparison to more or less standard teacher professional development (Lipowsly, 2010).

9.1.2. Teacher Sample

Recruitment of the teacher sample was done via the university's school network, as well as through announcements at the local teacher professional development institute. The final sample was 10 teachers and their 226 students (47.8% girls, 52.2% boys) in 10 science and math classrooms from German middle- or high-tracked schools. Teachers chose freely whether they wanted to participate in the Dialogic Video Cycle or the traditional workshops. They were not informed which group served as intervention and which as control condition. This avoided having the teachers feel reluctant to participate in the Dialogic Video Cycle or doubt the effectiveness of watching themselves (Fishman, Marx, Best, & Tal, 2003).

Six teachers opted for the intervention (Dialogic Video Cycle), and four chose the traditional teacher professional development programme. The two groups did not differ in age ($M_{age} = 38.3$, $SD = 5.56$, $U(6:4) = 7.5$, $z = -.97$, $p = .33$), teaching experience ($M_{experience} = 5.65$, $SD = 2.93$, $U(6:4) = 6.0$, $z = -1.30$, $p = .20$) or gender, $\chi^2_{gender}(df = 1) = .08$, $p = .79$. Both groups showed comparable engagement (and time spent) in prior teacher professional development programmes. They did not differ in their motivation ('*I want to learn more about communication in the classroom*', $M_{IG} = 3.51$, $SD = .47$; $M_{CG} = 3.81$, $SD = .38$; $U(6:4) = 7.0$, $z = -1.14$, $p = .25$) for the respective teacher professional development programme at the outset of the study or any of the other considered background variables, such as basic need fulfilment and satisfaction with the programme (Gröschner et al., 2015a). Video as a tool for reflection was only used in the intervention group. Since part of the analyses are exploratory research into each individual classroom of the intervention group – in order to trace the relationship between productive classroom talk and students' perceptions of motivational aspects such as autonomy and competence support – individual information for all six teachers in the intervention group are presented here (Table 4).

Table 4. Individual demographic information for all six teachers.

Teacher	Age [years]	Gender	Teaching experience [years]	Subject in teacher professional development ¹	Secondary level ²
Teacher 1	39	Female	10	Mathematics	High
Teacher 2	45	Male	4	Mathematics	Low
Teacher 3	33	Female	2	Physics	Low
Teacher 4	44	Female	5	Physics	High
Teacher 5	33	Female	2	Mathematics	High
Teacher 6	43	Male	5	Mathematics	Low

Note: ¹Secondary school teachers in Germany usually teach at least two subjects. ²Germany has a tracked school system in secondary education

9.1.3. Student Sample

Given their teachers' choices, there were 136 students in the intervention group and 90 students in the control group. The students' mean age was 15.67 years ($SD = .98$). The two groups differed regarding age, $t(224) = 5.20, p < .01, d = .71$ (IG: $M_{age} = 15.41, SD = .98$; CG: $M_{age} = 16.07, SD = .85$) and gender, $\chi^2_{gender} (df = 1) = 8.94, p < .01$ (IG: 39.7% girls; CG: 60.0% girls), for which reason both variables were accounted for as covariates during the data analysis.

As a preliminary step of the data analysis of Study 1, the student groups were compared with regard to pre-test (Tpre) differences on motivational outcomes. No difference between the groups was found for interest in the subject ($F(1; 200) = .35, p = .56, \eta^2 = .002$). Though no group comparisons were run for intrinsic learning motivation, perceptions of autonomy, competence and social relatedness, for a complete picture the groups were also compared on these measures. No significant differences between the groups were found for intrinsic learning motivation ($F(1; 200) = 2.13, p = .15, \eta^2 = .01$) and social relatedness ($F(1; 200) = 1.49, p = .22, \eta^2 = .01$). However, students in the intervention group perceived significantly less autonomy ($F(1; 200) = 6.57, p = .01, \eta^2 = .03$) and competence ($F(1; 200) = 4.99, p = .03, \eta^2 = .02$) than students in the control group at the beginning of the analysis. The effect sizes of these differences were minimal.

9.2. Instruments

The present dissertation employed a mixed-method approach, combining student self-reports via questionnaire and both a low and high-inference coding scheme for the video data. Figure 9 shows the use of the different instruments in the two studies. For the intervention group there were a total of four measurement points, while the control group only got assessed at pre and post-test (Tpre and Tpost). As a result, group comparisons can only be made for pre/post developments, while detailed analyses of the intervention group allow for analyses of the growth across four measurement points. Hence, Study 1 focuses more on group comparisons, while Study 2 is a more detailed analysis of the intervention group across four measurement points (see Figure 9). The questionnaire instruments used in the studies reported here were used prior in national studies on large samples (e.g., in the context of TIMMS: Kunter, 2005; in the context of PISA: Ramm, Prenzel, Baumert, Blum, Lehmann, Leutner, et al., 2006). The reliability scores reported in the literature were satisfactory and are comparable to the ones obtained in this project. Video analysis followed strict protocols and was based on instruments and experiences from prior studies (Seidel et al., 2005).

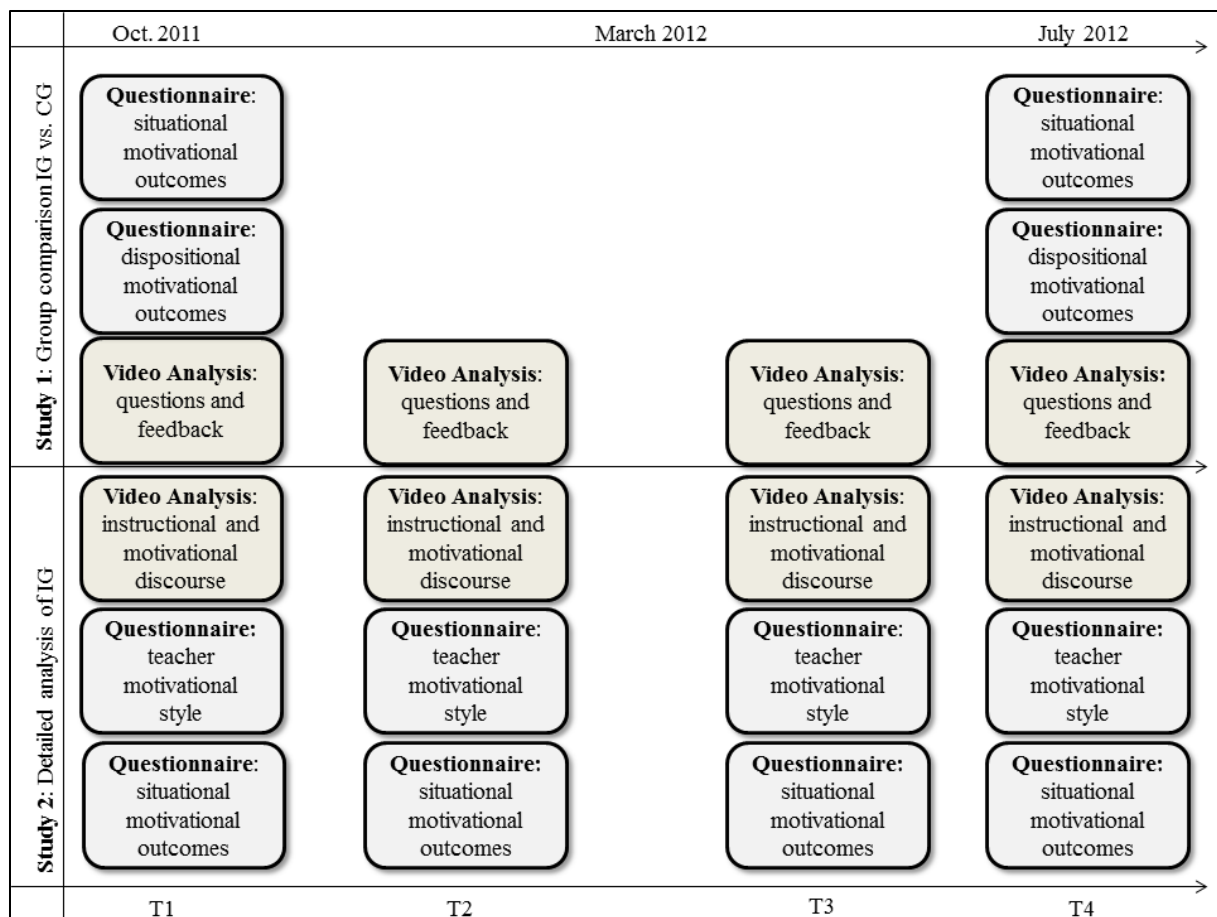


Figure 9. Study design and instruments used in Study 1 and Study 2.

9.2.1. Questionnaire

Figure 9 shows the administration of the different scales across the entire ‘Dialogue’ project and how they relate to the two studies comprising this dissertation. All items were answered on a 4-point Likert-scale ranging from 0 = ‘fully disagree’ to 3 = ‘fully agree’. The questionnaires were administered right after the videotaping of the lesson ended. Student codes allowed for an anonymous tracking of the individuals across the school year.

Interest in the subject: This scale consisted of five items (example item: ‘I am interested in mathematics/science’; Seidel et al., 2003b) and showed good reliability at both measurement points ($\alpha_{pre} = .84$, $\alpha_{post} = .87$).

Intrinsic learning motivation: This scale consisted of three items (example item: ‘This class was fun’; Ramm et al., 2006) with reliability scores ranging from $\alpha = .75$ to $\alpha = .85$ across the four measurement points.

Basic psychological need fulfilment: Autonomy perceptions were assessed with eight items (‘During this class, I had the feeling that the teacher was open for different student answers’; Kunter, 2005), competence perceptions with seven items (example item: ‘During this class, I had the feeling that the teacher thought us capable of challenging exercises’; Kunter, 2005) and perceptions of social relatedness with six items (example item: ‘During this class, I felt like I was important to the teacher’;

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Kunter, 2005). All scales showed satisfactory to good reliability scores at all measurement points: autonomy $\alpha = .75-.82$, competence $\alpha = .71-.83$ and social relatedness $\alpha = .69-.85$.

Experience of self-determination: Students' experienced self-determination was assessed with five items (example item: '*During the lesson I could allot my time freely*'; Kunter, 2005). With a Cronbach's α varying between $\alpha = .67$ and $\alpha = .72$, the scale showed acceptable reliability across the four measurement points.

Perceptions of autonomy support: Students' perceptions of their teacher's motivational style as autonomy-supportive were assessed with three items (example item: '*During the lesson, I felt like my teacher gave us enough time to work independently*'; Kunter, 2005). Internal consistency was good and ranged from $\alpha = .70$ to $\alpha = .85$ across the four measurement points.

Perceptions of competence support: The perceived competence support provided in a teacher's motivational style was assessed with seven items ('*During the lesson, I could get help if I got stuck*'; Kunter, 2005). Internal consistency varied from $\alpha = .71-.83$, providing good reliability scores.

Table 6 provides an overview of all instruments used for this dissertation (questionnaire and video data), as well as their descriptive statistics. Furthermore, Figure 9 illustrates their implementation in the longitudinal design of the 'Dialogue' project.

9.2.2. Video Analysis

Using the software Videograph (Rimmele, 2002), teacher-student interactions during whole-class discussions were analysed. Both a high and low-inference coding system was developed by the research team (Pehmer, Kiemer, & Gröschner, 2014). All video coding related to teachers' classroom practices and were assessed by five independent raters. The raters were trained using video material that came from the same study but did not go into the final data analysis. The development process of the coding systems followed previous video studies (Figure 10, Seidel, Prenzel, Duit, & Lehrke, 2003) and was based on existing systems (Seidel, 2003b) and extensive literature reviews of elements of productive classroom talk (Pehmer et al., 2014).

For the low-inference coding all classroom videos were first sub-divided into speaker turns (i.e., teacher, student, and no speaker) based on the event-sampling method (Bakeman, 1997). Low-inference coding systems were then developed applying disjunct categories. Each talk turn was first coded as to whether it was feedback or a question. Subsequently, each teacher question was coded as being either open or closed. According to the same procedure, each instance of teacher feedback was either coded as simple or constructive (more detailed descriptions of these categories follow below). The described coding procedure allowed for the quantification of a qualitative video analysis (Schümer, 1999). Since the study focused particularly on teachers' facilitation of classroom talk, only talk turns during whole class discussions were used in the video analysis. All video coding were aggregated on the class level. By dividing the total amount of each subcategory (e.g., open questions)

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by the total amount of the overall category (e.g., questions) the data were transformed into relative frequencies. This procedure equalised the data between the different time points and teachers and allowed for more meaningful comparisons.

For the high-inference rating system talk format (whole class discussion vs. seat work) was chosen as the decisive event for the event-sampling method (Bakeman, 1997). Each segment of whole class discussion was then rated by independent raters on numerous items relating to teachers' facilitation of instructional and motivational discourse (more detailed descriptions of the items follow below). For the rating a 4-point Likert-scale was used (0 = 'not applicable', 3 = 'fully applicable'), anchored at each end with illustrative examples from video material that was screened during the training process. For each lesson and item the average was formed to receive a measure of how each item overall applied to that particular lesson. In a second step, the averages of the individual items were averaged to form the scales of instructional and motivational discourse (Table 5). So once again, the qualitative video data was quantified for further analyses (Schümer, 1999). This procedure equalised the data between the different time points and teachers and allowed for more meaningful comparisons. After the training phase the raters showed satisfactory agreement, both on the low as well as the high-inference coding (see below).

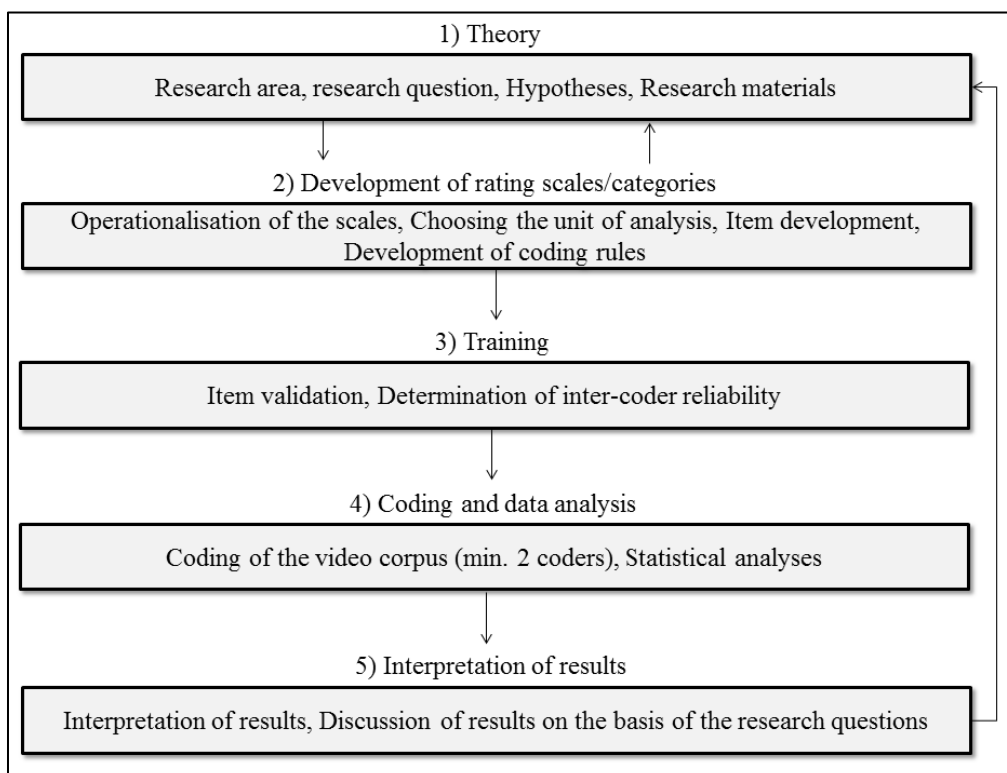


Figure 10. Development protocol of codes for video analysis (adapted from Seidel, Prenzel, Duit, & Lehrke, 2003).

Low-inference coding

The low-inference coding collected data on specific behavioural aspects of teaching activities during whole-class discussions (teacher questions and feedback). Research shows that these teaching behaviours are not equivalent to productive classroom talk (Boyd & Rubin, 2006), but serve as

opportunities for high-quality discussions (e.g., Chin, 2006), hence they are commonly used as indicators of productive classroom talk (e.g., Alexander, 2005, 2008; Franke et al., 2009). Unit of analysis was speaker turn ($\kappa = 1.0$). Five months of training preceded independent raters' scoring of the videos.

Teacher questioning: Independent raters classified each question as open (*'What do you think happens if we heat it up?'*) or closed (*'Do we have any right angles here?'*). Inter-rater reliability in this category was $\kappa = .79$ (direct agreement: 89.7%).

Teacher feedback: Teachers' feedback was characterised as constructive (*'That's a good strategy; just try to focus more on the mechanism'*) or simple (*'Nice job'*). The reliability between coders was satisfactory with $\kappa = .71$, and direct agreement 85.3%.

High-inference rating

A second, high-inference coding system was applied to accompany the analyses of specific talk moves with more qualitative analyses of teaching processes during whole class discussions (cf. Figure 1). Rather than the specific utterance, here the focus of attention was on the processes enabled during whole-class discussion. The unit of analysis for the high-inference ratings for instructional and motivational discourse was talk format (whole class discussion vs. seat work; $\kappa = 1.0$). All high-inference ratings were assessed on a 4-point Likert-scale (0 = *'not applicable'*, 3 = *'fully applicable'*). Table 5 provides all rating items used in the high-inference analysis of the dissertation and how they relate to prior research on instructional and motivational discourse (Turner et al., 2002). Descriptions of the different categories and subcategories are provided as well. Table 6 summarises the descriptive statistics of all instruments as they were used in this dissertation.

Instructional Discourse: A total of ten rating items were used to assess teachers' facilitation of instructional discourse (Table 5). The rating items focused on aspects such as negotiating meaning (*'The teacher provides students with strategies to reach their learning goals.'*) or transferring responsibility (*'Students work independently/autonomously. They take initiative in the learning process'*). The items were averaged to form a single rating scale for each aspect. Internal consistency was satisfactory across all four measurement points ($\alpha = .86-.93$).

Motivational Discourse: Seven rating items (Table 5) made up the scale of motivational discourse and assessed teachers' focus on learning (*'The teacher allows for errors and used them constructively.'*), their use of positive emotions (*'The teacher shows high regard of student contributions'*), and peer support and collaboration (*'Students are encouraged to actively shape the classroom talk.'*). Reliability of the scale ranged from $\alpha = .79$ to $\alpha = .89$ across all four measurement points.

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Table 5. Codes for instructional and motivational classroom discourse (unit of analysis is talk format, 4-point Likert-scale: 0 = ‘not applicable’, 1 = ‘partially not applicable’, 2 = ‘partially applicable’, 3 = ‘fully applicable’).

Discourse Type	Code in Turner et al., 2002	Description	Rating item in Pehmer et al., 2014
Instructional Discourse	Negotiating meaning (supportive)	Adjusting instruction, simplifying, clarifying, or elaborating; highlighting concepts or key features or contrasts; modelling what students should do – ‘thinking aloud’ with students	The teacher identifies and responds to errors.
	Transferring responsibility (supportive)	Supporting strategic thinking and autonomous learning; holding students accountable for understanding	The teacher uses errors to provide students with hints for their individual learning process. The teacher uses errors as opportunities for learning and adapts the lesson accordingly. The teacher makes the learning goals/central topic of the lesson explicit. The teacher provides students with strategies to reach their learning goals. The teacher is transparent in her expectations of the students. The teacher makes sure that all students have understood the expectations. The teacher probes for reasons, evidence, warrants, etc., in student responses.
	No Telling (supportive)	Not Prescribing how students should think and act conceptually or emphasising completion and accuracy over learning	Students work independently/autonomously. They take initiative in the learning process. The teacher allows students to answer fully without interruption (even if an answer is erroneous).
Motivational Discourse	Focusing on learning (supportive)	Focusing on the process of learning, challenging students, viewing errors as constructive or supporting persistence	The teacher allows for errors and used them constructively. The teacher makes sure that all students have opportunity to contribute and be engaged. The teacher poses cognitively demanding tasks.
	Positive emotions (supportive)	Using enthusiasm or humour, or reducing anxiety; addressing emotional needs	The teacher includes cheerful comments into the talk. The teacher shows high regard of student contributions. The teacher shows high regard for students’ independent/autonomous working.
	Peer support and collaboration (supportive)	Building collaboration, emphasising joint goals – shared responsibilities	Students are encouraged to actively shape the classroom talk.

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Table 6. Descriptive statistics for all instruments used in Study 1 and Study 2.

	Intervention Group						Control Group					
	Tpre		T2		T3		Tpost		Tpre		Tpost	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Interest in the subject	1.48	0.67	-	-	-	-	1.55	0.75	1.33	0.66	1.25	0.67
Intrinsic learning motivation	1.67	0.73	-	-	-	-	1.71	0.74	-	-	-	-
Autonomy	1.74	0.55	-	-	-	-	1.90	0.57	-	-	-	-
Competence	2.02	0.48	-	-	-	-	2.10	0.59	-	-	-	-
Social relatedness	1.92	0.53	-	-	-	-	1.91	0.61	-	-	-	-
Autonomy support	2.19	0.66	2.36	0.64	2.16	0.68	2.16	0.72	-	-	-	-
Competence support	1.99	0.49	2.15	0.53	1.98	0.56	2.03	0.59	-	-	-	-
Open questions	0.40	0.21	-	-	-	-	0.39	0.17	0.23	0.17	0.17	0.09
Constructive feedback	0.21	0.07	-	-	-	-	0.39	0.14	0.29	0.11	0.15	0.10
Instructional discourse	1.43	0.53	1.81	0.61	1.76	0.51	1.88	0.45	1.21	0.68	1.02	0.59
Motivational discourse	1.26	0.78	1.42	0.59	1.68	0.59	1.82	0.46	0.80	0.66	0.80	0.58

9.3. Data Analysis

Due to the quasi-experimental, longitudinal design of the ‘Dialogue’ project, the data structure of the different studies is nested in the sense, that there are both teachers grouped in treatment conditions, as well as teachers grouped in measurement points. Furthermore, this hierarchical structure occurs with students as well, as students are nested in teachers and measurement points nested in students. The sort of analysis that could accommodate this type of data structure would be a multi-level analysis with (at least) three levels (teachers: level 1 = measurement point, level 2 = teacher, level 3 = treatment condition; students: level 1 = measurement point, level 2 = student, level 3 = teacher). However, such an analysis would require a very large sample. The recommendations on how many subjects on each level are needed vary, but as a rule of thumb 50 units on the highest level are required, so as to not receive biased standard errors (Maas & Hox, 2006; Snijders, 2005). Schoppek (2015) reports results from simulation studies showing that, in samples with 5 units on level 2 (here the classes), multilevel models arrive at less robust regression weights and residual variances. Furthermore, the author points to restrictions in the power of such analyses (see also McNeish and Stapleton, 2016).

We acknowledge that a three-level, multilevel model is required to optimally represent the data; however the intra-class correlations (ICC) in our analyses mostly show limited amounts of between-variance, which makes the application of multilevel models optional ($ICC \leq .10$; see Lee 2000 for details on the appropriateness of MLM in such cases). Given the restrictions in sample size in the present study ($n = 6$ teachers with $n = 136$ students in the IG) and the small amounts of between-variance ($Var_{between} = .01-.11$), we refrain from multilevel modelling. Instead, we applied latent growth curve (LGC) models to model changes across time. Such analyses allow representing the longitudinal structure of the data adequately without the use of multilevel modelling and thus are also applicable for smaller samples (Duncan & Duncan, 2004). The specific analyses for the individual research questions are presented in the following sections. Teacher data was modelled independently.

9.3.1. Study 1: Effects of a classroom talk intervention on teachers’ practice and students’ motivation to learn mathematics and science

Research Question 1

To answer the first research question, a repeated measure non-parametric analysis of variance (Brunner, Domhof, & Langer, 2002) was performed for the pre and post-test comparisons, using treatment as the independent variable and behavioural indicators of teachers' productive classroom talk (questioning and feedback) as dependent variables. The analyses were run using the software package nparLD (Noguchi, Gel, Brunner, & Konietschke, 2012) in R (R Core Team 2013). Post-hoc Wilcoxon tests were run for intervention group data in order to track significant positive pre-post differences.

Research Question 2

A latent growth curve model, using treatment as predictor variable (dummy coded: IG = 1, CG = -1) over two measurement points (pre- to post-test) was created in SPSS (IBM Corp., 2015) to account for the nested structure of the data (Duncan & Duncan, 2004; Geiser, 2010). A linear trajectory was estimated, since there were only two measurement points available for group comparisons (see Section 9.1 for a full description of the study design). Age and gender were used as covariates, given the a priori differences in group composition (Shek & Ma, 2011). The intra-class correlation for this model was $ICC = 0.23$.

Research Question 3

In answer to Research Question 3 we calculated the relative change (Δ -scores between T_{post} and T_{pre}) in students' perceptions of basic psychological needs, intrinsic learning motivation, and interest in the subject. As preliminary analysis bivariate correlational analyses between the Δ -scores of all basic psychological needs and the Δ -scores of intrinsic learning motivation, as well as interest in the subject, were run. The scores were further submitted to a path analysis modelling the direct effect of $\Delta_{autonomy}$, and $\Delta_{competence}$ on $\Delta_{intrinsic\ learning\ motivation}$, as well as the direct effect of $\Delta_{intrinsic\ learning\ motivation}$ on $\Delta_{interest}$ in the subject. Also, we estimated indirect effects in the model (Figure 11).

9.3.2. Study 2: Instructional and motivational classroom discourse and their relationship with teacher autonomy support and competence support: findings from an intervention study on productive classroom talk

Research Question 1a

Video data of both the intervention and the control group were used in these analyses. To examine if teachers' facilitation of instructional and motivational discourse changes differentially between the intervention group (IG) and the control group (CG), pre/post comparisons were made using non-parametric analyses of variance (Brunner et al., 2000). The analyses were run using the software package nparLD (Noguchi et al., 2012) in R (R Core Team 2013).

Research Question 1b

In answer to Hypothesis 1b, more detailed information will be provided on the intervention group pertaining to all four measurement points. Friedman tests were applied to the data in order to establish positive changes on the measures for instructional and motivational discourse across time. Post-hoc Wilcoxon tests were run to analyse positive differences from pre- to post-test in the intervention group.

Research Questions 2 and 3

For answering Research Questions 2 and 3, questionnaire data from four measurement points in the intervention group was used. The intra-class correlations (ICC) are given in Table 7 and show for the most part negligible amounts of between-variance (Lee, 2000). Given the restrictions in sample size in the present study and the small amounts of between-variance, we refrain from multilevel modelling. Instead, using the software Mplus (Muthén & Muthén, 2014), latent growth curve models were applied to the data to model changes across time. For these models time scores were fixed. The variance of the slope was fixed to zero; therefore the estimated model represents a random intercept model.

Table 7. Intra-class correlations for students' perceptions of autonomy support and competence support (Tpre, T2, T3, Tpost).

	Tpre	T2	T3	Tpost
Autonomy support	0.25	0.14	0.09	0.08
Competence support	0.21	0.12	0.13	0.08

Research Question 4

In answer to Research Question 4, we calculated the relative change (Δ -scores between Tpost and Tpre) in students' perceptions of autonomy support, competence support, and experiences of autonomy and intrinsic learning motivation. These scores were submitted to a path analysis modelling the direct effect of $\Delta_{\text{autonomy support}}$ and $\Delta_{\text{competence support}}$ on $\Delta_{\text{self-determination}}$, as well as the direct effect of $\Delta_{\text{self-determination}}$ on $\Delta_{\text{intrinsic motivation}}$. Also, we estimated indirect effects in the model (Figure 11). The ICCs of the change scores show mostly limited amounts ($\text{ICC} \leq 0.10$; Table 7) of the variance to be attributable to the class level ($\text{ICC } \Delta_{\text{autonomy support}} = 0.06$, $\text{ICC } \Delta_{\text{competence support}} = 0.02$, $\text{ICC } \Delta_{\text{self-determination}} = 0.02$) – hence multi-level modelling is not appropriate in this case (Lee, 2000).

Research Question 5

Given that the indicators used for Research Question 5 were measured on different levels (autonomy support and competence support on the student level, instructional and motivational discourse on the teacher level), questionnaire data were aggregated to represent the overall perceptions of autonomy support and competence support in each classroom. That way the number of cases is restricted to $n = 6$ (classrooms) and only allows for exploratory analyses. Future research will be needed to back up any findings of the present study. Non-parametric correlations were performed in order to establish a relationship between the positive development of instructional and motivational discourse in the intervention group and changes in students' perceptions of autonomy support and competence support. The thesis further delved into each individual classroom, exploring the individual developments more qualitatively.

For the statistical analyses of this dissertation, different analytical approaches were chosen, depending on the data structure, sample size and research question. To be able to run all these

Methodological Approach

analyses, different software packages were used. Generally, for descriptive statistics, correlations and Friedman tests the software SPSS (IBM Corp., 2015) was applied. Moreover, the latent growth curve model in Study 1 was run in SPSS. The non-parametric analyses of variance for Research Question 1 of each study were done in R (R Core Team, 2015). Both the latent growth curve models in Study 2 and the path analyses of both studies were modelled using Mplus software (Muthén & Muthén, 2006-2015).

Study 1: Effects of a classroom talk intervention on teachers' practice and students' motivation to learn mathematics and science (Essay 1)

10. Study 1: Effects of a classroom talk intervention on teachers' practice and students' motivation to learn mathematics and science (Essay 1)

Parts of the present dissertation have already been published successfully. Conception, preparation, analysis, and presentation were done in the context of this dissertation and were described in Essay 1:

Kiemer, K., Gröschner, A., Pehmer, A.-K., & Seidel, T. (2015). Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science. *Learning and Instruction*, 35(1), 94-103. doi:10.1016/j.learninstruc.2014.10.003

All co-authors advised the origination process and the preparation. Workload was shared: 70% Katharina Kiemer, 15% Alexander Gröschner, 10% Tina Seidel and 5% Ann-Kathrin Pehmer. The essay was submitted to the journal *Learning and Instruction* and published in February 2015.

10.1. Research Questions

(1) *Do teachers' practices in the intervention group change towards more productive teaching (specifically questioning and feedback) in the course of the Dialogic Video Cycle, compared with teachers in a control group?*

Hypothesis 1: Teachers in the intervention group will exhibit an increased number of open questions and constructive feedback (Hypothesis 1a) and a decreased number of closed questions and simple feedback in a pre-post comparison (Hypothesis 1b), compared with the control group

(2) *Does a one-year Dialogic Video Cycle intervention show positive effects on students' development of interest in the subject compared with that for the control group?*

Hypothesis 2: The students of teachers participating in the Dialogic Video Cycle will show a positive development of interest in the subject at the end of the school year compared with the students of teachers in the control group.

(3) *Are the positive changes in interest in the subject at the end of the school year systematically related to changes in intrinsic learning motivation, which in turn is systematically related to a change in students' perception of basic psychological needs?*

Hypothesis 3: Repeated altered experiences with regard to basic psychological need perception (increased fulfilment of basic psychological needs) will lead to an increase in intrinsic learning motivation. In turn, the repeated experience of such learning motivation will manifest in increased individual interest in the subject.

10.2. Theoretical Rationale

In this study it was examined if teachers' participation in the Dialogic Video Cycle improves students' intrinsic learning motivation and interest development over the course of a school year. 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 et al., 2009), active engagement, learning motivation and interest (Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009).

Walshaw and Anthony (2008) differentiate two major teaching strategies in productive classroom talk: *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* – for instance, by giving individual feedback in a productive way to move thinking forward. Several studies on mathematical argumentation and scientific inquiry point out the relevance of these activities in creating productive classroom talk (Furtak, 2006; Furtak, Seidel, Iverson, & Briggs, 2012; Kovolainen & Kumpulainen, 2005; Ruiz-Primo & Furtak, 2006, 2007; Wells, 1999, 2001). The two activities can particularly be operationalised through productive forms of teacher questioning and meaningful feedback (Jurik et al., 2014). They were assessed through analysis of video observations as outlined in Section 9.

To ascertain whether the Dialogic Video Cycle can affect students' motivation to learn, we draw on Self-Determination Theory (Deci & Ryan, 1985; Section 5.2) and Person-Object Theory of interest (Krapp, 2002; Krapp & Prenzel, 2011; Section 5.3) to frame the importance of productive classroom discourse for students' learning motivation. In Self-Determination Theory, 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).

In Self-Determination Theory (Ryan & Deci, 2000, 2002) motivation is conceptualised as a situational construct, depending on a person's moment-to-moment experiences and the interpretation. By changing students' moment-to-moment classroom experiences – for instance, through productive classroom discourse – their need for autonomy, competence and social relatedness is repeatedly fulfilled, leading to self-determined learning motivation. Hence, 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.

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Grounded in the situated beneficial effects of productive classroom talk 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. The Dialogic Video Cycle aims at improving teachers' skills of creating productive classroom talk, which ought to lead to positive changes in intrinsic learning motivation through repeated instances of basic need fulfilment and thereby positively develop 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 intrinsic learning motivation and interest in the subject. Furthermore, we examine whether TPD programmes can help teachers counter students' decreases in learning motivation and interest throughout secondary school (Turner, Warzon, & Christensen, 2011).

10.3. Method

Both the teacher and the student sample of the intervention ($n_{\text{teacher}} = 6$, $n_{\text{student}} = 136$) and control group ($n_{\text{teacher}} = 4$, $n_{\text{student}} = 90$) were used in the analyses of this study (for a full description of the sample see Section 9.1). The two teacher groups were compared on measures for their questioning and feedback behaviour (data from the video analysis) by use of non-parametric analyses of variance (Brunner et al., 2004). By use of latent growth curve models students of the two treatment conditions were compared on their development of interest in the subject (scale based on Seidcel et al., 2003b). Treatment was used as (dummy-coded) predictor in the analyses. In answer to Research Question 3a path analysis with direct and indirect effects was run within the intervention group student sample. The analysis looked at the predictive value of changes in basic psychological need fulfilment (autonomy, competence, social relatedness; scales based on Kunter, 2005) for changes in intrinsic learning motivation (scale based on Ramm et al., 2004) and interest in the subject. The effect of changed perceptions of intrinsic learning motivation on interest in the subject was also examined (see Figure 11). For an extensive overview of the analytical approach see Section 9.3.

10.4. Results

Results of this study will be presented in the order of research questions and discussed briefly in the following section. A general discussion follows at the end of the dissertation, along with methodological reflections and ideas for future research.

10.4.1. Teachers' changed practices

All reported results are relative counts of the respective subcategory in relation to the total in that category. Table 8 gives the descriptive statistics and non-parametric analyses of variance of the video

Study 1: Effects of a classroom talk intervention on teachers' practice and students' motivation to learn mathematics and science (Essay 1)

analysis of teachers' questioning behaviour and feedback for both groups at both measurement points. For the intervention group teachers' questioning behaviour, the number of open questions increased and the number of closed questions decreased; yet this trend did not reach significance ($F_{open}(1) = .56$, n.s.; $F_{closed}(1) = .56$, n.s.). For their feedback behaviour, there was a significant increase in constructive feedback ($F(1) = 9.20$, $p < .01$) and a significant decrease in simple feedback ($F(1) = 9.36$, $p < .01$). Furthermore (as can be seen in Table 8), the relative treatment effect (RTE) concerning open questions dropped in the control group, while it remained stable in the intervention group. These results can be interpreted such that the probability of a randomly chosen observation from the whole sample at Tpre, resulting in a smaller score on closed questions than a randomly chosen observation from the IG is 38% (Noguchi et al., 2012). Similarly, the RTE for constructive feedback plummeted in the control group, while it more than doubled in the intervention group. In terms of effect sizes (using pooled standard deviations) results show $d = 0.24$ for the group comparison of open questions between pre- and post-test and $d = 3.52$ for constructive feedback (Morris, 2008). Post-hoc tests (Wilcoxon tests) for the intervention group showed that the pre/post-differences for constructive feedback also were significant ($z = -2.03$, $p = .04$), while the same test for open questions was non-significant ($z = -0.73$, $p = .46$).

Table 8. Descriptive statistics and results of the non-parametric analysis of variance for questioning and feedback.

		Pre-test				Post-test			
		<i>M</i>	<i>SD</i>	<i>Mean rank</i>	<i>RTE</i>	<i>M</i>	<i>SD</i>	<i>Mean rank</i>	<i>RTE</i>
Closed questions	<i>IG</i>	0.59	0.21	8.08	0.38	0.61	0.18	12.13	0.58
	<i>CG</i>	0.75	0.14	8.33	0.39	0.81	0.07	15.75	0.76
Open questions	<i>IG</i>	0.40	0.21	12.91	0.62	0.39	0.17	12.67	0.61
	<i>CG</i>	0.23	0.17	8.88	0.42	0.17	0.09	5.25	0.24
Simple feedback	<i>IG</i>	0.79	0.07	13.00	0.63	0.58	0.14	5.08	0.23
	<i>CG</i>	0.71	0.11	9.00	0.43	0.85	0.10	16.38	0.79
Constructive feedback	<i>IG</i>	0.21	0.07	8.00	0.38	0.39	0.14	15.92	0.77
	<i>CG</i>	0.29	0.11	12.00	0.58	0.15	0.10	4.63	0.21

10.4.2. Effects on students' interest in the subject

A preliminary inspection of mean values ($M_{IG} = 1.48, SD = 0.67; M_{CG} = 1.33, SD = 0.66$) showed comparable scores between both groups at pre-test. Descriptive comparisons between the mean scores of the pre and post-test show a slight increase in interest in the subject in the IG ($M_{post} = 1.55, SD = 0.75$) but a decrease in the control group ($M_{post} = 1.25, SD = 0.67$).

Model fit indices of the unconditional linear growth model (run in the software package SPSS, IBM Corp., 2015) showed that overall the model fitted the data ($\chi^2 (df = 2) = 0.82, p = .66; RMSEA < 0.05, CFI > 0.95$; Morin, Arens, & Marsh, 2016), especially given that the sample size is small for such analyses and fit indices are sensitive to small samples (Wu, Taylor, & West, 2009). The model exhibited a significant intercept ($\beta = 10.76, SE = 1.89, p < .01$) suggesting that the level of interest was not constant over time, while the non-significant slope suggests a constant positive growth rate in the level of interest in the subject over time in the full sample ($\beta = 3.04, SE = 2.70, n.s.$). The intra-class correlation for this model ($ICC = 0.23$) showed that 23% of the variation in interest scores is attributable to the individual level (as measurement points are nested in individuals in this form of analysis). After the estimation of this zero model, the factor treatment was introduced as a predictor variable to account for group differences. While treatment was not associated with the initial level of interest in the subjects ($\beta = -2.64, SE = 2.07, n.s.$), it is a significant predictor of the linear growth rate in interest between the two groups ($\beta = 5.87, SE = 2.96, p = .05$). There was a differential positive development of interest in the subject in favour of the intervention group as indicated by the positive β -value (treatment was dummy coded: 1 = intervention group, -1 = control group).

10.4.3. Student interest and its relation to changes in intrinsic learning motivation in the Dialogic Video Cycle

First, bivariate correlations for $\Delta_{pre-post}$ scores of basic psychological need fulfilment, intrinsic learning motivation and interest in the subject were run for the intervention group. As Table 9 illustrates, the correlational analyses revealed systematic positive relationships between the changes from pre to post-test for all situated motivational variables and students' interest in the subject, except for social relatedness.

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Table 9. Bivariate correlations of pre/post difference scores (Δ -scores) for interest in the subject, intrinsic learning motivation, basic psychological need fulfilment.

	Interest in the subject Δ pre-post	Intrinsic learning motivation Δ pre-post	Autonomy Δ pre-post	Competence Δ pre-post	Social relatedness Δ pre-post
1	1	0.28**	0.25**	0.36**	0.17 ⁺
2		1	0.47**	0.38**	0.25**
3			1	0.52**	0.46**
4				1	0.48**
5					1

As expected, the change in situated intrinsic learning motivation is significantly predicted by changes in perceived autonomy ($\beta = 0.27^{**}$, $SE = 0.09$) and experiences of competence ($\beta = 0.31^{**}$, $SE = 0.08$). Further, the change in situated intrinsic learning motivation is then predictive of the change in interest in the subject over the course of the intervention ($\beta = 0.48^{**}$, $SE = 0.08$). Changes in autonomy and competence perceptions also have an additional indirect effect on the change in interest via intrinsic learning motivation ($\beta_{\text{auton_ind}} = 0.13^{**}$, $SE = 0.05$; $\beta_{\text{comp_ind}} = 0.12^{**}$, $SE = 0.04$). Figure 11 depicts the model with direct and indirect effects. The model explained 21% of the changes in intrinsic learning motivation ($R^2 = .21$, $p < .01$) and 23% in interest in the subject ($R^2 = .23$, $p < .01$).

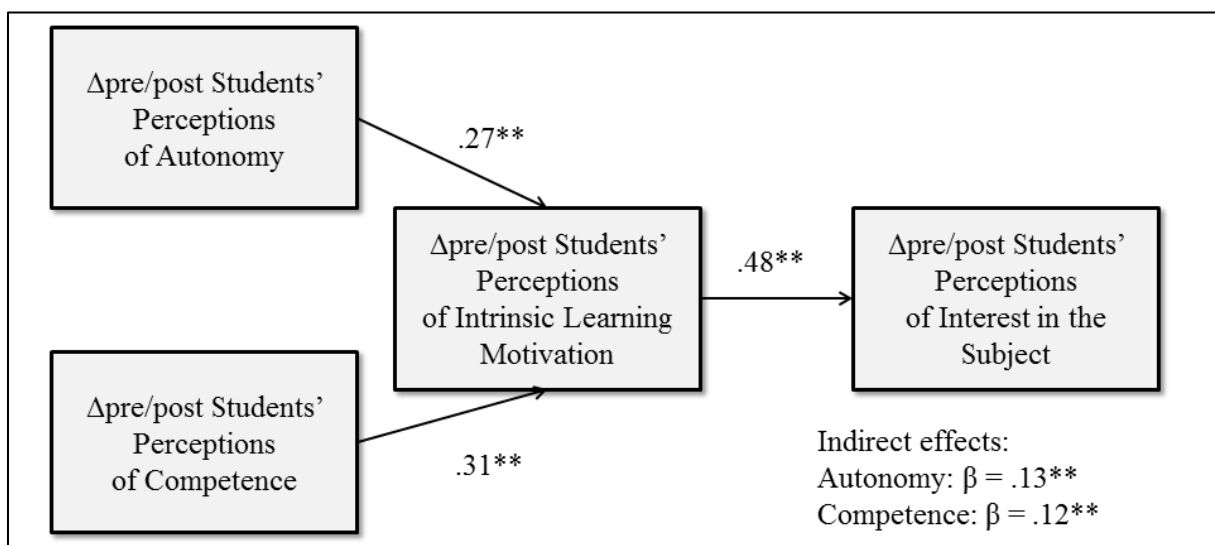


Figure 11. Path analysis of pre/post difference scores (Δ -scores) for autonomy, competence, intrinsic learning motivation and interest in the subject with direct and indirect effects.

10.5. Discussion

This study examines the extent to which a video-based teacher professional development intervention targeting productive classroom talk showed positive effects on teachers' practice and students' motivation to learn mathematics and science. It is, to our knowledge, the first study focusing explicitly on teachers' changed practices during classroom talk and students' motivation to learn mathematics and science. Furthermore, it takes both a situational and longitudinal stance on students' self-determined learning motivation and brings together state-of-the-art research on productive classroom

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discourse (e.g. Alexander, 2005, 2008, 2010; Asterhan & Schwarz, 2016, 2007; Chi & Meneske, 2015; Davies & Meissel, 2016; Duschl & Osborne, 2002; Howe & Abedin, 2013; Lipowsky et al, 2007; Mercer & Dawes, 2014; Mercer, Wegerif, & Dawes, 1999; Michaels, O'Connor, & Resnick, 2008; Michaels & O'Connor, 2012; Mortimer & Scott, 2003; O'Connor, Michaels, & Chapin, 2015; Resnick, Asterhan, & Clarke, 2015; Walshaw & Anthony, 2008; Wells & Arauz, 2006; Wilkinson, Murphy, & Binici, 2015) and the role of teachers and professional development in supporting students' learning motivation (Turner et al., 2011). After describing the successful implementation of a teacher professional development programme focusing on productive classroom talk (Gröschner et al., 2015a), we showed that the reported decrease in students' intrinsic learning motivation and interest (Eccles et al., 1993; Maulana et al., 2013) can be countered to a certain extent by teachers' facilitation of productive classroom talk. Hereby, the Dialogic Video Cycle assumed the position of a scaffold (Wood, Bruner, & Ross, 1976) for teachers to continuously engage in productive classroom talk.

The video analysis of teachers' teaching activities during classroom talk at pre and post-test of the study indicated that the teachers participating in the Dialogic Video Cycle changed their questioning and feedback behaviour positively. While the control group teachers showed increasingly more closed questions and simple feedback, indicating more teacher-centred and less productive teaching activities, participants in the video-based, reflection-oriented condition exhibited positive changes in the course of the study (Hypothesis 1a and 1b confirmed). The significant increase in constructive feedback in comparison to teacher questions suggest that this aspect of productive classroom talk is more likely to be demonstrated in observed practices (van den Bergh, Ros, & Beijaard, 2013a, 2013b). Thus, questioning seems to be a more-difficult-to-adapt teacher practice as teachers' style of asking questions is very much a routine (Oliveira, 2010) and teachers sometimes struggle with asking open questions because they require different situational interactions with students; whereas feedback is more of an instruction matter (Mercer, 2010).

Research on interest in the subject repeatedly reports decreases in interest across secondary school (Baumert & Köller, 1998; Eccles et al., 1993; Gottfried, Fleming, & Gottfried, 2001; Helmke, 1993; Maulana et al., 2013; Pekrun, 1993; Spinath & Spinath, 2005). These decreases are also observed in the control group, but not for teachers participating in the Dialogic Video Cycle (Hypothesis 2 confirmed). Thus, teacher participation in the intervention appears an appropriate mean to improve student interest in mathematics and scienc. A β -weight of 5.87 on this motivational student characteristic underscores the effectiveness of the Dialogic Video Cycle as a relevant, practice-oriented teacher professional development programme. Furthermore, the comparison between both conditions provides further evidence that video-reflection, as well as active learning and lesson planning (Table 3) characterise particularly powerful and effective professional development programmes (Borko et al., 2008; Desimone, 2009; Sherin & Han, 2004).

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Furthermore, this finding adds to the body of literature that conceptualises interest as a state-trait-like variable that can be developed through repeated positive interactions between person and object, as well as by the specific characteristics of the environment (Frenzel, Pekrun, Dicke, & Goetz, 2012; Sansone & Smith, 2000). The findings support those theories of interest development that propose situational interest as an antecedent of sustained individual interest and thus as a prerequisite for interest development (Hidi & Renninger, 2006; Krapp & Prenzel, 2011).

Regarding our third research question, the bivariate correlations in changed student perceptions of basic psychological need support, intrinsic learning motivation and interest in the subject, indicate that the positive differences in these variables are significantly related. The path analyses support that continuous changes in situational perceptions of autonomy and competence are predictive of students' changed perceptions of intrinsic learning motivation. Beyond that, perceptions of autonomy and competence are also indirectly predictive of students' experiences of interest in mathematics and science, as is their perception of situational intrinsic learning motivation (support for Hypothesis 3). These findings are in line with reported effects of productive classroom discourse on student motivation (Jurik et al., 2014) and research on the development of interest in the subject (Frenzel et al., 2012; Renninger & Hidi, 2011). These instances of perceived autonomy and competence can be enhanced through teaching practices that focus on productive classroom talk, or more specifically, on *student activation* and *scaffolding of student ideas* (Walshaw & Anthony, 2008). The next steps are to further examine the relation between perceived autonomy/competence and classroom talk, as well as the specific role of the teachers' support for basic need fulfilment in this context (Study 2). Furthermore, aspects of teachers' attitudes and beliefs as prerequisites for changed practice should be considered.

Study 2: Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support: findings from an intervention study (Essay 2)

11. Study 2: Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support: findings from an intervention study (Essay 2)

Study 2 of this thesis has been summarised in Essay 2 and was submitted for review and publication to the European Journal of Psychology of Education:

Kiemer, K., Gröschner, A., Kunter, M., & Seidel, T. (accepted). Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support. *European Journal of Psychology of Education*.

The essay has been accepted at the European Journal for Psychology in Education in November 2016. Conception, preparation, analysis, and presentation were done in the context of this dissertation (Katharina Kiemer 80%). The entire process was advised by all three co-authors: 5% Alexander Gröschner, 5% Mareike Kunter, and 10% Tina Seidel.

11.1. Research Questions

(1) Changes in the quality of teachers' facilitation of classroom talk due to the intervention:

- a) *To what extent does teachers' facilitation of classroom talk become more instructional and motivational in the intervention group in comparison to the control group?*
- b) *To what extent does teachers' instructional and motivational discourse change positively in the course of the intervention?*

Hypothesis 1: It was conjectured that teachers in the intervention group would show more instructional and motivational classroom talk in the course of the intervention, compared to the control group (Hypothesis 1a). Furthermore, we hypothesised that the use of instructional and motivational discourse would increase significantly in the intervention group (Hypothesis 1b).

(2) Changes in students' perceptions of autonomy support and competence support in a changing social context (intervention group):

- a) *To what extent do students' perceptions of autonomy support change during the intervention?*
- b) *To what extent do students' perceptions of competence support change during the intervention?*
- c) *To what extent are the changes in students' perceptions of autonomy and competence support predictive of their changed experiences of self-determination and furthermore changes in intrinsic learning motivation?*

Hypothesis 2: It was expected that in the intervention group students' perceptions of autonomy support change significantly positively (Hypothesis 2a) during the intervention, as well as students' perceptions of competence support (Hypothesis 2b). These positive changes would in turn predict students' experiences of self-determination and intrinsic learning motivation (Hypothesis 2c).

Study 2: Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support: findings from an intervention study (Essay 2)

(3) What is the relationship between changes in autonomy support, competence support and instructional and motivational discourse in the intervention group?

Hypothesis 3: Based on the present data set, exploratory analyses were pursued here, which do not warrant a priori hypotheses.

11.2. Theoretical Rationale

It is the aim of this study to integrate research on classroom talk and supportive social context in the sense of the Self-Processes Model (Appleton et al., 2008; Figure 5), as a common theme running through both of these areas of research is a perspective on the role of teacher as provider of guidance and scaffolding for student learning. Furthermore, this perspective entails a shift away from the teacher as authoritative figure responsible for delivering instruction and students as active agents in their learning process (Furtak & Kunter, 2012; Reeve & Tseng, 2011). The Self-Processes model provides a comprehensive framework linking the social context, the individual, their actions and educational outcomes. In our view, teacher-student interactions in classroom talk constitute a central element of the social context of classrooms (Meyer & Turner, 2002).

Research on productive classroom talk highlights the individuals' responsibility for their learning process (Michaels, O'Connor, & Resnick, 2007). In tightly-controlled classroom talk dominated by closed questions and short student answers, this responsibility is taken from students and traded for teacher-controlled learning processes (Alexander, 2008). Productive talk is open and non-coercive, as it sees teacher and students as equal partners in the learning process (Alexander, 2008; Michaels et al., 2008; Walshaw & Anthony, 2008; Wells, 2009; Wells & Arauz, 2006). Hence, the reduction of teacher control and shared responsibility for the learning process are hallmarks of productive classroom talk.

This perspective is at the heart of the Self-Determination Theory (Ryan & Stiller, 1991), in which reduction of teacher control is pivotal in promoting students' inner motivational resources and facilitate them with autonomy and competence. Students' ownership over the learning process is the conceptual link between this research and productive classroom talk (Alexander, 2005). Key here appears to be to allow for volitional functioning in students (Soenens et al., 2007), which is achieved through autonomy-supportive teacher actions. Numerous studies have shown the benefits of fostering volitional functioning, such as deep-level learning, positive affect, achievement and behavioural persistence (e.g., Buff et al., 2011). In turn, for the present study, we want to make the argument that a structured environment characterised by competence support is equally important in order for autonomy support to take full effect. Only in an environment that provides clear expectations, rights and responsibilities, as well as support mechanisms like constructive feedback, will students be willing to exercise their full (cognitive) autonomy.

Study 2: Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support: findings from an intervention study (Essay 2)

Furthermore, research has shown that the quality of teacher-student interactions plays a role in fostering desirable affective-motivational learning outcomes in students (Kaplan & Assor, 2012; Meyer & Turner, 2002; Turner et al., 2002). Turner and colleagues (2002) reported on the effects of teachers' talk on students' reported affect and achievement behaviours. In their study they differentiated between supportive instructional discourse focused on understanding and autonomy, and supportive motivational discourse focused on effort, affect and collaboration (see Section 3.1). The instructional discourse that supports students' autonomy focuses on transferring the responsibility of the learning process to students. It is characterised by the support of strategic thinking and autonomous learning and holds students accountable for understanding. Motivational discourse has a focus on learning and is achieved by challenging students, viewing errors as constructive and supporting persistence. In their research on the relationship between instructional discourse and student motivation, Meyer and Turner (2002) drew further on the concept of scaffolding for the description of instructional talk that is supportive of learning and motivation. Herein, instructional discourse becomes a form of autonomy and competence support.

With this study, we aim to connect these two strands of research by arguing that the function fulfilled by productive classroom discourse is an autonomy and competence-supportive one that produces the observed positive motivational learning outcomes in students (cf. Study 1). Turner and colleagues' (2002) differentiation of supportive discourse is derived from theoretical considerations only; their actual relationships to students' perceptions of autonomy and competence support have not been empirically scrutinised thus far. In this study, we aimed at addressing this gap by examining the connections between instructionally and motivationally supportive discourse, and students' perceptions of autonomy and competence support, as well as their experiences of self-determination and intrinsic learning motivation.

Some efforts have been undertaken to support teachers in their facilitation of basic psychological need support (e.g. Aelterman et al. 2014; Cheon and Reeve 2015; Tessier et al. 2008). However, to our knowledge, no such endeavours have so far been attempted in the context of classroom talk with the aim of providing students with more meaningful talk as a motivational scaffold. With the implementation of the Dialogic Video Cycle we addressed this second gap in research. Given the predominance of narrowly focused classroom discourse in today's classrooms, supporting teachers to change their discourse behaviour is a palpable method of classroom reform.

11.3. Method

Pre/post comparisons of teachers' facilitation of instructional and motivational discourse ($n_{IG} = 6$, $n_{CG} = 4$) were made using non-parametric analyses of variance (Brunner, Domhof, & Langer, 2004). They were accompanied by Friedman tests analysing changes in the intervention group across time. For a more fine-grained analysis of the students in the intervention group ($n = 136$), latent growth curve analyses modelling students' perceptions of autonomy and competence support (scales based on

Study 2: Instructional and motivational classroom discourse and their relationship with teacher autonomy and competence support: findings from an intervention study (Essay 2)

Kunter, 2005) across the school year were applied. In answer to Research Question 3, a path analysis was run with the intervention group student data, modelling both direct and indirect effects (see Figure 12). Finally, the relationship between changes in teachers’ talk practice and students’ perceptions of the social environment and their motivational learning outcomes were explored by running non-parametric correlational analyses and further relating each individual teacher’s practice to the perceptions of her students (for a full description of the analytic approach see Section 9.3).

11.4. Results

11.4.1. Changes in the quality of teachers’ facilitation of classroom talk due to the intervention

Descriptive statistics of instructional and motivational discourse in the control group and the intervention group show (Table 10) an increase in both instructional and motivational discourse in the intervention group, while in the control group instructional discourse decreases throughout the year and the quality of motivational discourse stays level.

Table 10. Descriptive statistics (mean values and standard deviations) for instructional and motivational discourse in the intervention and control group.

		Tpre		T2		T3		Tpost	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
IG	Instructional Discourse	1.43	0.53	1.81	0.61	1.76	0.51	1.88	0.45
	Motivational Discourse	1.26	0.78	1.42	0.59	1.68	0.59	1.82	0.46
CG	Instructional Discourse	1.21	0.68	-	-	-	-	1.02	0.59
	Motivational Discourse	0.80	0.66	-	-	-	-	0.80	0.58

Results of the non-parametric analyses of variance (Brunner et al. 2002) indicate time-related differences in instructional discourse in the two groups. Yet the interaction between time and treatment did not reach statistical significance ($F(1) = 2.92, p = .09$). The relative treatment effect (RTE) of the intervention group increased though ($RTE_{Tpre} = 0.48, RTE_{T5} = 0.73$), while during the same period of time there was a small decrease in the control group ($RTE_{Tpre} = 0.36, RTE_{T5} = 0.33$). These results can be interpreted as: the probability of a randomly chosen observation from the whole sample at Tpre resulting in a smaller score on instructional discourse than a randomly chosen observation from the intervention group is 48% (Noguchi et al. 2012). At Tpost this probability rises to 73% in the intervention group; consequently, on most occasions teachers in the intervention group outperform teachers in the control group on instructional discourse. The same analysis for motivational discourse produced a significant main effect for time ($F(1) = 4.00, p = .05$) and treatment ($F(2) = 3.93, p = .05$). Furthermore the interaction between time and treatment was significant ($F(1)=5.98, p = .01$). Similarly to instructional discourse, the relative treatment effect on motivational discourse increased in the intervention group ($RTE_{Tpre} = 0.50, RTE_{T5} = 0.75$), while it decreased slightly in the control group ($RTE_{Tpre} = 0.33, RTE_{T5} = 0.31$). In terms of effect sizes (using pooled

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standard deviations) results show $d = 1.04$ for the group comparison of instructional discourse between pre- and post-test and $d = 0.73$ for motivational discourse (Morris 2008).

Further analysis revealed that the significant differences found in the group comparisons come down to differential developments in the groups (increase in the IG, decrease in the CG) and not to significant positive changes in the intervention group. Friedman tests revealed no significant positive changes across the school year in the intervention group. This holds true both for instructional discourse ($F(1) = 7.19, p = .07$), as well as motivational discourse ($F(1) = 7.37, p = .06$). In light of the small sample significant differences are difficult to establish. Post-hoc comparisons (Wilcoxon tests) analysing only pre/post differences resulted in significant positive changes for instructional discourse ($z = -2.21, p = .03$), yet not for motivational discourse ($z = -1.73, n.s.$). Effect sizes for these comparisons were $r = .90$ for instructional discourse and $r = .23$ for motivational discourse, documenting medium to large effects (Cohen, 1992) and underscoring the interpretation that non-significant results may be due to the small sample.

11.4.2. Changes in students' perceptions of autonomy support and competence support in a changing social context (IG)

Descriptive statistics of students' perceptions of autonomy support and competence support (Table 11) show overall that students perceive autonomy support provided by the teacher as rather high (theoretical maximum of the scale is 3). The same is suggested for perceptions of competence support. Inspection of the mean values shows an increase on the scales from Tpre to T2, followed by a decrease (T2 to T3) and a levelling out at Tpost.

Table 11. Descriptive statistics (mean values and standard deviations) for students' perceptions of autonomy support and competence support across the school year (Tpre, T2, T3, Tpost).

	Tpre		T2		T3		Tpost	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Autonomy support	2.19	0.66	2.36	0.64	2.16	0.68	2.16	0.72
Competence support	1.99	0.49	2.15	0.53	1.98	0.56	2.03	0.59

Overall, the latent growth curve models show adequate fit (values greater than .90 for the CFI and TLI are considered adequate fit to the data, whereas it is values smaller than .08 for the RMSEA; Morin, Arens, & Marsh, 2016), especially given that the sample size is small for such analyses and fit indices are sensitive to small samples (Wu, West, & Taylor, 2009). Yet, limitations are in place when it comes to the RMSEA of competence support ($RMSEA_{\text{competence support}} = .10$), leading us to interpret the results carefully and tentatively (cf. Table 12).

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Table 12. Fit indices (RMSEA, CFI, TLI, SRMR) for latent growth curve models modelling students' perceptions of autonomy-support and competence-support across the school year (Tpre, T2, T3, Tpost).

	<i>RMSEA</i>	<i>CFI</i>	<i>TLI</i>	<i>SRMR</i>
Autonomy-support	< .05	>.95	>.95	.05
Competence-support	.10	.92	.91	.13

Note: Time scores1 were fixed to 0, time scores2 were fixed to 1, time scores3 and 4 were estimated freely; slope was fixed to 0; class was used as covariate.

A summary of the results of the latent growth curve models for autonomy support and competence support across 4 measurement points is given in Table 13. Overall, the mean values of the latent intercepts of both variables were significant, indicating significant differences from zero for the latent estimates of autonomy support and competence support at Tpre. Also, the latent intercepts of both variables vary significantly across students; they perceive autonomy support and competence support significantly different. The mean latent slopes indicate that small, yet significant positive changes occurred regarding students' perception of autonomy support and competence support across the school year. Variations between students in the slope factor could not be estimated as the slope was fixed, leading to zero variation ($Var_{slope} = 0$). In the case of autonomy support the latent growth factors (intercept and slope) explained between 33% and 40% of the variance in perceived autonomy support between students ($R^2 = .33-.40, p < .01$). For competence support it was between 42% and 54% ($R^2 = .42-.54, p < .01$). These results need to be reflected in light of the sample and resulting model fit; we see them as positive and encouraging, yet also only as tentative first support on the relationship between changes in students' social context and changes in their experience of autonomy and competence support.

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Table 13. Summary of the latent growth curve analyses for students' perceptions of autonomy support and competence support across the school year (Tpre, T2, T3, Tpost).

	Autonomy support	Competence support
<i>Time score</i>		
Tpre ¹	0	0
T2 ²	1	1
T3	0	0
Tpost	1	1
<i>M</i>		
Intercept	2.16** (0.05)	1.97** (0.04)
Slope	0.11** (0.05)	0.12** (0.04)
<i>Var</i>		
Intercept	0.16** (0.04)	0.14** (0.02)
Slope ³	0	0
<i>R²</i>		
Tpre	0.36** (.07)	0.54** (.05)
T2	0.39** (.08)	0.43** (.06)
T3	0.35** (.07)	0.50** (.07)
Tpost	0.32** (.08)	0.41** (.06)

Note: **p < .01, *p < .05; Standard errors given in brackets; ¹time scores 1 and 3 were fixed to 0; ²time scores 2 and 4 were fixed to 1; ³slope variance was fixed to 0

In looking more closely into possible processes involved results of path analyses are reported. In preparation of those path analyses correlational patterns were examined. Those correlations show the mean pre/post difference scores (Δ -scores) in the intervention group to be positive, yet rather small for all variables with the exception of perceived self-determination: $\Delta_{\text{autonomy support}} = 0.001$ ($SD = 0.66$), $\Delta_{\text{competence support}} = 0.07$ ($SD = 0.35$), $\Delta_{\text{self-determination}} = 0.23$ ($SD = 0.50$), $\Delta_{\text{intrinsic motivation}} = 0.07$ ($SD = 0.65$). The standard deviations here are somewhat larger than for the individual measurement points (see Tables 6 and 11). Furthermore, we found a significant positive relationship between $\Delta_{\text{autonomy support}}$ and $\Delta_{\text{self-determination}}$ ($r = .44, p < .01$), $\Delta_{\text{competence support}}$ ($r = .50, p < .01$) and $\Delta_{\text{intrinsic motivation}}$ ($r = .47, p < .01$). Also the correlations between $\Delta_{\text{competence support}}$ and $\Delta_{\text{self-determination}}$ ($r = .41, p < .01$), as well as $\Delta_{\text{intrinsic motivation}}$ ($r = .38, p < .01$) were significantly positive.

These findings are supported by the path analysis (Figure 12), in which the relationship between students' perceived autonomy and competence support and students' experience of self-determination and intrinsic learning motivation is modelled. Overall, the model had good fit (RMSEA = .06, CFI = .96, TLI = .96; Morin et al., 2016). The results tentatively indicate that the changed perceptions of

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autonomy support and competence support serve as positive predictors for changed experiences of self-determination and indirectly intrinsic learning motivation from pre- to post-test. Through these predictors 25% of the variance of changes in experienced self-determination ($R^2 = .25, p < .01$) and 13% of the variance of intrinsic motivation changes ($R^2 = .13, p < .05$) were explained.

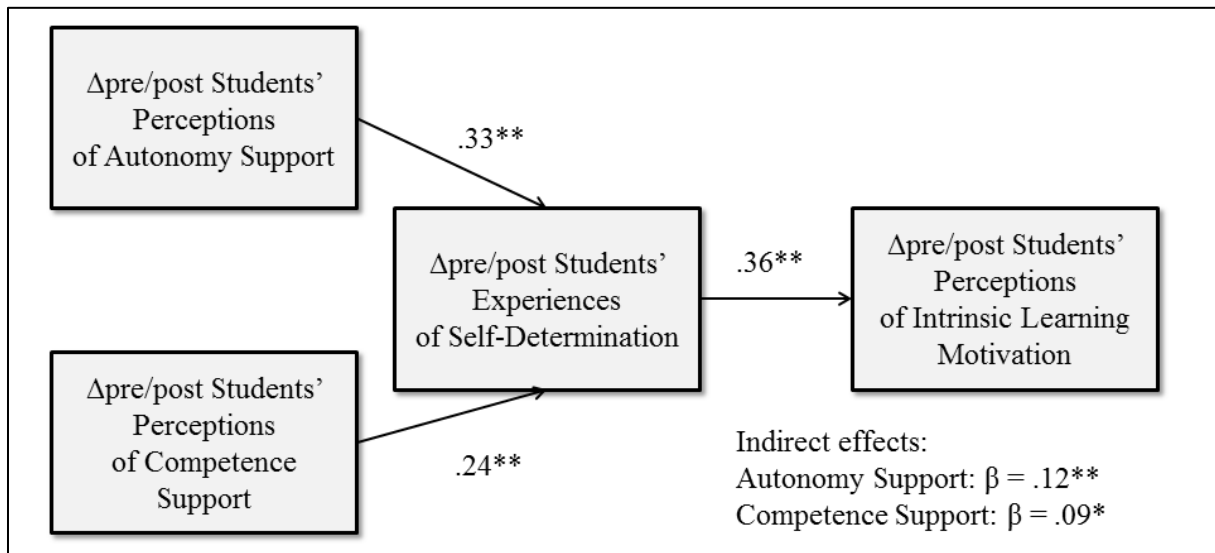


Figure 12. Path analysis of pre/post difference scores (Δ -scores) for autonomy support, competence support, self-determination and intrinsic learning motivation with direct and indirect effects.

11.4.3. Relationship between autonomy support, competence support and instructional and motivational discourse

Analysis of the aggregated Δ -scores shows a heterogeneous pattern of relationships (Table 14). Contrary to our hypothetical considerations, no significant positive relationship between instructional discourse and competence support on the one hand and motivational discourse and autonomy support on the other hand could be established. However, motivational discourse did show a relationship with competence support ($p < .1$) and experienced self-determination ($p < .05$). Both forms of talk also correlated with intrinsic learning motivation ($p < .1$). Correlations are medium to large in size (Cohen, 1992), yet do not continuously reach the typically used 95%- significance level, which potentially has to do with the limitations in sample size in the present study. Yet, results show a strong relationship between competence support and experiences of self-determination ($p < .01$), as predicted by Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000).

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Table 14. Non-parametric correlations of aggregated pre/post difference scores (Δ -scores) for instructional discourse, motivational discourse, autonomy support, competence support, self-determination and intrinsic motivation.

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Δ instructional discourse	-	.66	-.12	.38	.29	.75 ⁺
(2) Δ motivational discourse		-	-.03	.75 ⁺	.81*	.75 ⁺
(3) Δ autonomy support			-	.60	.37	.20
(4) Δ competence support				-	.94**	.66
(5) Δ self-determination					-	.60
(6) Δ intrinsic motivation						-

Note: ⁺p < .1, *p < .05, **p < .01

Looking at the individual classrooms, no clear pattern between the changes in teachers' classroom talk (both instructional and motivational) and changes in students' perceptions of autonomy support, competence support, self-determination and intrinsic learning motivation emerge (Table 15). It appears like students differed in how they saw and interpreted the changes to their social context in the form of more supportive classroom talk. Students of Teacher 2 seem to very much appreciate the redefinition of social context for their engagement. In contrast, similar changes in the classroom of Teacher 6 had a very different effect on his students. A further point of interest is the case of Teacher 3, whose students experienced less autonomy support despite more supportive instructional and motivational discourse, but more competence support at the same time. Furthermore, the results from Teacher 1 run counter to our theoretical perspective where motivational discourse fosters autonomy support, while instructional discourse fosters competence support. I gather from these findings that the interpretation of supportive classroom talk is interpreted differently in each classroom and might be dependent on prior experiences (prior teaching style), content, lesson sequencing (introductory lesson vs. repetition for a test) or students' different causality orientations.

Table 16 presents the data longitudinally across the four measurement points for each teacher. It shows that if split at the theoretical mean of the scale ($M_{theoretical} = 1.5$), there were some classrooms at Tpre that show accord between classroom talk and students' perceptions of autonomy support and competence support (Teacher 1, Teacher 2 and Teacher 5). Others (Teacher 3, Teacher 4 and Teacher 6) show rather non-supportive classroom talk ($M < 1.5$), while at the same time their students perceive them as rather supportive ($M > 1.5$). It is particularly these classrooms where students appear not to appreciate the changes in teachers' classroom talk (Table 15). Nonetheless, the developments in these classes are not homogeneous or linear. Across all classrooms T2 is perceived as being the most supportive from students. Overall, these results support – at least in part – our hypotheses. However, the question arises why student perceptions did not change more consistently, especially in the face of changed teacher practice as tentatively supported by the results of Research Question 1.

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Table 15. Mean values and rank order of the pre/post changes (Δ -scores) in individual teacher's classrooms for instructional discourse, motivational discourse, autonomy support, competence support, self-determination and intrinsic learning motivation.

	Δ instructional discourse		Δ motivational discourse		Δ autonomy support		Δ competence support		Δ self-determination		Δ intrinsic motivation	
	<i>M</i>	<i>Rank</i>	<i>M</i>	<i>Rank</i>	<i>M</i>	<i>Rank</i>	<i>M</i>	<i>Rank</i>	<i>M</i>	<i>Rank</i>	<i>M</i>	<i>Rank</i>
Teacher1	0.20	4	-0.50	4	0.10	3	-0.13	4	0.13	5	-0.02	4
Teacher2	0.75	1	1.14	2	0.40	1	0.23	1	0.33	2	0.38	1
Teacher3	0.55	2	1.21	1	-0.24	5	0.20	2	0.37	1	0.16	2
Teacher4	0.10	5	0.50	3	0.14	2	0.09	3	0.30	3	-0.14	6
Teacher5	0.50	3	0.50	3	0.08	4	0.09	3	0.29	4	0.12	3
Teacher6	0.55	2	0.50	3	-0.56	6	-0.15	5	-0.25	6	-0.07	5

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Table 16. Mean values of instructional discourse, motivational discourse, autonomy support and competence support across four measurement points (Tpre, T2, T3, Tpost) for all teachers individually.

	Tpre	T2	T3	Tpost
Teacher 1				
Instructional discourse	2.20	2.40	2.30	2.40
Motivational discourse	2.57	2.21	2.64	2.07
Autonomy support	2.33	2.46	2.37	2.45
Competence support	2.22	2.15	2.22	2.10
Teacher 2				
Instructional discourse	0.80	1.80	1.40	1.55
Motivational discourse	0.57	1.00	1.36	1.71
Autonomy support	1.44	2.16	1.82	1.78
Competence support	1.48	1.96	1.55	1.62
Teacher 3				
Instructional discourse	1.00	1.75	1.40	1.55
Motivational discourse	1.00	1.86	2.00	2.21
Autonomy support	2.42	2.44	2.36	2.15
Competence support	2.03	2.24	2.18	2.17
Teacher 4				
Instructional discourse	1.30	1.10	1.20	1.40
Motivational discourse	0.50	0.71	0.93	1.00
Autonomy support	2.08	2.46	2.26	2.14
Competence support	1.98	2.18	2.03	2.06
Teacher 5				
Instructional discourse	1.90	2.60	2.40	2.40
Motivational discourse	1.71	1.71	1.64	2.21
Autonomy support	2.44	2.67	2.09	2.39
Competence support	2.17	2.47	1.84	2.13
Teacher 6				
Instructional discourse	1.40	1.20	1.85	1.95
Motivational discourse	1.21	1.00	1.50	1.71
Autonomy support	2.38	1.89	1.83	2.04
Competence support	2.05	1.84	1.98	1.99

11.5. Discussion

The present study aimed to integrate two research perspectives based on the common perspective on the role of the learner as responsible for and autonomous in the learning process, including a shift away from the teacher as the only one responsible for delivering instruction and toward teachers as providers of guidance and scaffolding for student learning (Furtak & Kunter, 2012; Turner et al., 2002). In order to do so we examined the effects of the Dialogic Video Cycle on teachers' instructional and motivational discourse, their students' perceptions of autonomy and competence support during the same period of time, and implications for intrinsic learning motivation. The study finished by exploring possible links between the changed teacher practices and students' perceptions. In the following findings are discussed and connected to prior research. Both the implications for future research and practice are discussed.

Our analysis of the coded video material on teachers' changes of talk practices from pre-test (Tpre) and post-test (Tpost) of the study indicate systematic group differences in instructional and motivational discourse between the intervention and the control group. While the intervention group developed positively on these measures, the quality of instructional and motivational discourse in the control group decreased (support for hypothesis 1). These different trajectories in the groups led to large effects (Cohen, 1992) in the pre-/post-test group comparisons in favour of the Dialogic Video Cycle. With a likelihood of more than 70% the intervention group showed more supportive instructional and motivational discourse at Tpost, than did the full sample (Noguchi et al., 2012). So, despite attending on average 22 hours of teacher professional development that year in the control group, teachers' instructional quality (i.e. facilitation of productive classroom talk) decreased throughout the school year. Yet, while we found differential developments between the two groups, positive linear developments in the intervention group across all four measurement points were not large, indicating that teachers' implementations of talk practices were not straightforward but showed individual patterns. However, against the background that classroom talk is a very routine and hard-to-change practice (Alexander, 2005; Morton, 2012) and that even if learning took place in teacher professional development, the implementation of new practices into the classroom remains challenging for teachers (Buczynski & Hansen, 2010) the Dialogic Video Cycle appears to be a scaffold (Wood, Bruner, & Ross, 1976) that helps teachers to improve their productive classroom talk in practice. This is likely explained by the careful design of the Dialogic Video Cycle in accordance with state-of-the-art research on effective professional development and its inclusion of aspects that in other programmes often remain overlooked (such as reflection of practice and transfer). Therein could also lay the explanation as to why 22 hours of traditional teacher professional development was insufficient to produce positive changes in teaching practice in the control group.

Research into professional development has shown that the transfer of new knowledge into teachers' classrooms is an individual process affected by various cognitive and motivational–affective

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aspects, as well as situated and organisational frameworks (Clarke & Hollingsworth, 2002). Our findings – like many others in teacher professional development research – demonstrate that prolonged interventions and continuous reflection are necessary for teachers to change their practice and make these changes sustainable (Desimone, 2009; Furtak et al., 2016; Hetzner et al., 2012; Santangata, 2009; Zhang et al., 2011), even if on the way towards those goals teachers might show their individual learning paths. Our findings lend further support to Vesico and colleagues (2008) that it is carefully designed teacher professional development programmes, which are based on research on teacher professional development (e.g., Desimone, 2009; van Veen et al., 2012; Wilson, 2013) that produce favourable outcomes in teachers' practice and student learning. Given that in Germany teachers mostly visit single-day workshops in teacher professional development (Richter et al., 2011) it is necessary for research and teacher education to find ways of continuous support of teacher learning.

The mechanisms between teacher beliefs and their changing practice are still contested (e.g., Guskey, 1986; Pajares, 1992). Yet, Turner and colleagues (2009) stress the importance of belief change during professional development for sustained changes in practice to take place (also Reeve et al., 2014). They go on to argue that external factors (like the dilemmas teachers face; Windshittl, 2002) hamper with this change and when under pressure teachers fall back into their old routines. Similarly, research into prerequisites of teacher autonomy/competence support provide evidence that organisational and structural aspects in the form of experienced pressures (Reeve, 2009) as well as individual differences in personality dispositions (Leroy, Bressoux, Sarrazin, & Trouilloud 2007) affect their adoption of an autonomy/competence supportive teaching style. Moreover, it could be shown that teachers' causality orientations (Su & Reeve, 2011), as well as their beliefs (Reeve & Cheon, 2016; Reeve et al., 2013) play an important role as to how readily they incorporate new autonomy supportive practices into their teaching. As such individual differences were not considered within the scope of the present study, but affect teachers' learning and the implementation of new teaching activities, we strongly encourage including them in future research.

Descriptive statistics from the student questionnaire data show initial increases in students' perceptions of autonomy support and competence support (T2), followed by a return to the baseline level. For both trajectories positive developments during the school year were found. Overall, these results support – at least in part – our hypotheses. Yet, the question arises why student perceptions did not change more consistently, especially in face of changed teacher practice as tentatively supported by the results of Research Question 1. Looking at the teacher data one possible explanation might be that the most substantial change in teachers' facilitation of instructional discourse occurred at T2 as well. Possibly all further improvements were not pronounced enough for the students to increase their perceptions of autonomy and competence support. A comparison of the developments of students' perceptions of autonomy and competence support might shed more light onto this question. Since the

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present study design does not afford such comparisons, future analysis should revise the design accordingly.

Along the same lines, prior research found that the interpretation of classroom events by well-informed researchers can be quite different to the interpretation of the same events by students (Urduan, 2004); similar findings have been reported regarding the agreement between teachers and students (Lenski, Richter, & Pant, 2015). It is therefore possible that the changes the research team observed in teachers' talk were not experienced as empowering by students (Furtak & Kunter, 2012). Furthermore, it could be argued that a socialisation process into this new classroom culture occurred over the course of the school year. At T2 the new practices and talk teachers used were novel to the students and thus find expression in students' changed perceptions of support. The longer the study ran, the more students aligned their script of 'doing school' (Jimenez-Aleixandre et al., 2000; Pope, 2003) and consequently adjusted their threshold for increased autonomy and competence support. In future research, with larger samples, compositional effects reflecting the class perceptions of autonomy and competence support ought to be considered. This information would greatly help to understand how the climate of the class changed – not only the aggregate individual perceptions.

Also, this study focused on productive classroom discourse and documents positive results in this respect. It is not improbable that while becoming more supportive in this area, teachers became more controlling in other areas of support, such as communicating value and providing rationales or accepting students' expression of negative affect (Reeve, 2006). To account for this possibility, future research ought to consider all forms of autonomy and competence support and control for them in the analyses. With regard to this possibility, it is worth noting that Behrmann and Souvignier (2015) were able to demonstrate effects of fit or misfit between teachers' instructional beliefs and the teaching practices they use for student achievement. Consequently, in this study, students whose teachers had beliefs (transmission vs. constructivist) that did not align with the teaching practice they engaged in during the intervention may not have perceived the learning environment as supportive. Including teacher beliefs in future research may therefore not only shed light on a further level of effective teacher learning during the intervention (Guseky, 2002; Lipowsky and Rzejak, 2015), but also help to understand the present findings in more detail.

Aptitude-treatment interactions between students' motivational orientation (intrinsic vs. extrinsic) and their perception of supportive learning environments have been reported as well. Even after controlling for students' academic self-concept, extrinsically motivated students reported more negative affect than intrinsically motivated students under autonomy-supportive conditions; for directive support, the reverse trend was discovered (Knollmann and Wild, 2007). Possibly due to their prior experiences in rather narrowly focused, controlled learning environments, students tend to hold extrinsic causality orientations and thus experience more supportive environments as more aversive than more controlling ones. Students might also perceive supportive discourse as less structured than their

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custom teacher-student interactions. However, structure is important in order for students to experience their learning environment positively (Sierens et al., 2009). Jungwirth (1993) documented that routines and rules can fulfil positive functions in the interaction process during instruction, as well as having negative effects on learning outcomes. Struyven and Dochy (2008) also found great variation in students' likes and dislikes for more activating and less controlled learning environments. While lecture-style learning environments were commonly perceived as positive, extreme opinions (both negative and positive) prevailed for activating learning environments.

Similar to the pre/post-differences for autonomy support and competence support changes of students' experiences of self-determination and intrinsic learning motivation were on average not large in the intervention group. Yet, these changes showed significant positive relationships among each other. In line with our hypothesis and prior research (e.g., Hospel & Galand, 2016; Jang et al., 2010; Sierens et al., 2009; Vansteenkiste et al., 2012) the changes in autonomy and competence support (structure) were predictive of changes in students' experiences of self-determination, which in turn predicted changes in intrinsic learning motivation positively. Furthermore, autonomy and competence support had indirect effects on intrinsic learning motivation via experienced self-determination. Consequently, the support students perceived during classroom discussions fostered their learning motivation. These results underscore both the research on Self-Determination Theory (Ryan & Deci, 2002), as well as student engagement (Schindler et al., 2015; Pehmer et al., 2015b). Herein we can find further explanations of the positive effects of productive classroom talk, not only based on social constructivism (Mercer, 2010; Mercer & Howe, 2012; Mercer & Dawes, 2014; Wegerif, 2008; Wegerif, Mercer, & Dawes, 1999) but also based on motivational considerations.

From the reading of the relevant literature (Turner et al., 2002, Turner et al., 2003; Meyer et al., 2002), it is not explicit how instructional and motivational discourse ought to affect perceptions of autonomy and competence. Given the two definitions: '[s]caffolding instructional discourse [...] is reflected both in teachers' attempts to build understanding with their students and to help them attain higher levels of competence', while the 'motivational component would include such discourse practices as recruiting the students' interest, maintaining students' persistence, minimizing frustration and risk, or enhancing students' confidence' (Turner et al., 2002, pp. 90), it could be assumed that instructional discourse functions as a means for competence and autonomy support. Our exploratory analyses warrant only limited support for such relationships. Possibly, this might in part come down to methodological issues. The way autonomy is framed in the conceptualisation of Turner and colleagues (2002) it refers to what Stefanou and colleagues (2004) call cognitive autonomy – encouraging student ownership of the learning process. Our questionnaire items, though, are a mix of questions relating to cognitive autonomy ('*The teacher encouraged us to reflect on how to approach the task best.*') and procedural autonomy ('*The teacher gave us enough time to work independently.*'). Consequently, measurement artefacts and imprecisions may have concealed possible relationships. Also restrictions

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in sample size are likely to play a role here, as the correlation values are medium to large (Cohen, 1992), and yet do not reach statistical significance. However, our results support research by Turner and colleagues that instructional discourse supports students both cognitively and motivationally, as well as their finding that a combination of both forms of talk promotes the best motivational learning outcomes in students. Furthermore, despite the strong focus on competence and autonomy within instructional discourse, these basic needs also seem to be addressed through motivational discourse. Future studies, with larger samples, should further inquire into these relationships more closely. With reference to the Self-Determination Theory framework, results of Study 2 stress the strong connection between competence support and students' experiences of self-determination. In further analyses it would be worthwhile to research if this strong relationship only holds in contexts which are at the same time autonomy-supportive as suggested by Soenens and colleagues (Soenens et al., 2007).

Our exploratory analysis of individual classrooms produced interesting findings warranting further analysis. That apparently those students who came from classrooms characterised by little support of basic needs at Tpre did not appreciate changes in classroom talk to the same extent as students from more supportive classrooms calls for the need to include such climate variables in future studies in order to be able to investigate differential developments dependant on class prerequisites (Marsh, Lüdtke, Nagengast, Trautwein, Morin, et al., 2012).

12. Summary and Discussion of Central Results

Within the scope of this dissertation it was aimed to examine the extent to which teachers' participation in a newly developed professional development programme – the Dialogic Video Cycle – would improve the dominant teaching script in German mathematics and science classrooms – namely the facilitation of a narrowly-focused questioning-developing classroom talk (Kobarg & Seidel, 2007; Seidel, 2003a). To this end, teaching activities during classroom talk of participating teachers were compared to those of a control group in the course of one school year. As research on professional development (e.g., Cordingley, Bell, & Thomason, 2003; Fishman, Marx, Best, & Tal, 2003; Kwakman, 2003; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Timperley, Wilson, Barrer, & Fung, 2007; Desimone, 2009; van Veen, Zwart, & Meirink, 2012; Wilson, 2013) and particularly professional development on classroom talk (e.g., Davies & Meissel, 2016; Chinn et al., 2001; Lefstein & Snell, 2014; Michaels & O'Connor, 2015; Ruthven et al., 2016; Sedova et al., 2016; Van der Veen et al., 2016) shows, careful design and strong learning support during teacher learning are necessary prerequisites for successful practice change. Furthermore, teachers need to be enabled to witness the effects their actions have on students (Guskey, 2002; Hattie, 2012). Programmes in which teachers received feedback concentrated directly on the process of their teaching in class (Chinn et al., 2001; Sedova et al., 2016; Snell & Lefstein, 2011) led to a considerable change. In contrast, programmes in which the analysis of video recordings did not serve as a basis for feedback to teachers on their teaching method (Osborne et al., 2013; Pimentel & McNeill, 2013; Ruthven et al., 2016) did not result in substantial change. On this basis, the Dialogic Video Cycle was designed based on state-of-the-art research on teacher learning (e.g., Ball & Cohen, 1999; Clarke & Hollingsworth, 2002; Darling-Hammond, 2005) and effective components of professional development (e.g., Desimone, 2009; van Veen et al., 2012; Wilson, 2013) and implemented with a sample of six teachers in a year-long professional development programme in the school year 2011/2012. Feedback on teaching activities and student learning outcomes was most directly provided in the form of video reflections on teachers' classroom practice.

As Lipowsky (2010) points out, the effectiveness of professional development programmes can be determined on different levels. In this dissertation, the effectiveness of the Dialogic Video Cycle was examined on two of these: the level of change to teaching actions (teacher questions, feedback, instructional discourse, motivational discourse), and the level of change to student learning processes (perceptions of teacher support) and learning outcomes (basic psychological need fulfilment, intrinsic learning motivation, interest in the subject). In doing so, the work connected research on effective teacher professional development, productive classroom talk and social contexts that provide constructive learning support (Klieme et al., 2001; Prenzel et al., 2002) in the form of autonomy and competence supportive instruction (Prenzel et al., 2002).

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While research on the cognitive effects of productive classroom talk is increasing (e.g., Alexander, 2005, 2008; Applebee, Langer, Nystrand, & Gamoran, 2003; Bennett, Hogarth, Lubben, Campbell, & Robinson, 2010; Chi & Meneske, 2015; Chi & Wylie, 2014; Davies & Meissel, 2016; Furtak et al., 2016; Howe & Abedin, 2013; Kluger & DeNisi, 1996; Lipowsky et al., 2007; Mercer, Wegerif, & Dawes, 1999; Pehmer, 2015; Sodova et al., 2016; Scott & Mortimer, 2003; Ruthven et al., 2016; van der Veen et al., 2016), studies focusing on motivational outcomes are still rare (e.g., Andersen & Nielsen, 2011; Chen, Thompson, Kromrey, & Chang, 2011; Turner et al., 2002). In view of the great importance of learning motivation for achievement (Hattie, 2008) and life-long learning (Bolhuis, 2003), this research endeavour delves into the motivational benefits of a widely spread teaching script and its potential for productive change through teacher professional development. To this end a framework for the research was developed based on Utilisation-of-Learning-Opportunities models (Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014) outlining the relationships between indicators of productive classroom talk (such as open questions, constructive feedback, and instructionally and motivationally supportive discourse) as high-quality teaching activities, students' perception of autonomy and competence support, as well as basic psychological need fulfilment as utilisations of these learning opportunities, as well as intrinsic learning motivation and interest in the subject as student learning outcomes (Figure 6).

Within the two studies that make up this dissertation, different aspects of the framework were examined. Study 1 particularly focused on the relationship between indicators of productive classroom talk (learning opportunities) and the long-term motivational learning outcome of interest in the subject. Furthermore, processes by which this relationship comes to pass were reviewed in the form of basic psychological need fulfilment and intrinsic learning motivation. After establishing such general relationships, Study 2 focused in more detail on the utilisation of the learning opportunities provided during productive classroom talk. Particularly aspects of constructive learning support in the form of autonomy and competence support were researched. Two overarching questions guided the present dissertation and were pursued in the two studies presented above. These guiding questions were:

- *In the course of one school year, to what extent do teachers in the Dialogic Video Cycle change their classroom talk positively, when compared to a control group?*
- *To what extent are motivational student outcomes (interest in the subject, intrinsic learning motivation, and basic psychological need fulfilment) affected by teachers' changed classroom talk practice?*

In the next sections, the findings for the respective research questions are discussed in Sections 12.1 and 12.2 respectively. Following, I want to close by reflecting on the methodology applied for this project (Section 12.4), providing ideas for future research (Section 13.6) and drawing attention to the implications of the studies' results for the field (Section 1.1).

12.1. Changes to Teachers' Facilitation of Classroom Talk

Productive classroom talk is advocated from a variety of different perspectives, such as socio-culturalism, formative assessment and to some extent motivation research (see Section 3.1 and 3.2) and its benefits have been reported repeatedly. Nonetheless, while teachers appear to be in principle inclined towards productive classroom talk and declare a desire to teach in this way, they often fail to do so (Sedova, Salamounova, & Svaricek, 2014). After more than two decades of research, instead of engaging students in a productive classroom talk, many teachers continue to control both the content and the form of classroom communication and thus keep up a teaching script of tightly-focused, questioning-developing teaching (Alexander, 2005, 2008; Applebee, Langer, Nystrand, & Gamoran, 2003; Roth et al., 2006; Seidel, 2003a; Stigler et al., 1999; Stigler & Hiebert, 1999). Resnitskaya and Gregory (2013) argue that productive classroom talk is difficult for teachers to implement; this is due to the fact that teachers are not able to transform abstract theoretical principles into specific classroom practices that reflect productive classroom talk. In line with Ball and Cohen (1999), Resnitskaya and Gregory (2013) maintain that teacher education and development should focus on helping practitioners to develop coherent instructional frameworks that integrate theoretical and practical knowledge. In light of the results regarding teachers' practice the Dialogic Video Cycle appears to do just that. The two studies reported here support the argument that well-designed teacher professional development programmes, which provide teachers with opportunities for reflection on their own practice, and guide and support them in the learning process are successful approaches to classroom reform and scaling of productive classroom talk (Chinn et al., 2001; Sedova et al., 2016; Snell & Lefstein, 2011; Resnick, Asterhan, & Clarke, 2015). It has to be seen as a particular strength of this research that the results were obtained in a two-group, quasi-experimental design, as such rigorous designs are still lacking in much of the cited literature. The provision of feedback on teachers' (new) teaching activities appears as a crucial factor in such professional development (Hattie, 2012; Timperely et al., 2007). Video observations and feedback have been promising in this regard (Borko et al., 2010).

Working with teachers on classroom talk, which is a very routine teaching script (Alexander, 2005; Morton, 2012) is challenging because new teaching practices need to overcome old patterns. As Alexander (2005) points out: 'This script is remarkably resistant to efforts to transform it' (p. 2). Results of the studies presented here indicate that changes to practice are more readily accepted for feedback than for teachers' questioning style (cf. van den Bergh, Ros, & Beijaard, 2013a, 2013b). This resonates with prior research which has shown questioning to be more of a routine practice (Oliveira, 2010) and also one that allows the teacher to control classroom events, while feedback is reactive in nature and does not run the risk of unforeseen directions during the learning process (Pehmer, 2015). Furthermore, teachers sometimes struggle with asking open questions because they require different situated interactions with students, whereas feedback is more of an instructional matter (Mercer, 2010). Research into classroom talk (Kachur & Prendergast, 1997) and teaching scripts (Dalehefte, 2007) concluded that similar teaching strategies can be used in more or less productive forms.

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Consequently, no change in the number of teacher questions in the intervention group, does not necessarily represent a less productive teaching script; it could well lead to continued dialogic spells (Nystrand et al., 2003) if the initial question is sufficiently high in quality (Davies & Meissel, 2016). In keeping with the findings from Study 1 – stagnation in open questions in the intervention group, paired with decreasing occurrence of open questions in the control group – Pehmer and colleagues (2015) found less student elaboration during classroom talk in the control group than in the intervention group. This goes to show that despite anticipated positive developments not occurring, classroom talk in the intervention group remained more productive than in the control group in the course of the school year. As Mehan (1978), as well as Ruiz-Primo and Furtak (2006, 2007), pointed out successful interaction sequences consist of multiple, incomplete IRF cycles (or ESRU cycles in the nomenclature of Ruiz-Primo & Furtak) before arriving at a new teacher initiation (e.g., question) move. In order to understand the ways in which the limited number of open teacher questions might still have affected students' talk behaviour positive sequential analyses of the orchestration of talk turns and their quality are needed, relating the number and quality of student responses to the quality of initial teacher questions.

As Pehmer and colleagues (2015) have shown losing control over classroom events is still a big fear of Dialogic Video Cycle participants and an obstacle to practice changes. Given this fear of teachers, it is all the more encouraging that the Dialogic Video Cycle participation nudged them to increasingly share responsibility for the learning process with their students as evidenced by higher levels of supportive instructional discourse. This reduction of teacher control is one step towards a student-centred, autonomy supportive instructional style (Jang et al., 2010). The finding is furthermore encouraging as Reznitskaya and Gregory (2013) showed that even in classrooms with teachers embracing a constructivist approach to classroom talk feedback can be superficial, while student responses are not taken up, tested and used to move student thinking forward. Alexander described this practice of 'pseudo-enquiry' as engaging in 'an endless sequence of ostensibly open questions which stem from a desire to avoid didacticism, are unfocused and unchallenging, and are coupled with a habitual and eventually phatic praise rather than meaningful feedback' (Alexander, 2005, p. 3). Clearly, participating teachers did not fall prey to this trap; yet, at this point the question needs to remain open whether the opposite behaviour (unchanged amounts of meaningful, open questions and increased constructive feedback) is more productive. However, in view of the literature stressing the incredible importance of constructive teacher feedback for student learning outcomes (e.g., Chen et al., 2011; Chin, 2006; Harks et al., 2014; Hattie & Timperley, 2007; Hattie, 2008, 2012; Harackiewicz & Larson, 1986; Kluger & DeNisi, 1996; Lu & Law, 2012; Vallerande, 1983; van den Bergh et al., 2013b; Voerman et al., 2012), I see strong support for the argument that such change in teachers' practice is more productive than 'pseudo-enquiry'. Consequently, I maintain that the Dialogic Video Cycle facilitated teachers' learning of a more productive teaching script high in feedback and support.

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Regarding the effectiveness of the Dialogic Video Cycle, it needs to be noted that the improvements to practice in the Dialogic Video Cycle group were generally only statistically significant when comparing them to the control group; they did not reach statistical significance in the longitudinal analyses performed. The exception here is the use of constructive feedback in the intervention group. This indicator of a productive classroom talk increased significantly not only when comparing the developments with the control group, but also in the post-hoc tests within the intervention group. So in training teachers to use more constructive feedback the Dialogic Video Cycle was particularly successful. Overall, intervention group teachers' practice remained effective throughout the school year with the support of the Dialogic Video Cycle, while the instructional quality of the control group deteriorated. Considering the sample size of these studies, as well as the effect sizes, I feel confident in assuming that in future research with larger samples significant improvements to teacher practice within the intervention group can be found. In studies on training and professional development the reported effect sizes are usually small (e.g., Aelterman et al., 2015; Aelterman, Vansteenkiste, Van den Berghe, De Meyer, & Haerens, 2014); while in the studies reported here medium to large effects were found, underscoring the potential of the Dialogic Video Cycle for teacher learning and the implementation of reform practice. However, the finding also raises awareness that teachers seem to need support during the school year to maintain their teaching quality. Being able to support teachers in the facilitation of productive classroom talk has at least threefold importance: (1) it carries the possibility to make teaching and education more effective with regard to many different positive learning outcomes (Howe & Abedin, 2013; Mercer & Wegerif, 2004), (2) it can make student learning visible and can provide teachers with feedback on their performance (Furtak et al., 2016) (something rare in the teaching profession), and (3) it holds opportunities in terms of equity and access to educational opportunities for students (Wegerif, Postlethwaite, Skinner, Mansour, Morgan, & Hetherington, 2013; Wegerif, Littleton, Dawes, Mercer, & Rowe, 2004).

Analysis of individual teacher's patterns of change showed individual trajectories for different teachers. Overall, all teachers show positive developments on instructional and motivational discourse – with some fluctuation. With the exception of Teacher 4, teachers show similar scores and developments of instructional and motivational discourse, encouraging the reading that mostly those changes go hand in hand. Repeatedly, research has attested to individual learning patterns during professional development (Clarke & Hollingsworth, 2002; Furtak, Kiemer, Swanson, DeLeon, & Circi, 2015). Even if learning took place, the implementation of new practices into the classroom remains challenging for teachers (Buczynski & Hansen, 2010). With regard to obstacles to practice change, we need to consider that classrooms are very individual settings for the implementation of new or redefined instructional practices (van den Bergh et al., 2014), characterised by different resources and challenges, different administrative constraints and different student bodies. For example, research within the Self-Determination Theory framework has shown that the more teachers perceive pressures from above (e.g., administration, parents, curriculum) or below (e.g., nonself-

determined students) the less autonomous they feel in their teaching and the more they are inclined to use controlling teaching strategies (Pelletier, Séguin-Lévesque, & Legault, 2002). In future analyses, the results of the individual analyses of teachers' facilitation of classroom talk – or rather the change therein – should be related to their learning motivation and basic psychological need fulfilment during professional development, since such variables have been shown to decisively influence transfer of practice (Gegenfurtner, 2011). In a study with only a small data set, these individual challenges have big effects on the overall results. Additional case analyses (e.g., Schindler, Gröschner, & Seidel, 2015), and more qualitative research on the Dialogic Video Cycle (e.g., Pehmer, 2015) help to frame the results with a perspective on the individual implementation context.

12.2. Changes to Motivational Student Outcomes

Constructive learning support has repeatedly been established as one of the dimension making up the deep structure of effective classroom instruction (Klieme et al., 2001; Prenzel et al., 2002) and linked to positive student learning outcomes in the domain of motivation (Kunter et al., 2013). In different areas of research, constructive learning support is viewed, for example, as structure (Jang et al., 2010) or scaffolding (van de Pol, Volman, & Beishuizen, 2010, 2011). It is deemed essential for student learning, and understanding (Kirschner, Sweller, & Clark, 2006) as well as learning motivation (Ryan & Deci, 2000). Different authors have made the argument that productive classroom talk can provide this form of support (Alexander, 2005, 2008; Mortimer & Scott, 2003; Turner et al., 2002), by scaffolding student ideas to move thinking forward, for instance (Walshaw & Anthony, 2008). Specifically, in connection to this the high value of feedback has been highlighted as an aspect of constructive learning support (e.g., Chen et al., 2011; Chin, 2006; Hattie, 2008, 2012; Hattie & Timperley, 2007; Klieme et al., 2001; Kluger & DeNisi, 1996; Kunter et al., 2006; Lu & Law, 2012; Turner, 2014; Urdan & Turner, 2005).

The studies presented here could provide evidence that students' perceive productive classroom talk (characterised by feedback and motivationally supportive discourse) as more supportive than more narrowly focused forms of instruction. Herein, the thesis supports the notion that such a teaching script not only provides meaningful learning opportunities in the sense of cognitive activation (e.g., Lipowsky et al., 2009), but also in the form of constructive learning support. In line with prior research (e.g., Kunter et al., 2013), it could also be shown that such effective instruction has positive effects on students' motivational learning outcomes in the form of increased basic psychological need fulfilment, intrinsic learning motivation and interest in the subject. Within the context of the intervention students' perceptions of learning support, in the form of autonomy and competence support increased, which had a positive effect on their experience of self-determination and intrinsic learning motivation.

These findings attest to the assumption that productive classroom talk not only fulfils a *knowledge-construction* function (e.g., Dawes 2004; Mercer, 2010; Michaels et al., 2008; Myhill et al.

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2005; Webb, 2009), as well as an *assessment* (e.g., Ruiz-Primo & Furtak, 2006, 2007) and *social* (Scott, Mortimer, & Aguiar, 2006) function, but in addition also a *motivational* function. Also, increased perceptions of basic psychological need fulfilment in the intervention group led to higher levels of interest in the subject at the end of the school year. This development was significantly higher in the intervention group than in the control group. Consequently, the effectiveness of the Dialogic Video Cycle not only pertains to the level of teaching practice in the form of changes in teachers' facilitation of classroom talk (as outlines above), but also to the level of students' learning processes (Lipowsky, 2010). Increases in students' perception of constructive learning support in the context of reform instruction are especially noteworthy as van de Pol and colleagues (van de Pol, Volman, & Beishuizen, 2011) reported less contingent support from teachers in innovative teaching approaches. The authors argue that this lack of support is due to a lack of diagnosing students' understanding. Possibly, since productive classroom talk can serve an assessment function here this lack of diagnosing is circumvented, resulting in increased perceptions of support in students. If so, the different functions of productive classroom talk would complement and enhance each other, characterising this teaching script as particularly versatile and adaptive.

With regard to the mechanisms underlying increases in motivational student outcomes, the findings of Study 2 add to the body of literature that considers both autonomy support and structure – meaning competence support – important antecedents of student self-determination and intrinsic learning motivation (e.g., Hospel & Galand, 2016; Jang et al., 2010). A recent meta-analysis (Vasquez, Patall, Fong, Corrigan, & Pine, 2016) further supports this finding and also establishes links to student achievement (see also Pinquart, 2016). Also this meta-analysis found parental autonomy support to be related to students' psychological health. Given the similarities between parental and teacher autonomy support in terms of positive student outcomes (Chirkov & Ryan, 2001; Roth, Assor, Niemiec, Ryan, & Deci, 2009), a similar relationship may be assumed for teacher autonomy support and student mental health, which points to the possible benefits of productive classroom talk for student well-being in general.

Furthermore, Study 1 contributes findings supporting the link between intrinsic learning motivation and interest in the subject (Krapp, 2002). So far, this connection has often been analysed on the basis of the emotional valence of both interest in the subject and intrinsic learning motivation (e.g., Deci, 1992; Krapp, 2002; Figure 3). However, recent studies further point to the importance of competence for interest development (Schurtz, Pfof, Nagengast, & Artelt, 2014). Feedback from the teacher can be a major means for the perception of competence. As productive classroom talk highlights the use of constructive, process-oriented feedback (Walshaw & Anthony, 2008) there may also be direct effects of such talk on the development of interest in the subject, which need to be examined in further studies.

This dissertation adds to the body of literature that conceptualises interest as a state-trait-like variable that can be developed through repeated positive interactions between person and object, as well as by the specific characteristics of the environment (Frenzel, Pekrun, Dicke, & Goetz, 2012; Sansone & Smith, 2000). The findings support those theories of interest development that propose situated interest as an antecedent of individual interest and thus as a prerequisite for interest development (Hidi & Renninger, 2006; Krapp & Prenzel, 2011). The development of interest in the subject has been shown to be important for students' development of self-regulation (Sansone & Thoman, 2005; Sansone, Thoman, & Smith, 2000) and to play a role in career choices (OECD, 2007; Morgan, Isaac, & Sansone, 2001; Wang, 2013) – aspects of life-long learning and continuous engagement with STEM subjects. Hence, productive classroom talk could be shown here to be a form of instruction that not only has a positive effect on cognitive student outcomes (Howe & Abedin, 2013), but also motivational learning outcomes, thus presenting an effective approach for the achievement of multiple learning goals (Kunter, 2005) that readies students for the challenges of an information society, and supports their personality development and civic education (Bolhuis, 2003; Higham, Freathy, & Wegerif, 2010; Darling-Hammond, 1996; Wegerif, 2006).

12.3. Implications for Teacher Professional Development

Vescio and colleagues (2008) stated in their review of studies on the effectiveness of teacher professional development that well-developed programmes have a positive impact on teaching practice and student outcomes. This thesis provides further support for this claim, as the Dialogic Video Cycle was carefully designed with regard to effective components of teacher professional development (e.g., Desimone, 2009; van Veen et al., 2012; Wilson, 2013), especially providing teachers with options for active learning and reflection in a community of learners who worked together for an entire school year (Gröschner et al., 2015a). Also, prior research in the teacher professional development literature has suggested that the way in which teacher professional development is delivered is as important (O'Sullivan & Deglau, 2006; Swennen, Lunenberg, & Korthagen, 2008) – if not more important – than the specific content for internalisation processes to occur (Aelterman, Vansteenkiste, Van Keer, De Mayer, Van den Berghe, & Haerens, 2013). This argument stresses further the importance of careful design in the realm of teacher professional development. Also, it addresses the important role of the facilitator (Borko, Koellner, & Jacobs, 2014; Gröschner et al., 2015b). Furthermore, research argues that changes in teacher learning are more likely if teachers recognise improvement in their students' learning resulting from newly implemented practices (Clarke & Hollingsworth, 2002; Guskey, 2002; Opfer, Pedder, & Lavicza, 2011). Consequently, successful professional development needs to make teachers' learning visible and provide them with feedback on their performance in the classroom (Hattie, 2012). In this regard, using video recordings of teachers' practice along with systematic and careful reflection provides meaningful and important feedback to teachers capable of encouraging change (Powell, 2005; Santagata, 2009; Sedova et al., 2016; Sherin & van Es, 2009; Tripp & Rich, 2012; Wang, 2013a).

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However, despite positive findings on the use of video in teacher education and professional development (Avalos, 2011; Borko et al., 2008; Chinn et al., 2001; Furtak et al., 2016; Goldman et al., 2007; Krammer, 2006; Krammer et al., 2010; Lefstein & Snell, 2014; Powell, 2005; Santagata, 2009; Sherin & van Es 2009; Harford et al., 2010; Sedova et al., 2016; Seidel et al., 2011; Tripp & Rich 2012; Zhang et al., 2011), possible downsides need to be considered as well. The advantage that video observations of classrooms are ‘artefact of practice’ (Borko, et al., 2008) which reflect the interactional complexity of classrooms and possibly the interconnectedness of different stakeholders as outlined in the Utilisation-of-Learning-Opportunities model (Figure 6) can easily become a disadvantage if designer and facilitator of the professional development fail to recognise its great demands on people’s cognitive capacity (Syring et al., 2015a, 2015b, 2016). Another critical aspect is the finding that during professional development in which teachers observe videos of themselves, research has demonstrated that teachers are reluctant to comment critically about their peers’ practices (Borko et al., 2008; van Es, 2012; Zhang et al., 2011). Kleinknecht and Schneider (2013), as well as Seidel and colleagues (2011) provide evidence that participants engage more in knowledge-based reasoning processes with more frequent reflections on alternative ways of dealing with events if they watch someone else’s teaching on video. In contrast, teachers watching videos of others report higher levels of negative emotions – in particular, disappointment in the teaching actions of the teacher on display (Kleinknecht & Schneider, 2013). These findings point out that video use in teacher professional development is not in itself a guarantee for success, but needs to be considered with care and implemented with current research findings in mind. The design of the Dialogic Video Cycle recognises these findings and addresses them by (A) meeting regularly with teachers to provide them opportunities for practicing video-based reflection, (B) preselecting short sequences of video material that bear importance (instead of watching longer episodes), (C) watching video excerpts multiple times, before (D) reflecting on them with the support of guiding questions (Sherin & van Es, 2009; Zhang et al., 2011). Furthermore, (E) the facilitator is central in scaffolding teachers’ learning process (Gröschner et al., 2015b; Santagata, 2011). Given the encouraging results of the first implementation of the Dialogic Video Cycle, we maintain that its design (as outlined above) addresses challenges of video reflection in professional development appropriately.

In research on effective teacher professional development, the question often arises whether changing teachers’ practice also requires changing their beliefs on teaching and learning or if beliefs will follow suit once practice changes have occurred (Clarke & Hollingsworth, 2002; Turner, Christensen, & Meyer, 2009). For the German context, Richter and colleagues (2010) found evidence that teachers’ constructivist beliefs – as well as their professional engagement – are predictive of the amount of professional development teachers participated in a 3.5-year period (Richter, Kunter et al., 2010). In any case, research has shown that changes in teacher learning are more likely if teachers recognise improvement in their students’ learning as a result of their new practices (Guskey, 2002; Opfer, Pedder, & Lavicza, 2011). Connected research on the Dialogic Video Cycle (e.g., Pehmer et al.,

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2015; Schindler et al., 2015) provided evidence that teachers in the intervention group of the 'Dialogue' project were under the impression that students profited from their changed instruction.

A recent study in the field of physical education could furthermore show that teacher's effectiveness and feasibility beliefs about new autonomy supportive and structuring teaching practices are predicted by their basic psychological need fulfilment during training (Aelterman, Vansteenkiste, Van Keer, & Haerens, 2015). Consequently, even without explicitly addressing teacher cognitions, participation in the Dialogic Video Cycle produced (A) practice changes in teachers, and (B) different perceptions of or attitudes towards these practices. These results support the Interconnected Model of Professional Growth (Clarke & Hollingsworth, 2002) by demonstrating that change in one domain (domain of practice) relates to changes in other domains (personal domain) without explicitly addressing them in the learning process. Nonetheless, in the future, explicit reviews of teachers' changed cognitions during teacher professional development and their relationship to changed instruction appear to be fruitful (Jerabek et al., under review).

Motivation during professional development has recently garnered attention (Aelterman et al., 2016; Gegenfurtner et al., 2009) and is seen as essential for transfer to occur (Gegenfurtner, 2011). Results of the feasibility study of the 'Dialogue' project (Gröschner et al., 2015a) documented differing satisfaction with the programme between intervention and control group teachers. Furthermore, significant differences regarding basic psychological need satisfaction and learning motivation were found. This difference in motivation between the groups may have contributed to the differences found in teachers' up-take of aspects of productive classroom talk throughout the school year. Aspects of professional development interventions that motivate teachers have, to my knowledge, been neglected in research so far. Nonetheless, possible hypotheses could go into the direction of increased value when working directly on one's own practice (Wigfield & Eccles, 2000), increased perceptions of competence if practice, change and success are made visible, for example, through the use of video (Deci & Ryan, 1985), increased satisfaction of social relatedness due to the formation of learning communities (Lave & Wenger, 1991), etc. Though no findings have been presented in this area as of now, it appears like current models of professional development based on effective design principles (Desimone, 2009; Reinmann-Rothmeier & Mandl, 2001; van Veen et al., 2012; Wilson, 2013) offer more opportunity for learning motivation than traditional 'one shot' workshop approaches. Motivation also plays an important role in teachers' engagement in professional development in the first place (Richter et al., 2013). Results from the feasibility study (Gröschner et al., 2015a) support the view that teachers in professional development are already strongly motivated. Consequently, the issue of finding ways to engage less motivated teachers as well arises. Mapping and understanding the relationship between motivational aspects such as teacher self-efficacy, perceptions of autonomy and competence, or self-concept and participation in professional development are tasks for future research.

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The individual patterns of teacher change found in Study 2 testify to the conjecture that in research on teacher learning, as we do in research on student learning, more attention needs to be given to prerequisites, processes and contexts that affect the use of learning opportunities during professional development. While we acknowledge that student learning is a complex process that can be approximated by Utilisation-of-Learning-Opportunities models (Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014; Figure 6) it seems like we do not yet hold the same systematic view of teacher learning. As we have already in connection with research on instructional quality, we as a research community need to be thinking about how to teach adaptively in professional development to accommodate different prerequisites and systemic challenges. Short-term, one-size-fits-all approaches – as they are currently the reality for teachers in Bavaria – cannot be expected to produce the necessary changes in teachers (be it beliefs or practice) for sustained classroom reform and the implementation of innovative teaching approaches deemed necessary to ready the young generation for the challenges of the 21st century (Bolhuis, 2003; OECD, 2007, 2013). Some research on factors affecting professional developments participation (not learning) already exists, such as the value of professional development in a teacher's peer group of fellow teachers, teachers' job motivation, constructivist beliefs, and ambition (Richter et al., 2010). Also, findings have been reported mentioning obstacles to teacher learning during professional development and practice change (Osborne, 2015; Richter et al., 2013). So far research on learning opportunities during professional development, teacher prerequisites, and context factors have been mostly pursued independently. In order to more fully understand the learning processes taking place and the relationships between the different aspects of the Utilisation-of-Learning-Opportunities model (Helmke, 2012; Seidel, 2014; Seidel & Reiss, 2014; Figure 6) the research community needs to broaden its scope in research on professional development.

In this context, it has to be conceded that many of the publications available on professional development programmes (on productive classroom talk) provide limited descriptions on the intervention itself. It is doubtful that after reading these articles either researchers or practitioners could replicate the interventions, let alone the studies. In view of the so called 'replication crisis' in psychological research (Open Science Collaboration, 2015) and the call for replication studies (Lindsay, 2015) this is critical. Furthermore, it has implications for the advancement of the field, since it seems easier to develop a new intervention from scratch rather than build on existing research if it is not accessible. In view of generalising findings across different domains, cultures, age groups, etc., it would also be favourable to combine our efforts and increase research on interventions that have already been found effective – or at least use aspects of them – rather than always producing new approaches. This might possibly be a first step for transferring findings from research into practice and promote effective interventions. A positive example of such prolonged research is the follow-up project to the 'Dialogue' project, in which the question of optimal teacher professional development duration is analysed more closely in the form of a waiting group design. In addition, teachers' knowledge regarding productive classroom talk is assessed, along with students' perceptions of the

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quality of classroom talk and their achievement. Moreover, methodological and design limitations addressed above are handled in order to close gaps in existing findings on the Dialogic Video Cycle.

In sum, after presenting different approaches of professional development focusing on classroom talk in the theoretical background and presenting results of the ‘Dialogue’ project in the summaries of the two studies of this dissertation, I feel supported in the assumption that on the continuum of interventions (ranging from ‘one-shot’ workshops to very intensive programmes like the one reported by Sedova et al., 2016) the Dialogic Video Cycle represents an adequate trade-off between cost (intensity, time, manpower, etc.) and benefit (changes to teachers’ practice, beliefs, cognitions, and student learning outcomes).

12.4. Methodological Reflections and Limitations

Research on professional development is growing and produced thus far significant insights into teacher learning and the design of professional development activities, yet rigorous research on their effectiveness in terms of teacher learning and student outcomes are still rare – both nationally and internationally. In the review of the literature on professional development in general and on professional development on productive classroom talk in particular, only one study comparing results of the intervention with a control group could be made out (Cheon & Reeve, 2015). Therefore, the two-group longitudinal design of the overall ‘Dialogue’ project and the two studies comprising this dissertation is unique in this respect. The quasi-experimental design furthermore presents a great step forward for generating new knowledge about teacher learning and practice changes and its effects on motivational student outcomes. From the four levels of effectiveness of professional development programmes outlined by Lipowsky (2004) the ‘Dialogue’ project looked at three directly: teacher motivation during the programme, teacher practice change and student learning outcomes; while changes in teachers’ cognition were reconstructed indirectly from excerpts during professional development (Gröschner et al., 2015a; Pehmer et al., 2015a, 2015b; Schindler et al., 2015). Currently, teachers’ cognitions during the professional development workshops are also researched directly (Jerabek et al., under review). This comes to show the comprehensiveness and rigor of the project and the studies within it, regarding the assessment of the effectiveness of the Dialogic Video Cycle. The rigor of the teacher professional development design, in accord with effective components of teacher professional development (Desimone, 2009; van Veen et al., 2012; Wison, 2013) and current theories on (teacher) learning (e.g. Ball & Cohen, 1999; Darling-Hamond, 2005; Greeno, Collins, & Resnick, 1994; Lave & Wenger, 1991; Scardamalia & Breiter, 2003; Section 7.2), is another particular strength of the research as such programmes are more likely to produce practice changes in teachers (Vescio et al., 2008). The use of video, both as a tool for reflection, as well as a data source had a synergistic effect for the research. To improve productive classroom talk, video examples of classroom interactions are a promising tool for supporting teachers’ analysis and reflection on classroom practices and interaction patterns (Gaudin & Chaliès, 2015; Tripp & Rich, 2012). Using video in

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teacher professional development 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 (Borko et al., 2008; Pauli & Reusser, 2006; Santagata & Guarino, 2011; Santagata, 2009; Sherin & van Es, 2009). Further benefits of video-use in terms of teachers' learning processes are the encouragement of knowledge-based (Gaudin & Charliés, 2015; Sherin, Jacobs & Philipp, 2011) and case-based reasoning (Schank, 1982) together with the reinforcement of teachers' impact on student learning outcomes (Timperley et al., 2007); necessary elements for the development of expertise in teachers (Berliner, 2001). Video observations furthermore allowed for an objective view on teachers' practice and analyses from multiple vantage points (talk turn vs. talk format), providing opportunities for research both on the level of external teaching activities (questioning and feedback) as well as indicators of internal learning activities (instructional and motivational discourse).

Video studies allow for the much called for integration of qualitative and quantitative research methods (Johnson & Onwuegbuzie, 2004; Mayring, 2001; Renkl, 1999). Prenzel and colleagues (2002) argue for a connection of video observation and self-report to arrive at a fully-fledged picture of teaching and learning that adequately represents structural aspects of the instructional setting, as well as learning processes, beliefs and attitudes. This dissertation presents such a mixed-method approach by combining video analyses with student questionnaires in order to make visible, both teachers' practice and instructional style as well as internal student learning activities. This approach was innovative and turned out to be useful for exploring the connection between teaching and motivational student outcomes (Seidel, Prenzel, Schwindt, Rimmele, Kobarg, & Dalehefte, 2009). The method of video analysis of classrooms enables researchers to identify teaching and learning conditions in classrooms in a valid way (Brophy, 2004). As Praetorius and colleagues (2014) further demonstrated, for the assessment of constructive learning support one video observation already provides an accurate picture of the current instructional quality in a classroom. Therefore, the study allowed observable behaviour to be measured in a reliable and valid way and to be linked with internal processes. This connection makes it possible to acquire deeper knowledge regarding teacher-student interactions.

However, student self-reports are not free of methodological queries (Austin et al., 1998; Fan et al., 2006; Shulruf et al., 2008). Nonetheless, overall self-report data has shown to be reliable and valid (Chan, 2009) as a tool to access information on constructs that would be difficult to obtain otherwise. On the other hand, for student learning outcomes the objective perspective seems less important than students' subjective interpretation of their learning environments; as a consequence of which self-report measures seem appropriate in this context. For the future though data triangulation of subjective self-report measures and objective observational data for the same constructs is needed to replicate the

present findings in even more sophisticated designs and provide us with insights on the differences between students' interpretations and objective observers' evaluation of the same classroom situation.

Despite the call for longitudinal studies in educational research echoing in the community for more than forty years (Shulman & Tami, 1973), most research is still focused on short-term analyses. 'True' longitudinal studies with a minimum running time of one year are still scarce (White & Arzi, 2005). Also from research on need-supportive instruction such calls resound (Schuitema, Peetsma, & van der Veen, 2016; Stroet, Opdenakker, & Minnaert, 2013). Though the studies presented in this dissertation are at the lower-bound end of longitudinal studies with regard to running time, the design is unique inasmuch as they combine longitudinal assessment of classroom practice and student perceptions in order to examine the effects of productive classroom talk on students' motivational outcomes across an entire school year with the implementation of an innovative teacher professional development programme. Particularly in the context of intervention studies longitudinal designs are necessary, providing information on continuity or change and prediction; and about within-individual change (Farrington, 1991).

White and Arzi (2005) further point out that small initial gains during such interventions can have a cumulative effect; making it necessary to monitor changes across longer periods of time. The repeated measurement points allowed for modelling that took into account different growth patterns other than linear, depicting the variability both in teacher behaviour as well as student perceptions. Furthermore, it opened up new questions and avenues for future research, such as with respect to the patterns and systematics in teacher learning across a year-long intervention. Existing research often warrants fluctuation in such learning because of teachers grappling with new practices and the time needed to consolidate changes in routine practices (Bakkenes, Vermunt, & Wubbels, 2010), and it supports the often cited argument in teacher professional development research for continuous, long-term teacher learning (Borko et al., 2008). For an assessment of the cumulative effects of the Dialogic Video Cycle on teachers' practice change and student learning outcomes follow-up measurements in the following school year are to be encouraged in future research (White & Arzi, 2005). As a disclaimer it needs to be said though that in the context of German secondary school this might be difficult to realise, as it is by no means guaranteed that students will have the same teacher in the same subject the following year. Analysis in the primary sector can alleviate those difficulties; contributing further to the primary education bias in much of the research on productive classroom talk (Higham et al., 2014). Multi-cohort designs with pre/post comparisons such as realised in the 'Elevate' project (Furtak et al., 2016) present another possible solution to this query.

In educational research, teaching scripts are measured in different ways, often depending on the specific focus of the examination (in cognitive research reconstructive techniques such as stimulated recall and structure-formation are used, while in classroom research video observations seem more dominant). Overall, the use of video observations and accompanied coding proved valuable, especially

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since multiple coding schemes allowed for analyses on different grain-levels. While the categorical approach in Study 1 provided very objective, low-inferent data, they are at the same time rather abstract and removed from teaching processes and resulting learning. On the other hand, high-inference coding in Study 1 required more interpretation from the coders, which possibly affected data quality, but provides information more deeply rooted in the deep structures of instruction. The cross-validation of the data from these different coding passes further adds to the scientific rigor of this research project – similar developments in teaching activities in both groups were mapped with both instruments. However, a combination of different approaches to teaching script measurement in future studies would help our understanding regarding teachers' intentions, beliefs and attitudes towards certain teaching scripts and possible discrepancies with research findings on those scripts. Similarly, as results from Study 2 indicate, there appears to be somewhat of a difference between independent observers' interpretation of teaching activities and students' perceptions. To resolve this issue, the reconstruction of students' perceptions – for example, through stimulated recall or other forms of data triangulation – seem necessary.

A year-long intervention study – especially one using classroom videos – is an invasive method that a small number of teachers are willing to undergo (van Eekelen, Vermunt, & Boshuizen, 2006). Yet this holds true both for the teachers participating in the Dialogic Video Cycle as well as teachers in the control group, since all had to engage with the same effort with respect to time and content. To guarantee the participants' acceptance and minimise reactance, they were given a free choice between the two teacher professional development programmes, and were not assigned randomly. Since this was the first project exploring the effects of the Dialogic Video Cycle, we focused on not compromising the quality of the data by reactive behaviours during the school year (Gröschner et al., 2015a); yet there is of course awareness that this decision might have produced a positive selection bias in the intervention group. Looking at the data reported here no grounds for such an assumption is provided as non-parametric analyses of the first measurement point revealed no significant differences between intervention group and control group teachers regarding either the use of open questions and constructive feedback or the occurrence of instructionally and motivationally supportive discourse. Furthermore, in Gröschner and colleagues (2015a) no group differences regarding motivation during professional development were found in the beginning of the study. However, training motivation was rather high in both groups attesting to prior research findings that particularly teachers with high (job) motivation engage in professional development (Richter et al., 2013). For future studies random assignment to the programmes is warranted in order to avoid possible selection biases and provide the basis for generalizable results.

It needs to be acknowledged that the present data is nested; both as measurement points in students and as students in classrooms, and would thus require at least a three-level, multilevel model for an optimal representation of the data. However, Schoppek (2015) reports results from simulation

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studies that show that in samples with 5 units on level 2 (here classes) multilevel models arrive at less robust regression weights and residual variances. Furthermore, the author points to the restrictions in power of such analyses (see also McNeish and Stapleton, 2016). The choice of latent growth curve models to represent the changes across the school year allowed for partial modelling of the hierarchical structure of the data (time points nested in students), despite the limited sample size (Duncan & Duncan, 2004). Yet, linear growth curve models can only accommodate two levels; as the structure of the data in this project shows (at least) three levels, in future research it is necessary to recruit larger samples in order to verify the robustness and generalisability of the results. Also, in multilevel modelling composition and context effects (Marsh, Lüdtke, Nagengast, Trautwein, Morin, et al., 2012) can be considered, which would greatly further our understanding of changes in classroom structures (such as the salience of autonomy or control) occurring during the intervention. Similarly, I am aware that structural equation modelling (SEM) would have been a more state-of-the-art method to examine the predictive power of students' perception of the classroom environment on motivational learning outcomes. Yet here again, especially in the context of hierarchical, longitudinal designs such analyses require very large samples; usually at least 10 subjects for every estimate in the measurement and structure model (in many instances sample sizes are chosen too small; Wang & Wang, 2013; Westland, 2010). In the context of teacher professional development research any such endeavour very quickly arrives at an impasse, as it appears unlikely to recruit and manage samples of such magnitude in field-experiments involving video observations and high engagement on the side of participants (van Eekelen et al., 2006). However, in the context of SEM, measurement of invariance across measurement points would add to the assurance of measurement quality and possibly provide evidence for the notion that, with continued experience of autonomy and competence support during classroom talk students come to interpret the scales differently.

The studies presented here analysed how students' motivational outcomes develop within a changing social environment and how they depend upon students' perceptions of this environment across a school year. With this, the dissertation contributes to research examining the idiosyncratic developments of individuals in changing contexts (Turner & Patrick, 2008). Yet, the analyses into the particular relationships between teachers' productive classroom talk and motivational student outcomes remain only exploratory. Furthermore, much of the recent person-in-context research on students' learning motivation – as indeed the studies reported here – has seen person and environment as 'fits' to each other (Meyer & Turner, 2002b, p. 112), or examined the influence of context on student learning motivation. In future research, the reciprocity between person and context needs to be focused much more on – not least to determine obstacles for high-quality instruction.

12.5. Further Practical and Research Implications

Despite debates about enriching teaching through diverse didactical methods, classroom talk and verbal teacher-student interactions remain dominant in mathematics and science education (Appleebe et al., 2003; Jurik et al., 2013; Roth et al., 2006). Furthermore, the instruction German students experience is in many cases characterised by a lack of constructive learning support, limited teacher feedback and strong teacher-centeredness (Schiepe-Tiska et al., 2013). This dissertation shows that after successful implementation (Gröschner et al., 2015a) the video-based teacher professional development approach of the Dialogic Video Cycle was effective in changing teachers' external teaching activities towards more productive classroom talk. This finding is especially noteworthy because the comparison with the control group shows that without such support, teachers tend to narrow their talk practices (in the form of closed questions and simple feedback) towards more teacher-centred forms of talk over the course of a school year. If we take this finding and the body of literature on teacher learning and professional development (e.g. Ball & Cohen, 1999; Clarke & Hollingsworth, 2002; Darling-Hamond, 2005; Desimone, 2009; Guskey, 2002; Opfer, Pedder, & Lavicza, 2011; van Veen et al., 2012; Wilson, 2013) seriously, research and politics need to acknowledge that the way we currently handle professional development for teachers is probably not worth the effort (e.g., Ruthven et al., 2016) – neither teachers' nor workshop leaders'. New perspectives for supporting teachers in their daily practice are needed if we want teaching to remain effective throughout a school year. These approaches need to be continuous, relevant, close to a teacher's classroom and provide direct and constructive feedback on change efforts and student learning outcomes. Such support structures could be teacher-run, as in the form of video clubs (Sherin & van Es, 2009; Sherin & Han, 2004) where groups of teachers videotape their classroom and then regularly meet after school to discuss and reflect upon their teaching. Other options could be external long-term supports, such as the Dialogic Video Cycle. Successful programmes using blended-learning scenarios have also been reported in the literature (Krammer et al., 2006), which might reduce organisational factors and time issues present during long-term professional development.

For scaling such endeavours the research community needs to think creatively, combining workable aspects of different approaches and making them available to a wide audience. Possible avenues could be the training of teacher leaders or multipliers in different schools and districts (Borko, Koellner, Jacobs, 2014), encouraging teachers to be part of pre-service teacher's education, using technology like in blended-learning scenarios (Krammer et al., 2006) and online courses (Michaels & O'Connor, 2012). For example: At the University of Augsburg there are seminars where student teachers develop lesson units in tandem with experienced teachers, who then enact those lessons. As part of the seminar experienced teachers provide student teachers with feedback on their lesson plan from a practical perspective, while student teachers provide experienced teachers with a theoretical perspective (Hartinger, Dresel, Matthes, Rost-Roth, Strasser, & Schneider, 2015). The possibilities are

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surely endless, but all our innovations will be futile if teachers are not given the opportunity to engage in such continuous forms of professional development and if their initiative is not valued by schools, administrators and society at large.

Herein, the present dissertation sees the understanding of faculty as communities of practice (Lave & Wenger, 1991) as crucial. Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. As Guskey (2002) pointed out, most teachers see their effectiveness in terms of student learning; consequently it can be argued that they share a concern or a passion. However, with regard to the second aspect – interaction – it is still very much the case in Germany that teachers work independently from each other, sharing resources only scarcely and keeping their practice very much to themselves. Though this might be different for some teachers, there is definitely no system inborn time or space for teachers to start interacting around their practice at the moment. The provision of such a professional development time during the regular school day has to be seen as a necessary first step for career-long professional development in teachers, while simultaneously (at least to a certain degree) mending the problem that mostly enthusiastic and motivated teachers engage in current forms practice development.

Notwithstanding, systemic problems in the provision of professional development in Germany, in line with research on expertise (Berliner, 1994, 2001) any form of professional development needs to include deliberate practice in the form of repetition, feedback and purposeful engagement (Ericsson, Krampe, & Tesch-Römer, 1993). Historically, due to a lack of feedback the development of expertise in teachers has been made difficult (Berliner, 2001). Herein, I see a further strength of the Dialogic Video Cycle as implemented in the ‘Dialogue’ project, since it continuously provides teachers with direct feedback on their practice – and video feedback has been shown to be especially helpful for teachers to engage with their own practice (Gaudin & Chaliès, 2015; Santagata & Guriano, 2009). Furthermore, the development of expertise in any domain requires an initial, externally supported learning process, which after time becomes transitional and, in the end, self-regulatory (Glaser, 1996 in Berliner, 2001). As has been demonstrated in the studies presented above, the Dialogic Video Cycle can offer such external learning supports. Relatively new in research on professional expertise is the concept of *adaptive expertise* (Hatano & Inagaki, 1986; Hatano & Oura, 2003). Adaptive expertise is defined by balance between efficiency and innovation: a requirement for teachers to respond flexibly to newly arising situations in their practice (Wetze, De Arment, & Reed, 2015). Theory supports the development of adaptive expertise within learning environments that value collaborative thinking and shared perspectives in addressing new problems (Hatano & Inagaki, 1986). Further, emerging research suggests adaptive expertise can be promoted through reflection about teaching experiences (Crawford, Schlager, Toyama, Riel, & Vahey, 2005; Hayden, Moore-Russo, & Marino, 2013; Janssen, de Hullu,

& Tigelaar, 2008). The Dialogic Video Cycle was designed to incorporate these features making it a probable instrument for the promotion of adaptive expertise in teachers.

With the results of Study 2 it could be demonstrated that productive classroom talk affects students' perceptions of their learning environment as more supportive. Consequently, the way teachers facilitate classroom talk has implications for instructional quality. Given that this teaching script is incredibly wide spread and seems to be used often times without much thought, an awareness for the importance, the functions and the consequences of classroom talk should be part of pre-service teachers' curriculum. While a recent Delphi-study on pre-service teachers' pedagogical-psychological knowledge (Kunina-Habenicht, Lohse-Bossenz, Kunter, Dicke, Förster, Gößling et al., 2012) names models of teacher-student interaction as part of the curriculum, thus far it remains unclear to what extent it is actually addressed during university-based teacher education. In view of the multiple benefits attributed to productive classroom talk (achievement, higher-order learning, critical thinking, understanding and learning, scientific reasoning and argumentation, oral communicative competence, reading comprehension, cognitive development and now also intrinsic learning motivation and interest in the subject; Chi & Meneske, 2015; Davies & Meissel, 2016; Duschl & Osborne, 2002; Howe & Abedin, 2013; Lipowsky et al, 2007; Mercer, Wegerif, & Dawes, 1999; O'Connor, Michaels, & Chapin, 2015; Pehmer, 2015; Wegerif, Mercer, & Dawes; Wilkinson, Murphy, & Binici, 2015) the positive effects on our student body seem endless if we could manage to raise awareness for productive classroom talk within in-service teachers, pre-service teachers, university lecturers, and develop productive classroom talk to be a teaching script as deeply entrenched in the system as questioning-developing teaching currently is. Research into the Dialogic Video Cycle provides an evidence-base for design principles that will be helpful in this regard – and encouraging, by showing that it can be done.

One of those design principles surely ought to be the use of video as a tool for reflection and feedback. Unfortunately, it appears that such forms of reflection and feedback cause anxiety in German teachers. We have anecdotal evidence on this, as some teachers taking part in the 'Dialogue' project mentioned fears of video-based evaluation (as experienced during teacher training) as a justification for choosing the control group, some of which regretted their choice afterwards when realising the opportunities for learning in the intervention group. Apparently, despite its power, (peer) feedback on their teaching is still something unnerving for teachers. In light of the importance of feedback for the development of expertise (Ericsson et al., 1993) and the need for reflection of practice for adaptive expertise (Bransford, 2004; Crawford et al., 2005; Hayden et al., 2013; Janssen et al., 2008) our teacher training system appears to miss great opportunities for the qualification of our teacher body by failing to provide (pre-service) teachers with sufficient feedback opportunities and scaring them away from such feedback in those cases where it is currently used in Germany. Fortunately, at least university-based teacher training has picked up on this issue and can now report

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on positive examples where video (peer) feedback was used successfully in pre-service teacher education, resulting in deeper reflection of positive teaching events of their own practice (Kleinknecht & Gröschner, 2016). Possibly, by incorporating feedback on field experiences (Kleinknecht & Gröschner, 2016), lesson analyses (e.g., Santagata & Guarino, 2011; Sherin & van Es, 2005) and hospitation by our peer lecturers in our university seminars, we could establish a learning and feedback culture in our teacher education programmes which would make it normal for growing teachers to receive (peer) feedback and allow them to develop the expertise needed for high-quality instruction.

The present dissertation also underscores the importance of a supportive learning environment for motivational student learning outcomes (e.g., Kunter et al., 2013; Schiepe-Tiska et al., 2013). Such deep structures of teaching and learning are indicated by external teaching activities such as constructive feedback or instructional and motivational discourse. An increase of student control, alongside with supportive scaffolding during the learning process are pivot herein and connects research on productive classroom talk with research on autonomy and competence support. In consequence, the theoretical proximity as delineated in the theoretical background could be supported through the findings of Study 2. These results have implications for the theoretical conceptualisation of productive classroom talk, as both a cognitive activating (e.g., Lipowsky et al. 2007) and supporting instructional approach (Walshaw & Anthony, 2008).

Decreases in students' learning motivation – either situated or dispositional – have been noted frequently (Alexander, Murphy, Woods, Duhon, & Parker, 1997; Baumert & Köller, 1998; Frenzel et al., 2012; Helmke, 1993; Schurtz et al., 2014; Gottfried, Fleming, & Gottfried, 2001; Helmke, 1993; Maulana, Opdenakker, & den Brok, 2013; Pekrun, 1993; Spinath & Spinath, 2005; Turner et al., 2012; Turner & Patrick, 2008; Vauras, Salonen, Lehtinen, & Lepola, 2001). In addition to ontological developments and differentiations of individual interests (Krapp, Geyer, & Lewalter, 2014; Schurtz & Artelt, 2014), other reasons – which concern more the fit between environment and individual – have been discussed in research (Eccles et al., 1993). Results from the studies making up the present dissertation suggest that such mismatches do not occur to the same extent in classrooms characterised by productive classroom talk. Consequently, in view of life-long learning, student-centred, reform-oriented teaching practices such as productive classroom talk needs to become a default approach to teaching and learning in order to equip students with the necessary skills and competences to face the demands of ever-changing knowledge societies. Apart from motivational student outcomes, teachers' instructional style also has implications for their engagement and well-being (Reeve, 2009). Furthermore, students who experience their teacher as controlling manifest poor engagement, possess a lower ability to self-regulate their learning, achieve less, and suffer a lower sense of well-being (Shih, 2012; Soenens et al., 2012; Studsrød & Bru, 2012). So far, the effects of autonomy and competence support on the student side have been the focus of a good deal of research endeavours.

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What has been targeted much less is the question of what makes teachers autonomy supportive (Katz & Shahar, 2015). In the context of teacher professional development teachers' beliefs about feasibility and effectiveness have been shown to be important (Aelterman et al., 2015; Reeve et al., 2014). Furthermore, teachers' beliefs about learning motivation as well as their own motivation for teaching have been found to influence the adoption of an autonomy supportive instructional style (Katz & Shahar, 2015). To date, research into teacher motivation and the consequences it has on student learning outcomes has been rare (Butler, 2007; Janke, Nitsche, & Dickhäuser, 2015; Kaplan, 2014; Lam, Cheng, & Choy, 2010). In light of the results of this dissertation more research in this direction is to be encouraged.

This dissertation pursues a person-in-context approach (Lemos, 2001; Nolen et al., 2012; Pintrich, 2003; Vauras et al., 2001), stressing that a persons' motivation is a function of their inner motivational resources and aspects of the social context (Reeve, 2006). This form of research allows for the review of the relationship between individual and social context for the regulation of learning behaviours such as learning motivation (Hadwin, Järvelä, & Miller, 2011). Socio-cultural theory which informs much of the research on productive classroom talk (Mercer et al., 1999; Michaels et al., 2008; Wegerif et al., 1999) has also been influential for much research on learning motivation (Walker, Pressick-Kilborn, Arnold, & Sainsbury, 2004) and the conceptualisation of self-regulation as co-regulation in social contexts (Hadwin, Wosney, & Pontin, 2005; Volet, Summers & Thurman, 2009). Following Vygotsky, Valsiner (1997) suggests that social practices are transformatively internalised by the individual and subsequently externalised in the same or other social contexts. This notion of transformative internalisation provides a powerful explanation of the emergence of individual motivation from social settings and has profound implications for learning motivation. Internalisation forms an integral part of Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000), explaining how the social context can support students in the regulation of their motivation through the provision of autonomy and competence support. In consequence, productive classroom talk can be seen as a form of co-regulation of students' learning motivation in a social context.

Generally speaking, when examining classroom talk, researchers tend to concentrate on what the teacher does and how it resonates with students. We mostly see student engagement in classroom talk either as an outcome variable or a sign for its effectiveness, leaving (mostly) unattended that teacher-student interactions are reciprocal and student prerequisites and behaviour feed back to teachers and affect how they teach (for an exception see Jurik et al., 2012). However, in recent research a fourth component of engagement – besides behavioural, cognitive and motivational (Fredricks et al. 2004; Jimmerson et al., 2003; Figure 5) which might be seen as outcomes of a learning process – has been proposed, acknowledging students' active role in teaching and learning processes. Reeve and Tseng (2011) define *agentic engagement* as 'students' constructive contribution into the flow of the instruction they receive. What this new concept captures is the process in which students intentionally

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and somewhat proactively try to personalise and otherwise enrich both what is to be learned and the conditions and circumstances under which it is to be learned (Reeve & Tseng, 2011, p. 258). As a result, the Self-Processes Model as outlined in Section 6.1 (Connell & Wellborn, 1991; Skinner et al., 1990; Furrer, Skinner, Marchand, & Kindermann, 2006; Appleton et al., 2006; Figure 5) and the assumptions based on it need to be elaborated and replenished. This has implications for research on productive classroom talk, since the effectiveness of feedback has been shown to depend on aspects of the sender, the receiver, the message itself, and the context (Winstone, Nash, Parker, & Rowntree, 2016). The literature proposes, for instance, that individual differences in self-regulation (e.g., Nicol & Macfarlane-Dick, 2006; Orsmond & Merry, 2013), confidence, and academic self-concept (e.g., Baadte & Schnotz, 2013; Eva, Armson, Holmboe, Lockery, et al., 2012) affect learners' engagement with and use of feedback. Consequently, in future research we need to more strongly take into account the active role of students in the learning process; not only from the perspective of outcome quality, but also their role in the determination of process quality. With classroom talk being an act of communication, for a comprehensive understanding of its effects and benefits research needs to consider (at best simultaneously) all aspects of this communication (sender, receiver, message, and context). Furthermore, Reeve and Tseng (2011) point out that teachers' responsiveness to students' agentic engagement typifies their motivating style with more autonomy-supportive teachers allowing for more influence attempts from students (Reeve, Jang, Carrell, Jeon, & Barch, 2004). These considerations point to additional connections between classroom talk and student learning motivation, which bear implications for future research.

This dissertation made an attempt to integrate research on productive classroom talk, basic psychological need support and effective instruction based on the assumption that all three strands of research essentially revolve around transferring control and responsibility of the learning process to the learner, and doing so in an environment that is characterised by teachers support. While these frameworks for supporting student learning during the course of instruction have overlapping foci; however, and perhaps surprisingly, these literatures are siloed into different research traditions. As such, they rarely interact with each to support instructional change in the classroom. However, given the vision of ambitious instruction guiding efforts to transform mathematics and science instruction, I see value in elucidating the complementary nature of these frameworks. The results of the studies regarding students' perceptions of increased autonomy and competence support during more productive forms of classroom talk are encouraging in this regard. Yet, I believe research should move even more towards integrating multiple perspectives and arrive at a shared language, which would greatly facilitate the reception and take-up of research findings. A recent example of such an endeavour is the work by Furtak, Thompson and van Es (2016), who synthesised the literature on formative assessment (Shepard, 2000) and noticing (Sherin, Jacobs & Philipp, 2011) to note areas of overlap and omission, and to consider how alternative theoretical framings can provide ways to understand the relationship between different theoretical concepts. With regard to constructive

learning support, such attempts for integration could be made between the works on basic psychological need support on the one hand (Hospel & Galand, 2016; Jang et al., 2010) and research on scaffolding on the other (van de Pol et al., 2010, 2011). Also, as has been pointed out by van de Pol and colleagues (2010) there is overlap between research on scaffolding and research on informal formative assessment (Ruiz-Primo & Furtak, 2006, 2007), which in turn shares basic tenants and goals of research on productive classroom talk (Walshaw & Anthony, 2008). Much of this research is pulled together by the overwhelming importance of constructive teacher feedback (Hattie & Timperley; Hattie, 2008, 2012). As Hattie and Gan (2011) argue, perhaps what we need is instruction based on feedback – both for students and teachers (Hattie, 2012).

12.6. Future Research Questions

Starting from the findings and limitations of the present dissertation, different avenues for future research open up – some of which have already been noted above. In research to come, methodological issues like the small sample size and the unequal number of measurement points for the two treatment conditions ought to be addressed. Consequently, teachers could more readily be assigned randomly to the treatment conditions, which would counter any selection biases and provide a broader knowledge base for generalisations of any kind. What needs to be kept in mind though is that research has found evidence that particularly motivated teachers engage in professional development (Richter et al., 2013), producing a positive selection bias even with random assignment to groups. More fine-grained sequential analyses of the classroom talk (Bakeman & Gottman, 1997) would support efforts to determine the ‘productivity’ of certain (cyclical) interaction patterns (Ruiz-Primo & Furtak, 2006, 2007). Hereby, also a focus on students’ responses and their frequency and quality is necessary. It is understood that different forms of talk may be productive in different situations during classroom talk (Scott, Mortimer, & Aquiar, 2006). Sequential analyses could further our understanding of situations in which more dialogic or more authoritarian talk is beneficial. Such micro-level analyses of the teaching script of classroom talk could also be informed by the Script Theory of Guidance (Fischer, Kollar, Stegmann, & Wecker, 2013), which differentiates different hierarchically ordered components of a script (scenes, scriptlets, operations), including the cognitive activities engaged in and roles involved. Furthermore, connections between the teacher learning processes in the workshops and practice changes ought to be drawn (cf. Jerabek, Gröschner, & Seidel, under revision).

So far our analyses concerning motivational student outcomes and their perceptions of their teacher’s motivation style have been aggregates of the whole class. With the help of multilevel modelling it would be of great value in future analyses to separate context effects (Marsh et al., 2012) from the individual effects and further examine what impact the class composition (e.g., in terms of causality orientations or students’ perceptions of autonomy and competence support) has on the development of different aspects of student learning motivation in the context of productive classroom

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talk. Multilevel modelling would furthermore allow for more exact estimates of the relationships and effects by simultaneously considering within and between variance. Herein also lies potential with regard to individual learning patterns of teachers and the application of this learning in their practice. Other analytic alternatives (all requiring larger samples) could be the estimation of latent-change models for a better assessment of intervention effects on teacher practice and student learning outcomes or auto-regressive models for the analysis of stability and change in student-based variables (Geiser, 2010).

As has been argued above, the functional significance of a social context depends by and large on an individual's motivational dispositions and prior experiences in the context (Deci & Ryan, 2002). For future research, analysing students' prerequisites and prior experiences and examining differential effects between different groups would deepen our understanding not only about what it means to be autonomy and competence supportive as a teacher, but also whether productive classroom talk is equally beneficial for all students. This would mean extending the notion by Scott and colleagues (2006) that different forms of classroom talk are appropriate in different situations during instruction and in the pursuit of different goals to include the perspective of adaptive teaching for different groups of students. Pehmer and colleagues (2015) could show that especially students coming into the study with a low self-concept of ability profited from productive classroom talk, underscoring the differential effects productive classroom talk can have on different groups of students. This form of research is especially important since we know that teachers interact mainly with high-performing students (Brophy & Good, 1974) and that different groups of students interact differently in classroom talk; cognitively and motivationally 'strong' students engage statistically significantly more often, longer, and more intensively in classroom talk than 'struggling' students (Jurik, Gröschner, & Seidel, 2013). Similarly, Seidel (2006) pointed out that integrating cognitive and motivational-affective components is useful for identifying profiles that affect students' perception of supportive science lessons, which in turn affects the development of those cognitive and motivational-affective components (Hornstra, van der Veen, Peetsma, & Volam, 2013; Huber, Häusler, Jurik, & Seidel, 2015). Given that we now have evidence that motivational factors predict student engagement in classroom talk, as well as the learning support during productive classroom talk having positive effects on students' motivational learning outcomes, more integrative research is needed to analyse ways to also engage the ones that are less motivated, affording them opportunities for deep-level learning and motivational development during classroom talk.

In the same vein, prior research has shown that though autonomy supportive from the perspective of research students might interpret particular teaching practices differently (Furtak & Kunter, 2012). Hence, as a precursor for any further studies into the effectiveness of any teaching behaviour in terms of autonomy and competence support, we need to establish students' perspective first. Herein, the Problems in Schools Questionnaire (Deci, Schwartz, Sheiman, & Ryan, 1981; currently revised by

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Vansteenkiste and Reeve) could be used to assess students' favoured teaching behaviour in certain situations and consider these in future analyses. Connected research questions would pursue questions about differences and similarities of different classes, depending on the teaching behaviour that participants show before entering into the teacher professional development, and how students' preferences change during the intervention. Similarly, understanding what conceptions teachers have about the instructional style their students prefer and how that affects their practice change in following teacher professional development would be of great benefit for the field – both in research on student motivation, as well as on professional development. Picking up on this idea, Jang, Reeve and Halusic (2016) recently published research in which they investigate 'teaching students in their preferred way' as a new way of autonomy-supportive teaching.

Moreover, recent studies also established positive effects of autonomy supportive teaching on teachers. Cheon, Reeve and colleagues (2014) showed large and consistent benefits for teachers in an autonomy supportive teaching condition, including greater teaching motivation (psychological need satisfaction, autonomous motivation, and intrinsic goals), skill (teaching efficacy), and well-being (vitality, job satisfaction, and less emotional and physical exhaustion). Similarly, examining potential positive effects of constructive learning support or productive classroom talk on teachers would be great new avenues for future research. Already, negative relationships between teachers' emotional exhaustion and their instructional quality have been reported (Klusmann, Richter, & Lüdtke, 2016; Klusmann, Kunter, Trautwein, Lüdtke, & Baumert, 2008); findings of reverse effects could potentially hold implications for teacher education, the development of instructional quality, teacher well-being and burnout prevention. The finding that providing autonomy and competence support to others yields the giver as much psychological need satisfaction and well-being as does its receiving (Cheon et al., 2014; Deci et al., 2006) also holds importance with regard to motivation during professional development and requires further scrutiny.

In research on instructional quality, teaching scripts have been conceptualised and described in rather broad terms as internal knowledge structures that have been established through repeated engagement with a certain situation and which influence individuals' understanding of and behaviour within that situation. Yet, in research on collaborative learning (e.g., Dillenbourg & Jermann, 2007; Kollar & Fischer, 2006) and in other domains, such as medicine (Beltermann, Wessels, Kollar, & Fischer, 2015), the concept of scripts is used more fine-grained and also regards sub-units such as play, scene, role and scriptlet (Fischer et al., 2013). Micro-analysis of teaching and instruction on the basis of these categories would foster our understanding of effective teaching and also allows for further differentiation of surface structures. Findings that similar scripts vary decisively in their effectiveness (e.g., Dalehefte, 2007) could be re-evaluated under this perspective – in addition to conceptualisations of productive classroom talk systematised. However, such conceptualisations are not only tools for analysis; they can be used to reconstruct teachers' dominant internal teaching script

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(Fischer, 2016) likely to affect their behaviour in the classroom. Hence, internal teachings scripts are similar to values, beliefs or attitudes affecting our physical behaviour. The examination of internal teaching scripts can consequently contribute to our understanding of teacher decision-making and judgement (Shavelson & Sterne, 1981) during instruction. To this end, stimulated recall studies using teachers' own classroom videos from the work with the Dialogic Video Cycle could be used to access internal teaching scripts and reasons for particular teacher behaviour during instruction. Such studies could also help us to understand how teachers see certain behaviours which from a research perspective are deemed productive and where the obstacles to their implementation lie. The analysis of internal teaching scripts can also inform future intervention attempts to change them.

Finally, as teacher professional development in the form of the Dialogic Video Cycle demands large resources on the side of the teachers, as well as on the side of the research team and can therefore – most likely – not be scaled up without changes to the programme, in future research it will be necessary to assess the resources available on both sides and the willingness to forge engaged partnerships between sets of schools and universities. Furthermore, it has to be diagnosed what the demand on the side of teachers is, what forms of effective teacher professional development they can participate in for extended amounts of time, and how they can be built into their working day. The bulk of research on effective teacher professional development has shown that the way it is currently done in Germany (Richter et al., 2011) is less than effective (Clarke & Hollingsworth, 2002; Guskey, 1986). Nonetheless, endeavours like the one presented in this dissertation can only reach limited amounts of teachers, so we need to think about and examine possibilities for the whole of our teacher body in order to be able to take part in evidence-based, effective professional development.

13. Conclusion

In closing, I want to reflect on the aspects this dissertation brings to the field of research on teaching and learning. From the two studies it can be concluded that in order to identify effects of teacher professional development on teachers' practice and student outcomes, we need complex designs such as longitudinal field-experiments, drawing on multiple data sources. As the literature review on teacher professional development focusing on productive classroom talk showed such studies, especially those comparing interventions to assess their effectiveness are still rare. This circumstance points to the scientific importance of the findings presented in the two studies comprising this dissertation as well as all others studies derived from the 'Dialogue' project (Gröschner et al., 2015a, b; Jerabek et al., under review; Kiemer, Gröschner, Pehmer, & Seidel, 2014; Pehmer et al., 2015a, b; Schindler et al., 2015). Furthermore, these studies distinguish themselves by examining the effectiveness of professional development on multiple levels (Lipowsky, 2010).

As a consequence of the participation in the Dialogic Video Cycle, changes to teachers' dominant teaching scripts in the form of more open questions and more constructive feedback could be detected. On a more qualitative level, these were shown as more supportive instructional and motivational discourse. Consequently, carefully designed professional development providing teachers with opportunities for reflection, active learning and lesson planning is a mean to alter the dominant teaching script in Germany in a positive way and provide students a learning environment high in constructive learning support and cognitive activation (Pehmer et al., 2015b). Furthermore, Study 2 aimed to examine the theoretical distinction between instructionally and motivationally supportive discourse (Turner et al., 2002) by empirically determining their different benefits. To our knowledge, this study is one of the first to do so, and only provides limited support for the assumption of two independently working forms of supportive discourse.

Within the changing social context during the intervention, students' situated and dispositional motivational outcomes developed positively. In conclusion, the studies provided emerging evidence for the proposed *motivational function* of productive classroom talk. This further underscores the educational benefits of productive classroom talk as a high-quality teaching script. The conceptualisation of deep structures of instruction, especially the three dimensions of instructional quality (constructive learning support, cognitive activation, and classroom management) provided a fruitful theoretical framework for the explanation of these benefits and the findings of the studies. Furthermore, combining the frameworks of Self-Determination Theory (Deci & Ryan, 1985; Ryan & Deci, 2000), and Person-Object Theory of Interest (Krapp, 2002) with conceptualisations of productive classroom talk showed fruitful to explain the motivational benefits of classroom talk.

In closing, we have completed a complex project that – as a vestige of its design – provides strong evidence on the effectiveness of the Dialogic Video Cycle. Yet, as has been pointed out in the

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Discussion (Section 12), open questions remain which need to be addresses in future studies. Overall, we are encouraged that teachers in the intervention group came to change their dominant teaching script and that the changes in teachers benefited students in terms of different aspects of learning motivation. Supporting teachers to keep up the quality of their instruction throughout a school year ought to become a main goal in school development processes.

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List of Abbreviations

ATM:	Analyzing Teaching Moves Guide
CFI:	Comparative-Fit-Index
CG:	Control Group
DFG:	Deutsche Forschungsgemeinschaft (German Research Foundation)
DIPF:	Deutsches Institut für International Pädagogische Forschung
E.g.:	For example
epiSTEMe:	Effecting Principled Improvement in STEM Education
ESRU:	Elicitation–Student Response–Recognition–Use
Et al.:	And colleagues
Etc.:	Et cetera
F:	F-Value
I.e.:	That is
ICC:	Intra Class Correlation
IG:	Intervention Group
IPN:	Leibnitz-Institut für die Pädagogik der Naturwissenschaften und Mathematik
IRE:	Initiation–Response–Evaluation
IRF:	Initiation–Response–Follow-up
ISB:	Staatsinstitut für Schulqualität und Bildungsforschung
LGC:	Latent Growth Curve
M:	Mean Value
MLM:	Multilevel Modelling
MPI:	Max-Planck-Institut für Bildungsforschung
N:	Sample Size
NGSS:	Next Generation Science Standards
OECD:	Organisation for Economic Co-operation and Development
P.:	Page
P:	P-Value
PIRLS:	Progress in International Reading Literacy Study
PISA:	Programme for International Student Assessment
RSMEA:	Root-Mean-Square-Error-of-Approximation
RTE:	Relative Treatment Effect
SD:	Standard Deviation
SE:	Standard Error
SEM:	Structural Equation Modelling
SLANT:	Spoken Language and New Technology
STEM:	Science, technology, engineering, mathematics
T2:	Measurement Point 2
T3:	Measurement Point 3
TIMSS:	Third International Mathematics and Science Study
TLI:	Tucker-Lewis-Index
TPD:	Teacher Professional Development
Tpost:	Measurement Point 4 (Post-Test)
Tpre:	Measurement Point 1 (Pre-Test)
UK:	United Kingdom
VERA:	Vergleichsarbeiten
β:	Beta-Weight
Δ:	Delta-Score (Difference-Score)

Supplements

Supplement A.

Kierner, K., Gröschner, A., Pehmer, A.-K., & Seidel, T. (2015). Effects of a classroom discourse intervention on teachers' practice and students' motivation to learn mathematics and science. *Learning and Instruction*. 35(1). 94-103. doi:10.1016/j.learninstruc.2014.10.003

Supplement B.

Kierner, K., Gröschner, A., & Seidel, T. (accepted). Instructional and motivational classroom discourse and their relationship with teacher autonomy support and competence support: findings from an intervention study on productive classroom talk. *European Journal of Psychology of Education*.

Eidesstattliche Erklärung

Ich erkläre an Eides statt, dass ich die bei der promotionsführenden Einrichtung

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A Video-Based Intervention Study on the Effectiveness of a Teacher Professional Development
Programme*

in

Unterrichts- und Hochschulforschung

unter der Anleitung und Betreuung durch

Prof. Dr. Tina Seidel

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