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THEMENTEIL

How do teachers promote self-regulation of learning when students need to learn at home? The moderating role of teachers' ICT competency

Antonia Fischer · Charlotte Dignath

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Abstract The importance of self-regulation of learning became evident during the Covid-19 pandemic and the accompanying school closures. Using data from $N = 254$ German teachers, we analyze how teachers promoted self-regulation of learning in distance education and reasons why they did not promote it. Additionally, we examine which teacher and class variables predict the promotion of self-regulation of learning in distance education and whether teachers' technology competency moderates these relationships. Further, we look into whether these relationships differ during the first lockdown in spring 2020, for which teachers were not able to prepare for ahead of time, and the beginning of the new school year 2020/2021. Qualitative analyses indicate that teachers focused on promoting metacognitive strategies and used technology to engage students. Reasons why teachers did not promote self-regulation of learning are mostly a lack of resources and misconceptions about students' competences and needs. Regression analysis show that teachers' self-efficacy to promote self-regulation of learning and students' grade predict teachers' promotion of self-regulation of learning in distance education. Moderation analyses reveal interactions between teachers' technology competency and class size as well as

Antonia Fischer and Charlotte Dignath are now at TU Dortmund University, Center for Research on Education and School Development (IFS).

✉ Antonia Fischer · Charlotte Dignath
Center for Research on Education and School Development (IFS), TU Dortmund University, Vogelpothsweg 78, 44227 Dortmund, Germany
E-Mail: antonia2.fischer@tu-dortmund.de

Charlotte Dignath
E-Mail: charlotte.dignath@tu-dortmund.de

IDeA Research Center for Individual Development and Adaptive Education of Children at Risk, Rostocker Str. 6, 60323 Frankfurt am Main, Germany

DIPF | Leibniz Institute for Research and Information in Education, Rostocker Str. 6, 60323 Frankfurt am Main, Germany

grade—but only for the period after the summer holidays in 2020/2021. This paper uncovers areas of improvement for teacher education, such as their misconceptions, self-efficacy beliefs, and their technology competency—not only for homeschooling during a pandemic, but also for future learning opportunities in the 21st century that will contain the need for more self-regulation of learning due to the increasing use of technology and digital learning.

Keywords Self-regulation of Learning · Promotion of SRL · Misconceptions · ICT Competency · Distance Education · School Closures

Wie fördern Lehrkräfte Selbstregulation beim Lernen, wenn Schüler*innen von Zuhause Lernen Müssen? Die Moderierende Rolle der IKT-Kompetenz von Lehrkräften

Zusammenfassung Die Relevanz von Selbstregulation beim Lernen wurde während der Covid-19-Pandemie und den einhergehenden Schulschließungen deutlich. Anhand der Daten von $N = 254$ deutschen Lehrkräften untersuchen wir, wie Lehrkräfte Selbstregulation beim Lernen im Distanzunterricht gefördert haben sowie Gründe für die Nichtförderung. Zusätzlich analysieren wir, welche Lehrkräftevariablen und Variablen auf Klassenebene die Förderung von Selbstregulation beim Lernen im Distanzunterricht vorhersagen und ob die Technologiekompetenz der Lehrkräfte diese Zusammenhänge moderiert. Darüber hinaus untersuchen wir, ob sich diese Zusammenhänge während des ersten Lockdowns im Frühjahr 2020, auf den sich die Lehrkräfte nicht vorbereiten konnten, und zu Beginn des neuen Schuljahres 2020/2021 unterscheiden. Wir finden, dass Lehrkräfte einen Fokus auf die Förderung metakognitiver Strategien legten und digitale Medien nutzten, um die Schüler*innen zu erreichen. Gründe für die Nichtförderung lassen sich auf mangelnde Ressourcen zurückführen, gefolgt von Fehlkonzepten über die Kompetenzen und Bedürfnisse ihrer Schüler*innen. Die Ergebnisse multipler Regressionen zeigen, dass die Selbstwirksamkeit der Lehrkräfte und die Klassenstufe die Förderung von Selbstregulation beim Lernen im Distanzunterricht vorhersagen. Moderationsanalysen zeigen signifikante Wechselwirkungen zwischen der Informations- und Kommunikationstechnologiekompetenz der Lehrkräfte und der Klassengröße sowie der Klassenstufe – aber nur für den Zeitraum nach den Sommerferien 2020/2021. Diese Studie deckt mehrere Verbesserungsmöglichkeiten für die Lehrkräfteausbildung auf, wie z. B. die Fehlkonzepte von Lehrkräften, ihre Selbstwirksamkeitsüberzeugungen zur Förderung der Selbstregulation und ihre Kompetenzen im Bereich der Informations- und Kommunikationstechnologie – nicht nur für den Fernunterricht während einer Pandemie, sondern auch für zukünftige Lernmöglichkeiten im 21. Jahrhundert, die aufgrund der zunehmenden Nutzung von Technologie und digitalen Lernumgebungen mehr Selbstregulation beim Lernen erfordern werden.

Schlüsselwörter Selbstregulation beim Lernen · Förderung von SRL · Fehlkonzepte · IKT-Kompetenz · Fernunterricht · Schulschließungen

Self-regulation of learning (SRL) describes the ability to plan, monitor and reflect one's learning process (Zimmerman 2000). SRL is essential for students' academic performance and learning motivation (Donker et al. 2014). Covid-19 school closures emphasized its necessity even more: Students were suddenly in a less structured and less than usually supported learning environment (Wößmann et al. 2021), in which SRL was especially helpful (Carter et al. 2020). Since compared to in-classroom lessons, in most cases there was less teacher-student interaction and monitoring from the teacher side. For example, at the beginning of 2021, students on average only spent 1.3 h per day in a distance learning lesson, for example via a video conferencing tool (Wößmann et al. 2021). If there is less exchange and communication between students and teachers, students need to organize and monitor their learning process more (Grewenig et al. 2020). For example, students needed to plan their learning steps, set learning goals, monitor their progress over longer periods of time (e.g., a whole week in distance education instead of only one or several lessons within the classroom) and also reflect on their progress and difficulties they were experiencing. Given this need for SRL in distance education on the one hand, but research indicating that students are not using much SRL in their everyday learning (Lawson et al. 2019), it is central to support students in their SRL development. Since SRL trainings have proven to be successful both in regular education (Dignath et al. 2008) and in distance education (Edisherashvili et al. 2022), it shows that SRL can indeed be taught and learned. As teachers are interacting with their students daily and are the ones setting the tasks, they are in a good position to promote SRL, particularly when students have to self-regulate more than usually, such as during school closures. This paper aims to shed light on teachers' SRL promotion during pandemic distance education in Germany. To understand teachers' SRL promotion in distance education in detail, we code answers to open-ended questions on *how* teachers promoted SRL during school closures and reasons *why* they did not. Understanding why teachers have not promoted SRL in distance education can improve our comprehension of teachers' SRL promotion and provide new perspectives on teacher education. We further look into possible predictors of teachers' degree of SRL promotion in distance education, such as aspects of their professional competence regarding SRL, and class characteristics.

We also consider a moderating role of teachers' information and communication technology (ICT) competency. Since alternative means of contact did not provide as nuanced possibilities to support remote learning (Eickelmann and Gerick 2020), teachers were inclined to use ICT in order to promote their students' SRL in distance education (Robert Bosch Stiftung 2021). We assume an interaction between teacher and class characteristics and teachers' ICT competency; because even if teachers have the necessary skills and belief system and want to adapt their SRL promotion to class characteristics, in distance education they will likely only be successful if they use digital media to promote SRL. When speaking of teachers creating digital learning environments, we do not mean them coding and programming complex digital worlds for their students. Rather, the digital learning environments we mean promote students' use of SRL strategies on one hand. These include planning (e.g., by providing a tool with which students can plan their tasks for the upcoming week and set deadlines, move tasks from "not started" to "in progress" to "completed"

etc.), monitoring (e.g., by offering online vocabulary tests or math problems that immediately provide feedback on one's performance), evaluating (e.g., by providing the possibility to tick a task off online) and reflecting (e.g., by prompting students to answer questions about how well they understood the contents). On the other hand, such environments would foster students' SRL indirectly by providing students with the autonomy to decide when they want to work on which task with which materials, allowing for transfer (e.g., by watching videos) or allow cooperative learning with peers.

Lastly, we look into possible differences between teachers' SRL promotion in distance education in the first lockdown in spring 2020, for which teachers were not able to prepare for ahead of time, and the period of time after the summer holidays at the beginning of the new school year in 2020/2021, when teachers and schools had some time to come up with an approach for distance learning (Wößmann et al. 2021).

1 Theoretical background

1.1 The COACTIV model of professional teaching competence

Different aspects of teacher competence work together to affect teachers' instructional actions, which in turn influence student outcomes. According to the COACTIV model, these aspects include professional knowledge and beliefs, motivational orientations, and self-regulatory skills (Kunter et al. 2013). This paper draws on the COACTIV model and aims to transfer its assumptions to the context of SRL. When speaking of teachers' professional beliefs, we therefore refer to beliefs that are consistent or inconsistent with SRL theory (Vosniadou et al. 2021). Amongst others, they include beliefs about the nature of constructive learning and teaching or transmissive teaching (more details in the Method section). Likewise, in the context of SRL, teachers' motivational orientations can be observed via their self-efficacy beliefs, more specifically their belief of how well they can promote SRL among their students. Lastly, drawing on Kramarski and Heaysman's (2021) "triple SRL–SRT processes" framework, teachers' self-regulatory skills refer both to teachers self-regulating their own learning as a *learner* and them self-regulating their work as self-regulated *teachers*. The authors also name a third process, namely teachers activating their students' SRL as *teachers* of SRL, which in this article is our outcome variable *teachers' promotion of SRL in distance education*. To illustrate this with an example, based on Zimmerman's (2000) cyclical model, teachers can both plan, monitor and reflect on a learning process where they for example learned new content knowledge (therefore self-regulating their learning), reflect on whether they met their goals within a lesson (therefore self-regulating their working) or promote these behaviors amongst their students (therefore being promoters of their students' SRL).

Research has demonstrated that aspects of teacher competence that are specific to SRL (e.g., their beliefs about SRL or their own SRL) predict teachers' SRL promotion in the classroom (Darmawan et al. 2020; De Smul et al. 2018; Dignath and Veenman 2021). However, this has not yet been investigated in regular as well

as pandemic-related distance learning. As teachers' own SRL (Heaysman and Kramarski 2022), self-efficacy beliefs to promote SRL (Dignath-van Ewijk 2016) and beliefs about SRL (Darmawan et al. 2020) turned out to be most important predictors of SRL promotion in within-classroom settings, the present study looks into which of these are predictors that explain variation in teachers' SRL promotion in distance education as well.

1.2 Class characteristics

Research further assumes that teachers adapt their SRL promotion to class characteristics (Kunter et al. 2013). While there are plenty of class characteristics that might impact students' SRL, in the present paper we want to focus on class characteristics that affect how easily teachers can promote students' SRL in distance education. We do so by investigating the impact of two specific variables since teachers' SRL promotion in the classroom has been found to be adapted to them. Namely, these variables are class size and grade: Teachers promote SRL more in smaller classrooms (Vandevelde et al. 2012) and in higher grades (Dignath and Büttner 2018). However, whether teachers adapt their SRL promotion to both of these class characteristics has not yet been examined in the context of distance education.

1.3 A detailed look into teachers' promotion of SRL in distance education

Given the need for SRL in distance education (Wößmann et al. 2021) and the research finding that SRL skills can be acquired (Dignath et al. 2008), teachers should focus on promoting their students' SRL in distance education. According to Dignath and Veenman (2021), in regular classroom settings, SRL can either be fostered directly by promoting SRL strategies such as planning, monitoring or evaluating, or it can be promoted indirectly by offering learning environments that allow or nudge students to use SRL strategies. However, so far there is no research on whether these different approaches can also be found in teachers' SRL promotion in distance education. Since the instructional setting in distance education is very different from in-classroom settings, it is questionable whether teachers use the same instructional strategies they normally would and whether there are additional aspects that teachers take into account when promoting their students' SRL in distance education. As the first lockdown in spring 2020 and the associated distance learning came completely unexpectedly, teachers had no experience with this type of teaching. The unclear research situation requires an exploratory approach in order to understand how teachers promote SRL in distance education.

Basing our research on the COACTIV model, we are also interested in whether *how* teachers' promote SRL in distance education is related to aspects of teachers' professional competence and class characteristics. This leads us to our first (exploratory) research question:

RQ1 How do teachers report to promote SRL during distance education and how is this related to teacher and class characteristics?

Research on SRL promotion in in-classroom settings mostly use questionnaires to assess teachers' SRL promotion. However, these provide only limited information about teachers' actual behavior and do not display the variance of actions teachers use because participants may recognize the socially desirable response in the items even if they do not actually act on it, as questionnaires do not require open answers but present closed answer options. Due to this lack of depth as well as the fact that questionnaires have often been criticized to produce biased results (e.g., Winne and Perry 2000), in this paper we wanted to assess how teachers promoted SRL in distance education by additional means than only questionnaires.

1.4 Reasons why teachers did not promote SRL during distance education

Furthermore, with regard to teacher professionalization, it is important to understand *why* some teachers did not promote SRL in distance education. What were barriers that stood in their way? Research suggests that teachers' strategy instruction and their beliefs about learning are related (Dignath and Veenman 2021). The COACTIV model further suggests that teachers' competences and knowledge are related to their SRL promotion (Kunter et al. 2013). Hence, we want to look whether the assumptions of the COACTIV model hold up in the context of distance education, therefore investigating whether teacher beliefs and (a lack of) competences are reasons for teachers not promoting SRL in distance education. Analogous to the research question above, we use an exploratory approach to look into explanations for teachers' non-promotion of SRL. Further, we want to look into whether teacher competences and class characteristics are related to the reasons for non-promotion of SRL in distance education that we will find, leading us to our next research question:

RQ2 Why did some teachers not promote SRL during distance education and how is this related to teacher and class variables?

1.5 Testing the COACTIV model in the context of distance education

Kunter et al. (2013) argue that teachers' professional competence includes their professional knowledge, beliefs about learning, motivational orientations and self-regulatory skills. In the present study, we want to tailor this model to the context of SRL and therefore look into teachers' beliefs about SRL, their self-efficacy to promote it and their own self-regulatory skills. Since research has shown that teachers' own self-regulatory skills (Heaysman and Kramarski 2022), their self-efficacy beliefs to promote SRL (Dignath-van Ewijk 2016) and beliefs consistent with SRL theory (Darmawan et al. 2020) are positive predictors of teachers' SRL promotion in in-classroom lessons, we assume the same relationship for distance education settings. Whether beliefs inconsistent with SRL theory are predictors of SRL promotion has not yet been examined—both in in-classroom lessons as well as in distance education. We do however assume that they are negative predictors of SRL promotion.

Since teachers promote SRL more in smaller classes (Vandevelde et al. 2012) and in higher grades (Dignath and Büttner 2018), one can assume that this is also the case for SRL promotion in distance education. However, the class composition in distance education might influence teachers' SRL promotion differently than in in-classroom lessons, which is why we do not have any prior expectations how these constructs relate to SRL promotion in distance education. We therefore derive the following research question:

RQ3 Which teacher (consistent and inconsistent beliefs about SRL, self-efficacy to promote SRL, self-regulatory skills) and class characteristics (class size, grade) predict the degree of SRL promotion during distance education?

1.6 The role of teachers' ICT competency in their promotion of SRL in distance education

During pandemic school closures, many teachers started to implement more ICT in their teaching with teachers still using significantly less ICT in the initial lockdown in 2020 than they did later in the pandemic in 2021 (Lorenz et al. 2023). ICT usage allows to on the one hand substitute analogous teaching processes and on the other hand offers new ways to implement learning processes (Lachner et al. 2020).

The framework model for the integration of digital media (Lachner et al. 2020; in German: Rahmenmodell für die Integration digitaler Medien) draws on the COACTIV model by Kunter et al. (2013) and equally states that aspects of teachers' professional competence influence their teaching quality, which in turn influences students' learning. Additionally, the model proposes that student characteristics influence students' learning. However, going beyond the COACTIV model, the framework model for the integration of digital media proposes that the link between aspects of teachers' professional competence (including their ICT competency) and their teaching is affected by the quality of their media integration. This model is especially relevant for SRL promotion during distance education since teachers were inclined to use ICT in order to promote their students' SRL, since (a) teachers generally used more digital media than before to communicate with their students (Lorenz et al. 2023) and (b) digital media offered more nuanced possibilities to support remote learning and therefore individualize learning (Bartolomé and Steffens 2011; Eickelmann and Gerick 2020).

In the present paper, we used this model and adapted it to the context of SRL promotion in distance education. Figure 1 shows the adapted model: Following Lachner et al.'s (2020) model, we propose that teachers' professional competence influences their SRL promotion in distance education, which in turn influences student usage of SRL. Other than Lachner et al. (2020), we included class characteristics instead of student prerequisites, since teachers have been found to adapt their SRL promotion to them (Dignath and Büttner 2018; Vandevelde et al. 2012). We therefore added a path from class characteristics to teachers' SRL promotion in distance education. However, to design SRL-promoting digital learning environments, teachers may in addition have to possess sufficient ICT competency (Cerezo et al. 2010), which in Lachner et al.'s model (2020) is a part of their professional teaching competence.

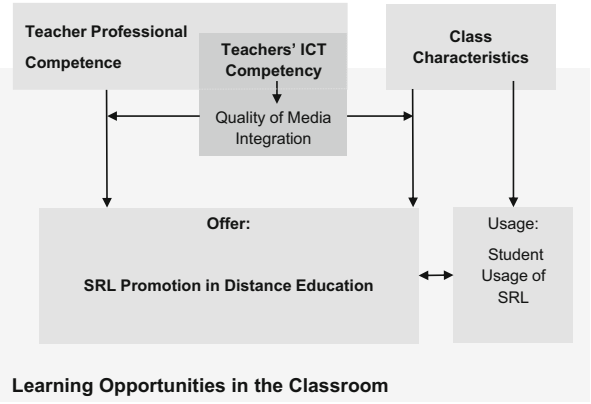

Fig. 1 Adaptation of the Framework Model for the Integration of Digital Media to the Context of SRL Promotion in Distance Education. (Only variables in bolt have been investigated in the present paper)

Even if teachers are highly competent SRL-promoters in terms of their professional competence and their willingness to adapt to class characteristics, they might be likely to promote SRL better in distance education if they have sufficient ICT skills. Although SRL could be promoted in distance education without using ICTs, for example by prompting students to reflect on their work after the completion of a task, this may be done easier and more specifically tailored to the individual student if the teacher uses ICT, such as online tools (e.g., video conference tools) and communication (e.g., emails). Accordingly, there may be an interaction between teachers' SRL competence and ICT competency that affects SRL promotion in distance education. Therefore, we looked specifically into teachers' SRL competency as an aspect of their professional competence, assuming that it has an effect on the quality of teachers' media integration. The aim of the present paper is to analyze the relationships proposed by our adapted model. Since we could not assess teachers' actual implementation of digital media and student usage of SRL only the variables in bolt were taken into account. We aim to answer the following research question:

RQ4 Does teachers' ICT competency moderate the relationships between teacher and class variables and SRL promotion in distance education?

1.7 Differences in teachers' SRL promotion in the first lockdown and after some time to adapt

Research that looked into teachers' use of digital media in distance education found that compared to the first lockdown in spring 2020, teaching in distance education after the second lockdown in spring 2021 took place in a more digital format, for example by using online conference tools or learning platforms (Lorenz et al. 2023). Further, teachers used more digital media in December 2020 after the first lockdown compared to before it in many different areas, such as exchange and coordination with colleagues, staying in contact with students or when they acquired new learning content. Moreover, teachers used new methods and instruments within their lessons compared to prior to the pandemic, and far more teachers used digital learning platforms than they did earlier, after the first lockdown (73% in December 2020

compared to 45% in April 2020; Robert Bosch Stiftung 2021). These findings could be explained by the fact that whilst the first lockdown came very unexpectedly and teachers did not have time to adjust to the changing conditions, in the summer holidays in 2020 they were able to develop new approaches and be prepared for future distance education. In addition, schools could now provide more ICT (both hardware and software), there was greater clarity about data privacy and which ICT tools schools could use (Lorenz et al. 2023). This might also be the reason why students' learning time was higher in a second lockdown starting in December 2020 than it was in the first lockdown in March 2020 (Bujard et al. 2021). According to the authors, this can be traced back to advances in digitization and the organization of distance learning. These considerations led us to investigate our last research question:

RQ5 Are there any differences between the degree of teachers' SRL promotion in spring 2020 during the first lockdown compared to after the beginning of the new school year 2020/2021?

We are interested in whether the same teacher or class variables predict SRL promotion for both points of time and whether teachers' ICT competency moderates the relationships between teacher and class variables in the same way.

2 Method

2.1 Sample

$N = 254$ German-speaking 1st to 8th grade teachers participated in an online survey ($M_{age} = 37.45$, $SD_{age} = 9.86$, $M = 10.56$ years of teaching experience, $SD_{experience} = 8.84$, 83% female). 44% of the participants taught at elementary school, while the rest taught at secondary school. Classes on average had $M = 23.19$ students, $SD = 4.51$.

2.2 Design

Data was collected in spring 2021. School closures and distance learning to restrict Covid-19 had already taken place in all parts of Germany in a first lockdown starting in March 2020 that lasted for 103 days (Bujard et al. 2021). Further school closures followed in December 2020 and lasted for another 173 days (full or partial school closures, Bujard et al. 2021). Whether schools were closed at the time of data collection depended on the incidence rate in the specific federal state. However, all teachers participating in the study had at least experienced one school closure in March 2020, see Bujard et al. (2021) for an overview of school closures and incidence rates in Germany. Our institute's ethics committee granted approval for the study. Participants' informed consent was obtained for data processing.

We used open-ended questions and questionnaires. A bilingual native speaker translated all foreign language instruments to German; they were then back-translated. The translations were tested with a pilot sample of teachers to check whether the items were understandable (see scale ranges for all instruments in Table 3).

2.3 Instruments

Since we performed both qualitative and quantitative analysis, we aimed to capture our outcome variable SRL promotion in distance education by multiple means. The first method (coding of answers to open-ended questions) allowed to qualitatively code *how* teachers promoted SRL in distance education in detail, while the second (self-report items) gave us information about the degree of SRL promotion and allowed to quantitatively analyze the data and run regression and moderation analysis.

At the time of our data collection, no published instruments existed to capture teachers' promotion of SRL in distance education.

2.3.1 SRL promotion in distance education—How do teachers promote it?

Therefore, in order to answer RQ1, we asked all teachers: "Please describe the ways you have discussed with your students how they can learn at home or how you plan to discuss it." The answers were analyzed according to Mayring's (2010) qualitative content analysis, a coding evaluation method that aims to assign categories to data material and thus break down the research question. We worked deductively with a theoretically based category system and inductively derived further categories from the data. The responses of 246 teachers were divided into events, resulting in 763 events that were all double coded by two coders. The overall interrater reliability was acceptable with $\kappa = 0.67$, since according to Landis and Koch (1977), values above 0.61 show substantial agreement. Discrepancy was solved by discussion.

Teachers' answers were clustered into three major clusters: (1) direct activation of SRL, (2) indirect promotion of SRL via the creation of learning environments, and (3) how teachers dealt with distance learning in general.

For the first and second cluster we worked deductively and followed the classification of SRL promotion from the ATES observation instrument (Dignath and Veenman 2021), which distinguishes between direct (cluster 1) and indirect (cluster 2) SRL promotion. With regard to cluster 1, it includes the activation of students' *metacognition, cognition* and *motivation* and *resources.* We inductively added activation of students' *emotion regulation.* With regard to indirect SRL promotion, the ATES contains the aspects *autonomy, transfer, cooperative learning* and *constructive learning*. For the third cluster, we inductively added six more categories based on the available data, namely *ICT usage, ICT competency, methodology, communication, feedback* and *design of distance learning*. We also created categories for when teachers stated to have conducted *no SRL promotion* during distance education and for *irrelevant* teacher statements that had nothing to do with the question asked. This resulted in 17 categories according to which teacher responses were systematically coded (see Table OR1.1 in Online Resource 1 for the coding scheme).

2.3.2 SRL promotion in distance education—How much do teachers promote it?

Additionally, for the quantitative analysis (RQ3, RQ4 and RQ5) we used two self-developed items that were answered on a five-point Likert-Scale ranging from *does*

not apply at all (1) to *fully applies* (5): "I have discussed the approach to learning at home ..."

a. "during the lockdown in spring 2020."
b. "at the beginning of the school year 2020/2021 since the reopening of schools in preparation for further school closures."

In doing so, we wanted to assess whether teachers' SRL promotion in distance education (1) differed between the period in which all schools were closed in spring 2020 and the period after the summer break in 2020/2021 and (2) whether teachers' ICT competency played a role at both time points, since teachers reported to use more digital media only after the emergency lockdown in spring 2020 (Lorenz et al. 2023) and teachers reported there was less need for improvement in teachers' competencies with digital learning formats in December 2020 than in April 2020, right after the first lockdown (Robert Bosch Stiftung 2021).

2.3.3 Why teachers did not promote SRL in distance education

The second open question we asked in order to answer RQ2 that all teachers were presented was: "Please describe the reasons why you have NOT or do NOT plan to talk to your students about how to approach learning at home." Based on the COACTIV model (Kunter et al. 2013) described earlier, we used deductive codes for (1) *teacher competences* and (2) their *misconceptions* as reasons for not promoting SRL. Misconceptions included the ideas that (2.1) students are not able to use SRL strategies (*misconceptions about students' competences*) or (2.2) that it is not necessary to teach students SRL strategies (*misconceptions about students' needs*), because they either already know how to use SRL strategies or they will not need SRL strategies. We added inductive codes for (3) a lack of *teacher* (and school) *resources*, (4) teachers' belief that distance learning would not occur again (*belief in further school closures*), (5) negative *consequences* that were expected if SRL was promoted, (6) *temporal reasons* making it impossible to promote SRL during distance education and (7) *irrelevant statements* (see Table OR1.2 in Online Resource 1 for the detailed coding scheme). The interrater reliability was substantial, $\kappa = 0.68$ (Landis and Koch 1977) and discrepancies were solved by discussion.

2.3.4 Beliefs about SRL

We assessed teachers' beliefs about SRL using the short version of the BALT (Beliefs about Teaching and Learning, Darmawan et al. 2020). 31 items assess beliefs that are consistent (14 items) and inconsistent (17 items) with a scientific understanding of SRL. Beliefs consistent with SRL theory include beliefs about the nature of constructive learning (e.g., "Learning requires organization of information in memory."), constructive teaching (e.g., "An important task for teachers is to teach students strategies for learning.") and the belief that SRL is relevant for performance (e.g., "When students learn how to learn, their performance improves.", Vosniadou et al. 2021). Beliefs inconsistent with SRL theory include beliefs about quick and natural learning (e.g., "Successful students learn things quickly."), transmissive teaching

(e.g., "The main task of the teacher is to dispense information.") and the belief that SRL is not relevant for students' achievement (e.g., "Students do not need to be able to describe their learning strategies."). Both subscales showed satisfactory reliability in our sample (consistent beliefs: Cronbach's $\alpha = 0.85$, inconsistent beliefs: Cronbach's $\alpha = 0.81$, Blanz 2015), using a six-point Likert scale ranging from *completely disagree* (1) to *completely agree* (6).

2.3.5 Self-efficacy to promote SRL

We captured teachers' self-efficacy beliefs to promote SRL using the TSES-SRL (Teacher Self-Efficacy Scale to implement Self-Regulated Learning, De Smul et al. 2018), consisting of 23 items (e.g., "How well can you teach your students which self-regulated learning strategies exist?") using a five-point Likert scale ranging from 1 (*cannot do at all*) to 5 (*highly certain can do*). The scale showed satisfactory reliability, Cronbach's $\alpha = 0.91$ (Blanz 2015).

2.3.6 Teachers' self-regulatory skills

We assessed teachers' self-regulatory skills as self-regulated learners and teachers using an instrument by Dörrenbächer and Perels (2016). It comprises eight items (e.g., "After completing an activity for school, I check to see if I have met my goals."), using a four-point Likert scale ranging from *rather not true* (1) to *rather true* (4) and achieved satisfactory reliability, Cronbach's $\alpha = 0.73$ (Blanz 2015).

2.3.7 Teachers' ICT competency

When speaking of teachers' ICT competency, we refer to basic ICT skills, such as the use of online communication tools, video conferencing systems or digital planning tools, but not to teachers' design of complex digital learning environments, since this was not the reality in most schools in Germany during distance education (Wößmann et al. 2021). Teachers' ICT competency was assessed with a scale by Vanderlinde and van Braak (2010). Five items measure the extent to which teachers feel competent to integrate ICT into their teaching practice (e.g., "I have sufficient technical knowledge and skills to use ICT in classroom.") on a five-point Likert scale ranging from *completely disagree* (1) to *completely agree* (5) with a satisfactory reliability, Cronbach's $\alpha = 0.89$ (Blanz 2015).

2.3.8 Class characteristics

Teachers were instructed to relate their responses to a specific class they were teaching at the time of the survey. For class characteristics, teachers reported this classes' grade and class size.

2.4 Analyses

To answer RQ1 and RQ2, we coded teachers' answers to the open questions and computed the frequency with which each code was assigned and correlations with teacher and class variables.

The quantitative data was analyzed using multiple regression and moderation analyses to answer RQ3, RQ4 and RQ5. In order to predict teachers' promotion of SRL in distance education, we included teacher (consistent and inconsistent beliefs, self-efficacy beliefs, self-regulatory skills) and class characteristics (grade, class size) in the models. We carried out separate analysis for the item assessing teachers' SRL promotion during the lockdown in spring 2020 and SRL promotion during distance learning after the summer holidays in 2020/2021 when teachers had been able to adapt to the situation. We started with a baseline model which only included the teacher variables, in a next step added the class characteristics, and in a third step modelled the interaction with ICT competency.

3 Results

In the following section, we start by answering RQ1 and RQ2 by analyzing the open-ended questions, and then continue to answer RQ3–RQ5 by looking into the questionnaire data.

3.1 How do teachers report to promote SRL during distance education and how is this related to teacher and class characteristics?

Table 1 shows the codes' frequencies in descending order, sorted by the three clusters direct activation of SRL, indirect promotion of SRL via the creation of learning environments and general approach to teaching students at home.

3.1.1 Direct activation of SRL

Of all aspects of SRL, metacognition was activated most frequently, followed by activation of students' motivation and resources. Only rarely mentioned was the activation of cognition or emotion.

To activate metacognition, teachers most often stated to foster their students' planning by working with weekly schedules and by completing and exemplary checking off the weekly schedule together. Teachers also indicated to talk to their students about time and task management and aided them in monitoring their actions while studying and reflecting on a task after its completion, for example by offering options to check off achieved goals in a digital tool.

To promote students' motivation, teachers reported to explain how a learning environment that is conducive to study productivity and motivation should be arranged. Other topics discussed were break management, movement exercises, how to proceed if students do not feel like studying, and how to use rewards to foster one's motivation. Some teachers reported that they provided students with feed-

Table 1 Frequency of Codes per Cluster

Cluster	Code	Frequency
Direct Activation of SRL	Metacognition	246
	Motivation	94
	Resources	65
	Cognition	14
	Emotion	6
Indirect Promotion of SRL via the Creation of Learning Environments	Autonomy	31
	Cooperative Learning	10
	Transfer	6
	Constructive Learning	0
General Approach to Teaching Students at Home	Methodology	94
	ICT Usage	82
	Communication	51
	ICT Competency	27
	Feedback	24
	Design of Distance Learning	14
Irrelevant Statements		10
No SRL Promotion		2
Total		*763*

$N = 246$
SRL Self-Regulation of Learning, *ICT* Information and Communication Technology

back on their learning, or taught students self-instruction to encourage and motivate themselves.

The resource strategy that teachers activated most frequently was help seeking (e.g., asking peers or parents for help). Furthermore, teachers told their students how to work with study helpers, such as dictionaries, or how to look for additional materials.

Teachers activated cognition by speaking about reading strategies (e.g., highlighting important text passages), organization strategies (e.g., using mind maps), and memory strategies (e.g., mnemonic bridges or using index cards).

Very few teachers stated to promote students' emotion regulation, for example by reflecting on students' feelings during school closures.

To test how teachers' reported SRL promotion in distance education is related to aspects of their professional competence, we calculated correlations between the number of direct SRL support measures named by the teachers in the open-ended answer and teachers' questionnaire answers. Teachers' description of their direct promotion of SRL and their beliefs consistent with SRL theory correlated positively, $r(221) = 0.21$, $p = 0.001$, while beliefs inconsistent with SRL theory correlated negatively with direct promotion of SRL, $r(221) = -0.18$, $p = 0.01$. In addition, the number of direct SRL support measures reported by the teachers was positively related to the items measuring SRL promotion in distance education from the online survey, both for during the lockdown in spring 2020, $r(215) = 0.22$, $p = 0.001$, and the period after the school holidays at the beginning of the school year 2020/2021, $r(219) = 0.24$, $p < 0.001$.

3.1.2 Indirect promotion of SRL via the creation of learning environments

With regard to the learning environment, teachers mostly reported to provide students with autonomy by providing them with a choice of tasks, timing, or order of task completion. Few teachers reported that students could decide freely what they wanted to learn.

Concerning cooperative learning, teachers stated that they assigned students to groups or study partners that worked on tasks together, in order for students to be able to help each other out in case of difficulties. Some teachers also assigned different roles to students for the working-from-home period.

Regarding transfer, few teachers reported to make a reference to everyday student life and to embed learning content in a concrete situation. No teacher stated to provide their students with a learning environment which fosters constructive learning.

We conducted correlational analyses to examine a possible relationship between the number of indirect SRL support measures cited by teachers and teacher and class variables, but found no significances.

3.1.3 General approach to teaching students at home

The second most frequently assigned code was *methodology*, which describes methods teachers used to promote students' learning during school closures. Many teachers provided students with materials and tips on how to study productively from home. Some stated that they additionally reflected about these tips with the students during their teaching hours, for example by having students talk about their learning experiences and commenting on these. Others modeled the daily routine when working from home to their students, for example by writing a letter from fictional students who describe how they study from home. Some teachers reported that their school had held a "study methods week" before the pandemic, where students had learned SRL strategies on which they could draw in the distance learning situation. Single schools also offered emergency care for students in need.

Unsurprisingly, many teachers stated ICT usage, such as video conferencing systems, learning platforms, study apps or interactive worksheets to engage their students in learning during school closures. Moreover, some teachers reported to promote their students' ICT competency. However, this was only a quarter of all teachers who had reported to use ICT to promote distance learning.

Regarding communication, many teachers offered consultation hours, communication by email, group or individual video conferencing calls, called their students by phone, or used messages on learning platforms to communicate. For younger students, some teachers stated that they often communicated with parents.

Few teachers reported to regularly ask their students for feedback so that they can adapt their lecture style during school closures according to students' experiences.

We found a substantial variation in teachers' reports about their creation of distance learning. While some teachers reported to follow their regular classroom schedule (e.g., two lessons of English, then Biology etc.), others did not conduct video conferences all the time, but had their students work independently at home accord-

ing to their timetable. Finally, others had video conferences in the morning and let their students decide independently when they wanted to work for the rest of the day.

Correlations with the number of ICT-related support measures and teacher and class variables revealed that teachers with a higher number of ICT-related support measures also reported more SRL promotion in distance education in the questionnaire, but only for the period of time at the beginning of the school year 2020/2021, not in the lockdown in spring 2020, $r(219) = 0.16$, $p = 0.002$. In addition, teachers with increasing professional experience cited more ICT-related support measures, $r(220) = 0.13$, $p = 0.04$.

3.2 Why did some teachers not promote SRL during distance education and how is this related to teacher and class variables?

Out of 254 teachers, 44 explained why they did not promote SRL during school closures. Table 2 shows the frequency of assigned codes. The reason most often mentioned is lack of resources. Mostly, teachers mentioned not to have enough time to implement SRL promotion in distance education in addition to the normal teaching content, (e.g., "I often don't have the time in class or I don't take the time.") or not to be able to reach their students (e.g., "I have limited ability to ask about learning behavior because our school does not have chats or video chats, but communicates solely via cloud and email."). These teacher statements illustrate teachers' misconceptions that it is not worth spending time promoting SRL, and that SRL promotion is dependent on face-to-face communication.

The second and third most frequently assigned codes were misconceptions about students' needs and competences. For example, teachers reported that they assumed their students do not need support because the tasks are simple enough (e.g., "In the case of easy-to-understand tasks in the workbook, I assume that the students can work independently without support."). Some teachers reported that they do not consider their students capable of thinking about learning (e.g., "My first graders still have a hard time explaining their learning behaviors.") Both examples illustrate teachers' misconceptions that students do not need SRL or that students are too young for SRL.

Table 2 Frequency of Codes

Code	Frequency
Lack of Resources	18
Misconceptions about Students' Needs	12
Misconceptions about Students' Competences	12
Teacher Competences	8
Belief in Further School Closures	5
Consequences	4
Temporal Reasons	4
Irrelevant Statements	3
Total	*66*

$N = 44$

Alongside this, some teachers do not promote SRL because they lack competences (*teacher competences*). For example, teachers have little or no experience with SRL (e.g., "too little personal experience"), or they lack concrete ideas for implementation (e.g., "Because I am partly unsure how to do it myself, I have no straightforward plan and no role models to guide me."). Thus, in addition to misconceptions, teachers' experience and self-efficacy also play an important role in why they did not promote SRL in distance education.

We performed T-tests to examine whether and how teachers, who indicated reasons why they did not promote SRL, differed in their SRL competence and in their class composition from teachers who did not indicate this. These teachers are found to have significantly lower self-efficacy to effectively promote SRL, $t(249) = -2.52$, $p = 0.01$, as well as significantly lower beliefs consistent with SRL, $t(251) = -1.98$, $p = 0.04$, and to provide less SRL promotion in their distance education, both during the lockdown in spring 2020, $t(242) = -5.25$, $p < 0.001$, as well as after the reopening of schools for the school year 2020/2021, $t(246) = -5.29$, $p < 0.001$.

3.3 Results of questionnaire data

We z-standardized the data for better interpretation. We conducted separate analysis with the two outcome items measuring SRL promotion during the lockdown in spring 2020 and the period after the start of the new school year 2020/2021. We first modelled the teacher variables (Model 1), then included the class characteristics (Model 2), and in the end implemented the interaction with ICT competency (Model 3).

3.3.1 Descriptive statistics

Table 3 shows that teachers scored below the scale mean regarding their own self-regulatory skills, very high in their beliefs consistent with SRL theory, and above average in ICT competency and SRL promotion in distance education for both time points. See Online Resource 2, Table OR2, for the correlation matrix.

Table 3 Descriptive Statistics

Variable	*M*	*SD*	Min	Max	Scale
Own self-regulatory skills	3.12	0.46	1.13	4.00	1–6
Self-Efficacy	3.52	0.53	1.95	5.00	1–5
Consistent Beliefs	5.02	0.49	3.57	6.00	1–6
Inconsistent Beliefs	2.19	0.51	1.00	4.24	1–6
Teachers' ICT Competency	4.05	0.79	1.40	5.00	0–5
Class Size	23.19	4.51	12	34	–
Grade	4.75	2.29	1	8	1–8
SRL Promotion in Distance Education in Spring 2020	3.60	1.24	1.00	5.00	1–5
SRL Promotion in Distance Education After the Summer Holidays in 2020/2021	3.80	1.12	1.00	5.00	1–5

ICT Information and Communication Technology

Table 4 Results of Regression Analysis Predicting SRL Promotion During the Lockdown in Spring 2020

	Model 1		Model 2		Model 3	
Variable	*β*	*SD*	*β*	*SD*	*β*	*SD*
Own Self-Regulatory Skills	–0.10	0.07	–0.09	0.07	–0.07	0.07
Self-Efficacy	**0.23**	0.07	**0.24**	0.07	**0.22**	0.07
Consistent Beliefs	0.06	0.08	0.08	0.08	0.06	0.08
Inconsistent Beliefs	0.03	0.07	0.05	0.07	0.06	0.08
Class Size	–	–	0.01	0.07	0.01	0.07
Grade	–	–	**0.24**	0.07	**0.22**	0.07
ICT Competency	–	–	–	–	0.07	0.07
Own Self-Regulatory Skills * ICT Comp.	–	–	–	–	–0.01	0.07
Self-Efficacy * ICT Comp.	–	–	–	–	–0.06	0.07
Consistent Beliefs * ICT Comp.	–	–	–	–	–0.01	0.07
Inconsistent Beliefs * ICT Comp.	–	–	–	–	–0.04	0.07
Class Size * ICT Comp.	–	–	–	–	0.10	0.07
Grade * ICT Comp.	–	–	–	–	–0.07	0.07
R^2	0.04		0.10		0.13	

Sample size: $N = 244$
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Coefficients in bold are significant at $p < 0.05$

3.3.2 Which teacher and class characteristics predict the degree of SRL promotion during distance education?

In the regression models, on the teacher side, we included teachers' (1) own self-regulatory skills, (2) self-efficacy beliefs about promoting SRL, (3) beliefs consistent and (4) inconsistent with SRL theory. On the class level, we considered (5) class size, and (6) grade. In the end, we included the interaction with (7) teachers' ICT competency.

3.3.3 Analysis with SRL promotion during the lockdown in spring 2020

The promotion of SRL during the lockdown in spring 2020 was positively predicted by teachers' self-efficacy beliefs and students' grade (see Table 4). These predictors remained significant over all three models, with $\beta = 0.22$, $p < 0.01$ for both variables in Model 3 (a small to average effect size according to Cohen 1988). There was no significant interaction between teacher or class variables and ICT competency. The multiple R^2 increased for each model, with a final resolved variance of 0.13 (a moderate resolved variance according to Cohen 1988).

3.3.4 Analysis with SRL promotion after the reopening of schools in 2020/2021

The promotion of SRL after the reopening of schools in 2020/2021 was again positively predicted by teachers' self-efficacy beliefs and students' grade (see Table 5). These predictors remained significant over all three models, with $p < 0.05$ in Model 3

Table 5 Results of Regression Analysis Predicting SRL Promotion After the Reopening of Schools in 2020/2021

	Model 1		Model 2		Model 3	
Variable	*β*	*SD*	*β*	*SD*	*β*	*SD*
Own Self-Regulatory Skills	–0.02	0.06	–0.01	0.06	–0.02	0.06
Self-Efficacy	**0.41**	0.07	**0.41**	0.07	**0.36**	0.07
Consistent Beliefs	–0.09	0.07	–0.09	0.07	–0.12	0.07
Inconsistent Beliefs	–0.05	0.07	–0.04	0.07	–0.06	0.07
Class Size	–	–	–0.03	0.06	–0.06	0.06
Grade	–	–	**0.15**	0.06	**0.14**	0.06
ICT Competency	–	–	–	–	0.10	0.06
Own Self-Regulatory Skills * ICT Comp.	–	–	–	–	0.10	0.06
Self-Efficacy * ICT Comp.	–	–	–	–	0.00	0.06
Consistent Beliefs * ICT Comp.	–	–	–	–	0.08	0.06
Inconsistent Beliefs * ICT Comp.	–	–	–	–	0.06	0.06
Class Size * ICT Comp.	–	–	–	–	**–0.17**	0.06
Grade * ICT Comp.	–	–	–	–	**0.17**	0.07
R^2	0.16		0.18		0.25	

Sample size: $N = 248$
ICT Information and Communication Technology
Coefficients in bold are significant at $p < 0.05$

and $\beta = 0.36$ for self-efficacy (an average effect size according to Cohen 1988) and $\beta = 0.14$ for grade (a small effect size according to Cohen 1988). There was a significant interaction between both class size and grade and ICT competency (see more details in the next paragraph). Again, the resolved variance increased with each extending step, leading to a moderate to high resolved variance according to Cohen (1988), who states that the cut-off value for a high resolved variance is $R^2 = 0.26$.

3.3.5 Does teachers' ICT competency moderate the relationships between teacher and class variables and SRL promotion during distance education?

Figure 2 shows the interaction between class size and ICT competency (Fig. 2a), $\beta = 0.17$, $p = 0.01$, and grade and ICT competency (Fig. 2b), $\beta = -0.17$, $p = 0.01$, for the outcome variable SRL promotion in distance education after the reopening of schools in 2020/2021.

Whilst teachers with a high ICT competency promoted SRL in distance education steadily regardless of class size, teachers with low or average ICT competency adapted their ICT competency depending on the size of their class. Teachers with an average ICT competency tended to increase their ICT promotion with more students in the class, while teachers with a low ICT competency tended to promote SRL in distance education less with an increasing class size.

Teachers with a high ICT competency also remained relatively stable in their SRL promotion in distance education with regards to students' grade and therefore did not promote SRL differently in lower or upper grades. Teachers with an average

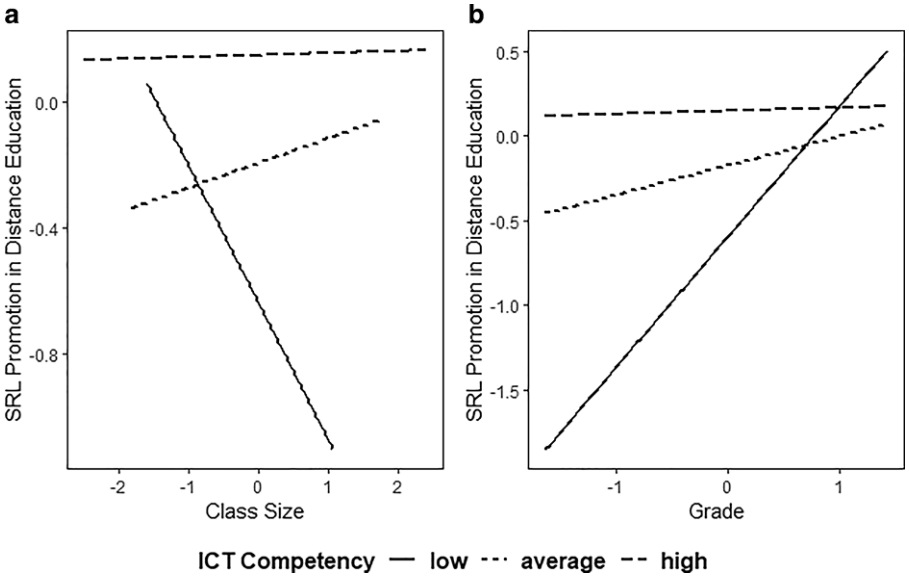

Fig. 2 Significant Interactions of the Variables with Teachers' ICT Competency

ICT competency only increased their SRL promotion slightly for older students, while teachers with a low ICT competency promoted SRL much more in higher than lower grades.

3.3.6 Are there any differences between teachers' SRL promotion in spring 2020 during the first lockdown compared to the beginning of the new school year 2020/2021?

Teachers reported more SRL promotion in distance education after the beginning of the new school year 2020/2021 ($M = 3.80$, $SD = 1.12$) compared to during the lockdown in spring 2020 ($M = 3.60$, $SD = 1.24$). The regression analysis indicate that during both points of time the same variables were significant predictors of teachers' SRL promotion (self-efficacy beliefs and grade). However, only after the summer holidays at the beginning of the new school year in 2020/2021, we found teachers' ICT competency to be a significant moderator of the relationship between class size and grade and teachers' ICT promotion in distance education.

4 Discussion

SRL is an important core competency, especially in situations where learners are on their own. Covid-19 school closures were an extreme example of a situation where students—even at a young age—relied heavily on themselves for learning (Vodafone Foundation Deutschland 2020). This makes it even more intriguing to understand how teachers promoted students' SRL in distance education and why

some teachers supported their students learning in general, and specifically their SRL, more than others (Dietrich et al. 2020). We examined how teachers promoted SRL in distance education and what reasons they had for not doing so. Additionally, we looked into which teacher and class characteristics might explain differences in teachers' SRL promotion in distance education. We also tested interaction effects with ICT competency for the particular situation of distance education and looked into whether there are differences in teachers' SRL promotion in the first lockdown in spring 2020 and after the summer holidays at the beginning of the new school year 2020/2021.

On the question of how teachers promoted SRL in distance learning, the qualitative analyses showed that teachers frequently mentioned to activate metacognition, and in some cases motivation, in their students, whilst rarely stimulating cognitive strategies or emotion regulation strategies. Whilst the promotion of metacognition is essential for SRL (Corno 1986), there is still potential for development since studies have found a link between emotions, academic performance and SRL usage (Pekrun et al. 2002). Especially in the particularly distressing situation of the pandemic, it is reasonable to assume that children's emotions played an important role in their learning, and insufficient emotion regulation may have stood in the way of learning (Lades et al. 2020).

Further, we found that while many teachers used the distance learning setting to give students choices in learning to promote autonomy, cooperative learning was used rather infrequently, teachers hardly reported to encourage transfer and no teacher provided students with constructivist learning environments. Whilst all of these aspects are conducive to a learning environment which enables students to use SRL strategies (e.g., De Corte et al. 2004), teachers should focus more on creating opportunities for cooperative learning (e.g., Vosniadou et al. 2001), transfer (e.g., Salomon and Perkins 1989) and constructive learning (Hmelo-Silver et al. 2007). The results show that some teachers were already implementing good ideas in distance education, while in terms of teacher professionalization, there were still some aspects of SRL strategies and SRL-conducive learning environments that could improve learning in distance education (see Dignath and Veenman 2021 for an overview). These findings are in line with Dignath and Büttner's (2018) perception that teachers need training in both their direct and indirect SRL promotion. Still, results of a parent survey after the Covid-related distance learning show that more than half of the parents agree that their child has learned to gain knowledge of the subject matter independently (Wößmann et al. 2021). While teachers' SRL promotion in distance education can still be improved, it seems that it has already improved students' SRL.

Looking at why some teachers did not promote SRL in distance education shows that teachers' resources and misconceptions about students' needs and competences are the main obstacle here, and they sometimes do not feel experienced and self-efficacious enough to implement it. This is in line with Nibali (2017) who state that even if teachers view SRL as important, they do not actually teach it due to a lack of resources and time; as well as Lawson et al. (2019), who argue that teachers' beliefs and misconceptions about SRL limit their SRL promotion, and with findings

regarding the role of teachers' self-efficacy for their SRL promotion (Dignath-van Ewijk 2016).

With regards to which teacher and class characteristics predict teachers' SRL promotion in distance education (Kunter et al. 2013), teachers reported more SRL promotion during distance education when being highly self-efficacious about promoting SRL, and with increasing grade. This is in line with findings on SRL promotion in in-classroom settings (De Smul et al. 2018 for self-efficacy; Dignath and Büttner 2018 for grade). Additionally, our results show that teachers' ICT competency plays a central moderating role in SRL promotion in distance education, but only in the period after the school holidays at the beginning of the new school year 2020/2021, not during the first lockdown in spring 2020. This might be related to the fact that teachers used much less digital media in their teaching in spring 2020 than they did for example in spring 2021 after a second lockdown (Lorenz et al. 2023). Highly ICT-competent teachers do not differ in their SRL promotion depending on the class size, whereas teachers with low ICT competency adapt their SRL promotion depending on the size of the class and promote SRL more in smaller classes. In regular in-classroom lessons, teachers have also been found to promote SRL more in smaller classes (Vandevelde et al. 2012). However, when fully exploiting the possibilities of digital media, it would be desirable for teachers to deliver the same degree of SRL promotion in distance education, regardless of the amount of students who are attending a class online. This calls for teacher professionalization in terms of their ICT competency, as numerous organizations already did (e.g., European Framework for the Digital Competence of Educators: DigCompEdu, Carretero et al. 2017).

In addition, we also found that highly ICT-competent teachers' SRL promotion remained relatively stable no matter the grade. Average and little ICT competent teachers however promoted SRL in distance education less in lower grades and more in higher grades. This overlaps with the findings from in-classroom SRL promotion research (Dignath and Büttner 2018). This effect was larger for teachers with little ICT competency. Our results show that students in higher grades (therefore older students) received more SRL support by their teachers, no matter their teachers' ICT competency, while students' SRL support in lower grades highly depended on their teachers' ICT competency. Apparently, a teacher must possess a high degree of ICT competency in order to provide a stable SRL promotion in distance learning. Since SRL trainings have proven to be successful already for young students in elementary school (Dignath and Büttner 2008), teachers should put a lot of effort in promoting their SRL already in lower grades. Presumably, teachers who indicated an average or low ICT competency did not know how to promote their students SRL using ICT that is suitable for this younger age group that possesses less relevant skills (fluent reading, typing, ICT competency) than their older peers.

This finding has even more significance when one considers that the mean on ICT competency was above average. Based on findings that German teachers tend to have below-average ICT competency, these results show that our sample is not representative (Eickelmann et al. 2019). As participation in this study was voluntarily, participating teachers might be more motivated or confident with ICT and distance education than others. Against this background, the results are particularly

relevant, since in the overall population of German teachers a significantly larger number are affected by low ICT competency.

Additionally, the disparity in the extent to which students in distance education benefit from learning opportunities depends not only on the ICT competency of their teachers, but also on that of their parents (Dimopoulos et al. 2021). This makes it even more important that schools manage to compensate for such inequalities in parents' educational backgrounds. Teacher ICT trainings are therefore necessary goals for education policy, even beyond the Covid-19 pandemic, to address family-based educational inequities.

We further looked into differences between teachers' SRL promotion in distance education during the lockdown in spring 2020 and their SRL promotion after the beginning of the new school year in 2020/2021. Teachers indicated to have promoted SRL more after the summer holidays than they did in spring 2020. For both points of time, we found that teachers' self-efficacy beliefs and students' grade were predictors of their SRL promotion in distance education. However, when we looked into the moderating role of teachers' ICT competency, we found that only after the beginning of the new school year in 2020/2021, when teachers had some time to prepare for additional distance learning situations and could come up with a plan and methods to deal with the situation, and not during the first unexpected lockdown in spring 2020, there was a significant interaction between teachers' ICT competency and students' grade as well as class size. This is in line with Lorenz et al. (2023) who found that teachers' used more digital media to communicate with their students in spring 2021 than they did in April 2020.

4.1 Limitations and implications

Our research findings are limited due to the self-report nature of our data. We are aware of self-report questionnaires' flaws (Winne and Perry 2000), but were not able to assess data any differently at the point of data collection due to Covid-19 school closures.

Additionally, we used self-developed items to measure SRL promotion during distance education. This was due to the time of data collection in the middle of the pandemic when no other instrument was available. While we are aware that this measure needs further validation, we figured it would be better to use a self-developed measure than to not be able to assess the information at all. For future research, it would be worthwhile to develop a validated instrument to assess SRL promotion for learning from home (e.g., for doing homework or for digital learning environments).

Nevertheless, the study provides preliminary evidence that teachers' promotion of SRL in distance education is related to their misconceptions and self-efficacy, and that ICT competency plays an important moderating role. Experimental or quasi-experimental intervention research could test whether causal relationships can also be demonstrated by investigating (a) the extent to which teachers actually adapt their SRL support to class characteristics, and (b) how teachers' self-efficacy can be increased (Dignath 2021) and their misconceptions about SRL be reduced (Vosniadou et al. 2020) in the course of teacher training. It would also be worthwhile to include

specific students' needs, such as students with learning disorders (Mastrothanais et al. 2018) or with a poor language proficiency (Blom and Severiens 2008) in the analyses. Fortunately, the pandemic situation has improved and its accompanying distance learning is over. Nevertheless, highly relevant findings can be derived from the results of this study, which also provide valuable implications for further research and school practice.

First of all, our study showed that teachers' ICT competency interacts with teachers' adaptivity of their SRL promotion in distance education. As digitization in schools has received a further boost after the pandemic (Yeigh 2020), teachers are increasingly expected to use digital media to support their students' learning (BMBF 2022). Although there will probably be no more distance learning like during the pandemic, learning with digital media and in digital learning environments will increase greatly and create similar conditions in which students are very much on their own. Our results show that teachers' ICT competency impact how well teachers can implement ideas to promote SRL. More research is needed to identify the specific conditions of SRL and SRL promotion in digital learning environments (Greene et al. 2010), especially when one is keeping in mind that the reality of promoting SRL with digital media is not anywhere near where it could me (Puentedura 2006). Teachers should not learn separately about ICT or SRL, but rather the two aspects should be linked in training so that teachers can realize the full potential of promoting SRL in digital learning environments.

Secondly, distance learning represents an extreme form of learning in which students rely on SRL more than is the case in regular classes. Yet, while working on homework, students are expected to organize themselves independently to work through assignments in a highly self-regulated way. Even in elementary school, students in Germany are expected to do homework for 30–60 min per day (VOGSV 2011, annex 2 to § 37). Successful homework completion shows high correlations with school performance, while learners who do not complete their homework have lower scores on achievement tests (Grodner and Rupp 2013). There are numerous studies showing that students also benefit from adult support with homework (e.g., Silinskas and Kikas 2019). This leads to educational disparities when students do not receive support from their parents at home. Against this background, it is even more important that teachers help their students become self-regulated learners who are independent of the support of others when working on homework. Teachers could very well use the experience they gained during the pandemic to help their students work independently to improve homework learning as well.

Third, teachers' self-efficacy has once again shown to be a powerful predictor for effective teaching. Experiences can strongly influence teachers' self-efficacy and, consequently, their future teaching practice (Vieluf et al. 2013). This means that teachers who made positive experiences teaching with innovative methods during distance education are likely to be more motivated and feel more able to change their teaching practice as a reaction to the pandemic. It is important to continue working with these experiences to further leverage teaching resources that have been created. Conversely, negative experiences can also help improve teaching in the future. Using these experiences now and making them fruitful for boosting teachers' self-efficacy would, in hindsight at least, still have a positive benefit from the pandemic.

Finally, the significant challenges that the pandemic has revealed for teaching and learning required that educators ensured students' learning at home. Now teachers have to start addressing the significant inequities that the pandemic has revealed (Masonbrink and Hurley 2020; Wößmann et al. 2021). Since disadvantaged children in particular are often deficient in self-regulation, it is these children who now need solid SRL support.

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