General introduction

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1.1 Introduction

Since the beginning of the 21st Century, computers and the Internet have spread dramatically worldwide. However, access to technologies varies significantly across countries and individuals around the world. Digital inequity has a significant negative impact on individuals and limits economic and social development (OECD, 2012). In many educational systems, the integration of technology in schools has been recognized as critical to move toward digital equity in education, thus prompting governments to launch particular initiatives and make substantial investments to access and use technology (Pittman, McLaughlin, & Bracey-Sutton, 2008). Technology integration offers new opportunities to enhance teaching and learning and students' motivation, engagement, and achievement in particular (Ainley, Enger, & Searle, 2008; Hinostroza, Labbé, López, & Iost, 2008). Still, we often see that technology is inappropriate or insufficient used in teaching. Many technologies used in primary and secondary education replicate old methods, strategies, and activities that are mainly teacher-centered without functional changes (see e.g., Crompton & Burke, 2020). Successful technology integration in the educational system entails more than just having Internet-connected computers in the classroom (Chauhan, 2017) and using technologies for replicating traditional teaching. For this reason, in this dissertation, we endorsed the definition of technology integration based on Belland (2009), who defined technology integration as "the sustainable and persistent change in the social system of primary and secondary schools caused by the adoption of technology to help students construct knowledge".

However, according to Niederhauser et al. (2018), it is not easy to achieve long-term sustainability and scalability in technical innovation and integration. The gap between policy and practice is regarded as one of the challenges reported by UNESCO (2015), and existing policies are largely oriented towards traditional curriculum paradigms (Kinshuk, Chen, Cheng, & Chew, 2016). Moreover, many barriers prevent primary and secondary school teachers from integrating new technologies into teaching and learning processes (Ertmer,

Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hew, & Brush, 2007). Among these barriers, teacher-level factors, especially teacher value beliefs toward technology integration, were important factors in classroom technology integration in terms of quantity and quality (Vongkulluksn, Xie, & Bowman, 2018). Apart from the well-known perceived barriers (such as a shortage of hardware, software, technical assistance, and teacher training) (Goktas, Gedik, & Baydas, 2013), new barriers include a lack of quality digital content, time to prepare and implement technology-based lessons, and opportunities to participate in decision-making regarding content development, technology use and professional development (Vrasidas, 2015).

Despite the value of technology integration for educational equity and quality being emphasized by numerous studies, many gaps exist about how technology integration can be approached in policy plans, implemented in pedagogical practices, and embraced by teachers, students, and parents. In the current dissertation, the focus is on teachers' pedagogical practices with technology in primary and secondary education, contributing to a more detailed understanding of what happens to integrate technology into the teaching and learning processes. Given this goal, we examined the different teaching and technology practices considering the concerted efforts of various stakeholders at different levels and contexts. The remainder of the introduction begins with a description of the theoretical background, followed by the context of the study, then research aims, and finally an overview of the following chapters.

1.2 Theoretical background

1.2.1 Determinants of technology integration: what makes teacher practice different?

Although research studies in education show that teachers' pedagogical practices incorporating technologies are important for school improvement, good quality teaching and learning, it is still unclear whether teachers integrating technology sufficiently in their educational practices. Some studies, e.g., Farjon, Smits, and Voogt (2019) indicated that teachers struggle with fully adopting technology for teaching. This technology integration practice has long been

regarded as complex and multifaceted (Mumtaz, 2000; Scherer, Siddiq, & Tondeur, 2019). Technology integration in education is explained by a range of social, organizational, personal, contextual, and technological factors which can change over time (Backfisch, Lachner, Stürmer, & Scheiter, 2021). For example, research found that school-level factors influenced the successful integration of tablets in Philippine public schools and further determined the long-term sustainability of this national large-scale technology program (Lumagbas, Smith, Care, & Scoular, 2019). Yet, teachers' role should be stressed after external obstacles have been removed (Tosuntaş, Ubukçu, & Tuba, 2019). A meta-analysis found that contextual factors of learning environments significantly moderate the overall effect of technology-supported instruction on student learning (Hillmayr, Ziernwald, Reinhold, Hofer, & Reiss, 2020).

To fully understand the mechanism for technology integration, many conceptual models to guide educational research and practice have been developed about the factors influencing teachers' technology use. Some conceptual models emerge from practice. One of the commonly used models is the Four in Balance (FIB) Model (Kennisnet, 2013). Given the interconnectedness of personal, pedagogical, and organizational contexts, the FIB model assumes that successful technology integration requires the balanced deployment of four basic elements: vision, expertise, digital content, and information and communications technology (ICT) infrastructure; leadership is a necessary element for ensuring the balance between the key elements through support and collaboration. This model has been applied in different countries, such as Kenya, Chile, and South Africa (Howie, 2010; Tondeur, Krug, Bill, Smulders, & Zhu, 2015).

Other conceptual models emerge from scientific research and have been empirically validated. A theoretical model that is very useful for explaining teacher behavior in terms of technology use is the Technology Acceptance Model (TAM; Davis, 1989), which includes both technological and psychological factors influencing the use of technology, based on the principles of the Theory of Reasoned Action (TRA; Fishbein & Azjen, 1975). As we believe that whether or not teachers use technology in their pedagogical activities is influenced

by their dispositions, one limitation of TAM and its updated versions TAM2 (Venkatesh & Davis, 2000) and TAM3 (Venkatesh & Bala, 2008) lies in that they are more technology-oriented and, therefore and less include critical individual psychological processes. Besides, TAM does not distinguish between the different levels in which various individual and environmental factors are involved. Therefore, more recent models appear to incorporate variables from different educational system levels into a multilevel structure (Voogt, Knezek, Christensen, & Lai, 2018). The Integrative Model of Behavior Prediction (IMBP; Fishbein & Ajzen, 2011) is one such model, that considers human psychological mechanisms and integrates various levels (e.g., teachers nested within schools). Based on a review about teachers' technology use, Kreijns, Vermeulen, Kirschner, Van Buuren, and Van Acker (2013) suggested using IMBP as an option and the IMBP appears to be a stable and parsimonious model for explaining teachers' use of various types of technology in educational settings (see, e.g., Admiraal, Lockhorst, Smit, & Weijers, 2013; Vermeulen, Kreijns, Van Buuren, & Van Acker, 2017). In this dissertation, building upon existing models and elaborating on relevant contextual aspects, various factors at different levels that are likely to influence technology integration in education were investigated.

1.2.2 Evaluating the effectiveness of technology integration in teaching and learning

In recent years, technology integration has evolved globally in various educational environments (see e.g., Han, Byun, & Shin, 2018; Pelgrum, 2001; Pelgrum & Voogt, 2009; Tondeur et al., 2015), given the belief rooted in education policy that technology promotes teaching and learning and the resulting expectation that school leaders and teachers should integrate technology into their school and classroom practices (Vanderlinde, Aesaert, & Van Braak, 2014). Governments and organizations worldwide are experimenting with innovative projects designed to providing supporting conditions to improve learning opportunities for all children (UNESCO, 2015) since leaders are seeking evidence to create high-quality, sustainable education systems that can compete globally (Peng et

al., 2014). These initiatives are also the focus of the newly emerging economies, such as China, South Korea, Indonesia, and Turkey.

However, knowledge on how educational practitioners respond to a new program or innovation is somewhat fragmented and inconsistent. Some of these inconsistencies may be due to the variation across studies, making it challenging to draw firm conclusions regarding the overall effectiveness of technology integration. For this reason, educational researchers have been interested in comparing the effectiveness of teaching with or without technology, and comparing the different technology-supported learning modes to find more effective learning approaches. Evaluation of current technology integration in education is vital for policymakers, school leaders, and teacher educators to make the decision about infrastructure investments, teacher professional development, and supporting logistics. Systematic reviews allow for a more objective appraisal of the evidence, which can provide the converging 'best evidence' for the overall effects of using technology in education in a given time. In learning scenarios, mobile technology has become a fast-growing research field in the world (Soloway & Norris, 2018). Though there have been several attempts to explain what mobile technology integration might look like and how to influence student learning in basic education in the Asia-Pacific region (UNESCO, 2018), policymakers hesitate to scale up the usage of mobile devices in primary and secondary schools, because of some adverse effects of using mobile devices (Churchill, Pegrum, & Churchill, 2018). Therefore, more research is needed on the best practices for using mobile technology in order to figure out when and how children should use mobile devices (Crompton & Burke, 2020). In addition to uncertainty about the overall effects of mobile technology on different types of the outcome variable, the potential influences of moderators need further exploration, since the main effects of mobile technology are not the same for all student groups and learning contexts.

Many earlier studies tend to rely on technology usage as a key indicator when evaluating technology integration in diverse contexts (Scherer, Siddiq, & Tondeur, 2020). While a usage model for evaluating technology integration is straightforward to implement, it falls short of covering all aspects of teaching

and learning processes, and an imbalance of pedagogy and technology will limit the potential of the learning environment (Knezek & Christensen, 2016). Students' perceptions of the learning environment can be used to get more insights into how learners perceive teaching and learning processes (Fraser, 1998), which in turn can help researchers and practitioners to maximize the effectiveness by identifying critical aspects that students in specific settings most prefer (e.g., Chang et al., 2015). Moreover, student learning is improved more by integrating particular educational strategies (e.g., the use of technology in the classroom) with global factors of instructional quality (Decristan et al., 2015). Therefore, there is a need to investigate the underlying mechanisms of learning that can be facilitated by teachers' instructional quality combined with the use of technology in order to gain a more comprehensive picture of the diverse conditions for improving teaching and learning quality. Moreover, both differences within and between classrooms can bring valuable insights into how learners view their learning environments (Göllner, Wagner, Eccles, & Trautwein, 2018). Therefore, to better interpret the results, there is also a need to consider multilevel data structure when examining students' perceptions of their learning process in the learning environments.

1.3 Context of the study

Despite all students in China having equal access to the nine years of compulsory education, the Chinese government faces challenges with ensuring quality education for all students (Peng et al., 2014). In particular, while China' coastal and Eastern areas have undergone massive economic growth in recent decades, the western regions have lagged behind, resulting in significant rural-urban divides. The Chinese government has provided special funding and projects for Western and rural China, hoping that technology can support disadvantaged groups and equalize educational opportunities. Knowledge about education and technology mainly flows from developed eastern regions to the less developed western regions and from the urban areas to the rural areas (Schulte, 2015). The national guideline (MOE, 2010) maintains that the government's aim is to achieve education equity by allocating quality resources to rural, remote and

disadvantaged ethnic minority regions, thereby narrowing the education gap. Nevertheless, in these priorities on technology integration in education in rural areas, connectivity was prioritized over potential pedagogical impacts, which might reveal the shortcomings of many past efforts.

To counteract this, in 2012, the first national ten-year ICT plan was released based on the premise that the use of these technologies would renew how knowledge is taught and learned (MOE, 2012). The introduction of the national ICT plan has accelerated the pace of ICT in rural education by connecting schools through the broadband network, connecting classes with quality digital resources, and connecting students in e-learning space. However, until 2015, "some educational administrations and schools still do not fully recognize the revolutionary impact of ICT on education," and technology is used insufficiently and inappropriately in teachers' daily pedagogical practices (MOE, 2016). In order to complete the development tasks determined by the ten-year plan and promote the ICT in education in a comprehensive and in-depth way, the MOE issued "13th Five-year Plan for ICT in Education (2016-2020)" in which the development of technology integration in education shifted to the benefits of technology for teaching and learning integrating a more learner-centered pedagogy. It is worth noting that local governments have formulated and implemented their policy plans under the call of the central government in the national plan. In 2018 alone, about 20 provinces and municipalities have issued official documents to improve the integration level of ICT and education.

Recently, given the potential impact of smart classrooms on the traditional teaching structure, China has made efforts to facilitate smart classrooms reported in "The announcement of the action plan for ICT in education 2.0". The Chinese central government calls teachers to move beyond traditional teaching and embrace innovative pedagogical approaches with emerging technologies (MOE, 2018). In order to respond to the national call and promote the smart classrooms, many local governments have issued their action plans. However, except some economically developed areas where schools have been provided with student personal tablet PCs and interactive desks (Li, Kong, & Chen, 2015), other local governments typically only provide the infrastructure and

equipment for classrooms, and it is not possible to equip each student with a mobile device. Under this circumstance, when students hope to study in smart classrooms, their parents need to buy them mobile devices. In the empirical studies of the current dissertation, schools and participants were purposefully selected from Western China where significant investments and supportive projects regarding technology integration in education had been carried out.

1.4 Research aims

The primary aim of this dissertation is to advance knowledge of technology integration in education. In order to obtain a holistic view, research into this issue was approached from several different stakeholders, different technological practices, and different contexts. Organized into three major thematic strands, this dissertation examines the link between ICT policy plans and ICT practices in rural schools, rural teachers' pedagogical practices with digital educational resources, and students' learning with mobile technology.

Specifically, this dissertation has three aims. First, this dissertation aims to examine technology integration in the context of rural schools in China. Our interest in the rural context focuses attention on how these technology integration practices are shaped by broader political, cultural, and social contexts of teaching, especially connecting rural schools to quality education. Since context matters and strategies must be adapted accordingly to the situation, this study emphasizes the importance of understanding why and how to integrate technology in rural schools.

The second aim of this dissertation is to be of practical value for policymakers, school leaders, and teachers. We argue that promoting digital equity and teaching quality at a high level in rural and remote areas in China can be supported by the use and sharing of digital educational resources. As a result, the emphasis of this dissertation is on school and teacher variables that are likely to explain and predict the use and sharing of digital educational resources by rural teachers.

The third aim concerns the effects of using new and emerging mobile technology on student learning. The current dissertation aims to provide a broader perspective and more in-depth understanding of the overall beneficial

effects of mobile technology usage in primary and secondary education. Yet it also aims to provide evidence of underlying mechanisms of learning facilitated by teachers' instructional quality combined with the use of technology in secondary education and for the design and implementation of smart classrooms.

1.5 Dissertation outline

This dissertation focuses on the pedagogical use of technology for teaching and learning in primary and secondary education. Chapters 2 to 6 contribute to the main aim of the dissertation, focusing on at least one or more stakeholder perspectives, technological practices, and contexts. Figure 1.1 provides a schematic overview of the dissertation. Five studies were performed in which:

(1) an overview of the link between local ICT policy plans and the ICT practices of rural schools (Chapter 2);
(2) rural teachers' use of digital educational resources aimed at promoting digital equity and education for all (Chapter 3);
(3) rural teachers' sharing of digital educational resources aimed at promoting teacher professional learning opportunities and development (Chapter 4);
(4) a meta-analysis on the effectiveness of various mobile technology usage on cognitive, affective, and behavioral learning outcomes in primary and secondary education was employed (Chapter 5);
(5) the relationships among teacher beliefs, classroom process quality, and student engagement in the smart classroom learning environment in secondary education were examined using teacher and student questionnaires with a multilevel mediation model (Chapter 6).

Chapter 2 describes a mixed-method study on key elements for integrating ICT in rural schools reflected in both local ICT policy plans and practices from a school improvement point of view. This exploratory study aimed to contributing to insights into whether and how local ICT policy plans are linked with the ICT practices of rural schools by examining the content of local ICT policy plans that have been developed and how school leaders and teachers perceive their experience with ICT practices of rural schools. Two research questions guided

the study: (1) How are elements of ICT integration in schools represented in local ICT policy plans? (2) What are rural school practices with ICT from the perspectives of both school leaders and teachers? Directed content analysis was used to analyze local policy plans. Within- and cross-case analyses were used to analyze other qualitative sources (i.e., interviews with school leaders, focus groups with teachers, classroom observations, and an ICT inventory). Descriptive statistics were used to analyze the teacher survey.

Chapter 3 describes a quantitative study aimed at providing insight into rural teachers' use of digital educational resources, and teacher- and school-level factors that explain differences in teachers' use of digital educational resources. Research questions were: (1) What types of digital educational resources do rural teachers use for their teaching? (2) Which school-level variables explain differences between rural teachers in their use of digital educational resources in teaching? and (3) Which teacher-level variables explain differences between rural teachers in their use of digital educational resources in teaching? Questionnaire data were collected from 462 rural teachers from 25 primary and secondary schools in three different areas throughout Western China. The teacher-level variables provided information about teachers' perceptions (attitude, self-efficacy, subjective norm, intention, knowledge and skills, and facilitating conditions) toward using digital educational resources and demographic characteristics (gender, age, class size, number of subjects, year of teaching with digital educational resources). The school-level variables provided information about the schools' types and locations. Except for descriptive statistics, multilevel analyses were conducted taking into account the nested structure (teachers within schools).

Since the use of digital resources can merely increase the resources without changing fundamental practices when teachers continue teaching based on direct instruction (Santana Bonilla & Rodríguez Rodríguez, 2019), exchanging teaching-related knowledge and making digital resources available to all students are the strategies to better handle the growing diversity of students. Thus, in **Chapter 4**, the focus moves from rural teachers' use behavior to sharing behavior with the main research question: How is motivation related

to sharing behavior regarding digital educational resources within and outside school? Unlike previous studies focusing on only one context of teachers' general knowledge sharing behavior (Akosile & Olatokun, 2020), this study explores the motivation-behavior relationship in the context of sharing behavior regarding digital educational resources both within and outside school. Self-reported questionnaires from 709 rural teachers were collected and analyzed employing the Structural Equation Modeling. To answer the main research question, the following sub-questions were formulated: RQ1 (a-e). Is motivation related to each of the dispositional variables (a) self-efficacy, (b) attitudes, and (c) subjective norm, (d) sharing intention within school, and (e) sharing behavior within school?; RQ2 (a-e). Is motivation related to each of the dispositional variables (a) self-efficacy, (b) attitudes, and (c) subjective norm, (d) sharing intention, and (e) sharing behavior outside school? Moreover, since more research on the link between intention and behavior is needed, the relationships between sharing intention and sharing behavior were examined, together with environmental variables. For this the following research questions were formulated: RQ3 (a-c). Is (a) sharing intention, (b) sharing climate, and (c) work pressure related to sharing behavior within school?; RQ4 (a-c). Is (a) sharing intention, (b) sharing climate, and (c) work pressure related to sharing behavior outside school?; RQ5. Is there an indirect effect of the motivation on the sharing intention within school through the dispositional variables? RQ6. Is there an indirect effect of the motivation on the sharing intention outside school through the dispositional variables?

To reimagine the current mobile-learning practices, **Chapter 5** reports the outcomes of a systematic review with a meta-analysis of experimental and quasi-experimental studies comparing the effects of learning with and without mobile technology. The purpose of this study is to provide new quantitative data that are expected to deepen the knowledge base on various learning outcomes and inform evidence-based decision-making on the use of mobile technology in primary and secondary education. The research questions that guided the study were: (1) When compared with traditional learning, what is the overall effectiveness of using mobile technologies in primary and secondary education

on students' learning outcomes in terms of cognitive, affective, and behavioral dimensions? (2) What, if any, factors based on Biggs' 3P learning process model, that is student factors, teaching context and learning process factors, moderate the relationship between mobile technology use and learning outcomes? (3) What, if any, study quality characteristics explain the heterogeneity in results? Meta-analyses, moderator analyses, sensitivity analyses, and publication bias were used to analyze 61 studies of 56 peer-reviewed papers between 2014 and 2020.

The results from the study in Chapter 5 indicated that studies in which students used their own handheld devices with multiple-functions for learning showed a significantly higher effect size in favor of their cognitive learning outcomes than students who shared single-function devices with others. Therefore, students and teachers using 1:1 tablets in smart classrooms were purposefully selected in the study reported in **Chapter 6**, and this study was focused on examining the relationships among teacher beliefs, classroom process quality, and student engagement across the student and class levels in smart classrooms in secondary education. Three research questions were guiding this study: (1) At the classroom level, which variables (i.e., teacher beliefs, teacher and class background variables) explain differences between students' shared perceptions of classroom process quality in the smart classroom learning environment? (2) At the classroom level (i.e., teacher beliefs, teacher and class background variables) and student level (i.e., students' shared and individual perceptions of classroom process quality, student demographic variables), which variables explain differences between student engagement in the smart classroom learning environment? (3) Is there an indirect effect of teacher beliefs, and teacher and class background variables on student engagement in the smart classroom learning environment through students' shared perceptions of classroom process quality? To obtain a comprehensive view of classroom process quality, two digital questionnaires were developed. The student questionnaire was developed to measure classroom process quality and student engagement, and the teacher questionnaire was developed to measure teacher beliefs. Given the sample's stratified nature, students were nested within

class. Multilevel regression analyses and a multilevel mediation analysis for a 2-2-1 mediation design were conducted. The final chapter, Chapter 7, provides a summary of the main findings of Chapters 2 to 6, a general discussion about the results, implications for practice and future direction, and the limitation of these studies.

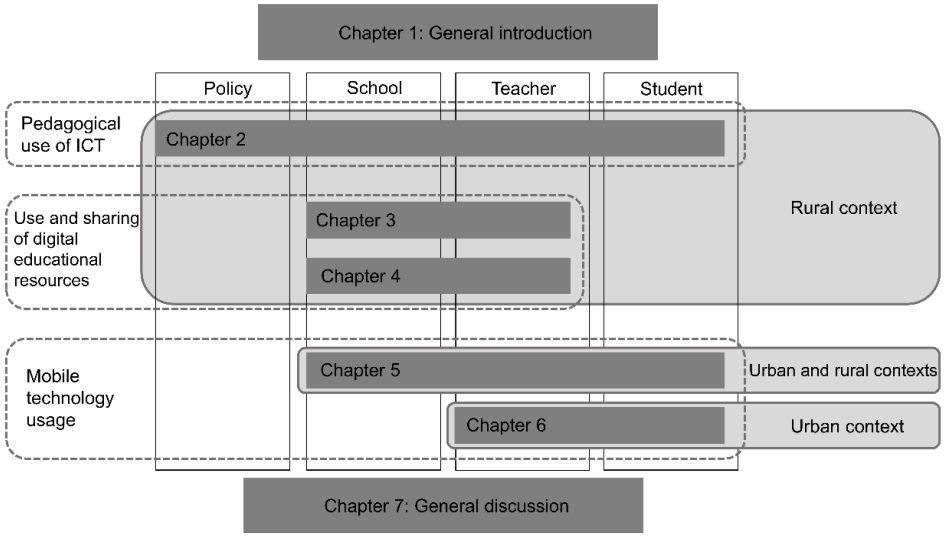

Figure 1.1. Overview of chapters in this dissertation.