

**INTERDISCIPLINARY DIDACTICS OF
STEM SUBJECTS AND PHYSICAL EDUCATION**

**INTERDISZIPLINÄRE DIDAKTIK DER
MINT-FÄCHER UND DES SPORTS**

03

PIERRE MEINOKAT

**Classroom Disruptions
in Digital Settings**

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INTERDISCIPLINARY DIDACTICS OF
STEM SUBJECTS AND PHYSICAL EDUCATION

Karlsruhe Institute of Technology (KIT)
Institute for School Pedagogy and Didactics

Volume 03

Edited by Prof. Dr. Ingo Wagner and the division „Interdisciplinary Didactics of STEM subjects and Physical Education“ at the Karlsruhe Institute of Technology

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Classroom Disruptions in Digital Settings

by
Pierre Meinokat

Karlsruher Institut für Technologie
Institut für Schulpädagogik und Didaktik

Classroom Disruptions in Digital Settings

Zur Erlangung des akademischen Grades eines Doktors der Philosophie
(Dr. phil.) von der KIT-Fakultät für Geistes- und Sozialwissenschaften des
Karlsruher Instituts für Technologie (KIT) genehmigte Dissertation

von Pierre Meinokat

Tag der mündlichen Prüfung: 1. Oktober 2025

1. Gutachter: Prof. Dr. Ingo Wagner

2. Gutachterin: Prof. Dr. Thamar Voss

Impressum



Karlsruher Institut für Technologie (KIT)
Kaiserstraße 12
76131 Karlsruhe

Institut für Schulpädagogik und Didaktik
www.isd.kit.edu



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2026

ISSN 2944-5566

DOI 10.5445/IR/1000185895

*Dedicated to both my father and my grandfather, who will never be able to read this but
would undoubtedly be proud.*

Summary

Following the publication of the PISA study (OECD, 2001), German educators and stakeholders were prompted to re-evaluate strategies for enhancing student academic achievement, which consequently reignited discussions regarding the prerequisites for effective teaching and learning. Notably, the absence of classroom disruptions has been identified as a significant predictor of success (Gurney, 2007; Meyer, 2003). This condition yields dual benefits: a reduced risk of psychological health issues for teachers (Brouwers & Tomic, 2000; Gonzalez et al., 2015; Greene et al., 2002; Kokkinos, 2007; Rajendran et al., 2020) and amplified opportunities for student academic achievement (Adeyemo, 2012; Brophy & Good, 1986; Marquez et al., 2016; Talebi et al., 2015). Concurrently, educational systems face increasing demands from policymakers to integrate digital media more effectively into pedagogical practices (European Union, 2020; KMK, 2017a, 2021; U.S. Department of Education, 2017). Synthesizing these imperatives, this dissertation investigates whether digital media serve to mitigate classroom disruptions or, conversely, exacerbate their occurrence.

Studies on classroom disruptions are situated within the broader research area of classroom management, a topic of enduring interest to educational researchers (Kounin, 1970, 2006). Effective classroom management ensures the smooth and efficient implementation of lessons (Mulvahill, 2018). Researchers have identified various categories of effective classroom management practices (Durak & Saritepeci, 2017; Greenberg et al., 2014; Martin et al., 2016), with the management of classroom disruptions consistently recognized as a critical component. Classroom disruptions are defined as actions and behaviors that temporarily interfere with the attainment of instructional goals (Biller, 1979; Lohmann, 2011; Maddeh et al., 2015; Stockton University, 2001). Existing categorizations of classroom disruptions vary, with some prioritizing disruptions hierarchically (Cogswell et al., 2020; Rattay et al., 2018; Scherzinger & Wettstein, 2019) and others classifying them into non-hierarchical categories (Biller, 1979; Lohmann, 2011; Winkel, 2011). Notably, the Student Online Misbehavior scale (SOMs) (Li & Titsworth, 2015) represents the sole existing categorization of classroom disruptions within digital settings, despite the proliferation of digitalization in educational contexts (Meinokat & Wagner, 2022). This dissertation focuses specifically on digital settings, encompassing face-to-face environments enhanced by digital media, online teaching and learning, and hybrid formats such as blended learning. To examine the influence of these settings on classroom disruptions, three research questions were addressed:

- RQ1: What is the current state of research on classroom disruptions in digital settings?
- RQ2: How do teachers address classroom disruptions in their digital teaching practices?
- RQ3: How do students perceive classroom disruptions in digitally supported learning settings?

A mixed-methods research design was employed to address these questions, incorporating three distinct perspectives. Firstly, the systematic literature review, conducted according to the PRISMA statement (Moher et al., 2009), was used to address RQ1, resulting in the analysis of 16 articles from an initial pool of 724 (Meinokat & Wagner, 2022). RQ2, focusing on teachers' perspectives, was addressed through qualitative semi-structured, guideline-based expert interviews with 31 German teachers from diverse disciplines and schools (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025), analyzed using qualitative content analysis (Mayring, 2014). The students' perspectives (RQ3) were addressed through a quantitative questionnaire administered to 254 students regarding their experiences with classroom disruptions in digitally enhanced mathematics classes, analyzed using multiple linear regression (Meinokat et al., under review).

To answer RQ1, the systematic literature review highlighted the diverse terminology used for digital settings, ranging from technology-specific terms like *virtual*, *digital* or *computer* to broader descriptors such as *hardware* or *software*. The variety of terms used for classroom disruptions could be separated into *behavior-related terms*, *classroom management related terms*, a direct connection to *rules and discipline* and wider terms such as *non-academic use* or *crime control*. Based on the analyzed articles, a definition for digital teaching and learning settings was developed, including digitally enhanced face-to-face settings, online teaching and learning, and hybrid settings.

In addressing RQ2, teachers reported employing a range of strategies to prevent disruptions, including *implementing transparent class structures*, *leveraging digital tools*, *setting rules*, *motivating students*, *involving external partners*, *adjusting expectations and teaching styles*, *building trust*, *maintaining and fostering communication*, *adapting instructional design*, *collaborating with colleagues*, and *fostering self-motivation*. Intervention strategies encompassed *verbal and direct interventions*, *improvised solutions*, *transparent performance criteria*, *reminders*, *disabling online functions*, *implementing breaks*, *excluding students*, *maintaining consistency*, and *appealing to students' understanding*. The analysis confirmed existing categorizations and enabled the development of a two-dimensional framework based on intentionality (x-axis) and severity (y-axis).

This graph facilitated the classification and prioritization of disruptions, shown for example by the integration of SOMs categories (*seeking unallowed assistance, internet slacking, aggressiveness, and lack of communication*) and teacher-generated categories. Teacher insights on assumed causes for disruptions highlighted the necessity of incorporating students' perspectives and led to the expansion of the SOMs with four additional categories: *technical errors, operating errors, illicit social behavior, and infrastructural problems*.

Additionally, in the context of physical education, the study established a link between existing frameworks for refusal behavior (Wolters & Gebken, 2005), a special form of classroom disruptions in physical education, and possible behavior strategies (Brophy, 1996; Fellner & Payer, 2021; Hietzge, 2005; Klingen, 2003; Klupsch-Sahlmann, 2005; Lüpke, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters, 2021; Wolters & Gebken, 2005), revealing a preference for software-based digital solutions.

After the perspectives of teachers were gathered, the student questionnaire, to answer RQ3, confirmed the integration of digital media in mathematics education, with tablets being the most frequently used device. A multiple linear regression analysis identified student-perceived disruption categories: *behavior of classmates, behavior of teachers, understanding of assignments, and technical issues*. Integrating student and teacher perspectives, five overarching categories of classroom disruptions in digital settings were identified: **behavior disruptions, communication disruptions, executional disruptions, participation disruptions, and external disruptions**. Thus, this study presents a novel categorization of classroom disruptions in digital settings, distinguished by its incorporation of both teacher and learner perspectives. This systematization offers a valuable framework for future research in this domain and can serve as a tool to support teachers in the reflective analysis of their pedagogical practices.

This categorization is yet to be validated. Future research should aim to validate these findings, expand the context to different educational settings and explore specific subject areas. Longitudinal studies and studies comparing teachers and students within the same subject are also recommended to increase validity and generalizability.

Zusammenfassung

Im Anschluss an die Veröffentlichung der PISA-Studie (OECD, 2001) sahen sich deutsche Pädagoginnen und Pädagogen sowie Interessengruppen veranlasst, Strategien zur Verbesserung der schulischen Leistungen von Schülerinnen und Schülern neu zu bewerten, was folglich die Diskussionen über die Voraussetzungen für effektives Lehren und Lernen neu entfachte. Insbesondere die Abwesenheit von Unterrichtsstörungen wird als signifikanter Prädiktor für Erfolg identifiziert (Gurney, 2007; Meyer, 2003). Dieser Zustand bringt doppelte Vorteile mit sich: Ein reduziertes Risiko für psychische Gesundheitsprobleme bei Lehrkräften (Brouwers & Tomic, 2000; Gonzalez et al., 2015; Greene et al., 2002; Kokkinos, 2007; Rajendran et al., 2020) und erhöhte Möglichkeiten für akademischen Erfolg von Lernenden (Adeyemo, 2012; Brophy & Good, 1986; Marquez et al., 2016; Talebi et al., 2015). Gleichzeitig sehen sich Bildungssysteme mit steigenden Anforderungen von politischen Entscheidungsträgern konfrontiert, digitale Medien effektiver in den Unterricht zu integrieren (European Union, 2020; KMK, 2017a, 2021; U.S. Department of Education, 2017). Die vorliegende Dissertation untersucht hierbei, ob digitale Medien dazu beitragen, Unterrichtsstörungen zu mindern oder ob sie deren Auftreten fördern.

Studien zu Unterrichtsstörungen sind im breiteren Forschungsbereich der Klassenführung, auch Classroom Management genannt, angesiedelt, einem Thema, das für Bildungsforscher von dauerhaftem Interesse ist (Kounin, 1970, 2006). Effektives Classroom Management gewährleistet die reibungslose und effiziente Durchführung von Unterricht (Mulvahill, 2018). Forscher identifizierten verschiedene Kategorien effektiver Klassenführung (Durak & Saritepeci, 2017; Greenberg et al., 2014; Martin et al., 2016), wobei der Umgang mit Unterrichtsstörungen durchgehend als kritische Komponente anerkannt wird. Unterrichtsstörungen werden als Handlungen und Verhaltensweisen definiert, die die Erreichung von Unterrichtszielen (vorübergehend) beeinträchtigen (Biller, 1979; Lohmann, 2011; Maddeh et al., 2015; Stockton University, 2001). Bestehende Kategorisierungen von Unterrichtsstörungen variieren, wobei einige Störungen hierarchisch priorisieren (Cogswell et al., 2020; Rattay et al., 2018; Scherzinger & Wettstein, 2019) und andere sie in nicht-hierarchische, koexistente Kategorien einteilen (Biller, 1979; Lohmann, 2011; Maddeh et al., 2015; Stockton University, 2001). Bemerkenswerterweise stellt die Student Online Misbehavior scale (SOMs) (Li & Titsworth, 2015) die bisher einzige bestehende Systematisierung von Unterrichtsstörungen in

digitalen Lehr-/Lernumgebungen dar, trotz der zunehmenden Digitalisierung in Bildungskontexten (Meinokat & Wagner, 2022).

Diese Arbeit konzentriert sich speziell auf digitale Umgebungen. Diese bestehen aus Präsenzveranstaltungen, die durch digitale Medien erweitert werden, Online-Lehre und -Lernen sowie hybride Formate wie Blended Learning. Um den Einfluss dieser Umgebungen auf Unterrichtsstörungen zu untersuchen, werden drei Forschungsfragen adressiert:

- FF1: Was ist der aktuelle Stand der Forschung zu Unterrichtsstörungen in digitalen Lehr- und Lernumgebungen?
- FF2: Wie gehen Lehrkräfte mit Unterrichtsstörungen in ihrer digitalen Lehre um?
- FF3: Wie erleben Schülerinnen und Schüler Unterrichtsstörungen in digital-unterstützten Umgebungen?

Ein Mixed-Methods-Forschungsdesign wurde angewendet, um diese Fragen zu beantworten, wobei drei verschiedene Perspektiven einbezogen wurden. Eine systematische Literaturübersicht, durchgeführt gemäß des PRISMA-Verfahrens (Moher et al., 2009), wurde verwendet, um FF1 zu beantworten, was zur Analyse von 16 Artikeln aus einem anfänglichen Pool von 724 führte (Meinokat & Wagner, 2022). FF2, die sich auf die Perspektiven der Lehrkräfte konzentrierte, wurde durch qualitative, halbstrukturierte, leitfadengestützte Experteninterviews mit 31 deutschen Lehrkräften aus verschiedenen Unterrichtsfächern und Schulen beantwortet (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025), die mittels qualitativer Inhaltsanalyse (Mayring, 2014) analysiert wurden. Die Perspektiven der Schülerinnen und Schüler wurden in FF3 fokussiert und durch einen quantitativen Fragebogen adressiert, der 254 Lernende zu ihren Erfahrungen mit Unterrichtsstörungen im digital erweiterten Mathematikunterricht vorgelegt und mittels multipler linearer Regression analysiert wurde (Meinokat et al., under review).

Bei der Beantwortung von FF1 hob die systematische Literaturübersicht die vielfältigen Terminologien hervor, die für digitale Umgebungen verwendet werden. Hierbei finden sich technologiespezifische Begriffe wie *virtuell*, *digital* oder *Computer* bis hin zu breiteren Deskriptoren wie *Hardware* oder *Software*. Die Vielfalt der verwendeten Begriffe für Unterrichtsstörungen konnte in *verhaltensbezogene Begriffe*, *klassenführungsbezogene Begriffe*, eine direkte Verbindung zu *Regeln und Disziplin* sowie breitere Begriffe wie *nicht-akademische Nutzung* oder *Verbrechensbekämpfung* unterteilt werden.

Die für die Beantwortung von FF2 interviewten Lehrkräfte berichteten von einer Reihe von Strategien zur Verhinderung von Störungen, darunter die *Implementierung transparenter Klassenstrukturen*, die *Nutzung digitaler Werkzeuge*, das *Aufstellen von Regeln*, die *Motivation von Lernenden*, die *Einbeziehung externer Partnerinnen und Partner*, die *Anpassung von Erwartungen und Unterrichtsstilen*, den *Aufbau von Vertrauen*, die *Aufrechterhaltung und Förderung der Kommunikation*, die *Anpassung des Unterrichtsdesigns*, die *Zusammenarbeit mit Kolleginnen und Kollegen* sowie die *Förderung der Selbstmotivation*. Interventionsstrategien umfassten *verbale und direkte Interventionen*, *improvisierte Lösungen*, *transparente Leistungskriterien*, *Erinnerungen*, das *Deaktivieren von Online-Funktionen*, das *Einlegen von Pausen*, das *Ausschließen von Lernenden*, die *Aufrechterhaltung von Konsistenz* und das *Appellieren an das Verständnis der Schülerinnen und Schüler*. Die Analyse bestätigte bestehende Kategorisierungen und ermöglichte die Entwicklung eines zweidimensionalen Rahmens basierend auf Intentionalität (x-Achse) und Schweregrad (y-Achse). Dieser Graph erleichterte die Klassifizierung und Priorisierung von Störungen, was anhand der beispielhaften Integration von SOMs-Kategorien (*Suche nach unerlaubter Hilfe*, *Ablenkung durch Internet*, *Aggressivität* und *Mangelnde Kommunikation*) und von Lehrkräften genannten Kategorien gezeigt wurde. Die Erkenntnisse der Lehrkräfte zu vermuteten Ursachen für Störungen unterstrichen die Notwendigkeit, die Perspektiven der Lernenden einzubeziehen und führten zur Erweiterung der SOMs um vier zusätzliche Kategorien: *Technische Fehler*, *Bedienungsfehler*, *Unerwünschtes soziales Verhalten* und *Infrastrukturelle Probleme*.

Darüberhinaus, im Kontext des Sportunterrichts, stellte die Studie eine Verbindung zwischen bestehenden Rahmenwerken für Schulsportverweigerung (Wolters & Gebken, 2005), einer speziellen Form von Unterrichtsstörungen im Sportunterricht, und möglichen Verhaltensstrategien (Brophy, 1996; Fellner & Payer, 2021; Hietzge, 2005; Klingen, 2003; Klupsch-Sahlmann, 2005; Lüpke, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters, 2021; Wolters & Gebken, 2005) her, wobei eine Präferenz für softwarebasierte digitale Lösungen deutlich wurde.

Nachdem die Perspektive der Lehrkräfte somit gewonnen wurde, konnte die Fragebogenstudie mit Schülerinnen und Schülern zur Beantwortung von FF3 die Integration digitaler Medien in den Mathematikunterricht bestätigen, wobei *Tablets* die am häufigsten verwendeten Geräte waren. Die multiple lineare Regressionsanalyse identifizierte von Schülerinnen und Schülern wahrgenommene Störungskategorien: *Verhalten von Klassenkameradinnen und -kameraden*, *Verhalten von Lehrkräften*, *Verständnis von Aufgaben* und *Technische Probleme*. Durch die Integration von Lernenden- und Lehrendenperspektiven wurden fünf übergeordnete Kategorien von Unterrichtsstörungen in digitalen Lehr-/Lernumgebungen identifiziert: **Verhaltensstörungen** (englisch: behavior

disruptions), **Kommunikationsstörungen** (englisch: communication disruptions), **Durchführungsstörungen** (englisch: executional disruptions), **Teilnahmestörungen** (englisch: participation disruptions) und **Externe Störungen** (englisch: external disruptions). Hierdurch wurde zum ersten Mal eine Kategorisierung für Unterrichtsstörungen in digitalen Lehr-/Lernumgebungen geschaffen, die sowohl die Perspektive der Lehrenden als auch die Perspektive der Lernenden in Betracht zieht. Diese Kategorisierung kann zukünftig genutzt werden, um weitere Forschung auf diesem Gebiet zu fundieren und ist ein mögliches Hilfsmittel für Lehrkräfte bei der reflektierten Analyse ihrer eigenen pädagogischen Praktiken.

Die Validierung dieser Kategorisierung steht derzeit aus. Zukünftige Forschung sollte darauf abzielen, diese Ergebnisse zu validieren, den Kontext auf verschiedene Bildungssysteme und Schultypen auszudehnen und spezifische Fachbereiche zu untersuchen. Längsschnittstudien und Studien, die Lehrenden und Lernende innerhalb desselben Fachs vergleichen, werden ebenfalls empfohlen, um die Validität und Generalisierbarkeit zu erhöhen.

Overview of Publications

This dissertation is based on three published papers, one paper currently in press and one paper currently under review. All articles have undergone or are undergoing double-blind peer-review processes and are intended for publication in international, English-language journals. The articles are:

Article 1
(published)

Meinokat, P., & Wagner, I. (2022). Causes, prevention, and interventions regarding classroom disruptions in digital teaching: A systematic review. *Education and Information Technologies*, 27(4), 4657–4684. <https://doi.org/10.1007/s10639-021-10795-7>

Article 2
(published)

Meinokat, P., & Wagner, I. (2024). Classroom disruptions in digital teaching during the pandemic – an interview study. *Frontiers in Education*, 9. <https://doi.org/10.3389/educ.2024.1335249>

Article 3
(published)

Meinokat, P., & Wagner, I. (2025). Classroom Disruptions and Classroom Management in Learning Factory Settings at Vocational Schools. *International Journal for Research in Vocational Education and Training*, 12(2), 266–288. <https://doi.org/10.13152/IJRVET.12.2.5>

Article 4
(in press)

Meinokat, P., Reimers, K., & Wagner, I. (in press). Refusal in Physical Education – Teachers’ Strategies and Utilization of Digital Media. *Frontiers in Sports and Active Living - Physical Education and Pedagogy*.

Article 5
(under review)

Meinokat, P., Funk, K., & Wagner, I. (under review). What Bothers Students? Students’ Perceptions on Classroom Disruptions in Digitally Supported Mathematics Lessons.

Acknowledgements

This dissertation represents the culmination of a long and enriching journey, marked by extensive learning and the invaluable contributions of numerous individuals. I am deeply grateful to those who inspired and supported me throughout this process. Therefore, I would like to thank a few people here in a non-specified order.

First and foremost, my deepest thanks go to Prof. Dr. Ingo Wagner. As a mentor, he facilitated my entry into the scientific community by offering me a position at the Karlsruhe Institute of Technology and accepting me as a PhD candidate. He also served as an instructor and guide through various research projects, ensuring all my questions were answered. Finally, he took on the role of primary reviewer for this dissertation. Without him, I likely would not have had the chance to work on projects like *digiMINT*, *MINTbewegt*, or *DiäS*, present the findings and results at conferences in places like Glasgow (United Kingdom), Porto (Portugal), Jyväskylä (Finland), and Nicosia (Cyprus), or even write this dissertation. His competent, intelligent, positively demanding, and consistently appreciative support helped me through the ups and downs of this work. Ingo, I cannot thank you enough for making this possible!

Secondly, I would like to thank Prof. Dr. Tamar Voss, who, despite us never having met before, agreed to be my secondary reviewer. This was a significant gesture, and I greatly appreciate it. Thank you very much for your time and effort!

I also want to thank Prof. Dr. Michael Bräutigam, who sparked the initial idea for my academic journey. During my time as a student at university his seminar “Discipline in Physical Education” inspired me to explore classroom disruptions, a passion that led to my bachelor’s and master’s thesis as well as this dissertation. Thank you for that inspiration!

Within our work group, two persons provided outstanding daily support. I deeply appreciate Dr. Olivia Wohlfart’s motivating, creative, professional, friendly, and consistently constructive approach. From our start in 2020 to her role as a leader and proofreader, Olivia has been a source of progress and success. Please continue to inspire people like you did me. Thank you!

Dr. Martina Füchte-meier was an invaluable addition to our team. Her positive, friendly, intelligent, and motivating spirit kept me going through tough times. Her support not

only streamlined my work, creating more time for progress, but also strengthened our team. And she also helped proofread this dissertation. Martina, thank you for being you and for all you do!

Although he is no longer part of our group, I could always count on Dr. Philipp Rosendahl. His critical, programmatic, and success-oriented perspective helped me develop my ideas over the past few years. Thank you for your help!

As this dissertation is based on five articles, I am incredibly grateful to my co-authors, Katja Reimers and Katharina Funk. Their excellent masters' theses laid the foundation for key aspects of my work. The discussions during supervision and article development were always enjoyable and productive. It was a pleasure to work with you both, and I wish you all the best.

I also appreciate Dr. Moritz Mödinger and Carolin Knoke as colleagues. From working together to attending conferences, every conversation was enriching. Thank you!

I am also thankful to Dr. Philipp Heimann, who encouraged me to pursue this path before I joined Karlsruhe and was a reliable source of support during my university days. Thank you!

The emotional and social support from my friends and my family was invaluable. Thank you all very much, and special thanks to my friend Stefanie, who also proofread this dissertation.

Finally, this work would not have been possible without my mother, Petra Meinokat, who went above and beyond to enable me to take this path. Mom, I love you and can not thank you enough.

Table of Contents

Summary.....	i
Zusammenfassung	v
Overview of Publications	ix
Acknowledgements.....	xi
Table of Contents	xiii
List of Tables	xvii
List of Figures	xix
List of Abbreviations	xxi
1 Introduction.....	1
2 Theoretical Framework.....	3
2.1 Classroom Management	3
2.2 Classroom Disruptions.....	5
2.3 Digital Settings.....	10
2.4 Research Gap.....	11
3 Methodology	13
3.1 Systematic Literature Review	14
3.2 Qualitative Interviews	15
3.3 Quantitative Questionnaire.....	18
4 Findings and Results - Publications	21
4.1 Causes, Prevention, and Interventions regarding Classroom Disruptions in Digital Teaching: A Systematic Review	21
4.1.1 Introduction	21
4.1.2 Framework	23
4.1.3 Research Questions.....	25
4.1.4 Methods	25
4.1.5 Results.....	28
4.1.6 Discussion.....	35
4.1.7 Limitations.....	40
4.1.8 Future Directions.....	41

4.1.9	Conclusion	42
4.2	Classroom Disruptions in Digital Teaching during the Pandemic - an Interview Study	43
4.2.1	Introduction	43
4.2.2	Theoretical Framework	44
4.2.3	Method	48
4.2.4	Findings	50
4.2.5	Discussion.....	58
4.2.6	Conclusion.....	67
4.3	Classroom Disruptions and Classroom Management in Learning Factory Settings at Vocational Schools.....	68
4.3.1	Introduction	68
4.3.2	Theoretical Background and Framework	68
4.3.3	Methods	73
4.3.4	Findings	75
4.3.5	Discussion.....	80
4.3.6	Limitations and Future Research	84
4.3.7	Conclusion	85
4.4	Refusal in Physical Education – Teachers’ Strategies and Utilization of Digital Media	87
4.4.1	Introduction	87
4.4.2	Theoretical Framework	87
4.4.3	Method	90
4.4.4	Findings	93
4.4.5	Discussion.....	98
4.4.6	Conclusion.....	106
4.5	What Bothers Students? Students’ Perceptions of Classroom Disruptions in Digitally Supported Mathematics Lessons	107
4.5.1	Introduction	107
4.5.2	Theoretical Framework	107
4.5.3	Methods	112
4.5.4	Results	113
4.5.5	Discussion.....	118
4.5.6	Future Research and Limitations	122
4.5.7	Conclusion	123
5	Discussion	125
5.1	Current State of Research on Classroom Disruptions in Digital Settings	125

5.2	How Teachers See and Deal with Classroom Disruptions in Digital Settings	128
5.3	Students' Perception on Classroom Disruptions in Digital Settings	130
5.4	Classroom Disruptions in Digital Settings – a New Categorization.....	132
5.5	Limitations	138
5.6	Future Research	141
6	Conclusion	143
7	References	147
8	Appendix	173

List of Tables

Table 2.1: Classroom Management Dimensions (Durak & Saritepeci, 2017)	4
Table 2.2: Big Five Classroom Management Categories (Greenberg et al., 2014, pp. i–ii)	5
Table 2.3: Aspects of Classroom Management (Martin et al., 2016, p. 32).....	5
Table 2.4: Overview of Type II Categorizations.....	8
Table 3.1: Sociodemographic Data of Participants in the Interview Studies	17
Table 4.1: Taxonomy—Groups of Terms for Digital Teaching	30
Table 4.2: Taxonomy—Groups of Terms for Classroom Disruptions	31
Table 4.3: Categories for Separating Categorizations	45
Table 4.4: Severity Weighting Categorizations	46
Table 4.5: Interview Questions	49
Table 4.6: Categories for Classroom Disruptions in Digital Teaching.....	50
Table 4.7: Categories for Causes of Disruptions	52
Table 4.8: Categories for Intervention Strategies	54
Table 4.9: Categories for Prevention Strategies	54
Table 4.10: Categories for Disruption Potentials in the Transition	56
Table 4.11: Categories for Potentials from the more Frequent Use or Overuse of Digital Tools	57
Table 4.12: Overview of Participants	73
Table 4.13: Interview Guide	74
Table 4.14: Linking the Categories Found in this Study with the Current State of Research.....	81
Table 4.15: Separation of Classroom Disruptions	82
Table 4.16: Sociodemographic Data of Interviewees.....	91
Table 4.17: Categories for Strategies Teachers Use to Deal with PER	92
Table 4.18: Categories of Digital Media and their Use for the Prevention and Intervention of PER	93
Table 4.19: Digital Media used in Various Strategies for Dealing with PER	102

Table 4.20: Didactic Potential of Digital Media for Mathematics Teaching according to the DZLM (2019)	111
Table 4.21: Details of the Scales formed	114
Table 4.22: Other Digital Media used in Mathematics Classes	116
Table 4.23: Statistics for Created Scales	116
Table 4.24: Model Summary for the Multiple Linear Regression Analysis of the Feeling of being Disrupted	117
Table 4.25: Coefficients for Enjoyment of Mathematics Classes	117
Table 5.1: Overview of Prevention and Intervention Strategies for Classroom Disruptions Reported by Teachers	129
Table 5.2: Categories for Classroom Disruptions with Examples	133
Table 8.1: Overview of Reviewed Articles with Findings on Disruptions in Digital Teaching	174
Table 8.2: Forms of Digital Tools Used and their Associated School Level	178
Table 8.3: Overview Research on Classroom Disruptions in Mathematic Lessons	180
Table 8.4: Questionnaire Items	181

List of Figures

Figure 2.1: Types of Categorizations of Classroom Disruptions.....	7
Figure 2.2: Planning Circle for Dealing with Disruptions.....	9
Figure 3.1: Illustration of the Mixed Methods Approach.....	13
Figure 3.2: Procedure of Systematic Literature Review.....	15
Figure 4.1: Procedure according to the PRISMA Statement (Moher et al., 2009)	28
Figure 4.2: 2D Graph of Classroom Disruptions	59
Figure 4.3: 2D Graph of Classroom Disruptions with Categories from Li and Titsworth (2015)	61
Figure 4.4: 2D Graph of Classroom Disruptions extended by Categories found in this Study	62
Figure 4.5: Examples for PER Behaviors.....	88
Figure 4.6: The Empirical Connection between Wolters and Gebken's (2005) Framework to Strategies found in Literature – Institutional Dimension	98
Figure 4.7: The Empirical Connection between Wolters and Gebken's (2005) Framework to Strategies found in Literature – Classroom Dimension	99
Figure 4.8: The Empirical Connection between Wolters and Gebken's (2005) Framework to Strategies found in Literature – Relationship Dimension	99
Figure 4.9: Classroom Dimension Strategies for Dealing with PER Systemized by Digital Media Category	104
Figure 4.10: Use of Digital Media in Mathematics Lessons in Total Numbers.....	115
Figure 4.11: Categories for What Disrupts Students.....	120
Figure 4.12: Connections Between Teachers' and Students' Perspectives.....	121
Figure 4.13: Categories for Classroom Disruptions from Different Perspectives	122
Figure 5.1: Linking categories of classroom disruptions to the new categorization	134
Figure 5.2: Categories for Classroom Disruptions in Digital Settings	136

List of Abbreviations

AG	Aggressiveness
ANOVA	Analysis of Variance
BM	Behavior Management
ICT	Information and Communication Technologies
DZLM	Deutsches Zentrum für Lehrkräftebildung Mathematik (English: German Centre for Mathematics Teacher Education)
ERIC	Education Resources Information Center
IM	Instructional Management
IS	Internet Slacking
ISB	Illicit Social Behavior
KMK	Kultusministerkonferenz (English: Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany)
LF	Learning Factory
LFs	Learning Factories
LoC	Lack of Communication
OE	Operating Errors
OECD	Organisation for Economic Co-operation and Development
PE	Physical Education
PER	Physical Education Refusal
PISA	Programme for International Student Assessment

List of Abbreviations

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
R	Pearson's Correlation Coefficient
RFID	Radio Frequency Identification
SC_ATT	Scale for self-reported level of attentiveness in lessons
SC_CLA	Scale for behavior of classmates
SC_DIS	Scale for student's feeling of being disrupted
SC_INT	Scale for self-reported intentional misuse of digital media
SC_JOY	Scale for perceived enjoyment of mathematics classes
SC QUI	Scale for experienced level of quietness in the classroom
SC_TEA	Scale for behavior of the teacher
SC_TEC	Scale for technical issues and preparation
SC_UND	Scale for student's understanding of given assignments
SD	Standard Deviation
SDR	Studentized Deleted Residuals
SE	Standard Error
SOMs	Student Online Misbehavior scale
STEM	Science, Technology, Engineering and Mathematics
SUA	Seeking Unallowed Assistance
TALIS	Teaching and Learning International Survey
TE	Technical Errors
VIF	Variance Influence Factors

1 Introduction

The 2001 Programme for International Student Assessment (PISA) results, published by the Organisation for Economic Co-operation and Development (OECD), revealed unexpected and unfavorable outcomes for the German educational system (OECD, 2001), indicating that German students' educational attainment was below expectations. In response, the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic of Germany (German: Kultusministerkonferenz or KMK) mandated "measures to consistently develop and ensure the quality of teaching and schools"¹ and "measures to improve the professionalism of the teaching profession"¹ (KMK, 2001). These directives placed significant expectations on teachers and the quality of teaching. Critically observed, "they [the results of PISA] determine the level of learning achieved by students, but they do not examine the processes that lead to this (e.g., quality of teaching)"¹ (Tillmann, 2015). Furthermore, "it is very possible (and also advisable) to address the overarching results of PISA as a critical question to the practice of one's own school"¹ (Tillmann, 2015). This prompts the fundamental question in educational science what conditions for successful teaching are. The literature highlights key attributes of such effective instructions. Gurney (2007) posits that effective teaching is student-achievement-focused and goal-oriented. To achieve these goals, Meyer (2003) advocates for the intensive use of learning time, including the minimization of disruptions. This approach facilitates successful teaching and benefits both teachers and students. Teachers experience a reduced risk of physical and psychological health issues, including burnout, when disruptions are minimized (Brouwers & Tomic, 2000; Gonzalez et al., 2015; Greene et al., 2002; Kokkinos, 2007; Rajendran et al., 2020). On the other side, students benefit from reduced disruptions through enhanced academic achievement, which is linked to efficient use of learning time (Adeyemo, 2012; Brophy & Good, 1986; Marquez et al., 2016; Talebi et al., 2015). The prevalence of classroom disruptions, occurring on average more than once per minute (Maddeh et al., 2015; OECD, 2014; Wettstein & Scherzinger, 2018), underscores the importance of effective management strategies.

In addition to these daily challenges, the COVID-19 pandemic necessitated a global restructuring of educational systems. Homeschooling, utilizing online teaching and learning, was rapidly implemented (Meinokat & Wagner, 2024; Wohlfart et al., 2021).

¹ Translated by the author.

This accelerated the demands from policymakers, stakeholders, and educators for the integration of digital media in education (European Union, 2020; KMK, 2017a, 2021; U.S. Department of Education, 2017). Given the increasing emphasis on digital education and the well-established body of research on classroom management (Kounin, 1970, 2006), this dissertation investigates the interplay between these two domains, with a particular focus on classroom disruptions. By incorporating multiple perspectives, this study seeks to evaluate whether digitalization enhances the management of disruptions or, conversely, introduces new avenues for their emergence.

2 Theoretical Framework

As established in the introduction, this dissertation addresses the relationship between the digital transformation in education and classroom disruptions, thereby necessitating a comprehensive theoretical foundation. In alignment with the title, “Classroom Disruptions in Digital Settings”, key terminologies are elucidated, including *classroom management* (chapter 2.1, p. 3), *classroom disruptions* (chapter 2.2, p. 5), and *digital settings* (chapter 2.3, p. 10).

2.1 Classroom Management

Kounin (1970) pioneered the conceptualization of group management and effective learning environments. Emphasizing *withitness*, which requires instructors to be acutely aware of classroom dynamics, Kounin (1970) positioned teachers as the primary agents responsible for classroom management. Over subsequent decades, international educational researchers have acknowledged, critiqued, and expanded upon Kounin’s framework, establishing the field of *classroom management*.

Reflecting the growth of classroom management research, Doyle (1985, p. 31) synthesized the prevailing state of research, defining classroom management as “actions teachers take to solve the problem of order in classrooms” and further articulating it as the “task to gain and maintain the cooperation of students in activities that fill classroom time” (Doyle, 1980, p. 9). This definition was refined by Brophy (1986, p. 182), who defined effective classroom management as “the ability to establish, maintain, and (when necessary) restore the classroom as an effective environment for teaching and learning”. Grounded in prior research, this definition is indicating a direct correlation between teachers’ classroom management skills and students’ academic success, as effective classroom management enhances students’ time spent learning (Brophy & Good, 1986).

As classroom management research has proliferated, so too has the diversity of interpretations and definitions. Evertson and Weinstein (2006) defined classroom management as

“actions teachers take to create an environment that supports and facilitates both academic and social-emotional learning. [It] not only seeks to establish and sustain an orderly environment so students can engage in meaningful academic learning, it also aims to enhance students’ social and moral growth.” (Evertson & Weinstein, 2006, p. 4)

Focusing on specific teacher actions, Zoder-Martell et al. (2023) asserted that classroom management strategies are employed to maintain students’ on-task behavior, attentiveness, and academic engagement. Similarly, Mulvahill (2018, p. 1) defined classroom management as a “wide variety of skills and techniques that teachers use to ensure that their classroom runs smoothly, without disruptive behavior from students.”

These interpretations represent classic definitions of classroom management. Contemporary research also presents categorizations that categorize classroom management into distinct dimensions. Durak and Saritepeci (2017, p. 443) identified five key areas: “management of physical structure of the classroom”, “teaching management”, “time management”, “management of intra-classroom relationships”, and “behavior management”. Table 2.1 (p. 4) provides an overview of the authors’ understanding of each category.

Table 2.1: Classroom Management Dimensions (Durak & Saritepeci, 2017)

Classroom Management Dimension	Explanation
Management of physical structure of the classroom	Ensuring the compatibility between the use of classroom tools and educational goals, and organizing factors related to the classroom environment.
Teaching management	Planning teaching methods and principles in accordance with the environment to achieve educational goals.
Time management	Planning activities to improve learning and teaching activities in a limited period.
Management of intra-classroom relationships	Ensuring communication between students to allow for effective teaching in the learning environment.
Behavior management	Preventing negative behaviors in the classroom atmosphere and control negative student behavior according to class rules.

Greenberg et al. (2014, pp. i–ii) proposed another set of five categories, termed the “Big Five”: “rules”, “routines”, “praise”, “misbehavior”, and “engagement”. Their interpretations of these categories are presented in Table 2.2 (p. 5).

Table 2.2: Big Five Classroom Management Categories (Greenberg et al., 2014, pp. i–ii)

Classroom Management Category	Explanation
Rules	“Establish and teach classroom rules to communicate expectations for behavior”
Routines	“Build structure and establish routines to help guide students in a wide variety of situations”
Praise	“Reinforce positive behavior using praise and other means”
Misbehavior	“Consistently impose consequences for misbehavior”
Engagement	“Foster and maintain student engagement by teaching interesting lessons that include opportunities for active student participation”

Martin et al. (2016) presents an overview of five interrelated aspects of classroom management, emphasizing developmental, culturally responsive classroom management (see Table 2.3, p. 5). This concept posits that teachers’ behaviors are shaped by two primary components: *behavior management* and *instructional management* (Martin & Sass, 2010). With the explicit mention of behavior management, defined as “efforts to prevent misbehavior as well as teacher’s response to it” (Martin et al., 2016, p. 36), it is evident that a key aspect of classroom management is the management of classroom disruptions.

Table 2.3: Aspects of Classroom Management (Martin et al., 2016, p. 32)

Aspects of Classroom Management	Explanation
Teacher emotions and classroom management: managing the self	“Creating and maintaining an image while attending to ‘faces’ constructed by students”
A relational perspective of classroom management	“Demonstrating rather high degree of teacher authority and high degree of care”
Temperament-based classroom management	“Recognizing, reframing, responding, scaffolding and stretching”
Developmental, culturally responsive classroom management	“Managing behavior and instruction in a culturally responsive, developmentally appropriate manner”
Classroom management as defined from a participation centered perspective	“Ritualizing routines and practices that define classroom community; helping children achieve membership”

2.2 Classroom Disruptions

Research and definitions of classroom management reveal a wide variety of approaches to addressing issues within the classroom. While the term *Unterrichtsstörungen* is

widely accepted in the German educational research community, international research exhibits an ambiguous and synonymous use of various descriptors. Examples include, but are not limited to, combinations of the words *student*, *classroom* or *school* with *misbehavior*, *issues*, *problems* or *disturbances*. For the sake of clarity, the standardized term *classroom disruption* will be used in this dissertation (Meinokat & Wagner, 2022).

Bräutigam (2015) addresses the concept of a disruption as a discrepancy between a given standard and an observed fact. The author further explains that solutions to this discrepancy can be achieved in two ways: by adapting the fact to the standard or by modifying the standard to align with the fact. In contrast to conceptual representations such as Bräutigam's, numerous conceptual definitions can be identified in the literature.

Specific definitions in this area vary in their level of detail. Belt and Belt (2017, p. 55) provided a broad definition of classroom disruptions as "general issues hindering students' and teachers' classroom work". Lawrence et al. (1983, p. 82) defined classroom disruptions as "behaviour which interferes seriously with the teaching process and/or seriously upsets the normal running of the school". Biller (1979, p. 28) explained that "anything that interrupts or could interrupt the process or the relationship structure of teaching situations can be defined as a concrete or potential disruption to teaching"².

Contemporary definitions of classroom disruptions continue to emphasize the importance of the teaching process. Lohmann (2011, p. 13) defined classroom disruptions as "events that impair, interrupt, or render the teaching-learning process impossible by partially or completely overriding the conditions under which teaching and learning can take place"². Maddeh et al. (2015, p. 144) shifted the focus slightly towards behavior, explaining that "disruptive behaviors refer, essentially, to any behavior that disrupts school activities, particularly behaviors that disturb teachers and/or students in class. These behaviors harm, generally, the teaching/learning process". Stockton University (2001, p. 1) defines classroom disruptions as "behavior a reasonable person would view as being likely to substantially or repeatedly interfere with conduct of a class".

Despite the varied terminology used in classroom management research, definitions of classroom disruptions share common aspects. The behavior of an unspecified participant in the teaching-learning process impedes the process, either temporarily or partially. Notably, earlier definitions tend to focus on the teaching aspect (Biller, 1979; Lawrence et al., 1983), placing teachers in positions to determine what constitutes a classroom disruption. Later definitions shift the focus to the process itself (Lohmann,

² Translated by the author.

2011; Maddeh et al., 2015; Stockton University, 2001), allowing for multiple perspectives.

Beyond definitions, literature on classroom disruptions presents various attempts to categorize these disruptions. Generally, there are two types of categorizations: Type I, which involves grouping disruptive situations and rating them based on their severity, and Type II, which summarizes disruptive situations as coexisting, unrelated groups. A comparative illustration of these two types is provided in Figure 2.1 (p. 7).

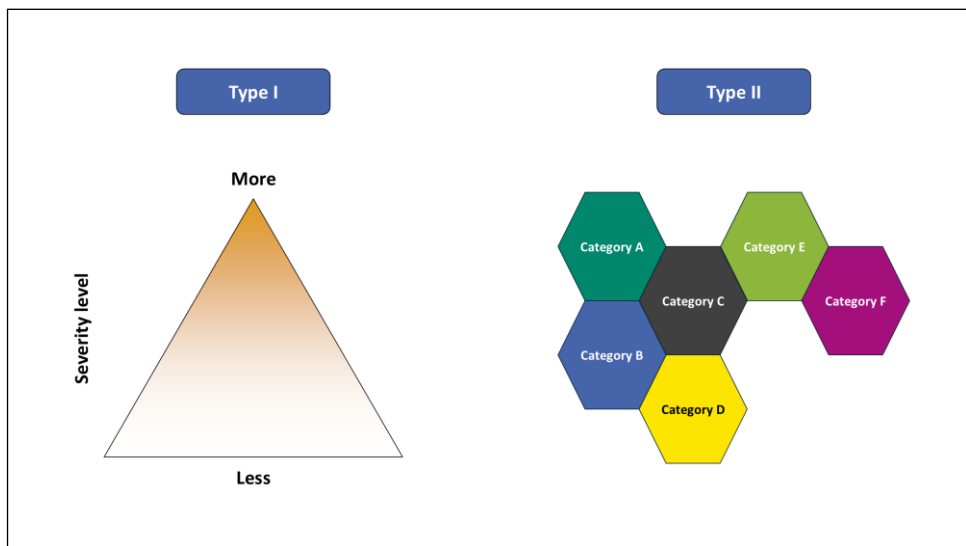


Figure 2.1: Types of Categorizations of Classroom Disruptions

Examples of Type I categorizations include those by Cogswell et al. (2020), Rattay et al. (2018), and Scherzinger and Wettstein (2019). Scherzinger and Wettstein (2019) categorize disruptions along a spectrum from *nonaggressive* to *aggressive*, while Cogswell et al. (2020) employ a distinction between *high-level* and *low-level* disruptions. Rattay et al. (2018) offer a more detailed classification, delineating five levels: *impairments* (minor distractions), *interruptions* (disruptions to lesson flow), *impossibilities* (temporary cessation of learning), *behavioral problems* (recurring misbehavior), and *conduct disorders*. The first four levels are grouped as *situational behavior*, whereas *oversituational* conduct disorders, which are beyond classroom resolution and often linked to clinical behavioral abnormalities, constitute the fifth level. Classroom disruptions rooted in medically indicated illnesses, categorized by Rattay et al. (2018) as oversituational,

constitute a distinct area for scientific inquiry. While there is a conceptual proximity between such behavioral disorders and classroom disruptions, the medical etiology and focus of these disruptions warrant separate consideration. Consequently, this dissertation does not address this type of disruption as a discrete category.

Examples of Type II categorizations include those by Biller (1979), Li and Titsworth (2015), Lohmann (2011), and Winkel (2011). In contrast to hierarchical categorizations, these classifications present non-hierarchical, though overlapping, categories. Biller (1979) categorizes disruptions as *minor faults*, *(in)direct disruptions*, *unrecoverable disruptions*, and *unavoidable disruptions*. Lohmann (2011) identifies *verbal disruptions*, *lack of willingness to learn*, *motoric restlessness*, and *aggressive behavior*. These systems differ in focus: Lohmann's approach is practical and observation-based, while Biller's offers broader classifications into which other categories can be integrated. Li and Titsworth (2015) provide categories related to digital settings, such as *seeking unallowed assistance* and *internet slacking*, alongside general categories like *aggressiveness* and *lack of communication*. Winkel (2011) expands this with seven categories, including *disciplinary disruptions*, *provocation*, *acoustic and visual disruptions*, *restlessness*, *missing concentration*, *external disruptions*, *refusal to learn*, and *lack of motivation*. A comprehensive overview of these categorizations is provided in Table 2.4 (p. 8).

Table 2.4: Overview of Type II Categorizations

Biller (1979)	Lohmann (2011)	Li and Titsworth (2015)	Winkel (2011)
• Minor faults • (In)Direct disruptions • Unrecoverable disruptions • Unavoidable disruptions	• Verbal disruptions • Lack of willingness to learn • Motoric restlessness • Aggressive behavior	• Seeking unallowed assistance • Internet slacking • Aggressiveness • Lack of communication	• Disciplinary disruptions • Provocation and aggression • Permanent acoustic and visual disruptions, as well as restlessness and missing concentration • Disruptions from outside the class • Refusal to learn and passivity • Missing motivation • Neurotic disorders

In addition to categorizing classroom disruptions in various ways, research on addressing disruptive situations also distinguishes two temporal categories for strategies:

preventive measures, implemented prior to a disruption, and *interventions*, implemented following a disruption (Lohmann, 2011). Lohmann further subdivides each strategic category into two subcategories. Strategies are differentiated by timing: prevention strategies which are integrated into lesson planning to proactively minimize disruptions (*planning*) and those implemented during instruction to address emerging disruptions (*avoidance*). Similarly, intervention strategies are categorized as immediate, direct actions taken to resolve a disruption (*action*), and post-disruption adjustments made to lesson planning (*change*). This cyclical approach to disruption management is visually represented in Figure 2.2 (p. 9).

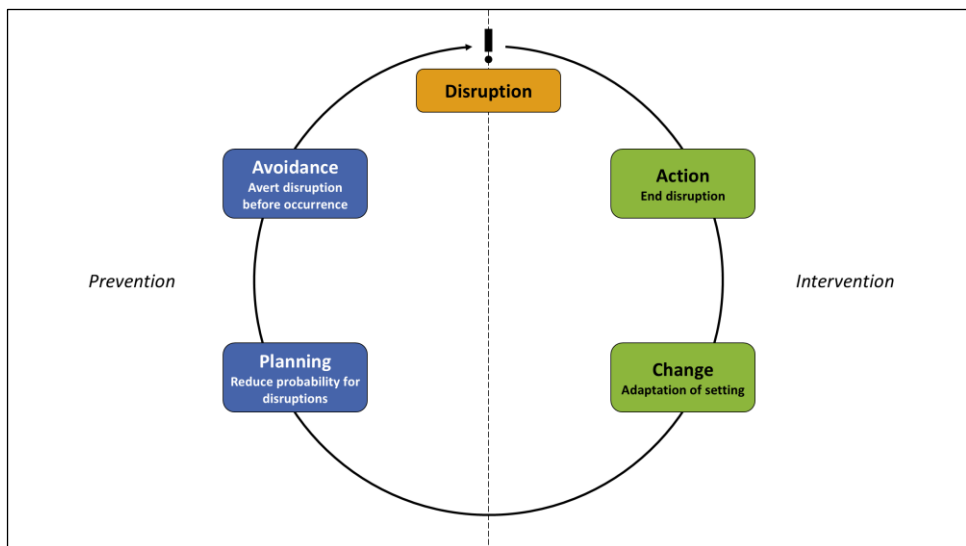


Figure 2.2: Planning Circle for Dealing with Disruptions

Within the established definitions of classroom management and classroom disruptions, the terms *teaching* and *learning* are consistently prominent. This distinction carries significant weight. Teaching denotes the transmission of knowledge, the act of instruction, and thus casts teachers in an active, directive role (Oxford English Dictionary, 2025c). Conversely, definitions that incorporate the learning process acknowledge the students' central role, defining learning as the acquisition of knowledge, understanding, or skill, represents the fundamental objective of students within educational settings (Oxford English Dictionary, 2025a). Consequently, a number of researchers employ the composite terms "teaching-learning processes" or "teaching-learning experiences" to

capture the reciprocal nature of the educational endeavor (Dwaik et al., 2016; Kárpáti, 2004; Rosendahl & Wagner, 2024).

These teaching-learning processes unfold within a specific location or environment, designated as a *setting*. A setting encompasses “the environment or surroundings in which a person or thing is ‘set’” (Oxford English Dictionary, 2025b). In the context of teaching-learning processes, this setting refers to the space where teachers impart instruction and students engage in learning. While traditional classrooms have historically served as the primary setting, recent societal shifts have broadened the spectrum of viable educational environments.

2.3 Digital Settings

The digital transformation of society, driven by factors including the COVID-19 pandemic, has accelerated at an unprecedented pace (Daniel, 2020). However, educational institutions have often demonstrated a delayed response to this transformative trend (Cho et al., 2020). To ensure accuracy, it is imperative to differentiate between *digitization* and *digitalization*. Digitization pertains to the conversion of analog data into a digital format, whereas digitalization encompasses the integration of digital technologies into a given setting (Frenzel et al., 2021; Gradillas & Thomas, 2023). This dissertation prioritizes the examination of digitalization.

This focus is substantiated by the directives of education policymakers and stakeholders within the educational system. The European Union has articulated a strategic objective to ensure that 80% of Europe’s population possesses fundamental digital skills, while also addressing the need for 20 million specialists in Information and Communication Technologies (ICT) (European Union, 2023). A Digital Education Action Plan calls for a fundamental recalibration of education to prepare for the digital age (European Union, 2020). In Germany, the KMK serves as a national body that guides the direction of the education system. Publications issued by the KMK echo the European Union’s demands, consistently emphasizing the imperative for enhanced integration of digitalization into educational practices (KMK, 2017a, 2017b, 2021, 2024).

This integration entails multiple facets of digitalization. The European Union (2023) highlights ICT, a field defined as “a combination of technological tools and resources that are used to manipulate and communicate information” (Kaware & Sain, 2015, p. 27). These technological tools encompass “electronic & digital devices like computers,

Internet and broadcasting technologies” (Kaware & Sain, 2015, p. 27). Thus, ICT constitutes an integral component of digitalization.

Another category referenced in the context of digitalization is digital tools (Cho et al., 2020; Wohlfart & Wagner, 2024). The KMK refers to these tools as *digital media* (KMK, 2017b), a term widely employed in the literature. In this dissertation, the encompassing term digital media will be used to denote all digital enhancements for teaching and learning. Furthermore, and in conjunction with the aforementioned understanding of the term setting, *digital settings* will be conceptualized as teaching and learning environments in which digital media play a crucial role.

Research indicates that the relationship between the effects of digital settings or digital media and classroom management has been increasingly investigated. As demonstrated by Sing Yun’s (2023) systematic literature review, while research is adapting to this evolving area and increasing in volume, a specific focus on the subarea of classroom disruptions in digital settings and with or through digital media remains limited.

2.4 Research Gap

As evidenced by the theoretical framework, research has been conducted on classroom management, classroom disruptions, and, increasingly, on digitalization within educational contexts. Furthermore, in response to demands from policymakers, stakeholders, and society (European Union, 2020; KMK, 2017b; U.S. Department of Education, 2017), initial research efforts have explored the intersection of classroom management and digitalization (Sing Yun, 2023). Nevertheless, the scientific community has largely overlooked the critical subarea of classroom disruptions within an increasingly digitalized educational landscape. As previously shown, effectively addressing disruptions is integral to successful teaching and learning and is therefore of paramount importance for both educators and learners. This dissertation seeks to address this significant research gap.

Educational research is inherently complex, with a multitude of factors influencing teaching and learning. This complexity is reflected in attempts to develop systematic models for education, such as the didactic triangle (Heimann, 1947), a schematic representation of the key actors in the teaching and learning process (teachers, learners, and content), and its subsequent iterations (Pätzold, 2011). These models aim to simplify the intricate dynamics of teaching and learning while acknowledging the existence of diverse influencing factors, or perspectives. Consequently, this dissertation adopts a

multi-perspective approach. Building upon the foundational tripartite division of the didactic triangle, and in conjunction with the identified research gap, three central research questions emerge:

- RQ1: What is the current state of research on classroom disruptions in digital settings?
- RQ2: How do teachers address classroom disruptions in their digital teaching practices?
- RQ3: How do students perceive classroom disruptions in digitally supported learning settings?

3 Methodology

To comprehensively address the identified research gap through the articulation of three distinct perspectives, a cumulative dissertation project was executed. This design facilitated the implementation of a mixed-methods approach, as visually represented in Figure 3.1 (p. 13).

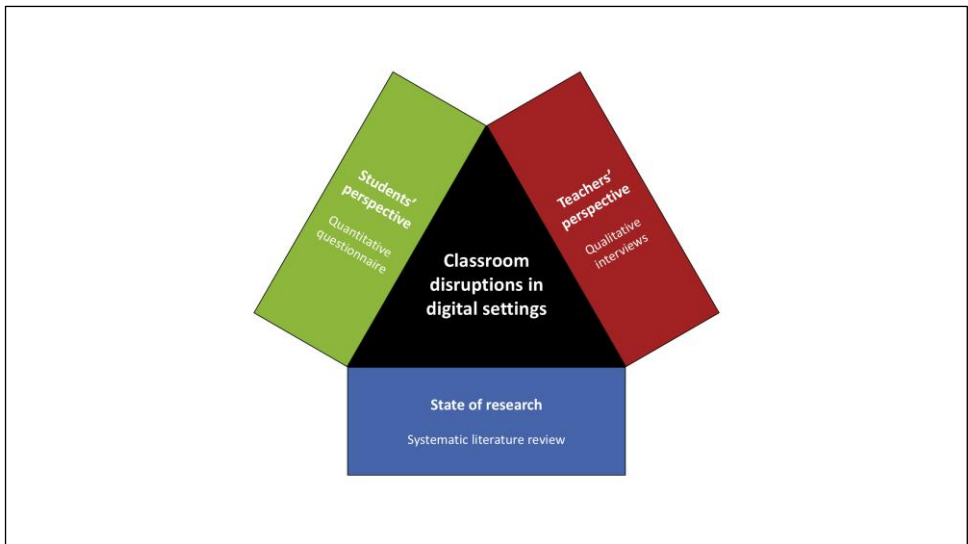


Figure 3.1: Illustration of the Mixed Methods Approach

The foundational component of this dissertation is a systematic literature review, which meticulously examined the current state of research pertaining to classroom disruptions within digital settings (Meinokat & Wagner, 2022). Building upon the insights gleaned from this review, qualitative, semi-structured, guideline-based expert interviews were conducted with teachers representing a spectrum of teaching domains (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025). To achieve a holistic understanding of the dissertation's central theme, students' perceptions of classroom disruptions in digitally supported mathematics lessons were gathered through the administration of a quantitative questionnaire (Meinokat et al., under review), with a targeted focus on an exploratory approach to understand the students' perspective. The distinct methodological approaches employed to explore these three perspectives are delineated below. It is

important to note that while the methodologies of the individual studies are presented in outline form here, detailed expositions can be found within the respective chapters of the individual publications (see chapter 4).

3.1 Systematic Literature Review

This research project commenced with the undertaking of a systematic literature review. The primary objective of this review was to address RQ1: What is the current state of research on classroom disruptions in digital settings? To achieve this objective, the following subsidiary research questions were formulated:

- RQ_{A1}: Which terminologies can be found in research literature to describe digital settings and the disruptions within it?
- RQ_{A2}: What are the methodological approaches used in previous research on the subject of disruptions in digital settings?
- RQ_{A3}: How does research systematize disruptions in digital settings?
- RQ_{A4}: What are the causes of disruptions in digital settings and what prevention and intervention strategies exist to deal with them?

The research was conducted utilizing the Education Resources Information Center (ERIC), Academic Search Ultima (via EBSCOhost), and Web of Science databases. Inclusion criteria were rigorously defined, limiting the scope to English-language, peer-reviewed, study-based articles. The general procedure of the review adhered to Moher et al. (2009) who stated a Preferred way of Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). This statement prescribes a four-step process (illustrated in Figure 3.2, p. 15): identification of potentially relevant publications, screening of titles and abstracts, assessment of eligibility through focused review of articles, and inclusion of final articles. Through this process, 16 articles were ultimately selected for full-text analysis.

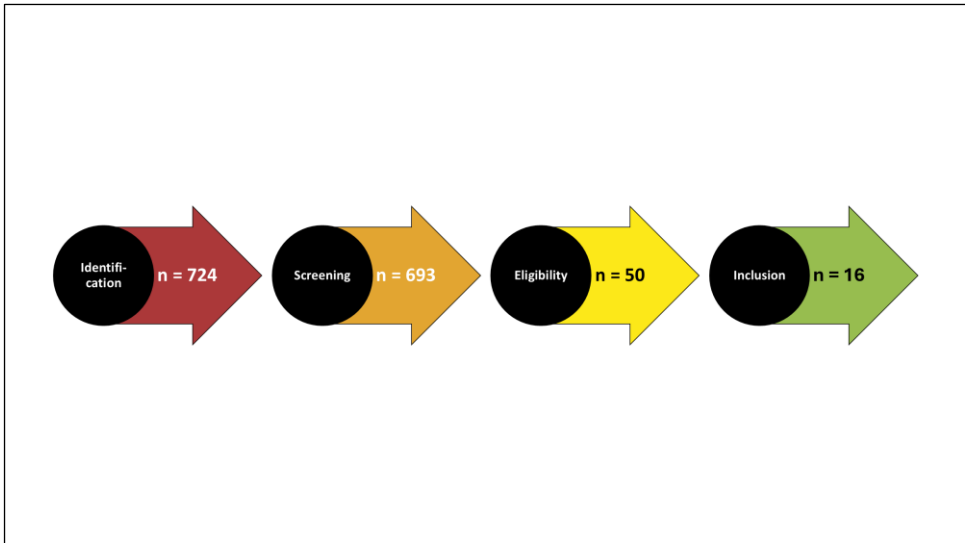


Figure 3.2: Procedure of Systematic Literature Review

3.2 Qualitative Interviews

The extant body of research predominantly reflects a teacher-centric perspective within investigations of classroom disruptions and classroom management. However, as previously emphasized, the nuanced impact of digitalization on these dynamics remains comparatively underexplored. Consequently, the subsequent phase of this research endeavor involved direct engagement with teachers to specifically scrutinize their strategies for managing disruptions within digital settings. Given the relatively nascent stage of scholarly inquiry in this domain, a qualitative approach was deemed most appropriate. Individual expert interviews were selected as the primary data collection instrument to facilitate an exploratory investigation, enabling the capture of rich, context-specific insights (Denzin & Lincoln, 2018). To ensure both comparability and flexibility in data collection, semi-structured interview guidelines were developed, providing a framework for discussion while allowing for the emergence of unanticipated themes (Hussy et al., 2013). The overarching objective of this methodological approach was to address RQ2: How do teachers address classroom disruptions in their digital teaching practices? An inherently interdisciplinary research approach necessitated the execution of multiple, targeted interview studies.

The initial interview study focused on eliciting teachers' strategies for managing disruptions during the period of pandemic-induced teaching restrictions. This study sought to address the following research questions:

- RQ_{B1}: What forms of classroom disruptions occur in digital teaching?
- RQ_{B2}: What are the underlying causes of classroom disruptions in digital teaching?
- RQ_{B3}: How do teachers deal preventively with and intervene in classroom disruptions in digital teaching?
- RQ_{B4}: What potential do teachers see when transferring elements of digital teaching from online teaching during the pandemic to face-to-face teaching?

Recognizing that the participants in the initial study were drawn exclusively from secondary education levels I and II, it was determined that broadening the participant pool was essential to enhance the generalizability of the findings. The subsequent interview study targeted vocational education teachers, with a specific focus on the unique didactic context of Learning Factories (LFs). This study sought to address the following research questions:

- RQ_{C1}: What types of classroom disruptions occur in Learning Factories?
- RQ_{C2}: What preventive and interventive measures do teachers use to deal with classroom disruptions in Learning Factories?

Observations derived from the literature review and preliminary interview findings underscored the significant variability in disruption management strategies across diverse educational settings. Consequently, a third interview study was conducted, focusing on physical education (PE) teachers, given the distinct pedagogical characteristics of PE within the curriculum (Hunger & Zander, 2020). Within this study, a particular emphasis was placed on the phenomenon of Physical Education Refusal (PER), a specific type of classroom disruption. The research questions addressed in this study were:

- RQ_{D1}: What strategies do teachers use to deal with PER?
- RQ_{D2}: How can digital media be used to deal with PER?

A total of 31 teachers participated across the three interview studies. Table 3.1 (p. 17) provides a comprehensive overview of the participants' sociodemographic characteristics.

Table 3.1: Sociodemographic Data of Participants in the Interview Studies

Alias	Age	Gender	Teaching Experience in Years	Participant of which Study
T1	49	Male	15	Interviews with teachers during the pandemic (Meinokat & Wagner, 2024)
T2	44	Male	16	
T3	36	Male	3	
T4	46	Male	17	
T5	30	Male	2	
T6	37	Male	7	
T7	37	Male	7	
T8	30	Male	2	
T9	30	Female	4	
T10	59	Female	27	
T11	40	Female	12	
T12	27	Female	1	
T13	29	Female	1	
T14	-	Male	25	Interviews with vocational education teachers (Meinokat & Wagner, 2025)
T15	-	Male	20	
T16	-	Male	14	
T17	-	Male	12	
T18	-	Male	20	
T19	-	Male	9	
T20	-	Male	11	
T21	36	Male	9	Interviews with PE teachers (Meinokat et al., in press)
T22	28	Male	2	
T23	53	Female	24	
T24	38	Female	2	
T25	31	Male	2	
T26	38	Male	11	
T27	55	Male	22	
T28	29	Female	3	
T29	52	Male	22	
T30	38	Male	10	
T31	37	Male	10	

Following the acquisition of informed consent from all participants, all interviews, whether conducted in person or online, were audio-recorded, anonymized, and transcribed in accordance with established methodological guidelines (Clausen et al., 2020; Hussy et al., 2013; Kuckartz & Rädiker, 2022). The interviews were conducted in German, and relevant excerpts were translated into English by the authors for publication. Qualitative content analysis, as described by Mayring (2014), was employed for each study, utilizing MAXQDA software (versions 2022 and 2024), to systematically address the respective research questions. This approach was selected over an analysis following Kuckartz and Rädiker (2022) due to the presence of a well-established theoretical framework in each area of inquiry.

3.3 Quantitative Questionnaire

Building upon the findings from the literature, the insights derived from the systematic literature review, and the qualitative interviews with teachers, the student perspective was determined to be essential for a comprehensive understanding of classroom disruptions within digital settings. In contrast to teachers, the recruitment of student participants is often encumbered by stringent data protection regulations and ethical considerations. However, the administration of questionnaires to entire classes, when feasible, allows for the efficient collection of data from a substantial number of participants (Queirós et al., 2017). This methodological advantage, coupled with the theoretical framework underpinning the final publication, which is firmly rooted in mathematics education, led to the decision to employ a quantitative questionnaire. A total of 254 students participated in the questionnaire, providing data to address the following research questions:

- RQ_{E1}: How are digitally supported mathematics classes perceived by students?
- RQ_{E2}: What makes students feel disrupted in digitally supported mathematics classes?

Of the 254 student participants, 124 (48.8%) identified as female, 117 (46.1%) as male, nine (3.5%) as other, and four (1.6%) declined to specify their gender. The students' mean age was 14.09 years ($n = 248$, $SD = 1.492$), with ages ranging from 11 ($n = 1$) to 17 ($n = 6$). The questionnaire was administered to students in grades 7, 8, 10, and 11 at a secondary school in the federal state of Baden-Württemberg, Germany, representing a diverse age range within secondary education.

The primary objective of this study, within the broader context of this dissertation, was to address RQ3: How do students perceive classroom disruptions in digitally supported learning settings? To achieve this objective, the developed questionnaire was meticulously designed based on existing research pertaining to classroom disruptions in mathematics and the integration of digital media in educational settings. The questionnaire comprised 60 items, with the majority utilizing five-point Likert scales to assess student perceptions. These Likert-scale items were supplemented by nominal-scale questions to gather categorical data, as well as demographic items to contextualize the responses. Data were collected in person using printed questionnaires, with meticulous attention to ensuring a standardized administration procedure.

Data analysis was conducted using SPSS software (versions 29 and 30). The questionnaire, originally developed and administered in German, was subsequently translated

into English for the purposes of publication and this dissertation. A multiple linear regression analysis was performed to examine the relationships between student perceptions of disruption and various independent variables, providing a robust statistical foundation for the findings.

The methodologies described for the systematic literature review, the interview studies, and the questionnaire study were implemented sequentially throughout the dissertation project in individual studies, each culminating in the publication of a journal article in a scientific journal. These individual articles collectively constitute the findings and results of this dissertation.

4 Findings and Results - Publications

This chapter presents the publications upon which this dissertation is based. The sequence of presentation adheres to the methodological approach outlined previously. Figures and tables have been adapted to conform to the style of this dissertation. The content of each article corresponds to its published or submitted version, with the reference provided in a footnote at the beginning of each chapter. For clarity, abstracts, keywords, and other publication-specific elements have been omitted. The references from each article have been integrated into the comprehensive bibliography of this dissertation.

4.1 Causes, Prevention, and Interventions regarding Classroom Disruptions in Digital Teaching: A Systematic Review³

Pierre Meinokat and Ingo Wagner

4.1.1 Introduction

Classrooms without disruptions are desirable, yet utopic. Thanks to Kounin (1970), the field of classroom management has been researched greatly in the last 50 years, and findings show that handling disruptive classroom situations is part of classroom management (Durak & Saritepeci, 2017; Egeberg et al., 2016; Kubat & Dedeali, 2018; Moltudal et al., 2019). Moreover, “effective classroom management has been identified as a key predictor of student success” (Marquez et al., 2016, p. 88). However, the emerging field of digital teaching and learning has seldom been studied regarding disruptions.

Yet, ICT can be found in various parts of everyone’s daily life nowadays. For example, in the early 2000s, the first widely used mobile phones were produced, personal comput-

³ Meinokat, P., & Wagner, I. (2022). Causes, prevention, and interventions regarding classroom disruptions in digital teaching: A systematic review. *Education and Information Technologies*, 27(4), 4657–4684. <https://doi.org/10.1007/s10639-021-10795-7>

ers entered private households, the internet became accessible, and social media platforms like Facebook and YouTube were made available. Nowadays data are processed digitally at work, smartphones and tablets are more and more used on every educational level and modern science is based on international communication via technology. Undoubtedly, ICT has grown in importance and is receiving more and more attention. The penetration of educational areas with ICT and digitalization in general seems inevitable, especially since the outbreak of the COVID-19 pandemic in 2020. Global education is being forced toward digitalization faster than ever before and the use of ICT plays a crucial role in this. It is worth mentioning here that the use of ICT in education is important on different levels. Information systems like (e.g.) internet forums and social networks happen to get more and more integrated in daily educational practice as well as communication systems (like smartphones) and computer systems including their hardware (PCs, Laptops, etc.) and software (apps, learning platforms, etc.). While subjects like computer science are inevitably connected to ICT, other subjects are increasingly using the advantages of digital media. With a first brief view on the field of classroom disruptions, the increasing usage of ICT evolves potential problems in a variety of areas. For example: problems with the school network, data protection for students' and teachers' data, etc. All these topics are located in one or more areas of ICT and therefore, this review will refer to all these different forms as ICT. All forms of education from primary education to university level are affected. International research focuses on education in digital settings in order to improve knowledge of teachers and students who are forced away from traditional face-to-face education. As part of this research, this review will contribute to attempts to improve the education of future teachers and will summarize information needed to train teachers on their classroom management skills.

The importance of a well-developed digitalization (culture) and the proper use of ICT in teaching and learning had been highlighted around the world by governments and related institutes (KMK, 2017a; U.S. Department of Education, 2017) even before this global incident. Although its importance has been recognized, current research "does illuminate the slow pace at which classroom management research has entered the digital age" (Cho et al., 2020, pp. 8–9). Scientific research is responsible for accompanying this "digital revolution" (Collins & Halverson, 2018, p. 1), and there is a need to enhance already existing research on classroom management and digitalization in education while creating a new foundation for future research in digital teaching and learning. Special attention should be paid to disruptions in digital teaching and how to prevent or deal with them in order to make such teaching and learning as effective as possible. As a part of this task, this review aims to reveal the current state of interna-

tional research in the field of classroom disruptions in digital settings and to discover possible research gaps to enhance the future quality of digital teaching.

4.1.2 Framework

Two main concepts appear when focusing on the objective of this review. First, there is the concept of *classroom disruptions*. This is defined as “behavior a reasonable person would view as being likely to substantially or repeatedly interfere with conduct of a class” (Stockton University, 2001, p. 1). The mentioned behavior can further be described as “any behavior that interferes with teaching and learning” (Franken, 2020, p. 445). However, current research is missing sorts, types, or patterns of classroom disruptions besides problematic student behavior. A deeper look into existing research reveals that classroom disruptions are seldom investigated on their own and are mostly found in a contextual setting. This setting is widely known as *classroom management* and is much more researched than classroom disruptions alone. It was Kounin (1970) who conveyed the term classroom management to a wider audience. It was defined as “the actions teachers take to create an environment that supports and facilitates both academic and social-emotional learning” (Evertson & Weinstein, 2006, p. 4). During the last 50 years of research into classroom management, scientists have come up with numerous models regarding what it is and what it includes, in contrast to research on the specific sub-area of classroom disruptions. As Balli (2011) mentioned, three models have appeared most often in teacher education research. First, the *assertive discipline model* (Canter, 2009) was criticized for its more traditional (student and teacher) behavior approach and was updated with more emphasis on establishing a positive classroom climate through rules and procedures (Balli, 2011). Second, Kounin’s (1970) *withitness and group management model* demanded teachers to remain aware and revealed the need to multitask and the risk of focusing on one student for too long (Balli, 2011). Third, the *choice theory model* by Glasser (1986) advised teachers to be lead managers in a democratic classroom rather than boss managers controlling students (Balli, 2011). While these models focused on a more constructional view of teachers’ behavior, recent research has shifted its focus to categories of classroom management in daily practice (Greenberg et al., 2014).

Three different reviews, Simonsen et al. (2008), Oliver et al. (2011), and Epstein et al. (2008), together included over 150 different studies of classroom management from the last 60 years. “Despite the wide variation in research citations in these sources, there is congruence in their findings on essentially five strategies for classroom management” (Greenberg et al., 2014, p. 3). These big five are as follows: “rules”, “routines”, “praise”,

“misbehavior”, and “engagement” (Greenberg et al., 2014, pp. 3–4). Misbehavior, as an essential part of classroom management, leads to disruptions in classrooms and therefore “harm[s ...] the teaching/learning process” (Maddeh et al., 2015, p. 144). This review will search for disruptive situations within a learning process to have a wide overview of possible actions that can be understood as classroom disruptions. To do this in a systematic way, mentioned models and definitions will be used. Yet, what all models and definitions have in common is that they lack a connection to a digital setting.

The second main concept of this review is *digital teaching*. While digitalization seems to be a widespread social topic, a definition of digital teaching and learning is still lacking. First, as a temporary conceptual definition, this review concentrates on the two individual terms *digital* and *teaching*. “Nowadays the term digital is used instead of such previously used terms as information and communication technology (ICT) or information technology when talking about technology-related skills” (Ilomäki et al., 2016, p. 656). Based on this definition this review will understand the term digital related to any kind of technology supported settings. The second term teaching on the other side has a wide field of definitions that can be found in numerous publications. For the purpose of this review the authors decided to use the definition of the Stellenbosch University (2021): “Teaching can be defined as engagement with learners to enable their understanding and application of knowledge, concepts and processes”. Classes are mentioned as a common place for this engagement. In combination with and without the term digital, various forms of settings can be found: face-to-face teaching in a non-digital setting, face-to-face teaching supported by digital tools or “virtual classroom[s]” (Kennedy-Clark, 2011; Park et al., 2019). These different kinds of classes were often considered from a learner’s perspective where it is not about the teaching and more about the learning aspect. This is supported by the fact that, in contrast to digital teaching, digital learning is described by several terms, some of which are used synonymously: “digital learning” (Harju et al., 2019), “e-learning” (Basak et al., 2018; Kriesen, 2011), “blended learning” (Akhtar et al., 2017; Mason, 2005), and “mobile learning” (Burden et al., 2019; Charles, 2012). This shows the need for a clearer definition of digital teaching, which will be addressed through this review.

When faced with disruptive situations in a digital setting, two possible, timewisedifferent points of view appeared: the time before, called *prevention*, and the time during/after a disruption, when an *intervention* may be applied. To create a greater understanding of each complete situation, research has often looked at these two periods simultaneously (Cerezo et al., 2017; Walonoski & Heffernan, 2006). Intervention strategies were often related to teachers’ behavior (Gebbie et al., 2012), while prevention strategies often searched for causes (Handley et al., 2016). To generate a complete

overview of the current literature on classroom disruptions in digital teaching, this review covers articles about causes, prevention, and interventions. To date, despite the high relevance resulting from the increase in digital teaching and learning, no such overview exists.

4.1.3 Research Questions

To create an overview, discover problems, and find research gaps, this systematic literature review elaborated multiple research questions:

- RQ_{A1}: Which terminologies can be found in research literature to describe digital teaching and the disruptions within it?
- RQ_{A2}: What are the methodological approaches used in previous research on the subject of disruptions in digital teaching?
- RQ_{A3}: How does research systematize disruptions in digital teaching?
- RQ_{A4}: What are the causes of disruptions in digital teaching and what prevention and intervention strategies exist to deal with them?
- To answer this question properly, three sub-questions were generated:
 - RQ_{A4.1}: What are the causes of disruptions in digital teaching?
 - RQ_{A4.2}: How can disruptions in digital teaching be prevented?
 - RQ_{A4.3}: What intervention strategies regarding disruptions in digital teaching are addressed in the research literature?

4.1.4 Methods

This review used the following databases: ERIC, Academic Search Ultima (via EBSCO-host), and Web of Science. All the databases included pedagogical literature as well as literature related to the computer science/technological field. This led to a higher output of potential studies to review and decreased the chance of missing publications in this field of research. Since the number of investigations on digitalization has grown over the last decades, only studies published in the last 20 years were included. Also, only English-language, peer-reviewed, study-based articles were integrated to maintain a high and international scientific standard. The general review procedure was based on the PRISMA statement of Moher et al. (2009).

For the literature research, a search string was developed based on the current scientific point of view, as explained in the framework earlier. Based on the terminologies found

in the classroom management models and the big five, word clusters based around *(mis-)behavior*, *discipline*, *classroom*, and *disruption* were created for the concept of classroom disruptions. Due to the missing definition of digital teaching, closely related terms, like *learning* and *education*, were connected to analogies for the term digital, like *electronic* and *virtual*. In combination, this led to this search string (which was modified in terms of syntax to fit in the different databases):

("behavior management" OR "behaviour management" OR "behavior problems" OR "behaviour problems" OR "behavior referrals" OR "behaviour referrals" OR "discipline policy" OR "discipline referrals" OR "classroom dilemmas" OR "classroom management" OR "disruptive behavior" OR "disruptive behaviour" OR "school discipline" OR "student behavior" OR "student behaviour" OR "misbehavior" OR "misbehaviour") AND ("e-learning" OR "digital learning" OR "digital education" OR "virtual classroom" OR "electronic learning" OR "blended learning")

Because of problems in converting the search string for different databases, truncation was avoided. This search string created a total of 724 hits. Duplicates were eliminated using the reference management software Citavi, leaving 705 articles divided between the databases as follows:

- ERIC: 453 articles
- Academic Search Ultimate (via EBSCOhost): 228 articles
- Web of Science: 24 articles

These 705 articles were screened based on their titles and abstracts. During the title screening, another 12 articles were found to be duplicates, so 693 articles passed to the title and abstract screening. Exclusion criteria were set to eliminate articles that did not match the scope. Due to lack of a definition of digital teaching, the abstracts were searched for possible digital or digital supported executions of teaching and a consideration of disruptions inside or related to this teaching. Therefore, we focused on the main aspects that can be found in the title of this review as well:

- Are there causes of classroom disruptions mentioned?
- Can prevention or intervention strategies be found/expected to be part of the article?
- Does the title/abstract at least mention classroom disruptions or synonymously understood terms?
- Is there some sort of digital setting acknowledgeable in the title or the abstract?

Articles not fitting this purpose were excluded. Studies located in a non-school setting, like advanced technical training for jobs or medical education, were excluded as well. Often connected to a medical point of view were behavioral issues based on emotional and behavioral disorders, attention-deficit/hyperactivity disorder (ADHD), and likewise. Since this review focuses on the educational context, medical contexts were also eliminated. Also, the term cheating was found several times during the screening but was not included in this review because of its different intention of use. These criteria, in combination with the organizational framework (a study, published in English, etc.), were applied by the authors and a co-worker to create a reliable outcome of 50 articles left for a selective review. The final coincidence rate of 98% was reached through 3 screening steps. The researchers and co-worker screened the articles independently from each other, and their results were shared after screening the first 50, then half of, and finally all the abstracts. General problems in understanding different designations were discussed, and a uniform understanding, which will be part of the discussion section of this review, was created during these iterations. This procedure left 50 articles for the next step.

During the selective review, the articles were reviewed based on their findings. In general, the same inclusion criteria were used on the selective review as for the title and the abstract earlier in the process. The authors focused on the described methods, the results and conclusion out of the results found in the article. This more selective procedure allowed to scan all 50 articles in more detail and to decide if they fit in the purpose of this systematic review. Studies that did not meet the given criteria, as well as those that were not studies were excluded. This reduced the results down to a final total of 16 articles, that deal at least partially with causes, prevention and intervention strategies on disruptions in the context of digital or digital supported teaching.

These 16 articles have been fully analyzed. Therefore, we have read the full texts several times with a strict focus on a specific research question. With the help of the knowledge organization functions of the reference management software Citavi, we were able to generate and collect answers to the research questions depending on the orientation and detail of the respective article. Table 8.1 (Appendix) shows the entire collection of results. Figure 4.1 (p. 28) illustrates the reviewing process.

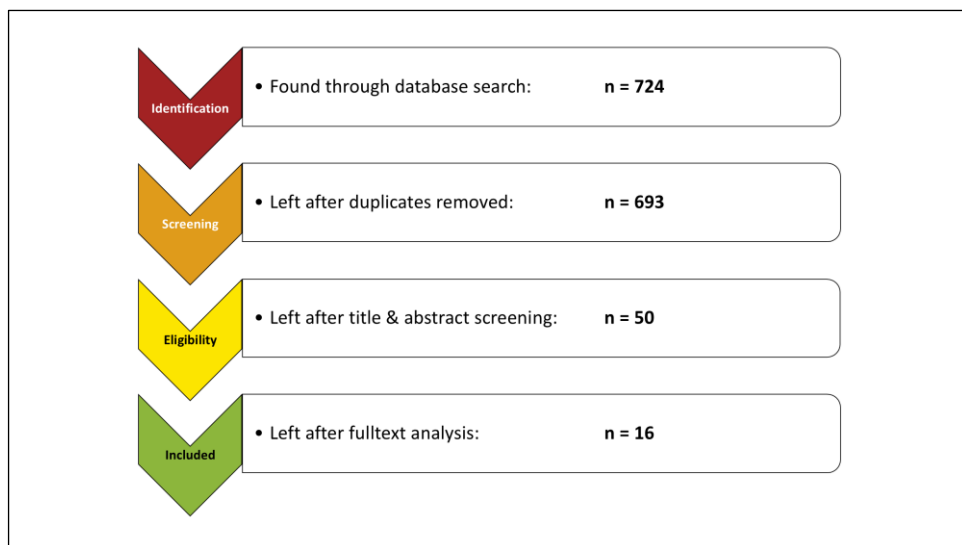


Figure 4.1: Procedure according to the PRISMA Statement (Moher et al., 2009)

4.1.5 Results

All 16 reviewed articles are listed in Table 8.1 (Appendix). The results of this review will be presented according to the research questions.

4.1.5.1 RQ_{A1}: Which terminologies can be found in research literature to describe digital teaching and the disruptions within it?

The results with regard to this research question will be shown separated in terms of the general term *digital teaching* and the *disruptions* therewithin.

Digital Teaching

With respect to the terms applied to digital teaching and learning, the authors used different word cluster concepts, which varied in terms of their precision. While some of them mentioned very general explanations, like *internet* (Boyaci, 2010), *online* (Hummel et al., 2015; Li & Titsworth, 2015), *software* (Boyaci, 2010), or *tools* (Charles, 2012), others decided to name the exact tools, like *cell phones* (Charles, 2012; Storch & Juarez-Paz, 2019), *laptop* (Rosen & Beck-Hill, 2012), and *video* (Kurz & Batarelo, 2010). The majority of the researchers opted for grouping the terminology.

Some research held on to the term digital and combined it with other terms to create word clusters for digital teaching. This led to designations like *digital learning* (Blundell et al., 2019), *digital [...] system* (Homer et al., 2018), *digital technologies* (Blundell et al., 2019), or *social digital networks* (Charles, 2012).

Another group of terms, like *computer based* (Muir et al., 2013), *databased* (Bruhn et al., 2020), and *web based* (Boyaci, 2010), was more related to computers and electronic data processing.

The field of virtual reality contained terms such as *mixed reality* (Judge et al., 2013), *virtual classroom* (Muir et al., 2013), *virtual environment* (Judge et al., 2013; Muir et al., 2013), and *virtual technology* (Judge et al., 2013).

The approach of not mentioning the term digital directly but of instead applying connections to the word technology was used, for example, *educational technology* (Rosen & Beck-Hill, 2012), *ICT* (Heitink et al., 2017; Moltudal et al., 2019), *mobile technologies* (Charles, 2012), and *technology based* (Bruhn et al., 2020).

Table 4.1 (p. 30) shows the division of the conceptual groups. Detailed information on which terminology can be found in which article can be seen from Table 8.1 (Appendix). Observing the amount of different designations used, it became clear that there is still no standardized terminology when it comes to digital teaching.

Disruptions

In accordance with the digital teaching terms, those describing the types of disruptions could also be systematized into subgroups.

By far the biggest group of terminologies found was connected to the term behavior. Combinations like *behavior disruptions* (Judge et al., 2013), *behavior management* (Judge et al., 2013), *behavioral expectations* (Storch & Juarez-Paz, 2019), *challenging behavior* (Bruhn et al., 2020), *classroom behavior management* (Muir et al., 2013), *disruptive or unengaged behavior* (Judge et al., 2013), *inappropriate behaviors* (Ho, 2004), *incompatible behavior* (Judge et al., 2013), *misbehaviors* (Li & Titsworth, 2015), *negative behavior* (Homer et al., 2018), and *problem behaviors* (Bruhn et al., 2020) were mentioned.

Some authors used wider terms, such as *being off-task* (Homer et al., 2018) or *non-academic activities* (Moltudal et al., 2019), or declared them to be a *crime* (Moltudal et al., 2019), when talking about disruptive issues.

Table 4.1: Taxonomy—Groups of Terms for Digital Teaching

digital teaching (n = 33)	technology related (n = 12)	technology (n = 3) ICT (n = 2) digital technologies (n = 1) educational technology (n = 1) mobile technologies (n = 1) technical (n = 1) technology-based (n = 1) technology integration (n = 1) virtual technology (n = 1)
	general explanations (n = 5)	online (n = 2) internet (n = 1) software (n = 1) tools (n = 1)
	virtual related (n = 5)	mixed reality (n = 1) virtual classroom (n = 1) virtual environment (n = 1) virtual technology (n = 1) virtual worlds (n = 1)
	digital related (n = 4)	digital badges-and-points (n = 1) digital learning (n = 1) digital networks (n = 1) digital token point system (n = 1)
	exact tools (n = 4)	cell phones (n = 2) laptop (n = 1) video (n = 1)
	computer related (n = 3)	computer based (n = 1) data based (n = 1) web-based (n = 1)

With the terms *rule-breaking* (Charles, 2012) and *rule violations* (Baker et al., 2016), researchers focused more on the advantages and problems of rules. This can also be connected to *disciplinary issues* (Rosen & Beck-Hill, 2012).

The complexity of classroom management was found in terminological combinations as well: *classroom behavior management* (Muir et al., 2013), *classroom management dilemmas* (Hummel et al., 2015), and *typical classroom management situations* (Kurz & Batarelo, 2010). As Muir et al. (2013) showed, the boundaries were sometimes blurry.

Table 4.2 (p. 31) shows the division of the conceptual groups. Detailed information on which terminology can be found in which article can be seen from Table 8.1 (Appendix).

Table 4.2: Taxonomy—Groups of Terms for Classroom Disruptions

classroom disruption (n = 29)	behavior related (n = 19)	inappropriate behaviors (n = 3) problem behavior (n = 3) behavior management (n = 2) behavioral expectations (n = 1) behavioral interventions (n = 1) behavior supportive adaptive teaching (n = 1) challenging behavior (n = 1) classroom behaviours (n = 1) disruptive behavior (n = 1) incompatible behavior (n = 1) misbehavior (n = 1) negative behavior (n = 1) off-task behavior (n = 1) student behaviours (n = 1)
	rules and disciplinary (n = 4)	breaking rules (n = 1) disciplinary issues (n = 1) rules violations (n = 1) students without discipline (n = 1)
	classroom management related (n = 3)	classroom behavior management (n = 1) classroom management dilemmas (n = 1) typical classroom management situations (n = 1)
	wider tasks (n = 3)	crime-control (n = 1) disruptions (n = 1) non-academic use (n = 1)

4.1.5.2 RQ_{A2}: What are the methodological approaches used in previous research on the subject of disruptions in digital teaching?

Since the research field has still not been explored much, the methods used in the research studies vary. Table 8.2 (Appendix) shows the kind of research design, the number of participants, and the digital tools used in each article.

Of the 16 articles considered for this review, 7 articles (Baker et al., 2016; Blundell et al., 2019; Boyaci, 2010; Charles, 2012; Kurz & Batarelo, 2010; Muir et al., 2013; Storch & Juarez-Paz, 2019) made use of a purely qualitative approach, and 3 (Heitink et al., 2017; Ho, 2004; Judge et al., 2013) chose a quantitative one, leaving 6 studies that utilized a mixed-methods approach (Bruhn et al., 2020; Homer et al., 2018; Hummel et al., 2015; Li & Titsworth, 2015; Moltudal et al., 2019; Rosen & Beck-Hill, 2012). In terms of the qualitative articles, content analyses based on written texts and semi-structured interviews were applied the most. Questionnaires appeared in most of the quantitative articles. As the mixed-methods approach implies, the use of research methods from both areas had multiple goals, for example, to “explore and discover (qualitatively), and then test and confirm (quantitatively)” (Moltudal et al., 2019, p. 84).

The numbers of participants in each study differed as well. The smallest groups were $n = 6$ by Blundell et al. (2019) and Judge et al. (2013). By far the biggest number of participants was found in the quantitative (second) part of Moltudal et al.'s research (2019) ($n = 2579$). It is worth mentioning that every study included teachers somehow. Practicing teachers were part of 10 studies (Blundell et al., 2019; Bruhn et al., 2020; Charles, 2012; Heitink et al., 2017; Ho, 2004; Homer et al., 2018; Li & Titsworth, 2015; Moltudal et al., 2019; Rosen & Beck-Hill, 2012; Storch & Juarez-Paz, 2019), and 6 studies mentioned beginning/pre-service teachers (Baker et al., 2016; Boyaci, 2010; Hummel et al., 2015; Judge et al., 2013; Kurz & Batarelo, 2010; Muir et al., 2013). Combined with this, in 5 studies, students were also a part of the research design (Bruhn et al., 2020; Homer et al., 2018; Li & Titsworth, 2015; Moltudal et al., 2019; Rosen & Beck-Hill, 2012).

The digital tools used differed just as much as the school levels at which they were used. Table 8.2 (Appendix) gives an overview of what form of tool was used for which level of education. To make it easier to compare, the levels of education were divided into primary education (like elementary school), secondary education (middle and high school) and university level. If mentioned in the article, the level of class (grade or year) is shown separately in its own column. As mentioned, the authors encountered the research field in a variety of ways, which is why there is no clear connection between digital tools used and the level of education. Furthermore, most studies do not specify their model of teaching. This is due to the fact that, on the one hand, the majority of the studies only partially deal with classroom disruptions and, on the other hand, a tendency towards recommendations for action can be recognized. This takes the focus away from the specific disruptive situation and is therefore not analyzed in this review. In addition, an assignment to existing models of teaching, such as direct instructions, cooperative or project-based learning, in the articles can at best be speculative.

Of the 16 studies, 2 approached the field of digitalization on a more abstract level. Moltudal et al. (2019) took a deeper look into the digital competences of teachers in relation to the matter of classroom management and managing disruptive behavior. Li and Titsworth (2015), using an online classroom simulation as part of their study, developed the Student Online Misbehavior scale (SOMs).

4.1.5.3 RQ_{A3}: How does research systematize disruptions in digital teaching?

Only two research groups made an attempt to identify concrete disruptions within teaching and systemize them into categories. Ho (2004) delivered six types of problems, and for each of these, a video vignette was watched by participants. The types "were based on preliminary studies" (Ho, 2004, p. 378) in which teachers from Australia and

Hong Kong responded to an open-ended question. This led to the identification of three “major types of problems[...] learning motivation problems, disruptiveness in class, and inappropriate interpersonal behaviors” (Ho, 2004, p. 378). Teachers were asked about problem behaviors in general. Therefore, it can be assumed that these types of problems were not exclusively connected to digital teaching. This statement was supported by the fact that none of the examples given concerning the types of problems had a digital context or angle (Ho, 2004).

This issue was taken up by Li and Titsworth (2015). They created the SOMs. In multiple studies, the researchers used misbehaviors reported by teachers who were teaching online classes to create four factors that influence misbehavior (including a total of 15 items – see Table 8.1 in Appendix):

- “Seeking unallowed assistance”
- “Internet slacking”
- “Aggressiveness”
- “Lack of communication” (Li & Titsworth, 2015, p. 47)

The Researchers developed this scale through two separate studies. In the first study the purpose “was to inductively generate a typology of online student misbehaviors that could form an inventory for use in subsequent studies of online classes” (Li & Titsworth, 2015, p. 42). Results of the surveys generated twenty student misbehavior types which are summed up in the second study into the four factors of the SOMs by further exploration through additional surveys.

4.1.5.4 RQ_{A4}: What are the causes of disruptions in digital teaching and what prevention and intervention strategies exist to deal with them?

To look in more detail at the *causes* of disruptions, as well as at *prevention* and *intervention* strategies, three sub-questions were answered.

RQ_{A4.1}: What are the causes of disruptions in digital teaching?

Of the 16 studies analyzed, 6 mentioned causes of disruptions within digital settings. As Blundell et al. (2019) and Storch and Juarez-Paz (2019) noted, digital tools themselves were sometimes a source of distraction. The possibilities offered by technological devices, like smartphones or tablets, seemed to also create opportunities to go off-task. As a major reason for this, teachers referred to a lack of self-regulation or self-discipline. “Teachers held students most responsible for displaying inappropriate behaviors (lack of [...] self-discipline) and themselves as least responsible” (Ho, 2004, p. 386).

These issues in terms of self-regulation and self-discipline were observed in conjunction with another missing factor. In Boyaci's (2010) study, multiple students "focused on limited communication" (Boyaci, 2010, p. 225), which did not appear to be an issue in non-digital, face-to-face education. The importance of good and detailed communication between teachers and students was demonstrated by the fact that multiple studies recommended a change in teaching style to more of a moderating and mentoring style (Boyaci, 2010; Moltudal et al., 2019).

However, it was not only the communication between students and their teachers that was observed to be important. As Charles (Charles, 2012) showed, a possible cause of distraction was a lack of communication and coordination between teachers and officials. "Teachers enforce [...] rules differentially" (Charles, 2012, p. 10). This made it difficult to predict what would be a distraction for each participant in a class.

RQ_{A4.2}: How can disruptions in digital teaching be prevented?

Almost half of the reviewed articles (7 out of 16) gave an answer to RQ_{A4.2}. Among these answers, "rule-setting" (Charles, 2012, p. 12) seemed to be the most advised prevention strategy. A clear understanding of what is appropriate and what is not was found to be essential for using digital tools in teaching.

Another strategy mentioned by Greenberg et al. (2014), not only useful in digital teaching, is creating routines: giving students and teachers the possibility of knowing what is coming next and how to act properly to avoid disruptions (Baker et al., 2016).

Charles (2012) suggested the development of meta-awareness. This includes teachers' participation and underlines the aforementioned change of teaching style to a more moderating role.

Concrete strategies, like permanent and "individual communication" (Boyaci, 2010, p. 213), "active monitoring" (Storch & Juarez-Paz, 2019, p. 16), and "the use [of a] language of understanding" (Baker et al., 2016, p. 32), were also discussed.

However, for all the strategies it was important that teachers felt comfortable in terms of their teaching (Blundell et al., 2019, p. 9). It is important to mention that all the advice given was not exclusively limited to disruptions in digital teaching but could definitely be used within this setting.

Homer et al. (2018) showed that the use of a digital token system could lead to increased positive behavior and prevent problematic attitudes. This was not exclusively

linked to problematic behavior within a digital teaching, but it showed how parts of digitalization themselves could be a prevention strategy. It also tried to use digitalization as an opportunity to enhance existing strategies.

RQ 4.3: What intervention strategies regarding disruptions in digital teaching are addressed in the research literature?

Of the 16 articles reviewed, 3 provided an answer to this question. Storch and Juarez-Paz (2019) recognized the need to warn students to stay on-task or return to it when the usage of cell phones was observed to have led them off-task.

As part of their results, Bruhn et al. (2020) showed that an app could be used as an intervention strategy. Since students could monitor their rated behavior themselves, negative changes could be avoided by the students. Changes in student behavior were indirectly initiated by the teacher's rating (Bruhn et al., 2020). Like Homer et al.'s (2018) study, this showed a possible digital solution to a not exclusively digital problem.

Although Baker et al. (2016) gave a couple of possible intervention strategies for pre-service teachers, those strategies were not specifically designed to deal with disruptions in digital teaching.

4.1.6 Discussion

As was already suspected, the pure quantity of terms found in answer to RQ_{A1} (Which terminologies can be found in research literature to describe digital teaching and the disruptions within it?) shows a significant need for further development. Since there is no standardized designation for teaching that uses digital tools or is based on them, it is inevitable to find multiple approaches to naming this construct.

The results of this review show that there are two general approaches: *naming or grouping the tangible tools*, for example, video, computer-based, digital system, or trying to *combine these tools under the term technology* and, optionally, combining it with an enhanced setting, like educational technology or information and communication technology. Technology is defined as "scientific knowledge used in practical ways" (Oxford University Press, 2020b). This does not explain what these practical ways are exactly and what knowledge is used for it. Assuming digital is defined as "using a system of receiving and sending information as a series of the numbers one and zero" (Oxford University Press, 2020a), it is conceivable that digital tools are required for the use of such technology.

On the other hand, along with the digital context, a clear understanding of the teaching setting varies from article to article. In general, three different types of teaching/learning capable of using digital tools were found among the studies: (1) purely *online education* in which teachers and students are only in touch online, (2) purely *face-to-face education* enhanced by digital tools and in which teachers and students are physically present at the same place at the same time, and (3) a mixed version called *blended learning*. This three-way division, in connection with the understanding of the term digital discussed above, allows an attempt at defining digital teaching:

Digital teaching is the generic term for online teaching and learning, digitally enhanced face-to-face teaching and learning, as well as blended teaching and learning, assuming that digital tools are used as technology to enable or support the respective form.

Another terminological problem in this review is associated with the term disruption. Results show that disruptions in teaching are often described as a sort of behavior, often associated with a related negative declaration, like inappropriate or problem behavior. However, the term behavior covers a wide area of understanding. Suler (2004), for example, sees behavior management in online learning as management to create a better learning output. Greenberg et al. (2014), on the other hand, show that the management of (disruptive mis-)behavior is indisputably connected to classroom management. Therefore, it is important to take a detailed look at the usage of the term behavior in order not to miss a possible connection to classroom disruptions, and then to separate those understandings that do not mention disruptions.

When mentioning classroom disruptions, it is noticeable that not all of the reviewed articles clarify what specific disturbing situations are declared as disruptions. Some authors give examples like “student told me he hated me” (Baker et al., 2016, p. 29), “students wanted to use digital technologies at times and in ways that were different to planned uses” (Blundell et al., 2019, p. 8), “daydreaming in class, not completing homework, talking in class, lesson disruption, bullying, and rudeness to the teacher” (Ho, 2004, p. 378), “talking out of turn” (Homer et al., 2018, p. 141), “pupil continues to disturb the lesson by insulting his peers” (Hummel et al., 2015, p. 672), “Seeking Unallowed Assistance, Internet Slacking, Aggressiveness, and Lack of Communication” (Li & Titsworth, 2015, p. 41) and “student’s discipline issues” (Rosen & Beck-Hill, 2012, p. 234). Other authors do not give explicit examples for disruptions but refer to (pre-service) teacher’s strategies (Baker et al., 2016; Judge et al., 2013; Muir et al., 2013) or perceptions and attitudes (Boyaci, 2010; Charles, 2012; Heitink et al., 2017; Kurz & Batarelo, 2010; Storch & Juarez-Paz, 2019). This illustrates understandings what class-

room disruptions in detail contain, but the results are so diverse that it is not possible to deduce which disruptions might be more relevant than others. Since this question is related to a subjective view it does not surprise that different teams of authors mention, that the severity of each disruption depends on the teacher's perception (Charles, 2012; Moltudal et al., 2019; Storch & Juarez-Paz, 2019). This shows the teacher-centered orientation of current research as well as a still missing analysis of classroom disruptions in detail.

While there are various definitions and models about classroom management, such things are rare for classroom disruptions alone. As mentioned, this topic can be found more embedded in classroom management models. This missing focus may often lead to a superficial perspective on disruptions as articles predominantly consider the misbehavior of students. If combined with the quite new field of digital teaching and learning, this results in several approaches to discussion. On the one hand, there is need for a detailed model about classroom disruptions that includes more than just inappropriate student behavior. Teacher behavior as well as external factors, especially related to the newly used digital tools, can be causing disruptions as well. Bringing in the factor of digitalization and the new use of ICT inside a classroom while disruptions occur, this creates multiple possible assumptions: Does ICT create disruptions that did not occur in former education? On the other hand, as Bruhn et al. (2020) show, the proper use of ICT can help teachers and students to handle disruptive situations better than without digital tools. This inevitably raises the question: Can digitalization of teaching reduce disruptions? Scientific research on this field must face the fact that digital teaching has multiple dimensions and therefore, a complex answer can be assumed.

Since the use of ICT in daily life often creates new problems like missing connection, lack of electricity and so on, the growth of digital teaching may create a chance to shift the focus from classroom disruptions as mainly student-caused to a more open view of all possible triggers. In addition, a specific connection between the use of certain ICT and the occurrence of certain disruptions has been unexplored so far.

The models, causes, as well as prevention and intervention strategies found are rarely tied to a digital setting. This is not surprising keeping in mind that digital teaching is an enhanced form of teaching and is therefore likely to face problems and strategies that non-digital teaching has already considered. However, isolated results (Homer et al., 2018) show that there is a chance to use the strategies developed for non-digital teaching and enhance teaching in general with digital tools to take advantage of them and to deal with disruptions that occur in both digital and non-digital teaching. As disruptions

are key in terms of classroom management, there is an urgent need to look deeper into opportunities like this.

In general, findings show that even after a structured selection process studies differ in their point of view on disruptions in digital teaching. Some studies focused on classes (and their disruptions) that are supported by digital tools, some studies investigated pure online (and therefore digital) classes and other studies used digital tools to evaluate disruptions in teaching. This realization raises the questions of an additional filtering of the selected studies. A more precise look would be able to offer more detailed results. Yet, it should be noted that further selection would also lead to an even smaller number of samples.

The results in relation to RQA₂, regarding the methodological approaches of previous research in terms of the subject of disruptions in digital teaching, show that the approaches in this field are methodologically broad. This may be explained by the fact that this field of research has still not been explored much. On the one hand, this has led to a pleasant variety of methodological approaches, but on the other hand, scientific comparison is therefore missing. In general, ongoing concepts shared between scientists and educators and developed by multiple researchers are missing as well. None of the reviewed studies was implemented as a longitudinal study, although approaches like that of Li and Titsworth (2015) used an iterative process to successfully develop a scale. Since this field of research is, compared to other parts of educational research, relatively young, future studies may fill this gap. This review provides a definition for digital teaching and clarifies the possibilities for enhancing existing models so that future research based on it seems promising.

Although the answers to RQA₃, how research systematizes disruptions in digital teaching, are the least elaborated on, they create a lot of potential for discussion. The SOMs derived by Li and Titsworth (2015) shows a first step to having a more detailed view of disruptions in digital teaching. Since the scale focuses on online teaching, the question arises of whether this scale might be transferable to other digital teaching. During the development process, inputs given by teachers focused on online teaching, but transferring this to face-to-face or blended teaching seems practicable as well. It will be interesting to see if future scales in the area of digital teaching differ significantly from the SOMs.

Besides Li and Titsworth (2015), none of the reviewed studies created a new categorization for student misbehavior, and the SOMs does not answer the following questions: Does digitalization provoke misbehavior that is not yet covered by the existing catego-

ries? Furthermore, how does digitalization affect teachers' misbehavior? As mentioned earlier in the framework of this review, models for classroom management already exist. It is not surprising that the findings of the different articles partly fit into these models: developing meta-awareness (Charles, 2012) fits into the choice theory model by Glasser (1986), letting students know what is acceptable behavior and what is not (Baker et al., 2016; Greenberg et al., 2014) corresponds with the assertive discipline model by Canter (2009), concrete strategies mentioned in Storch and Juarez-Paz (2019) relate to the model of Kounin (1970), and the often-mentioned rule-setting (Moltudal et al., 2019) can be found as one of the big five strategies in classroom management (Greenberg et al., 2014). The Classroom Disruption Protocol (Stockton University, 2001) mentions the unallowed usage of cell phones, what is mentioned by Charles (2012) as well as parts of the SOMs by Li and Titsworth (2015) fits in parts of the major disruptions mentioned in the protocol. All the existing models refer to existing classroom practices but miss a connection to digitalization. Furthermore, most models deal with classroom management in general and do not focus on the disruptions therewithin. An extension of an existing model into a digital setting or a model for disruptions in digital teaching is needed. It is conceivable, for example, that one or more specializations of the Classroom Disruption Protocol could represent a possible result here. Perhaps existing concepts are unsuitable for various reasons. This would make it necessary to develop a new type of model.

RQ_{A4.1} to RQ_{A4.3} deliver answers regarding what current research reports are the causes of disruptions in digital teaching and how to prevent them or intervene in relation to them. Among the results, the lack of student self-discipline is often mentioned as one of the main causes. This underlines the aforementioned focus of the research as being on the teacher's perspective and is supported by the fact that all the studies used (pre-service) teachers as participants. Some studies included students as well, but the focus on the teacher's perspective is clear. Studies that include the student's perspective have the potential to deliver results that teacher-focused research cannot provide. Unfortunately, most of the analyzed articles are missing this potential opportunity. It is obvious that a deeper insight into disruptions from the student's perspective will lead to a greater quantity of and interesting results.

Student and teacher behavior is often mentioned in this review. The leadership style of teachers is linked to classroom situations (like disruptions) and students' learning outcomes (Solomon et al., 1964). Since this review focuses on the aspect of disruptive classroom situations, there was no focus on teachers' behavior strategies. Nevertheless, it must remain clear that there is no possibility of denying the connection between these two fields. Classical "core elements of General Didactics" (Zierer & Seel, 2012, p.

5) already understand interaction, and thus the behavior dimensions of those involved, as an essential part of interaction in teaching. The lack of findings with regard to specific disruptive situations in digital teaching suggests the need to investigate these further before developing possible prevention and intervention strategies. This review does not claim to predict whether there is a further field to explore in terms of research about behavior strategies, but since the idea that digitalization can enhance existing concepts has already been mentioned, it can be assumed with optimism that future research will discover development potential here too.

Considering different perspectives on this field of (future) research seems to be a possible way of obtaining a more selective view of the three different types of digital teaching as well. It is noticeable that the majority of studies either focus on online learning or face-to-face learning. The blended learning approach, with its combined character, may be able to identify different disruptions from both groups. Keeping in mind that science has the obligation to expand existing research, this seems to be a good way of connecting the old and the new.

4.1.7 Limitations

Since the selection of digital tools, the degree of influence and application as well as integration differ greatly depending on the subject, teacher, and type of school, it was difficult to assign this review to one specific area of ICT. In particular, further research may address relationships between types of disruptions and linked ICT areas like data security, requirements for educational platforms or databases. This may also lead to valuable insights on educationally influenced software developments.

While creating the search string for the literature research, it was impossible to include all existing digital tools. To avoid missing relevant articles, the search string included a lot of common combinations and big word groups, like the previously mentioned terms of behavior, technology, and classroom management. Because of the lack of a uniform definition, this review had to be conducted on this very general level. As a consequence, the search term, which was equipped with general terms but nevertheless focused, sometimes also included articles that clearly missed the main perspective of the review. The review process therefore resulted in a significant reduction in the number of articles to be reviewed. This problem could not be circumvented due to the conceptual obstacles in the beginning, but an established standardized review-procedure was applied.

The large number of used designations created a need for a larger quantity of more detailed exclusion criteria, while leaving wide fields of research open. During the reliability check process, the researchers stopped twice to adjust the criteria and to create a uniform understanding of all the terms. All the required understandings are based on the fact that there is a lack of uniform definitions in the first place. Nevertheless, it is possible that missing word combinations or the creation of a concrete understanding of specific terms “too late” in the review process led to very specific articles not being found. The suggestion regarding the development of uniform terminologies will help future research in this area.

4.1.8 Future Directions

Concerning one of the main findings of this review, further research should be directed at the field of digital teaching and the disruptions within. Observing digital teaching, interviewing students and teachers about their opinions, and keeping in mind that new generations of future teachers are growing up in a more digital world will create multiple opportunities for future research while keeping its practical relevance in mind. As already mentioned, research is still very focused on the teachers’ perspectives. Having a more detailed view of disruptions in digital teaching from a student’s point of view seems promising.

The gathered information will be useful in terms of rethinking answers regarding causes of disruptions in digital teaching and possible prevention and intervention strategies. This will also open up new possibilities and potential for international comparison since a major part of the research ($n = 8$) in this field is located in the United States.

As mentioned, future research should focus on investigating concrete disruptive situations in digital teaching. For this, it will be important to have a clear understanding of what is considered to be a disruption and what is not. Since teaching and learning inevitably go together, opinions from teachers and students are important here. Future teachers are growing up in a more digital world and ICT, not only but especially in education, is becoming more and more important. One main goal of our research is to optimize teaching and teacher education. Therefore, adapting existing research (like the SOMs) or developing new models seems very promising. For example, an interview study with (prospective) teachers and students could provide basic knowledge that is necessary for designing a new model for classifying disruptions in digital teaching. Future research should also consider to investigate disruptions in specific situations and therefore have a look at actual digital teaching practices.

4.1.9 Conclusion

ICT has entered daily life and digitalization has entered education. With classroom management having been an important factor in terms of teaching for at least fifty years now and dealing with disruptive classroom situations being a part of successful classroom management, the possibilities and risks regarding the use of ICT within are getting more and more attention. The global COVID-19 pandemic forced educational systems worldwide into digital teaching faster than ever before and as part of an increased scientific research on this field of interest, this review presented missing links to the important subject of classroom disruptions in digital teaching. Reviewing international, English-language articles about causes, prevention, and interventions with regard to disruptions in digital teaching from the last 20 years, this review shows the lack of precision when it comes to terminology and the absence of comprehension in terms of disruptive situations in a digital setting. The results point out that researchers are using multiple ways to approach this. The findings related to disruptions are still very general, largely teacher-focused, and not specific to digital teaching. With indications that digitalization in teaching and learning has the possibility to enhance education, promising results will rely on more practically relevant and deeper research in the future.

4.2 Classroom Disruptions in Digital Teaching during the Pandemic - an Interview Study⁴

Pierre Meinokat and Ingo Wagner

4.2.1 Introduction

Classroom disruptions steal precious time from learning. In the Teaching and Learning International Survey (TALIS) teachers reported that over 30% of their actual teaching time was spent dealing with disruptions (OECD, 2014). The YouGov surveys show that students are losing up to an hour of learning time each day due to disruptions in classrooms (OECD, 2014, p. 4). While students may be losing learning and development opportunities (Marquez et al., 2016), teachers' health is at risk when facing disruptions (Brouwers & Tomic, 2000; Gonzalez et al., 2015; Greene et al., 2002; Ingersoll, 2001; Kokkinos, 2007; Rajendran et al., 2020; Wettstein et al., 2021). As an additional challenge arising from the COVID-19 pandemic, education across the world has been rapidly forced into digitalization (Cho et al., 2020; Daniel, 2020). Changes that occurred during the pandemic have shaped the way how teachers and students participate in teaching and learning (Gross & McCann, 2022; Gülmez & Ordu, 2022; Lemov, 2022). New strategies for teachers, as part of their classroom management, were developed (Gross & McCann, 2022).

However, current research about disruptions deals only, if at all, with classroom management in general (Sepúlveda-Vallejos et al., 2023; Thiel et al., 2023; Zoder-Martell et al., 2023). There is only a marginal focus on the topic of dealing with classroom disruptions in the digital context, which is particularly important for pre-service and newly in-service teachers, since lockdowns, forced online learning, and frequent changes in requirements have made it hard, if not impossible, for these young professionals to refine their abilities in dealing with difficult situations (Marcum-Dietrich et al., 2021). Practicing teachers would also benefit from knowledge on this topic, since the relevant tools and tips are often updated, but teachers may not be aware of these changes (Moltudal et al., 2019).

⁴ Meinokat, P., & Wagner, I. (2024). Classroom disruptions in digital teaching during the pandemic – an interview study. *Frontiers in Education*, 9. <https://doi.org/10.3389/feduc.2024.1335249>

4.2.2 Theoretical Framework

The considerations of this study are based on various definitions and categorizations for classroom disruptions, teachers' behavior, and classroom management in general. Furthermore, current research shows that digitalization and the pandemic have generated several challenges for educators worldwide (Sing Yun, 2023). To create an overarching framework and implement the current state of digitalization in education into this, we first look at existing research on these topics.

4.2.2.1 Definitions and Current State of Research

Various terms, such as *classroom disruptions*, *classroom disturbances*, *disorders*, or *disruptive/disturbing behavior*, are used synonymously (Meinokat & Wagner, 2022). Exemplary definitions have described disruptions and disruptive behaviors as "behavior a reasonable person would view as being likely to substantially or repeatedly interfere with conduct of a class" (Stockton University, 2001, p. 1), "general issues hindering students' and teachers' classroom work" (Belt & Belt, 2017, p. 55), "any behavior that interferes with teaching and learning" (Franken, 2020, p. 445) or "behavior that seriously interferes with the teaching process, and/or seriously upsets the normal running of the classroom" (Infantino & Little, 2005, p. 493). What all these definitions have in common is the notion that a disruptive effect makes the actual teaching and learning process (temporarily) impossible. Drawing from a systematic literature review to transfer this quintessence to classroom disruptions in digital settings, digital teaching will be understood as "the generic term for online learning, digitally enhanced face-to-face learning, and blended learning, assuming that digital tools are used as technology to enable or support the respective form of teaching" (Meinokat & Wagner, 2022, p. 4671).

Aside from the above definitions, earlier research has tried to systemize, categorize and theorize classroom disruptions in various forms. For a better understanding, concepts taken from the literature to display classroom disruptions in a systematically way will be referred to as categorization here. These categorizations can be fundamentally divided into two forms: categorizations that aim at being able to weigh classroom disruptions against one another, and those that distinguish between different types of disruptions (Figure 2.1, p. 7).

Prime examples for categorizations that are separating disruptions into different types are Biller (1979), Lohmann (2011), and Winkel (2011). Biller (1979) separates classroom disruptions into four categories. They are named: (1) minor faults which include for

example forgotten homework, (2) (in)direct disruptions which affect the classroom climate and the teacher-student relationship, (3) unrecoverable disruptions which include disruptions that cannot be solved by the teacher alone (rather with the help of other professionals like psychologists), and (4) unavoidable disruptions which include all disruptions that simply cannot be avoided. Lohmann (2011) distinguishes into four categories as well: (1) verbal disruptions are disruptions by students through interjections, (2) lack of willingness to learn is shown by students lacking interest in the current subject, (3) motoric restlessness can be seen throughout physical movement of the students in times when such behavior is not expected, and (4) aggressive behavior refers to actions that try to harm others physically or emotionally. Winkel (2011) creates seven different categories: (1) disciplinary disruptions such as failure to follow the class rules, (2) provocation and aggression, which include aggressive behavior toward others, (3) permanent acoustic and visual disruptions, as well as restlessness and missing concentration seen by interjections or motoric movement, (4) disruptions from outside the class such as loudspeaker announcements, (5) refusal to learn and passivity which include non-attendance, (6) lack of motivation, which is reflected in the care with which the students complete their assigned tasks, and (7) neurotic disorders which include behavior that goes beyond a single classroom disruption situation.

Table 4.3: Categories for Separating Categorizations

Non-digital Setting			Digital Setting
Biller (1979)	Li and Titsworth (2015)	Lohmann (2011)	Winkel (2011)
• Minor faults • (In)Direct disruptions • Unrecoverable disruptions • Unavoidable disruptions	• Seeking unallowed assistance • Internet slacking • Aggressiveness • Lack of communication	• Verbal disruptions • Lack of willingness to learn • Motoric restlessness • Aggressive behavior	• Disciplinary disruptions • Provocation and aggression • Permanent acoustic and visual disruptions, as well as restlessness and missing concentration • Disruptions from outside the classe • Refusal to learn and passivity • Missing motivation • Neurotic disorders

While the above mentioned categorizations are generally based on non-digital settings, Li and Titsworth (2015) are the only ones so far that developed a scale, the Student Online Misbehavior Scale (SOMs), to connect disruptions to an online setting. In this scale the authors compose four categories of disruptions: (1) seeking unallowed assistance which includes cheating, (2) internet slacking seen by students using the internet

for noneducational purposes, (3) aggressiveness which include physical and psychological actions in the classroom as well as in the virtual room, and (4) lack of communication such as failure to give answers or not being available. An overview of these categories is shown in Table 4.3 (p. 45).

Examples of categorizations that relate classroom disruptions to one another can be found in Cogswell et al.'s (2020) research on low-level classroom disruptions (LLCD) or Rattay et al. (2018), who distinguished between five escalation levels, as well as Scherzinger and Wettstein's (2019) categorization by aggressiveness. The authors created scales to distinguish how severe a classroom disruption is perceived. Cogswell et al. (2020) named their scale easy to understand: from low-level (perceived as less disruptive) to high-level (perceived as highly disrupted) classroom disruptions. Scherzinger and Wettstein (2019) named the dimensions of their scale in a different way. They separate from non-aggressive, and therefore non-directional, to aggressive, directional, and behavior. Rattay et al. (2018) give more stages of their scale, starting at the lowest and least disrupting dimension with impairments (e.g., students being distracted), going over interruptions (the flow of the lesson is disrupted), impossibilities (e.g., problems from outside the class are transferred into the class and make the learning process impossible), behavioral problems (e.g., a student is disruption repeatedly) to conduct disorders (e.g., developmental and adjustment disorders). While the first four stages are declared as situational behavior, conduct disorders are named over-situational and therefore go beyond classroom disruptions that consist of single situations and can be solved immediately. Table 4.4 (p. 46) gives an overview.

Table 4.4: Severity Weighting Categorizations

	Non-digital Setting		
Severity	Cogswell et al. (2020)	Rattay et al. (2018)	Scherzinger and Wettstein (2019)
	High-level classroom disruption	Conduct disorders	Aggressive
		Behavioral problems	
		Impossibility	
		Interruption	
	Low-level classroom disruption	Impairment	Nonaggressive

4.2.2.2 Relation to Classroom Management

In a wider context, managing classroom disruptions is a part of classroom management (Durak & Saritepeci, 2017). According to Mulvahill (2018) “simply put, classroom management refers to the wide variety of skills and techniques that teachers use to ensure that their classroom run smoothly, without disruptive behavior from students” (Mulvahill, 2018, p. 1). Although researchers in educational science are aware that not only students can be disruptive in a classroom (P. Kearney et al., 2002; Scherzinger & Wettstein, 2019), and different perspectives inside a classroom create different views on classroom disruptions (Eckstein, 2019; Montuoro & Lewis, 2015; Wettstein, Ramseier, et al., 2016), studies in this area have often been teacher-centered (Meinokat & Wagner, 2022). This research about classroom management is focusing on general strategies to achieve the goal of having a smooth classroom environment (Zoder-Martell et al., 2023). Hereby, dealing with classroom disruptions is implied but not explicitly focused in latest research (Durak & Saritepeci, 2017; Zoder-Martell et al., 2023), often leaving the question open how to deal with it.

As one of their two priorities, the European Commission is urging for the enhancement of digital skills and competences (European Union, 2020). Teachers, as the initiators of good classroom management (Mulvahill, 2018), are focused here. The importance of their role in the process of managing the classroom and digitalizing the education process is obvious (Wohlfart & Wagner, 2023), leaving questions open for current research which competencies, skills, and roles teachers need (Sepúlveda-Vallejos et al., 2023). Especially skills and strategies for teachers to deal with classroom disruptions are hereby only vaguely implied in general strategies and recommendations for classroom management (Durak & Saritepeci, 2017).

4.2.2.3 The Influence of Digitalization and Research Questions

Although digitalization, accelerated by the pandemic, has already found its way into most schools, science about the topic of digital teaching and learning has still some conceptual ambiguity (Noor et al., 2020; Storch & Juarez-Paz, 2019). While research on classroom management in general and its connection to digitalization in particular is growing (Demir & Çatak, 2023), such limited developments show how slowly we have “entered the digital age” (Cho et al., 2020, p. 9). As classroom management consists of multiple aspects and areas (Balli, 2011; McLeod et al., 2003; Mulvahill, 2018), and dealing with disruptions is just one part of the process (Durak & Saritepeci, 2017), research that connects a focused view on classroom disruptions to digitalization is underrepresented compared to work on classroom management in general (Meinokat & Wagner, 2022). Existing categorizations of disruptions, with the exception of that of Li

and Titsworth (2015), are not based on a digital setting (Biller, 1979; Cogswell et al., 2020; Lohmann, 2011; Rattay et al., 2018; Scherzinger & Wettstein, 2019; Winkel, 2011) and existing research on digitalization in education is missing the importance of dealing with classroom disruptions so far (Sing Yun, 2023). Furthermore, the special situation of the pandemic has resulted in a research gap that this explorative study tries to close. To generate useful information for practicing and future teachers regarding classroom disruptions in digital settings, the following research questions structure the present study:

- RQ_{B1}: What forms of classroom disruptions occur in digital teaching?
- RQ_{B2}: What are the underlying causes of classroom disruptions in digital teaching?
- RQ_{B3}: How do teachers deal preventively with and intervene in classroom disruptions in digital teaching?
- RQ_{B4}: What potential do teachers see when transferring elements of digital teaching from online teaching during the pandemic to face-to-face teaching?

4.2.3 Method

The exploratory character of this study led to the adoption of a qualitative approach (Denzin & Lincoln, 2018). Data were derived from semi-structured guideline-based interviews, which were performed with 13 teachers from the state of Baden-Württemberg, Germany, via Microsoft Teams in the period from May 18 to 28, 2021. The interviews lasted between 34 and 56 minutes (in total: 9 hours and 31 minutes). Each interview was recorded, anonymized, and transcribed according to the transcription rules by Claussen et al. (2020). The interviews were conducted and transcribed in German, and quotations from the interviewees were later translated into English by the authors.

4.2.3.1 Participants

A purposeful sampling strategy based on the work of Patton (2015) was employed. As we wanted to generate various insights in teaching scenarios amongst different student ages, we invited teachers from the federal state of Baden-Württemberg who taught classes of the secondary levels I and II (where students are between 10 and 18 years old). In addition, the teachers were required to have had different professional experiences from each other and to have taught different combinations of subjects. We considered whether the teachers had different workloads associated with extracurricular activities at their school, such as departmental management or collaboration on the

media development plan commission, as well as different familial responsibilities. All teachers have taught before and during the pandemic. From all invited teachers, five female and eight male teachers, all teaching at Gymnasium (highest form of secondary school in Germany) with an age range of 27 to 59 years, with various subject areas of expertise and different years of experience (1 to 27), took part in the interviews. The teaching load varied from 5 to 25 (highest possible) hours a week. Nine out of the 13 teachers performed additional functions in the school.

4.2.3.2 Interview Guide

Table 4.5: Interview Questions

Interview Question (subquestions)	Related Research Question
• What classroom disruptions have you experienced in your digital teaching? ○ (What happened/What was the setting like?) ○ (Who was involved?) ○ (What do you think: Why did the disruption occur?) ○ (How did you react to the disruption?) ○ (How did the students react to the disruption?) ○ (How would you deal with this situation today?) ○ (How do you think this situation can be avoided?)	• RQ_{B1}: What forms of classroom disruptions occur in digital teaching? • RQ_{B2}: What are the underlying causes of classroom disruptions in digital teaching? • RQ_{B3}: How do teachers deal preventively with and intervene in classroom disruptions in digital teaching?
• In your opinion, what new, digital experiences/tools can and will be retained after the pandemic? ○ (What do these new possibilities bring with them in terms of (new) disruption potential?) ○ (Do you think that the transfer of new opportunities into the post-pandemic phase can provoke disruption?) ○ If yes: Which? If no: Why not?)	• RQ_{B4}: What potential do teachers see when transferring elements of digital teaching from online teaching during the pandemic to face-to-face teaching?

A semi-structured, guideline-based interview format was chosen to maintain the spontaneous character of an interview while keeping the conversation structured and comparable (Bortz & Döring, 2016; Misoch, 2015). The structure of the guidelines was modeled on the four-step procedure proposed by Misoch (2015). After starting with a brief section containing an overall introduction, background information, and data protection matters, the interview started with a general icebreaker question to set a friendly and trustworthy conversation climate. After that, the main part of the interview contained five questions, each accompanied by supporting questions, and all on the

topic of teaching during the pandemic, as well as classroom disruptions. An overview of the questions, potential additional questions and relations to research questions is shown in Table 4.5 (p. 49). The interviews ended with the gathering of demographic information.

4.2.3.3 Analysis

The transcripts of the interviews were processed using the qualitative content analysis approach adopted by Mayring (2014). Therefore, the transcripts were read multiple times by the authors, and segments were coded using the software MAXQDA Plus 2020. The codes were generated mostly deductively from existing research. First, the interviews were coded according to the four research questions of this study. Further coding iterations grouped segments according to their similarities and their differences, generating subcodes. The procedure was repeated until no further subcategories could be identified, and every segment was at least part of one code. In total, 208 coded text segments were used in this study.

4.2.4 Findings

The findings are shown separately for each research question.

4.2.4.1 Reported Forms of Disruptions

The 13 teachers mentioned a total of 58 situations that were coded as classroom disruptions. These disturbances were categorized into different codes representing different forms of classroom disruptions in digital teaching based on similarities and differences in a specific situation (Table 4.6, p. 50).

Table 4.6: Categories for Classroom Disruptions in Digital Teaching

Code	Number of Coded Segments
Conversations and messages not related to the subject	11
Technical difficulties	11
Occupation with non-school content	9
Problems in operations	8
Missing communication	6
Exploit given administrative digital rights	5
Rule breaking	3
Extracurricular distractions	2
Psychological attacks	2
Overenthusiasm	1
Total	58

The most mentioned form was *conversations/messages not related to the subject* (n = 11). In such cases, students would be talking off-topic, using the chat function and “sometimes just somehow writ[ing] several words in and let[ting] the chat go through” (T6), or using the shared note’s function, which “seventh graders just wrote some shit into” (T7).

Teachers reported disruptions due to *technical difficulties* (n = 11). For instance, one teacher was inclined to ask, “can the Wi-Fi in the school handle it? Will the online connection break off? How good is the acoustic connection?” (T2). All these questions showed possible technical problems disturbing the class.

Difficulties with the technology can arise in other forms. For example, when there are problems with handling the PC, where “if you said, ‘open the folder’, they took out their paper notepads and opened them instead of somehow clicking on any file directory” (T9) or certain specifications in software, like Zoom, where “you can just give yourself a name to join the conference with. If you ask the students to take their own name, 90% do it, maybe 5% don’t want to, and the other 5% can’t do it” (T8). These disruptions sometimes led to increased waiting times for students, which created more room for disruptions:

If, for example, I want to show them briefly how the app works, and three students are not ready yet, and everyone else has to wait for these three students, then of course there is a phase in which some have nothing to do but the other three maybe just sit in front of the computer and wait because the update graphic is showing. (T9)

These sorts of disruptions are summarized as *problems in operations* (n = 8).

Once the digital tool was running (again), it could lead to another stated form of disruption: *occupation with non-school content* (n = 9). In particular, the permanent and easy access to the internet caused problems because “you can’t control it very well when every student has a device or when the two of them have a device; are they really doing what they are supposed to do, or are they watching videos on YouTube?” (T13).

Another mentioned form of disruption was students not giving answers when asked questions or *missing communication* (n = 6). Teachers declared that to be normal, as indicated when one teacher said that this

is actually the classic case where you ask a question, or you want to involve a student or that you [...] want to involve the class and want to start a [...]

conversation or discussion and you are sitting in front of 24 black tiles with initials on them and no one answers. (T5)

Student actions in digital settings were not always aimed at improving the class. Some students *exploited their given administrative digital rights* ($n = 5$) when “they tried to call some girl from the parallel class and invite her to the meeting” (T11) or “they [...] just raised the [digital] hands of other students and said ‘I think he will answer,’ even though he did not want to” (T13).

Most of the students and teachers experienced these forms of disruption when they were in home schooling. During home schooling, *extracurricular distractions* led to disruptive situations ($n = 2$). For instance, in one case, such disruptions were described as encompassing situations where “the cat runs through the webcam” (T6).

Teachers also reported disruptions that occurred in digital environments, but which could also be found in a general, nondigital setting as well. Students *broke* previously established *rules* ($n = 3$), for example: “as soon as I leave the classroom, they think they can get up and walk around” (T1). The interviewees also reported direct psychological attacks on other students ($n = 2$) or disturbing overenthusiasm ($n = 1$).

4.2.4.2 Causes of Disruptions

While classroom disruptions are determined by the point of view and determination of the reporting person, the causes for this are reported partly assumptions that can be categorized according to similarity. Five different reasons for classroom disruptions were suggested by the teachers (Table 4.7, p. 52).

Table 4.7: Categories for Causes of Disruptions

Code	Number of Coded Segments
Disruptions by infrastructure	15
Disruptions by organizational or administrative problems	8
Disruptions by lack of motivation and dissatisfaction	7
Disruptions by technical operating errors or inexperience	5
Disruptions by environmental influences	2
Total	37

The most frequently mentioned causes of disruptions were related to *infrastructure* ($n = 15$). Teachers explained that the situation with the given technology sometimes “was problematic [...], because depending on what kind of attachment they wanted to add,

our school e-mail system did not allow us to send 20 megabytes" (T9). More generally, one teacher indicated that "the technical equipment is simply not yet stable" (T1).

Even if the technical infrastructure was capable of the task, *technical operating errors*, or inexperience (n = 5) were also reasons for disruptions: "Somehow, people turn on the camera and distract everyone because they are now fetching their cocoa, eating their muesli, or forgetting to turn off their microphone" (T2).

In some cases (n = 8), the teachers attributed the cause of the disruption to *organizational or administrative problems*. This affected not only their own organization, but it also concerned the administrative requirements they were expected to meet. T4 described such a case when talking about a hybrid setting, he was teaching in: "I have to deal with half a class in the classroom at the same time, then, of course, I am no longer there at the computer [to] answer questions that arise [here]."

Another source of distraction were *environmental influences* (n = 2). It was reported that "one of the schoolgirls forgot to turn off her microphone and then made fried potatoes in the background" (T13).

Since the reason for this specific period of online learning was the pandemic, teachers also saw the *lack of motivation and dissatisfaction* (n = 7) of the students as an underlying cause:

There were also a lot of people who were very dissatisfied with this situation, so that many also found this change—with now sometimes being there [in school], sometimes being at home—so stupid, and somehow you can't really make progress [...]. Your friends [are] in the other group; they are now at home, and you are at school yourself, and of course it would be nice if you could at least see your friends at school, and it would just be one of them. Yes, none of the problems were in the subject being taught, nor was it something with me, just this inner dissatisfaction that they had, that, somehow, they had to get out. (T12)

4.2.4.3 Prevention and Intervention Strategies in Digital Teaching

In total, 32 intervention strategies and 29 prevention strategies were coded in the transcripts. Table 4.8 (p. 54) and Table 4.9 (p. 54) show overviews of the generated categories for these types of strategies as they are explained later.

Table 4.8: Categories for Intervention Strategies

Code	Number of Coded Segments
Verbal interventions	14
Disable functions/delete posts	9
Improvised solutions	3
Break in class	3
Exclusion	3
Total	32

Table 4.9: Categories for Prevention Strategies

Code	Number of Coded Segments
New abilities in digital teaching and the administrative assignment of rights	10
Rule setting	8
Create motivational and interesting classes	8
Involving parents	2
Adjusting expectations	1
Total	29

Intervention Strategies

As seen in Table 4.8 (p. 54), the major component of the intervention strategies used by the teachers was *verbal* (n = 14). Examples of this sort of strategy were the following: “then I say, ‘leave it, or there will be trouble’” (T9), and “you say that [the students should stop] once and then it has mostly been cleared up” (T8). These strategies were mentioned multiple times for online settings as well as for others.

If a verbal intervention was not appropriate, *disabling functions or deleting posts* without a comment (n = 9) was a quick solution (T4). Here, the teachers took advantage of digital features in the learning environment. Sometimes the teachers had to *find improvised solutions* (n = 3), even in cooperation with the students (T10).

Two more radical intervention strategies chosen were a *total break in class* (n = 3), where “the entire lesson was [...] paused” (T12), or an *exclusion of the disruptive student* (n = 3): “if something happens, then you kick them out of the conference, say they can no longer participate today, and then they are simply blocked from the conference and are gone” (T8).

Generally, the teachers reported mostly about their strategies in an online setting, but some of the mentioned strategies can be used in other settings as well. They were not asked to specify what setting they were in when using the strategies.

Prevention Strategies

To prevent disruptions, many teachers used their new abilities in digital teaching and the *administrative assignment of rights* (n = 10). For instance, according to one teacher, “there is an authorization function [...], which I have now switched on” (T7). With this function the teacher was able to control entry to their online classroom as well as what features students can use in the online environment.

They *set rules* (n = 8) to make it clear what students “are allowed to do and what not” (T6), a strategy that was reported in all three forms of online, hybrid, and face-to-face teaching.

The teachers also tried to *create motivational and interesting classes* (n = 8) because “the more you get them involved and they do their own work, or the more you let them exchange ideas via group rooms, the lower the risk of them losing interest or wanting to be distracted” (T6).

Sometimes, especially in home schooling settings, it was necessary to *involve the parents* (n = 2): “we also tried to make it clear through the parents that you don’t need a cell phone during class, and that they [the parents] are allowed to go into the room here and there” (T3).

One teacher declared the rise of their own frustration level as a strategy to prevent seeing some situations as disturbing. Generally spoken, the teacher was able to change the way what he defines as a classroom disruption for himself. Disruptions that would have been bothering in the past were now seen as no disruption for the interviewee. This *adjustment in expectation* (n = 1) prevents disruptions from being impactful.

Most of the prevention strategies were applicable to online lessons. This could also be explained by the fact that the teachers taught online for the most part during the period covered by the interviews. Otherwise, almost one-third of the strategies were usable in other settings.

4.2.4.4 Potentials for Transfer from Online to Face-to-Face Teaching

Teachers often referred to times before the pandemic or tried to compare the circumstances of the pandemic to a non-pandemic situation. The interviewers asked the

teachers if they predicted any disruptive potential during the transition from online teaching during the pandemic to face-to-face teaching.

Disruption Potential in the Transition

An overview of categories for disruption potentials in the transition can be found in Table 4.10 (p. 56). The change in teaching created new habits, and teachers saw *disruptive potential in the adaption to these new behaviors* (n = 5): “it is certainly possible that students will have to get used to it again” (T7).

Table 4.10: Categories for Disruption Potentials in the Transition

Code	Number of Coded Segments
Getting used to/new habits	5
New technical equipment	4
New opportunities	3
Need for new rules and infrastructure	2
Learning deficits	1
Total	15

The teachers recognized that the forced change in teaching brought forth new possibilities. This generic formulation also opened a wide field of possible problems. Thus, some teachers (n = 3) asked themselves critical questions: “what will happen to teachers who are sick in the future? Are you still expected to post learning material online? Is it expected that students who are sick will be provided with learning material at home [...]?” (T4). Teachers saw the impact of pandemic teaching first-hand, and one of the interviewees expected problems due to the *learning backlog* generated during this phase of teaching. This problem was considered subject-related:

Students who were now pulled through under pandemic conditions would probably not have made the transfer [to the next grade] under normal circumstances. This certainly creates potential for conflict between the students, between teachers and students, and certainly between [teachers and] the parents. (T12)

The most obvious change through digital teaching, the *usage of new digital tools*, was considered to have disruptive potential as well (n = 4). Teachers predicted that

other problems will certainly arise now as well. We now have some students who would like to continue working with the iPad [...]. They bought

it for home schooling, and now they are familiar with it, so they would like to continue using it. (T3)

This usage of new digital tools came along with the *implementation of new rules*, and the lack of such rules was another potential for disruption mentioned by teachers (n = 2).

The pandemic creates a *learning deficit* what is seen to be a potential cause for disruptions (n = 2).

Potential from the more Frequent Use or Overuse of Digital Tools

Table 4.11: Categories for Potentials from the more Frequent Use or Overuse of Digital Tools

Code	Number of Coded Segments
File sharing	8
Multimedia usage/differentiated access	6
Better/easier communication	6
Easier use	5
Easier administration	3
No need for presence	2
Data backup	2
Total	32

Table 4.11 (p. 57) shows that teachers saw a variety of potential advantages. For example, *file sharing online* (n = 8), like “put[ting] the solutions on Moodle [... so] I get feedback from the students” (T12), was thought to benefit the organization, and teachers reported that they “no longer [needed to] copy things, but instead could say, ‘you have it as a PDF’” (T2).

In general, the teachers saw that the work with *digital tools became easier and more efficient* (n = 5). According to one teacher, “It [the use of online learning platforms] is now so well established that it works” (T4). This also applies to the *administration and the overall organization*, which became easier to handle and benefited from the use of digital tools (n = 3). Teachers felt more confident in trying new things, like, for example “booking the computer room online” (T13).

The *new ways to convey knowledge* made it easier for the teachers to enact different approaches (n = 6), and as one teacher stated, “in the future, [...] when it comes to homework, [...] I will use such learning videos more often” (T6).

The interviewees reported that the *reduced need to be personally present* and mediate in person (n = 2) was a good opportunity to reduce stress. This also applied in the case of the “many meetings, sessions, parents’ evenings, and so on” (T4) that the teachers were normally expected to attend.

Better and/or permanent communication (n = 6) was reported as potentially effective in avoiding possible disruptions. Teachers thought “that students are now daring to seek direct contact with the teacher” (T2).

Two interviewees reported on the *benefits of data backup* (n = 2), which would potentially come in handy to avoid disruptions in the future preparation of classes.

Potential for less Frequent Use or Underuse of Digital Tools

In five cases, teachers reported that they would not use (parts of) the newly implemented digital tools because they saw either disruption problems or declared that non-digital solutions were more likely to lead to higher educational outcomes. Some teachers “believe [...] that the children will need more of the conventional approach again” (T10):

I believe that by the time the pandemic is so far over that everyone can go to schools, one thing or another has already changed. For instance, I think communication will definitely be different in the long term. But I think some things like MS Teams or BigBlueButton will no longer have the status they have now for a long time. (T9)

Teachers already see changes in their classes, regardless of whether they evaluate them as positive or negative. Such an assessment is the responsibility of each individual teacher.

4.2.5 Discussion

The findings provide numerous opportunities for further discussion. In particular, the necessary adaptations to the theoretical framework, the dependency of actions on certain settings, and the impact of the pandemic will be discussed in detail as well as the limitations of this study.

4.2.5.1 Necessary Adaptations to the Previous Framework

The findings show that existing categorizations of classroom disruptions by different authors, need adjustment. Referring to the categorizations of Rattay et al. (2018) and

Cogswell et al. (2020), both categorizations can be merged. From impairment to conduct disorder, the categories also represent an increasing escalation, which is comparable to the development of low-level to highlevel classroom disruptions. Across these levels, Scherzinger and Wettstein (2019) have differentiated between directional, aggressive and rather undirectional, nonaggressive disruptions. In considering these categorizations in relation to one another, a 2D graph can be created where the x-axis is scaling according to Scherzinger and Wettstein (2019) and the y-axis is scaling according to Cogswell et al. (2020) and Rattay et al. (2018) (Figure 4.2, p. 59).



Figure 4.2: 2D Graph of Classroom Disruptions

To implement the 2D graph of classroom disruptions, specific examples must be chosen and inserted into the graph. It is important to state, that this is representing a single point of view, for example, the point of view from a teacher, who perceived disruptions during lesson and is now trying to classify them to systematically decide how to deal with them in the future. Categories of disruptions, such as those proposed by Biller (1979), Li and Titsworth (2015), Lohmann (2011), and Winkel (2011), can be used for implementing with caution since the disruptions they contain can vary in their position on both axes. For example, a disruption like a talking student who distracts a classmate with a question could be a directional or an undirectional disruption (Scherzinger & Wettstein, 2019), depending on the intention of the initiating student. It also can be a very low-level disruption, if it is not affecting the class heavily or a rather high-level

disruption (Cogswell et al., 2020), when it happens more often and disrupts more than just the two students involved.

The SOMs by Li and Titsworth (2015) is the only categorization to provide categories that relate to disruptions in digital settings. The teachers were interviewed about their experiences in this particular setting and our approach is based on this conceptualization. Thanks to its name, category aggressiveness (AG) can easily be placed within the graph. Aggressive behavior, such as being “aggressive toward the teacher” (Li & Titsworth, 2015, p. 46), can imply the impossibility of continuing to teach and indicates general behavioral problems. This shows very directional behavior. Therefore, AG can be included as high-level and directional in the 2D graph of classroom disruptions. A lack of communication (LoC) makes it impossible to generate a productive teaching-learning environment. However, the degree of directionality is unclear here. It seems more plausible that missed communication is at least intentional on one side. Slacking on the internet (IS), for example, by or because of procrastinating (Li & Titsworth, 2015), is not reported as aggressive or directional. If anything, this activity only interrupts the class for a short moment. This is generally reported as a problem for one student at the time, unlike seeking unallowed assistance (SUA), where at least two students have to be involved. Therefore, this category must be classified a bit higher depending on its escalation level. Furthermore, this behavior is based on a directional decision from the student and therefore can be placed accordingly on the graph. An example of placing those four categories into the graph is shown in Figure 4.3 (p. 61).

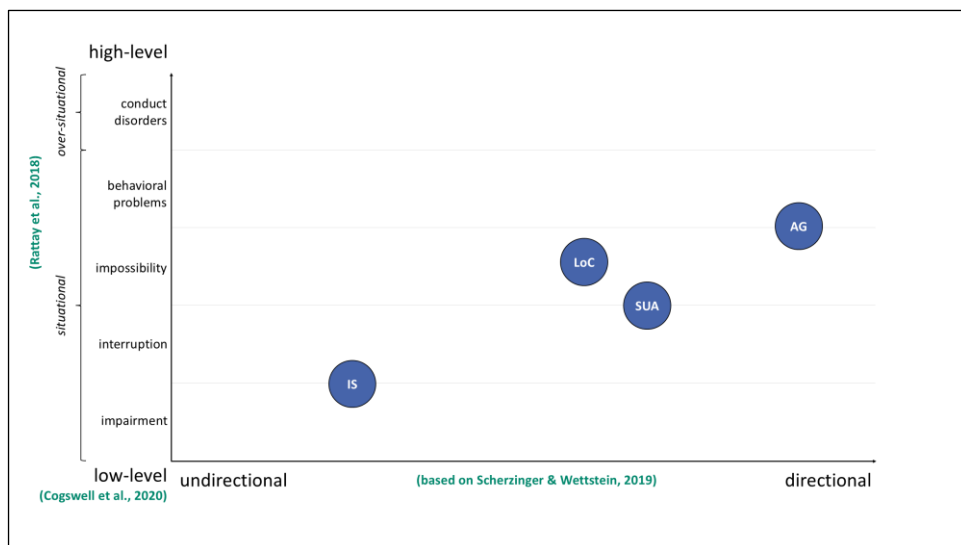


Figure 4.3: 2D Graph of Classroom Disruptions with Categories from Li and Titsworth (2015)

Depending on the situation and ones' personal thinking about the severity of the disruptions, the placement of categories may vary. None of the mentioned categories reached the level of conduct disorders. According to Rattay et al. (2018), this is to be expected since conduct disorders are on a level that is beyond daily classroom disruptions. As mentioned, when deciding which categorization suits the best for choosing categories for disruptions to put them into the graph, some of the disruptions reported by the teachers do not fit into the existing categories, such as the exploitation of given administrative rights, the violation of established rules, operating errors, technical errors, and non-topic-related use of the chat/note's functions. To implement these disruptions, three more categories were generated and added to the already-mentioned categories by Li and Titsworth (2015). These include *Technical Errors* (TE), *Operating Errors* (OE), and *Illicit Social Behavior* (ISB). TEs occur, for example, when students cannot connect to an online meeting, as mentioned by T8. Such issues make teaching impossible, but they are not clearly indicative of directional behavior on the part of the student. OE, as exemplified by T2's description of students forgot to turn off their microphone, can be both very directional and undirectional. In this case, forgetting the microphone setting is undirectional and interrupts the class for a moment. Finally, ISB is based on a more directional behavior of a student, and its impact at least interrupts teaching, if not worse. For example, T11 mentioned that some students invited another student from a parallel class to their meeting when they had the chance to do so. This intentional

behavior interrupted the session and forced the teacher to pay attention to this situation. In Figure 4.4 (p. 62) these new categories are added into the graph as shown earlier.

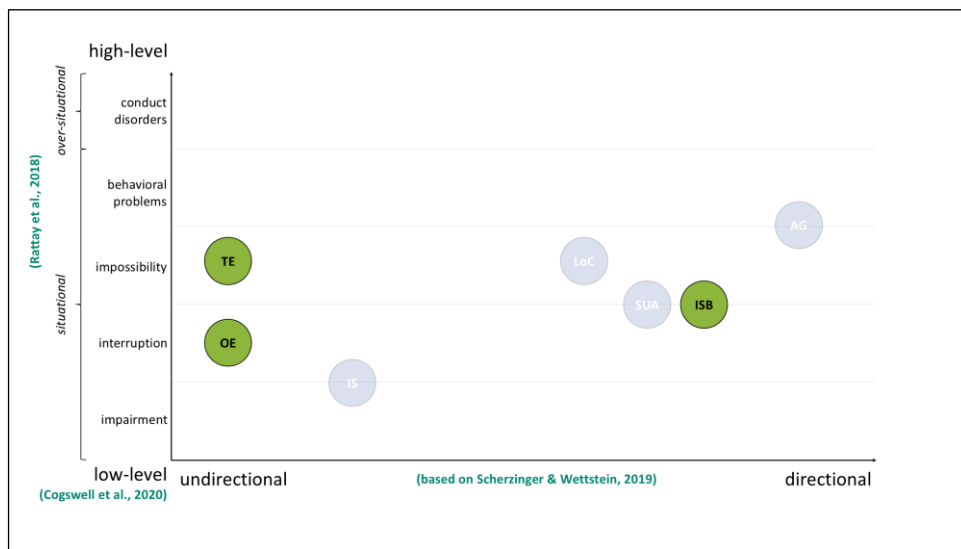


Figure 4.4: 2D Graph of Classroom Disruptions extended by Categories found in this Study

Again, based on the specific disruption chosen for each category, placement on the graph may vary, according to the person choosing. Putting examples on this graph provides two advantages for teachers. On the one hand, teachers can see the number of disruptions and their escalation levels and therefore predict the impact disruptions have on their teaching. On the other hand, if disruptions are (un-)directional, this gives indications of the causes of the disruptions for the teacher.

4.2.5.2 Necessity to Change Teachers' Strategies

The reported disruptions in digitally enhanced face-to-face settings show that already existing disruptions were still present, while new sorts also appeared. As demanded by the European Commission, teachers must enhance their digital skills and competencies (European Union, 2020) and according to the findings of this study, teachers are already adapting their existing strategies to new developments. This goes along with the findings of Zoder-Martell et al. (2023), where classroom management systems in form of different strategies are used to keep students on track of class. Attentive and academically engaged students (Zoder-Martell et al., 2023) are less likely to disrupt the class-

room (Durak & Saritepeci, 2017; Li & Titsworth, 2015; Rattay et al., 2018) and more likely to achieve academic success (Marquez et al., 2016). Furthermore, these adaptations help teachers to effectively deal with classroom disruptions and therefore decrease the amount of stress they are experiencing (Sepúlveda-Vallejos et al., 2023; Wettstein et al., 2021).

Both the prevention and intervention strategies chosen by the teachers are highly dependent on the setting in which they are located, as suggested by Lohmann (2011). It can be assumed that certain properties of the respective setting, such as the spatial dimension or physicality, determine which strategies teachers prefer more than others. A majority of the enacted strategies can be found in the categories of verbal interventions (i.e., an intervention strategy). Verbal communication (and therefore a verbal intervention, if needed) is the main form of interaction in the online setting. This can easily be explained by the missing physicality due to distance learning. In a face-to-face setting, verbal interventions are used by teachers as well. However, due to other possible interventions because of the physical setting, other strategies are used more frequently than they may be in the online setting. Before the pandemic, the teachers were not used to this form of teaching. They were forced into this new setting (Cho et al., 2020; Daniel, 2020) and, according to the teachers interviewed, found that the strategies they had used before on a regular basis were no longer unadapted applicable. At the same time, the teachers reported that new opportunities emerged that were not likely to be discovered without the forced change in settings due to the pandemic. Examples are new ways to interact with students and new ways to convey knowledge. We believe that one important aim of our research here is to advise teachers that new possibilities have to be examined, alternative solutions have to be developed, and (future) teachers have to be instructed on these new possibilities. According to Lemov (2022), students (amongst others) have changed during the pandemic. The rise of smartphone and social media (Lemov, 2022) is one example of what teachers have to adapt to. This is supported by the different views on classroom and schools returning to the school after the pandemic (Gülmez & Ordu, 2022). According to the challenges that digitalization brings to the educational systems worldwide (Sing Yun, 2023), the findings of this interview study show that teachers are at least subconsciously aware of this need to adapt and are already (and inevitably) adapting.

In hybrid settings, one form of the digital settings (Meinokat & Wagner, 2022), the teachers reported organizational problems arising more often than in the other settings. Having one-half of the class being present in the classroom and the other half connected to the class over the internet tasked the teacher with having to manage two separate places at the same time. In other words, the teachers had to expand their spatial per-

ception into the digital room, a skill that no teacher had learned before. This shows, that the interviewed teachers support one of the four main themes for digitalization challenges as stated by Sing Yun (2023, p. 15): “Digital Competence and Pedagogy Challenges.” It is also supporting evidence for the demand of the European Commission (European Union, 2020), although still lacking a sufficient solution to the teachers’ problems. While this challenge was already demanding for the teachers, they also often had to deal with technical and organizational difficulties as well. It is easy to imagine that the strategies teachers had used so far to keep the classroom operations running smoothly were now partly unusable. To generate more space for teachers to focus on both the students and the teaching subject, teachers need to be prepared and supported during this challenge. A total of 10% of the reported disruptions were in such a form that teachers saw the urgent need for the school administration and political authorities to create realistic expectations and a solid infrastructure again supporting a main theme of Sing Yun (2023, p. 15) “Challenges to Sustainable Development of a Digitalized Learning.”

4.2.5.3 Constantly Changing Demands

With the findings of this study, we were able to improve the state of research developing a graph to systemize and prioritize classroom disruptions. Furthermore, the mentioned adaptation of strategies show, that we are already in a changing environment when it comes to daily educational practices (Lemov, 2022). When asked about the process of this transformation, teachers respond mostly optimistically in terms of usefulness of digital settings as well as their perceived change in roles. During the interviews, teachers acknowledge their change to a more moderating position inside the classroom rather than an instructive one. As seen in the overview from Wohlfart and Wagner (2023), this change is perceived in many countries. This leaves the question open how international teacher education is addressing this adaptation. The teachers in the interviews already see benefits in using digital tools such as video technology for their instruction. Research shows that this is also happening in teacher education at universities (Thiel et al., 2023) as well as used by educators for their already practicing teacher colleagues (Biermann et al., 2023). Further research is advisable so that future teachers can develop the skills and competencies needed (European Union, 2020).

While the teachers report positive effects of newly found communication between teachers, students, and parents, it has to be critically asked what such changes lead to in terms of psychological health for teachers (Rajendran et al., 2020). Being available most of the day and combining this with the already high commitment to their profession, teachers should pay close attention to their work-life balance and be aware of the risks

of burnout (Kokkinos, 2007). This is not only necessary for the fact that more teachers are required worldwide (Bümen, 2010), it is also a problem for students and their academic achievement (Klusmann et al., 2016). When teachers are aware of this problem, the digitalization can be used to address certain challenges (Sing Yun, 2023). The interviewees mention an easier organization through digital tools as well as the possibility to attend meetings from a distance as examples. In terms of optimization and sustainability research has to investigate what will last.

4.2.5.4 Pandemic's Influence and Future Directions

As we see from the discussion so far, the pandemic acted as a catalyst for changes in education. Wohlfart et al. (2021) stated that the pandemic has had a great impact on teachers' attitudes toward digital education. This is underlined by the findings shown in chapter 4.2.4.3. Although the pandemic is still affecting the world partly at this point, more and more societies and education systems have paved their way back to some sort of normality or as Gross and McCann (2022, p. 10) state: "returning to more than normal." The predictions made by the teachers are now being tested daily.

While Wohlfart et al. (2021) made more general statements about teachers' acceptance of technology, the findings and discussion of this study show, for the first time, the direct effects that can be examined in real school scenarios at the moment, according to the teachers asked. Digital teaching, in the form of online, hybrid, and enhanced face-to-face learning, and the disruptions coming with it, will probably become more standardized in future education. Our findings go along with contemporaneous research findings, supporting the challenges for digitalization in education (Sing Yun, 2023) as well as experienced and expected changes in (social) behavior (Lemov, 2022). Teachers' views on classrooms after returning to school after the influence of the pandemic in other parts of the world (Gülmez & Ordu, 2022) go hand in hand with the statements of our interviewed teachers, showing that educational systems worldwide suffered similar problems and can profit from more international research. Teachers already benefit from the experiences they have had and the skills they have developed while adapting to digital settings and will certainly profit the other way around. Our findings allow us to assume that these experiences, skills, and tools will endure over the pandemic, and digital teaching will lose its status as a new, special, or alternative mode of instruction. Therefore, it is not desirable to generate new models or categorizations of classroom disruptions, especially in digital settings. Merging adaptations into existing research (Biller, 1979; Scherzinger & Wettstein, 2019; Stockton University, 2001) and expanding existing categorizations (Li & Titsworth, 2015) allows future researchers and teachers to generate a better overview of their teaching and better prepare for classroom disruption.

tions and their challenges (Lemov, 2022; Sing Yun, 2023). Rather than assigning research on this topic in digital settings a separate status, it supports the prediction that digital teaching will enhance existing teaching and create new possibilities for better learning outcomes in the future. This, of course, creates additional complexity and new challenges. However, with this integration, teachers will be able to face these challenges through their accumulated experiences and benefit from their newly gathered knowledge to further enhance their teaching. Particular attention should be paid to the future development of hybrid/blended settings, especially from the point of view of internal differentiation.

4.2.5.5 Limitation

Educational lessons consist of at least three components: a teacher, students, and a subject. This study took a closer look at only one of these components: the teachers. A study that will account for all three perspectives at the same time might become too expansive and miss the in-depth perspective that is often required. Therefore, the authors decided to look at one perspective at a time, knowing that this limits the insights gathered about the overall topic of classroom disruptions in digital settings.

The sample size was also limited. The information gathered from 13 qualitative interviews provides ample opportunities to obtain insightful information about teachers' perceptions regarding classroom disruptions but cannot generate a complete overview over common practices for all teachers. Due to the exceptional situation of the pandemic, the willingness of the teachers to participate in interviews, and the practicability of conducting those interviews, this limitation is accepted, knowing well that larger samples would have generated more data, and using a different methodical approach could also provide further insights.

As mentioned in the discussion, the use of the 2D graph is highly depending on the person using it. It gives a framework for a single individual to systemize experienced disruptions. This generates the possibility to collaboratively work on strategies for classroom disruptions. Nevertheless, the graph could receive further improvements to generate a standardized tool. This might be difficult since different perspectives always will present uncertainties about comparability and the view on disruptive situations is highly subjective. In addition, the students' point of view would generate even more complexity, which is still needed for an attempt of a mutual understanding of teacher and students.

4.2.6 Conclusion

While students lose precious time for learning due to classroom disruptions (Marquez et al., 2016), such situations are also one of the biggest health issues for teachers of all experience levels (Wettstein et al., 2021). To gain insight into classroom disruptions from a teacher's point of view, qualitative guided interviews were held with 13 teachers from secondary schools in Baden-Württemberg, Germany. These teachers were asked to describe disruptive situations (RQ_{B1}) and their possible causes (RQ_{B2}). Prevention strategies to avoid a disruption before its occurrence and intervention strategies to deal with them when they are occurring were also discussed (RQ_{B3}). Finally, teachers reported their thoughts about the possible problems that could arise from the transition from pandemic-caused online teaching to digitally supported face-to-face teaching (RQ_{B4}).

The findings show that existing categorizations of classroom disruptions need adjustment to integrate digital teaching. Thus, we generated a 2D graph for classroom disruptions to account for specific situations according to their impact on the teacher/lesson and the intention the students had. Based on the SOMs developed by Li and Titsworth (2015), we were able to generate a categorization that included categories of digital teaching for the first time.

The strategies used by the teachers depended on the setting in which the teaching was carried out. These and other insights from the findings, as well as international research, show that research does not have to view digital teaching as a special form, but instead as an integral part of all teaching in the future.

Considering the limitations of this study, future research should focus on other perspectives on classroom disruptions and concentrate on specific areas of digital teaching and learning.

4.3 Classroom Disruptions and Classroom Management in Learning Factory Settings at Vocational Schools⁵

Pierre Meinokat and Ingo Wagner

4.3.1 Introduction

Classroom disruptions are known to prevent schools from providing effective learning time for students (Marquez et al., 2016; Scherzinger & Wettstein, 2019) and create health risks for (beginning) teachers in all types of schools (Gonzalez et al., 2015; Kokkinos, 2007; Little, 2005; Rajendran et al., 2020). One of these types is vocational schools, in which LFs have become increasingly common. The new and special setting that LFs provide is expected to create the highest possible level of competence in students with respect to work-oriented behaviors (Fasshauer et al., 2021). This represents a new type of learning arrangement that meets both the pressing educational demands in the area of digitalization (European Union, 2020; KMK, 2021) and the growing need for vocational training (Pfeiffer et al., 2022). In this practice-oriented and independent form of instruction, learners gain realistic insights into the production processes of their future professional worlds. Due to the inclusion of digital components, LFs can be considered a digital setting, according to the definition advanced by Meinokat and Wagner (2022). While schools in vocational education and training (VET) have recognized the potential of LFs in this context, it is not yet clear how this novel setting impacts the ways in which classroom disruptions are managed.

4.3.2 Theoretical Background and Framework

This article examines the ways in which LFs may be vulnerable to classroom disruptions. Understanding this vulnerability requires knowledge of certain related classroom management practices.

⁵ Meinokat, P., & Wagner, I. (2025). Classroom Disruptions and Classroom Management in Learning Factory Settings at Vocational Schools. *International Journal for Research in Vocational Education and Training*, 12(2), 266–288. <https://doi.org/10.13152/IJRVET.12.2.5>

4.3.2.1 Classroom Management and Classroom Disruptions

The effective and successful arrangement of a classroom has been a topic of research since the 1970s (Kounin, 2006). The wealth of research in this area has led to a variety of explanations and definitions being proposed for the term *classroom management*. A modern meta-analysis that sought to attend to the uniformities as well as the differences between these definitions generally concluded that classroom management is based on “a multitude of actions to establish and maintain” (Martin et al., 2016, p. 31) smooth classroom practices. Generally speaking, classroom management refers to the activity of teachers in shaping the learning environment in a way that makes professional, emotional, and social learning possible (Evertson & Weinstein, 2006). On a non-subject-related level, such management includes multiple areas of foci, such as the management of the physical structure, teaching management, time management, management of intra-classroom relationships, and behavior management (Durak & Saritepeci, 2017). The right combination of these different aspects of management can lead to a relatively undisturbed lesson, which is beneficial for both students and teachers (Kokkinos, 2007; Marquez et al., 2016; Rajendran et al., 2020; Scherzinger & Wettstein, 2019). Accordingly, research has shown that well-structured instruction with minimal disruptions is a predecessor to growth in competences among students (Byo & Sims, 2015).

Classroom disruptions are understood as entailing “behavior a reasonable person would view as being likely to substantially or repeatedly interfere with conduct of a class” (Stockton University, 2001, p. 1). As such, they “impair, interrupt or make the teaching-learning process impossible”⁶ (Lohmann, 2011, p. 13). Distractions in the classroom have been found to reduce learning success (Wilbers, 2007). However, conducting quality research on this topic depends on an appropriate understanding of the relevant cultural influences and certain conceptual accuracies. While the German language has its own word for classroom disruptions, *Unterrichtsstörungen* (*Unterricht* for classroom and *Störungen* for disruptions), the international literature contains references to several terms (Meinokat & Wagner, 2022). As just one aspect of classroom management, classroom disruptions are often researched alongside other related practices and behaviors. Research dedicated exclusively to classroom disruptions in certain settings is still lacking (Meinokat & Wagner, 2022). General research on the topic of classroom disruptions shows that there are two types of categorizations: (a) categorizations that weigh the severity of disruptions against each other and (b) categorizations that group

⁶ Translated by the author.

disruptions without weighing them (Meinokat & Wagner, 2024). Examples can be found in Table 2.4 (p. 8) and Table 4.4 (p. 46).

In terms of digital settings, where LFs are located in, so far only one categorization for disruptions exists: The SOMs by Li and Titsworth (2015). They name four categories for disruptions in a digital classroom: *Aggressiveness, lack of communication, internet slacking, and seeking unallowed assistance*. These categories are expanded by Meinokat and Wagner (2024) with three more categories: *Technical errors, operating errors, and illicit social behavior*.

4.3.2.2 Vocational Education in Germany and Learning Factories

Education systems differ internationally, as do teacher training and school conditions. This is considered below.

Educational System in Germany

To establish a general understanding of the status of vocational education and vocational schools in Germany, it is important to have some knowledge of the German education system. Since education lies within the responsibility of each of the 16 federal states in Germany, there is no such thing as one singular German educational system (Edelstein, 2013). Nevertheless, while the forms of the schools and the styles of participation may differ from state to state, the basic structure remains similar. Generally, vocational schools, referred to as *Berufsschule* in Germany, are a part of the second half of secondary education, which is designed to target young people after their mandatory minimum schooling period. There are two main types of vocational schools. The first type is part of a dual educational system in which the students are trained mostly in companies, and this perennial education is supported by blocks of several weeks in which they attend the vocational school for mandatory additional education. The second type of vocational school is full-time attendance in a particular school in preparation for the chosen job (Edelstein, 2013). Only vocational schools of the first type were included in this study.

VET Teachers

To become a teacher in Germany, multiple career paths exist. Most (future) teachers chose their (two) subjects to teach and study them at bachelor and consecutive master programs at university. After reaching the master's degree, the teachers enter a preparation phase. During this phase new teachers are teaching part-time with supervision and as well receive external training (one day a week). After approximately 1.5 years

and passing their exam, they become full teachers. In Addition, even without teacher training at university graduates can apply for a teacher job in VET according to their profession and will get a pedagogical training during their beginning phase of their teaching profession (Federal State of Baden-Württemberg, 2024a). There is also the possibility of a *Seiteneinstieg* for professionals in which persons can become teachers without being to university before. This is connected to certain conditions and will be guided with pedagogical training as well (Federal State of Baden-Württemberg, 2024b). Although all teachers experience a sort of pedagogical training, due to the multiple possibilities in becoming a VET teacher, not every teacher is equally prepared for challenges in their classrooms.

Learning Factories

Since vocational schools are closely linked to students' training companies, the schools themselves and their equipment need to be as close as possible to what the students will actually encounter in their respective professions (Abele, 2019). The constant change in modern industrial techniques makes it necessary for schools to adapt their education as well. To achieve this aim, the federal state of Baden-Württemberg in Germany began to foster the integration of 16 LFs, *Lernfabriken* in German, into schools in 2016. Two years later, another 21 LFs were established. Other vocational schools have set up LFs without state funding (Barthruff, 2024). Therefore, it is evident that LFs are increasingly being established in vocational schools to provide students with insight into real production processes as early as possible in their careers (Abele, 2019). Overall, the focus of LFs lies on learners' acquisition of competencies and increasing their motivation (Jossberger et al., 2018). Therefore, an LF is understood as "a learning environment specified by processes that are authentic, include multiple stations, and comprise technical as well as organizational aspects" (Abele, 2019, p. 1027). Learners are exposed to the complex thinking and programming behind the factory's operations and can directly practice certain tasks with the available equipment. The LFs implemented in schools are as different as the schools themselves. In general, these replicas of real production facilities are integrated into the school building itself. When it comes to the specific equipment of the LF, the schools set their priorities according to their profile. What all schools have in common is that the integrated LFs enable students to access realistic production facilities within the school building. The factories often have a modular structure, allowing the teacher to focus on specific areas of real production chains (Abele, 2019).

Accordingly, LFs comprise a setting that facilitates the successful transfer between school and professional life, and as Bonnes and Hochholdinger (2020) have highlighted,

they provide the education required for a contemporary apprenticeship. To implement these processes, the components used in LFs are recognized and processed in real time using technical identification methods (e.g., Radio Frequency Identification [RFID] codes; (Pistorius, 2020)). Furthermore, the modules of an LF are often provided on digital devices. Also, many parts of LFs are based on digital communication and use monitors or other peripherals for in- and output. According to the specific form of LF in schools, other digital parts may also be integrated. Therefore, LFs are part of digital settings according to Meinokat and Wagner (2022).

This variety of design options creates didactic leeway for teachers. Teachers can initiate both instruction-driven and explorative lessons. Prior familiarization with the existing hardware is essential. The didactic setting can be adapted to the requirements of the content and the learning group within the spatial possibilities of the LF and the time available to the teachers. Therefore, other possibilities are given than compared to settings in a more classical classroom.

Research Gap

Like all other didactical settings, LFs suffer from classroom disruptions, which lead to various educational disadvantages. This includes a decreased student academic success (Marquez et al., 2016) when the teaching-learning environment is disrupted. Meinokat and Wagner (2024) show, that the increased number of digital settings bring up new challenges as well as new possibilities for teachers. LFs, as a relatively new digital setting inside vocational schools, are thus in need of further research to address these issues. As Meinokat and Wagner (2024) have shown, there is a need for settings outside of the standard classroom to be investigated in terms of classroom disruptions and how participants deal with them. While some research has been conducted on both preventive (preceding a disruption) and interventive (following a disruption) teacher behaviors (Evertson & Emmer, 2013; Lohmann, 2011; Mayr, 2006; Syring et al., 2013), the ways in which those working in LFs can manage classroom disruptions has thus far been unexplored (Abele et al., 2015; Cachay et al., 2012; Scheid, 2018; Steffen et al., 2013). Due to their differentiated design and teachers not being experienced herein, it should also be assumed that digital-based LFs demonstrate an opportunity for new forms of disruptions (Meinokat & Wagner, 2024). Considering these issues, in combination with previous research, the following research questions were formulated:

- RQ_{C1}: What types of classroom disruptions occur in LFs?
- RQ_{C2}: What preventive and interventive measures do teachers use to deal with classroom disruptions in LFs?

4.3.3 Methods

The lack of research on this topic suggested that a qualitative, exploratory design would be most appropriate (Denzin & Lincoln, 2018). Similar research in this area, arguably in the absence of reference to LFs, shows that the actual impressions of practicing teachers can be very informative (Meinokat & Wagner, 2024). To gain new insights while maintaining some flexibility (Denzin & Lincoln, 2018), this study relied on semi-standardized, guideline-based interviews conducted with teachers at vocational schools in the federal state of Baden-Württemberg, Germany, who were actively teaching at LFs.

4.3.3.1 Sample

The restriction to vocational schools with learning factories in the state of Baden-Württemberg reduces the choice of potential schools for this study. Eligible schools were contacted in writing and the request was forwarded internally to eligible teachers. Seven of these teachers agreed to take part in the study and were asked in advance to give their written consent to the information about the use of the interviews for scientific research and to data protection in accordance with current legal regulations in Germany.

Table 4.12: Overview of Participants

Alias	General Teaching Experience in Years	LF Teaching Experience in Years
T14	25	5
T15	20	4
T16	14	5
T17	12	1
T18	20	2
T19	9	5
T20	11	2

A total of seven teachers were interviewed. The interviews were conducted partly online and partly face-to-face; all were recorded and transcribed verbatim before the analysis (Hussy et al., 2013). The transcription was carried out with the aim to maintain the intended meaning rather than to generate easy-to-read accessibility. A total of 45 pages with 2601 lines of interview transcript were generated out of the approximately four hours of recorded interviews. Since the interviews were held in German, parts of the transcripts were translated into the English language by one of the authors and all authors discussed whether the intended meaning was kept during the translation

process. Before each interview, all teachers were informed in detail about the purpose of the interview and gave their consent for further data processing. Any information that allowed for any conclusions to be drawn about names, schools, or local characteristics was anonymized. Biographical information was also collected from the teachers, who received the main questions of the interview in advance to prepare their responses and to decide for themselves which answers they would like to provide. As a result, it was hoped that the subject of disruptions could be addressed as openly as possible.

4.3.3.2 Interview Guide

According to Misoch (2015), semi-structured, guideline-based interview protocols are suitable for conducting expert interviews. Therefore, an interview guide was developed, which included a set of main questions that aimed to find answers to the given research questions and supportive questions that could be used in case additional information was needed. This allowed for good comparability while simultaneously maintaining the individuality of each interview (Hussy et al., 2013). Furthermore, there was the possibility of using additional questions not mentioned in the guide to clarify some of the statements provided by the teachers if necessary. The same order of questions was maintained throughout all the interviews, and a simplified version of the guide can be seen in Table 4.13 (p. 74). As mentioned above, organizational information, relevant declarations, and socio-demographic information about the teachers were all provided or obtained prior to the interviews.

Table 4.13: Interview Guide

RQ _{C1}	Main question: • What kinds of classroom disruptions are you experiencing in LFs?
	Support questions: • What consequences do classroom disruptions have for the students? • How do you recognize that your lessons are free of disruptions?
RQ _{C2}	Main question: • How do you act to avoid or react to classroom disruptions during your lessons in LF?
	Support questions: • What strategies do you use to deal with classroom disruptions? • How do you plan your lessons to avoid disruptive situations? • How does the LF setting affect classroom disruptions?

4.3.3.3 Analysis

A qualitative content analysis in line with Mayring’s (2019) specifications was carried out using MAXQDA. Through this process, the aim was to analyze the interviews in a systematic, rule-based, and theory-driven manner (Mayring, 2019). The findings drawn

from the teachers' answers were organized according to certain empirical themes (Mayring, 2019). Research has shown that categories of classroom disruptions in digital settings and the strategies used to deal with them can be adapted from existing categories employed in research on non-digital settings (Meinokat & Wagner, 2024). This led to the further assumption that these categories could be applied to the findings related to LFs as well. Therefore, the fundament of this analysis was a theory-based category system according to Meinokat and Wagner (2024). During the process, additional categories were developed inductively. The coding process was repeated until no further categories were identified. A comparison between literature-based categories and inductively developed will be discussed.

For quality assurance, the focus was on the classic quality criteria recommended by Mayring (2019). A level of objectivity resulted from the comparability created by the guidelines and an interview orientation that was always presented in the same way. The evaluation was carried out systematically, and each step was documented. The consistency of the questions, which were delivered by the same interviewer, generated good reliability. Good validity was ensured by the fact that experts in their specialist fields were interviewed, they reported on real situations, the questions were known in advance, and no evaluation took place during the interviews.

4.3.4 Findings

The results are presented here according to the research questions.

4.3.4.1 Types of Classroom Disruptions in Learning Factories (RQ_{c1})

A total of 27 disruptions were reported during the interviews. From the point of view of the teachers interviewed, disruptions could occur both through the *behavior of the students* and through the *circumstances of the LF* itself.

Disruptions Through Student Behavior

In terms of disruptions through student behavior, the teachers viewed certain actions on the part of students as being disruptive to student success and lesson progression. The most reported classroom disruption in LFs was the *(un-) intentional manipulation of hardware* (n = 7), where "they think they can swap some plugs or [...] they pull on some power supply plugs [...] to annoy their classmates, and these are the things that disrupt lessons" (T17). This category also applied to situations in which students would fiddle with parts of the hardware until something broke. In both cases, the student's behavior

resulted in some measure of non-functionality in (parts of) the factory, leaving other students in the situation of being unable to continue their work.

Almost as often as manipulation, the teachers reported the disruption of *students dealing with content not related to the current lesson* (n = 6). An example for this kind of disruption was given by teacher T16, who mentioned the unallowed use of smartphones during their lesson, and how “I always tell them that I don’t want them [...] to do things with their cell phones [...]. Nevertheless, some do it” (T16). Besides being often related to digital possibilities, like using their smartphones, surfing online, or watching videos, the disruptive behavior from students in this category was not exclusively limited to the connection with digital media and tools, “because when I’m up here at the front, something else is being done back there” (T16). This “something else” could be for example reading a piece of paper written by another student.

Disruptions in the category of *non-participation* (n = 3) could occur in two different ways: Students were either absent entirely or they were present but not participating in the lesson activities. As one teacher reported, “the main problems are disruptions to lessons such as [that] they are missing every two or three days” (T17). This statement shows that missing students adversely impact the learning progression intended by the teacher and were therefore considered a classroom disruption. At the same time, “if one person just sits there quietly and does nothing [...] that could also be [...] a disruption” (T14). In both cases, the teachers maintained that being absent, whether physically or mentally, disrupted their teaching in LFs.

Disruptive social interaction between students was also mentioned by the teachers (n = 2). In such cases, the teachers referred to students who were talking to one another or engaging in social activities that were not appropriate at the moment. For example, “maybe some games will start again with the table next to you” (T17). Teacher T19 also mentioned that it could be disruptive when students are very talkative.

Theft was another disruption mentioned by the teachers (n = 2). While the act of stealing something might not be immediately disruptive if it goes unnoticed, the consequences could lead to problems. Specifically, problems like “when classes are unsupervised, a compressed air seal is suddenly missing [or] a sensor is missing” (T20) led to the non-functionality of the LF and therefore to a disrupted classroom.

Teacher T14 also mentioned *tardiness*, and that time was limited when learning practically and within an LF. Therefore, “if they arrive late” (T14), it detracts from the learning

time available to the late student, as well as that afforded to other students in cases where extra effort is needed to bring the late student back on track.

Disruptions Through the Learning Factory Setting

Teachers described disruptions that arose not only through the students, but also via problems with the LF setting itself. The biggest problem in their opinion was the *total failure* of the entire factory ($n = 2$), as mentioned by T19: “If it breaks down completely, then you’re left standing in front of the class, and nothing on [...] the learning factory works”. Having planned an entire lesson inside or with the LF and not being able to use it would require the teacher to alter their entire plan in cases where the LF was not operable.

Not only could a total failure lead to disruptions, but problems could also arise due to *wear and tear* happening over time in the LF ($n = 2$). Teachers described this form of disruption as inevitable. Generally, it was related to the high number of maintenance requirements that could be issued and depended on the amount of usage by different classes and teachers.

The *shared use* ($n = 1$) of the setting was mentioned by T20 as another possible disruption. In this particular example, the LF needed a specific setup to function according to the teacher’s plan for the students. In such cases, a problem may arise when teachers who must use the LF shortly after other learners require a different setup. This generates the need to reset the software and adjust other features in a short amount of time.

T20 also stated that it could sometimes be problematic to ensure that all students were active at the same time due to *infrastructural circumstances* ($n = 1$). Due to the limited space available, not all students could work in the LF at the same time, which led to extended periods of time, as in a case where “they [the students] normally need 15 minutes for that but they now need one and a half hours in total” (T20) for all students to finish the task. The loss of time here could detract from the time spent other parts of the lesson, therefore creating a disruptive situation.

4.3.4.2 Preventive and Interventive Measures (RQ_{c2})

Keeping in mind that classroom disruptions lead to missed learning time, the teachers tried to use *preventive* strategies to avoid such disturbances. If those disruptions occurred anyway, the teachers attempted to use *interventive* strategies to deal with them. Since this led to two separate sets of possible measures, the findings are described separately.

Prevention

To prevent classroom disruptions, the teachers used certain strategies. Specifically, the teachers mentioned the following strategies to prevent disruptions in their LF settings: *Being physically present as a teacher, setting rules, having a trustful relationship with the students, having good knowledge about the students, effectively arranging the didactical setting, and maintaining direct communication.* The teachers described these strategies in multiple ways, so it was not possible to quantify the use of the strategies. Teachers mentioning a strategy were not asked how often they used them. Instead, the results will show the number of teachers mentioning a specific way to approach disruptions.

Four teachers ($n = 4$) mentioned the importance of *being physically present as a teacher* to prevent disruptions. This included being in a proximity to potentially disturbing situations as well as “being a role model and being authentic” (T16). On the one hand, a close distance made it possible for the teachers to see possible disruptions before they occurred. On the other hand, the students were less likely to act out against a *set rule* when the teacher was nearby. In fact, such rules were another prevention strategy mentioned by the teachers. Sometimes, in addition to the already existing school rules, four teachers reported setting specific rules for lessons inside an LF. Other teachers mentioned no need for the development of new rules just because of the new setting: “Everything is normal. There are no special rules” (T20).

Having mutual trust with the students was described as a prevention strategy by four of the teachers ($n = 4$). Since the high monetary value and high maintenance costs put the schools, and therefore the teachers, in the position of having to take special care of the arrangements and provisions in the LF, in some cases, the teachers were tasked with selecting whom to bring to the LF and whom to leave out. The importance of this selection process was recognized by the students as well and generated a transparent situation for both sides, therefore laying the foundation for further trustful interactions. Such prerequisites for being selected included “getting to know each other” (T16) before entering the LF, as well as earning some opportunities to explore what the LF had to offer (T15).

Knowledge about the students and their abilities was considered crucial for three teachers ($n = 3$) to prevent disruptions or damage to the factory. Through this strategy, “excessive demands can be avoided” (T15), the motivation could be held up high, and frustration could be minimized, all leading to an overall more fruitful learning experience (T14, T15 and T17). Furthermore, teachers with good knowledge of their students

and their abilities could prepare more effective lessons accordingly. This also mitigated the potential for teachers' stress as well as students' overload.

Teachers T15 and T16 ($n = 2$) reported on the importance of an adapted and *well-thought-out didactical setting*. Such a practice was built partially on good knowledge about the students, as well as a strong understanding of the LF itself. With these two factors combined, the teachers could design their lessons to generate a maximum learning experience while lowering disruptions to a minimum. The teachers stated that there was not necessarily a gold standard for teaching in an LF, since many factors came into play, such as the students and their professions, time and infrastructure, and possible histories between the students and teachers, among many others. Therefore, dedicating time and effort to planning a good class in an LF setting was an effective strategy for preventing possible classroom disruptions related to these factors.

While other teachers indirectly implied the use of this strategy as well, two teachers ($n = 2$) reported *direct communication* with the students as an effective means of preventing disruptions. As soon as they felt that a problem was emerging, Teachers T16 and T19 sought to establish a bilateral dialogue with the possible troublemaker. Through this process, potential disruptions could be avoided before they affected other students, in which case there would have been a need for a bigger intervention.

Intervention

The teachers described several strategies for dealing with classroom disruptions in LFs as they occurred. Among all the mentioned measures, the teachers emphasized the *importance of being persistent and demonstrating stringency*:

You just have to keep pointing it out and insisting on the rules you want, and then it usually works out. Of course, if you get sloppy, then they'll quickly get on your back. That can also happen. (T19)

All the teachers in this study were working with students who were trained primarily in their respective companies and were only partially educated in vocational schools. Therefore, the most important points of contact for these students involved the companies and their instructors. As one intervention strategy, five of the seven teachers mentioned the possibility of *getting in contact with the companies* and reporting on the students' misbehavior. Since this could lead to even more problems for the students in terms of their job, this strategy was seen as highly effective by Teachers T14, T16, T17, T19, and T20.

On a solely school-based level, four of the teachers made use of the possibility of (*temporarily*) excluding students from the LF if they considered it necessary. Not only did this make a visible statement to other students in the class, but it was also a situation that the students did not want to experience because they would lose their privilege of being in the LF. As T15 reported, if a particular student was disruptive, “then he can go [...]. I won’t need him in the learning factory anymore, and he won’t like that either because he’ll know he’ll be excluded from it all.”

Before escalating the disruption to an exclusion, four teachers chose the *verbal intervention* as a direct strategy, although this was understood implicitly as being exercised by all the teachers interviewed. Based on their personalities, the teachers met their students on different social levels. Personal contact or the use of irony in dealing with classroom disruptions were possible approaches, for example. Behavioral changes on both sides played an important role here, as this afforded both the students and teachers the opportunity to revise their own behaviors in such challenging situations. Such an approach can be seen as connected to the preventive strategy of the teachers’ establishing relationships of trust with their classes, as well as maintaining direct communication:

[In such a situation,] I go over to them, and then I’m interested in what they’re doing. And when they switch off, then I say, “That’s unfair”, then I want to see what they’ve done. [...] I really say, “No matter what it was, bring it on again”, and then we watch it, and then I ask them why they didn’t do that [what they are supposed to do] now. If it’s something interesting, we also talk about it for two or three minutes. (T16)

4.3.5 Discussion

The results show how the special setting of the LF affected classroom disruptions and the teachers’ behavior toward them. The explorative character of the study and the impressions of the teachers have given rise to further insights, which is presented here in the same order as the findings.

4.3.5.1 Types of Classroom Disruptions in Learning Factories

The classroom disruptions mentioned by the teachers are consistent with current definitions of the term, such as those proposed by Lohmann (2011) and Stockton University (2001). With reference to the work of Wilbers (2007), it can further be confirmed that classroom disruptions in LFs have the same impact on the learning process as

disruptions that occur in other settings. Since LFs are embedded in vocational school settings, this should come with no surprise.

The investigation of this special setting shows, for the first time, that there is a connection between LFs and other classroom settings that offer a somewhat non-standard environment for delivering lessons. Specifically, the mentioned disruptions could sometimes be transferred from/to other classroom settings or subjects. For example, the intentional manipulation of hardware, wear and tear, and the problem of a total operational failure can be found in computer science classes, and issues with the shared use of resources can be found in the education of STEM subjects. As mentioned before, the existing research by Li and Titsworth (2015) is modified by Meinokat and Wagner (2024) identifying a total of seven categories of classroom disruptions in digital teaching environments: *Aggressiveness, lack of communication, internet slacking, seeking unallowed assistance, technical errors, operating errors, and illicit social behavior*. Almost all the categories of disruptions mentioned in this study can be sorted into this categorization, which further confirms its applicability (Table 4.14, p. 81).

Table 4.14: Linking the Categories Found in this Study with the Current State of Research

Category of Classroom Disruption in this Study	Corresponding Category from the Literature
(Un-) Intentional manipulation	Operating error
Dealing with content unrelated to the lesson	Illicit social behavior / internet slacking
Non-participation	Lack of communication
Disruptive social interaction	Illicit social behavior
Theft	Illicit social behavior
Tardiness	Illicit social behavior
Total failure	Technical error
Wear and tear	Technical error
Shared use	Technical error / operating error

The literature-based categories *aggressiveness* and *seeking unallowed assistance* (Li & Titsworth, 2015) were not represented in the interviews. A conclusion that those kinds of disruptions were not part of disruptions in LFs would be wrong. Rather this indicates that the interviewed teachers were not able to remember and report them.

Looking from the other side, the only category mentioned by a teacher in this study that could not be related to an existing category in literature was that of *problematic infrastructure*. Described by the teacher as a problem with space and time that could be attributed to the circumstances of a school's layout and location, this disruption is not necessarily correlated with the behavior of an individual participant. Rather, it highlights

a structural problem that is beyond the control of both the teachers and students. A similar category for this type of disruption would be a *technical error*, since their occurrence cannot be attributed to the teachers or students, but rather to technological problems that were not thought of or dealt with beforehand. Accordingly, this study shows that there is a separation between disruptions based on human behavior and interaction and those caused by external conditions. Table 4.15 (p. 82) shows how the existing research relates to this new separation, based on the disruptions reported in this study.

Table 4.15: Separation of Classroom Disruptions

Classroom Disruptions Caused by Human Behavior or Interaction	Classroom Disruptions Caused by External Aspects
Lack of communication	Technical errors
Internet slacking	Infrastructure problems
Operating errors	
Illicit social behavior	

Technical errors and infrastructure problems are caused by external conditions, while the other categories are associated with human behavior or interaction. With this expansion of the current state of research, this study opens up new questions about the ways in which classroom disruptions in digital settings can be dealt with. Can teachers only prevent or intervene in disruptions caused by human factors? How is the didactic preparation of teachers linked to the external factors of disruption? Are school administrators and education policymakers responsible for or able to counter teaching disruptions at an infrastructural level? Further research is needed to answer each of these questions.

4.3.5.2 Preventive and Interventive Measures in Learning Factories

Elsewhere, teachers have shared the opinion that prevention is more important than intervention when it comes to disruption-free teaching (Kounin, 2006; Lohmann, 2011). This statement is supported by the fact that the teachers in the present study mentioned more preventive strategies to deal with classroom disruptions in their LFs than interventive strategies (chapter 4.3.4.2). While generally, the difference between these strategies was not very large, the teachers seemed to be very careful with their choice of students to bring to the LFs, keeping in mind the high monetary value of the factory, as well as the possibility of working in this setting being viewed as a privilege.

Regarding the types of classroom disruptions within LFs, it became clear that the strategies used to deal with them, both preventive and interventive, seemed to be transferred from other (partially digital) settings. Therefore, it is imaginable that the strategies used by the teachers in the LFs were also used before in lessons that were not held in these settings. According to the teachers interviewed in this study, there was a certain simplicity to implementing instruction in the new learning environment of the LF based on the teachers' existing repertoire of actions, as well as in implementing and adapting already-existing strategies for dealing with classroom disruptions in this new classroom setting. This goes along with current research on teachers' strategies for managing classroom disruptions in digital settings (Meinokat & Wagner, 2024). It can further be confirmed that teachers are capable of choosing the right strategy according to their respective personalities to effectively deal with a certain situation (Lohmann, 2011). Therefore, LFs, as a digital setting in vocational education, can be integrated easily into the teachers' repertoire if the school itself is willing to invest in such a setting. Such investment would support the need expressed by the teachers to ensure that digitalization is an integrational part of their daily work (Meinokat & Wagner, 2024).

Furthermore, it is striking that the relationship of trust between the students and teachers was addressed so frequently during the interviews. It can be assumed that LFs, due to their special equipment, high monetary value, and high maintenance requirements, increase the demands for good behavior on the part of the students, which means that teachers may only want to work with learning groups that they trust. Among other factors, learners may develop trust through fewer disruptions in previous lessons, which means that fewer disruptions should be expected in the LF. For the students, there is a possibility to not participate in the LF which may also makes the lessons appear more interesting, and research shows that interesting lesson designs can themselves prevent disruptions (Mayr, 2006). It may thus be worthwhile to make interdisciplinary comparisons with other digitally-based teaching formats and to include the aspect of motivation in such considerations. Furthermore, the distinctive influence of special settings and their connection to the amount and severity of disruptions would be valuable to consider, as the LF setting here gives a clear indicator that this change in setting was significant. As a result of these insights, this study shows that there is a need for research into more special settings, as well as comparisons between more traditional settings.

The mention of expulsion as a possible strategy to intervene in classroom disruptions stands in contrast to those strategies that aim at establishing a positive learning climate and mutual trust. Since the teachers reported this as a sort of *ultima ratio*, and research shows that expulsion can have a negative impact on student behavior (Russell & Rausch,

2015), the use of this measure in LFs is as questionable here as it is in other settings. At the same time, it confirms the findings of Rattay et al. (2018) and Cogswell et al. (2020), both of whom based their research on a form of escalation process, choosing the impact of classroom disruptions according to their severity. The strategies mentioned by the teachers reflect this escalation process, wherein approaches like verbal intervention are located at the lower end of the severity scale and expulsion on the higher end. Linking the chosen strategy and its severity to the encountered disruptions and their impact on the class seems like a productive approach for teachers to maintain a smooth-running lesson. Categorizations like those provided by Meinokat and Wagner (2024) may therefore be helpful for teachers to decide how impactful their strategy has to be to deal with certain situations.

4.3.6 Limitations and Future Research

It should be noted that the study presented here is of a highly explorative character. This can be seen in the limited number of participants. Due to the limited number of qualified schools and teachers having an LF, the number of possible interviewees was necessarily limited. This could lead to missing findings. A possible example for this is the absence of reported disruptions in the literature-based categories *aggressiveness* and *seeking unallowed assistance*. Based on the answers given by the teachers, it can be assumed that an appropriate saturation level is reached but an increased number of participants could further improve the findings.

Findings to RQ_{C2} show limitations in the quantification of answers. Given the explorative character of this study, the interview guide and the questions within should be considered for revaluation in future research. Using more support questions during an interview could create more precise findings, but of course, they should not be suggestive.

The topic of classroom disruptions is sensitive for some teachers, since they do not want to talk about the rather unpleasant aspects of their teaching. This may have contributed to the fact that only a small number of teachers agreed to take part in the study. Future studies could reconsider the approach. Nevertheless, those teachers who were willing to participate were highly transparent about their teaching, and as a result, the findings of this study provide a reliable and important baseline. Accordingly, this study should be considered the first step in a new area of inquiry. Nevertheless, voluntary participation in the interview study cannot rule out the fact that perhaps only teachers with positive preferences regarding the LFs made themselves available. Hence, the results cannot be considered representative. A larger number of participants is needed to obtain more

varied and in-depth insights. This also raises the possibility of taking other methodological approaches to the subject. In the future, the question may arise as to whether LFs in this form will continue to increase at vocational schools or whether smaller, cheaper, and more mobile alternatives will find their way into this context. Irrespective of such a development, research on LFs, with a special focus on classroom management and classroom disruptions, provides a basis for decisions on future forms of settings. On this foundation, future research can take a closer look at the specific features of high-quality teaching in LFs. To achieve this aim, it would be particularly interesting to obtain the students' perspectives, as research in this field and on classroom management in general is already very teacher-oriented. Another interesting fact arising from the findings of the study and their discussion is the connection between classroom settings and experienced disruptions. Since connections between, for example, computer science classes and LF settings can demonstrate similar disruptions, such as intentional manipulation, it is likely that other settings have similarities as well. Special settings like physical education in gyms, natural science education in laboratories, or extracurricular activities outside the school may share similarities and exhibit key differences from more standard classroom settings like those suited to mathematics or language education. Further research is needed. This also applies to the separation of human and external factors that contribute to classroom disruptions in digital settings, and the connection between special settings like LFs and the appeal to classroom management for certain settings.

The findings show that teachers adapt their existing strategies more than invent new strategies to deal with disruptions. This opens the question whether teachers are not yet using digital settings to their full potential in terms of new ideas and solutions or if digital settings are not generating such possibilities. It could be assumed that teachers need more external perspectives, for example in form of teacher trainings, to widen their horizon in possibilities of new digital settings.

4.3.7 Conclusion

LFs, which can be considered a digital setting due to their digital components (Meinokat & Wagner, 2022), represent a special learning environment that is especially suited to meet the growing demands of education and digitalization (European Union, 2020; KMK, 2021). These expensive systems, which involve a great deal of organizational effort, represent real existing process and production chains in industry and enable vocational students to gather practical experience in the school environment, which prepares them for their later work. With reference to this special status, this study examined the occurrence of classroom disruptions and the preventive and interventive

approaches to addressing these disruptions. The teachers from vocational schools in Baden-Württemberg, Germany, who were interviewed in this partially standardized, guideline-based interview study, all taught in LFs. The results show that all the actors involved were aware of their special status. In extending existing research, this study shows that classroom disruptions can be based on more than just human factors. In considering LFs as digital settings, external factors come into play as well, which pose distinctive challenges to teachers with respect to their didactical preparations. The teachers interviewed optimized their patterns and strategies for teaching in LFs based on their experiences in other learning settings; in doing so, they enabled optimal learning success for the students, and, at the same time, by averting potential destruction, they protected the monetary value of the LF. The prevention and intervention strategies were based on an escalation process that is linked to the severity of the disruption. In general, it was found that established classroom disruptions categorizations from other digital settings can be applied to LFs; thus, LFs, as new learning environments in vocational schools, do not require a particular classroom management style. It seems that the style teachers use to manage their classrooms depends more on the teacher's personality than on the subject and is just adapted situationally. Classroom management practices from other didactical settings can be applied in LFs as well. Teachers and their ongoing adaptation of strategies can use findings of this study to evaluate their own lessons. Furthermore, being able to systemize experienced disruptions and prioritize strategies accordingly creates space for other aspects of classroom management that teachers can deal with.

4.4 Refusal in Physical Education – Teachers’ Strategies and Utilization of Digital Media⁷

Pierre Meinokat, Katja Reimers and Ingo Wagner

4.4.1 Introduction

Minimizing classroom disruptions is essential for student academic success (Adeyemo, 2012; Marquez et al., 2016; Talebi et al., 2015). However, classroom disruptions are frequent, occurring on average every 42 seconds (Wettstein & Scherzinger, 2018). In physical education (PE), this issue is confirmed by Maddeh et al. (2015), who report 1.2 disruptions per minute. These disruptions impede learning and, in addition, can negatively affect teacher well-being (Kokkinos, 2007; Rajendran et al., 2020; Wettstein et al., 2021). Effective classroom management is crucial for addressing these disruptions. Dealing with students refusing to participate is a key challenge in PE classroom management (Wolters & Gebken, 2005). While this constitutes a known challenge, the ongoing digital transformation of education (Cho et al., 2020; Daniel, 2020; European Union, 2020) requires investigating the untapped potential of digital media in addressing student PE refusal.

4.4.2 Theoretical Framework

4.4.2.1 Classroom Management and Classroom Disruptions

Kounin (1970) introduced the concept of classroom management, initially focusing on student and group management. Currently, classroom management encompasses “the actions teachers take to create an environment that supports and facilitates both academic and social-emotional learning” (Evertson & Weinstein, 2006, p. 4). Smooth classroom and lesson operation (Mulvahill, 2018) is influenced by various factors (Durak & Saritepeci, 2017). Although authors emphasize different aspects of classroom management, a common thread is the development of skills to create a productive and effective learning environment.

⁷ Meinokat, P., Reimers, K., & Wagner, I. (in press). Refusal in Physical Education – Teachers’ Strategies and Utilization of Digital Media. *Frontiers in Sports and Active Living - Physical Education and Pedagogy*.

A crucial component of classroom management addresses classroom disruptions, defined as “behavior that seriously interferes with the teaching process, and/or seriously upsets the normal running of the classroom” (Infantino & Little, 2005, p. 493). Disruptions can manifest in various forms. While the integration of digital media has introduced new types of general classroom disruptions (Meinokat & Wagner, 2024), the unique context of PE also presents distinct challenges (Aboshkair, 2022).

4.4.2.2 Physical Education Refusal

School refusal is a broad term (C. A. Kearney et al., 2004) encompassing resistance to school or specific classes. Physical education refusal (PER) describes this issue within PE. Wolters and Gebken (2005, p. 4) defined PER as “all behaviors in which the rejection of PE is expressed (from disrupting, sitting on the bench and forgetting sportswear to absenteeism)”⁸. While this issue is not unique to the German educational system, international research on PER so far remains limited. Research using synonymous terms for PER such as *benchwarmers*, *reluctance*, *unwillingness* or simply *missing interest* (Frohn, 2022) so far is not connected to the field of research on classroom management in PE.

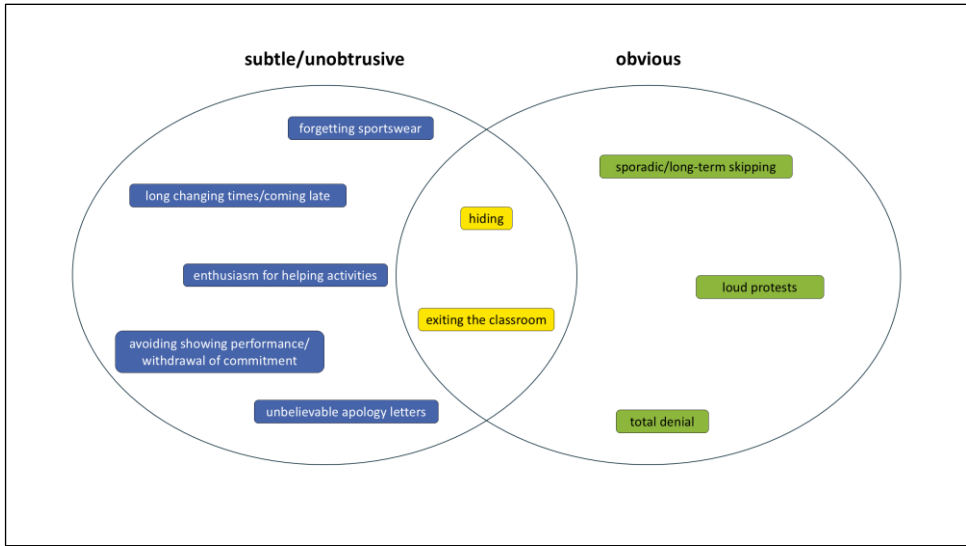


Figure 4.5: Examples for PER Behaviors

⁸ Translated by the author.

Kleiner and Reichel (2008) categorized PER behaviors on a spectrum from subtle and unobtrusive to overt refusal. Behaviors described by other researchers (Hietzge, 2005; Klupsch-Sahlmann, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters & Gebken, 2005) fit within these categories. Subtle behaviors include forgetting sportswear, extended changing times, feigning enthusiasm for helping activities, avoiding performance displays, or providing implausible excuses. Overt behaviors include outright refusal, potentially with vocal protests, or repeated and extended absences. Some behaviors, like hiding or quietly leaving the classroom, can fall into either category. Figure 4.5 (p. 88) illustrates the state of research in this regard.

4.4.2.3 Teachers’ Strategies Regarding PER

In response to student PER behaviors, teachers employ strategies to manage these situations. Strategies are defined as the actions and practices teachers use to maintain or restore effective classroom management (Mitchell et al., 2017). Wolters and Gebken (2005) categorized the reasons for PER as *in-school* or *out-of-school*. They argued that teachers and students have greater influence over in-school factors, leading to three dimensions for understanding PER reasons: *institutional*, *classroom*, and *relational* (between classroom stakeholders). Within this framework Frohn (2022) is able to confirm these dimensions for primary school level through an interview study with students. While this creates a structural framework for understanding PER behavior other authors report strategies teachers use as a response to various situations in PE, including PER (Brophy, 1996; Fellner & Payer, 2021; Hietzge, 2005; Klingen, 2003; Klupsch-Sahlmann, 2005; Lüpke, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters, 2021; Wolters & Gebken, 2005). Research on these strategies shows, that so far, a connection to a structural framework of reasons for PER constitutes a research gap, especially in relation to the inclusion of the use of digital media in these strategies.

4.4.2.4 Digital Media Use for PER

The utilization of digital media has experienced a notable surge in recent years, accelerated by the COVID-19 pandemic (Cho et al., 2020; Daniel, 2020). While stakeholders have advocated for this increased integration (European Union, 2020) a discourse concerning the pervasive implementation of digital media within daily educational practices has emerged (Meinokat & Wagner, 2024). Research indicates that educators perceive novel pedagogical opportunities while simultaneously emphasizing the need for prudent application and consistent evaluation of digital media’s impact (Meinokat & Wagner, 2024). This discourse assumes heightened significance within PE, a discipline where sustained engagement in physical activity is paramount (Jastrow et al., 2022).

Recent research has broadly addressed digitalization in PE, particularly since the pandemic, which has accelerated the integration of digital media into education (Meinokat & Wagner, 2022; Wohlfart & Wagner, 2024). The concept of digital media is continually evolving (Van Dijk, 2004). In this study, digital media encompasses all technological devices, software, and methodological settings used.

Teaching and learning often occur in digital settings, defined as a “generic term for online learning, digitally enhanced face-to-face learning, and blended learning, assuming that digital media are used as technology to enable or support the respective form of teaching” (Meinokat & Wagner, 2022, p. 4671). This definition applies to PE when digital media are used. While research on digital media in PE has not focused on PER, some studies offer relevant insights. For example, Jastrow et al. (2022) found that digital media use in PE is associated with increased student motivation. Meinokat and Wagner (2022) demonstrated that digital media can support and enhance individual learning in PE, citing examples like movement learning and analysis using video feedback, potentially reducing PER. Similarly, Krick and Nowak (2022) suggested that digital media can streamline organization and assessment, preventing general disruptions, and Raab (2021) argued for their effectiveness in teaching exercise- and sports-related knowledge. These findings suggest that digital media may be relevant for teachers addressing PER. Conversely, Aagaard (2022) highlighted teacher concerns about digital media as a source of distraction. The question of whether digital media offers more solutions or creates more problems remains open.

4.4.2.5 Research Questions

Given that existing research on PER strategies lacks an overview and does not consider digital media, this study investigates such strategies in general and whether the use of digital media enables new strategies or modifies existing ones. Specifically, this study addresses the following research questions:

- RQ_{D1}: What strategies do teachers use to deal with PER?
- RQ_{D2}: How can digital media be used to deal with PER?

4.4.3 Method

This study adopts an exploratory approach (Denzin & Lincoln, 2018) to address the research questions, aiming to understand the realities of daily PE. Gathering information from participants within a school setting is crucial for this purpose. Building upon existing teacher-focused research, this study employed interviews (Denzin & Lincoln, 2018)

with expert teachers regarding their experiences with PER. While other qualitative methods were considered, interviews were deemed most likely to yield rich insights. Eleven teachers were interviewed, some online and some in person. Interviews were recorded and transcribed following Kuckartz's and Rädiker's (2022) guidelines and analyzed using qualitative content analysis (Mayring, 2014) with MAXQDA 2020 software.

4.4.3.1 Sample

All 11 participating teachers taught in the first and/or second levels of secondary schools in Germany. Other school types and age groups were excluded to ensure comparability of PE settings. Table 4.16 (p. 91) presents the interviewees' sociodemographic data. Interviews, conducted by one author, ranged from 18 to 44 minutes in length.

All participants gave their written consent before the study, they were introduced to the research design and intended use of their answers before the interviews started, their confidentiality was ensured, and they were informed that they had the option to withdraw at any given time without the occurrence of any disadvantages.

Table 4.16: Sociodemographic Data of Interviewees

Alias	Gender	Year of Birth	Years of Experience	Subjects Taught (excluding PE)
T21	Male	1987	9	Mathematics
T22	Male	1995	2	Physics
T23	Female	1970	24	Mathematics; Chemistry; Computer Science
T24	Female	1985	2	German; Mathematics; French
T25	Male	1992	2	Geography; German; Business, career, and study-orientation
T26	Male	1985	11	Mathematics
T27	Male	1968	22	Science, Technology, Engineering, and Mathematics; Geography
T28	Female	1994	3	Mathematics
T29	Male	1971	22	Biology
T30	Male	1985	10	Biology; Science, Technology, Engineering, and Mathematics
T31	Male	1986	10	Ethics; Philosophy; Social Studies; Economics

4.4.3.2 Interview Guide

Following best practices for expert interviews (Döring, 2023; Misoch, 2015), a semi-structured interview guide was developed. This approach allowed for structured conversation while providing flexibility for in-depth probing and ensuring comparability across responses. The interview guide, in reference to Misoch (2015), began with informing

interviewees about data protection rights and providing background information about the study. The core of the interview focused on the research questions. While the main questions remained consistent across interviews, additional, context-specific questions were incorporated as needed. This standardization ensured comparability, while individualized questions facilitated detailed responses. The interview concluded with collecting sociodemographic data and addressing any remaining questions.

4.4.3.3 Analysis

Qualitative content analysis aims to systematically, using established rules and theory, analyze conversations to identify emergent themes (Mayring, 2014) and integrate findings with existing PER research. The well-defined theoretical framework of this study justified the use of qualitative content analysis according to Mayring (2014), rather than Kuckartz and Rädiker (2022). The data were organized according to empirically and theoretically relevant aspects to enable structured presentation of results (Mayring, 2014). Structured categories were developed and used to code the interviews. The process of category development, coding, and analysis was iterative, continuing until no new categories or data emerged. This iterative approach allowed for both deductive and inductive category development (Mayring, 2014). Table 4.17 (p. 92) and Table 4.18 (p. 93) display the categories and sub-categories. First-order categories were derived from the research questions, while sub-categories were drawn from existing literature and developed inductively during the analysis process (italicized in the tables).

Table 4.17: Categories for Strategies Teachers Use to Deal with PER

Category	Sub-category	Sub-sub-category
Strategies teachers use to deal with PER	Attitude toward PER	Capacity
		Perception
	Strategies in institutional dimension	School guidelines
		Collegial exchange
		Work with parents
	Strategies in classroom dimension	Rule setting
		Variety in scenarios/motivation
		Differentiation
		Performance and evaluation
		Division
		Inclusion of passive students
	Strategies in relationship dimension	Classroom climate
		Teacher behavior
		Interpersonal relationships

Table 4.18: Categories of Digital Media and their Use for the Prevention and Intervention of PER

Category	Sub-category	Sub-sub-category
Digital media used to prevent and/or intervene in PER	Movement learning	Movement analysis
		Practice template
		Gamification
	Performance assessment	-
	Organization	Documentation
		Team division
	Teaching sports-related knowledge	Content participation
	Involvement of passive students	Exercise development
		Assistance

4.4.4 Findings

4.4.4.1 Teachers’ Strategies

Teacher strategies were categorized according to their respective dimensions: *institutional*, *classroom*, and *relational* (Wolters & Gebken, 2005).

Strategies in the Institutional Dimension

In some cases, teacher actions were *dictated by school policy*. For example, late arrivals were documented (T25), and absences from PE required parental notes (T27). One teacher reported assigning copying text tasks to inactive students (T24). These strategies are based on pre-established institutional rules.

Notably, none of the teachers reported *collaborating with colleagues*, a strategy mentioned in the literature. One teacher expressed a need for such collaboration, stating, “because as a teacher, you are usually on your own” (T23), indicating a desire for institutional support.

One teacher *engaged with parents* to prevent PER, particularly regarding swimming lessons. He explained, “so, in swimming, we really try to prevent this [PER] through parents’ information evenings where we ask parents to send their children to us regularly for swimming training” (T27). This strategy addresses the issue at a higher, out-of-classroom level.

Strategies in the Classroom Dimension

Teachers recognized the importance of varied learning opportunities, differentiation, and incorporating student interests to prevent PER. They reported creating diverse activities to challenge and support every student (T26), noting the need to address both high and low achievers to avoid boredom (T29). Some students might withdraw due to fear of certain exercises (T27), which teachers addressed through methodical instruction (T26, T28). One teacher explained,

if a child is incredibly afraid of doing a somersault, [...] then maybe the child won't do a somersault, but maybe they can do something else great in that area. (T27)

Referencing student interests increased engagement and motivation (T24), although teachers acknowledged limitations imposed by the curriculum. One teacher explained the need to justify curricular choices: “why this [topic] or that [method] is following [now] or why this [topic] or that [method] is not following [immediately]” (T21), highlighting the interplay between institutional and classroom dimensions.

Teachers *emphasized the multifaceted nature of PE*, beyond just performance: “that it is not just about performance, as PE simply has more aspects” (T26), such as “healthy lifestyle” (T26), “fun and games” (T26), and overcoming fear (T22). One teacher advocated for reducing performance pressure:

[We should be] focused more on small successes as well, and the main thing is that the child gathers some experience of movement. I don't think they have to get a grade for everything. That would take the pressure off many, many children. (T27)

When grades were given, they included progress, motivation, cooperation, and social behavior (T25, T29).

When PER was attributed to group dynamics, teachers initially used *random group assignments, adjusting as needed* (T31). One approach to creating balanced teams was performance-based: “good ones playing against the good ones [and] the weaker ones playing against the weaker ones” (T23). Another teacher allowed students to self-select teams based on “sympathy” (T30) but still made adjustments if necessary.

To proactively prevent avoidance, one teacher aimed to *keep all students engaged* “and if that doesn't work, then I try to give those who are not active at the moment some

kind of assignment" (T30). Assignments included assisting with movement (T21, T22, T23, T25, T26, T30, T31), preparing equipment (T23, T31), writing reports (T26), conducting observations (T30), or refereeing/scoring (T31).

Regarding forgotten sportswear, some teachers (T25, T27, T28) *allowed participation when possible*:

Basically, if someone has just forgotten their sportswear, then they still take part in PE, even if it's a gray area, of course. You're not always allowed to do this for safety reasons; of course, it also depends on the sport. But it's a practical way of preventing people from just saying, 'I don't feel like it' and 'I've forgotten my sportswear'. (T28)

Strategies in the Relationship Dimension

One classroom strategy involved *establishing rules*. One teacher emphasized the importance of reinforcing agreements and "to set an example of a certain strictness or consistency," to avoid student rebellion (T22). However, flexibility in applying rules was also recognized (T21), contrasting with institutionally defined rules and highlighting teacher-student collaboration in rule creation.

Structuring lessons around *basic and familiar concepts* was also recommended. For example, one teacher used familiar games to connect with and motivate students (T23), again demonstrating collaborative lesson development.

Teachers aimed to *create a positive classroom climate*, recognizing its influence on PER (T21, T26, T29, T31). This involved fostering a good atmosphere, a shared responsibility between teacher and students (T28), and preventing "derogatory comments or degrading behavior" (T31). Open communication between teachers and students, as well as among students (T26), and a "supportive culture" (T29) were prioritized. Building personal relationships was seen as essential for students to "open up and say what the problem is" (T24).

Teachers addressed barriers to interaction, such as shame, through targeted interaction (T26). One teacher described their approach to building rapport from the first lesson:

A concern for me [is] to be able to remember the names very quickly, to have the person in mind, and to be able to call them by name. I also always ask them what their favorite sport is, so that I can build a personal relationship. (T22)

In cases of refusal, teachers *engaged in direct conversations* with students (T21, T22, T23, T24, T26, T28, T31) to “see what the reason is and take countermeasures accordingly” (T31). One teacher explained: “You have to be there immediately as a teacher and then defuse the situation and react to it” (T26), emphasizing the importance of immediate intervention and motivation. Teachers also stressed the *importance of their own motivation* (T24).

4.4.4.2 Digital Media for Dealing with PER

The digital tools mentioned by teachers are categorized by their application (see Table 4.18, p. 93).

Movement Learning

Digital tools for movement learning included exercise templates provided via *digital station cards* or explanatory *videos* (T22, T25, T27) on *tablets* (T22, T25) or assigned for home viewing (T27). These templates provided variety, reduced downtime (T21), facilitated self-regulated learning (T24), and enabled differentiation (T25), all identified as potential triggers for refusal behavior. Careful attention to student-friendly language and appropriate level was emphasized (T21).

Video recordings with subsequent movement analysis as feedback were used to accelerate progress and increase motivation (T30). Video recordings also helped students correct their self-perception, reducing anxiety and facilitating learning (T22, T27). Standard camera apps on *smartphones/tablets* or *video delay programs* were used (T27).

Performance Assessment

One teacher suspected that performance pressure contributed to PER: “You don’t want to present yourself in front of others in a sport where you are not so good” (T31). He suggested *video recordings* and *tracking apps* to alleviate this pressure:

If, for example, it's about fear, like performing something in front of the group that is then graded, a video recording would be possible [...] I did that once during [COVID-19], where the students used a running app to track what they practiced and things like that, and then, of course, that can be included in the assessment. (T31)

This approach allowed performance assessment without direct social interaction.

Organization

One teacher used a *tablet to record* forgotten sportswear (T21). *Online surveys* were used to gather student interests and inform lesson planning, reducing reasons for avoidance (T21, T22). An *app* was used to quickly and easily create balanced teams, minimizing potential frustration (T21, T23, T31).

Teaching Sports-Related Knowledge

One teacher (T26) identified the *flipped classroom* as a preventive strategy against refusal behavior:

Many don't have previous contact points to a certain kind of sport, so, via a video, for motivation, I can give them homework in preparation for the lesson. I make sure that I simply keep the students a bit interested and also inform them about some of the rules and regulations. Maybe also a bit of the history of sports. (T26)

This approach addresses the theoretical aspects of sports. When refusal occurred, students could be meaningfully engaged with sports theory (T31). *Film or video content* on sports, rules, game tactics, or techniques could be shown or assigned as homework (T21, T23, T29). One teacher suggested using movement simulation *apps*, if available:

Such a task, I think, could also help people who refuse lessons to simulate certain movements on the iPad and present them to others. [This could] help them visualize and reflect on basketball [techniques]. (T21)

Involvement of Passive Students

Teachers frequently suggested auxiliary activities to involve refusing students (T22, T23, T25, T26, T28, T30, T31), including:

- Recording *videos* and *analyzing* movements with classmates (T22, T23, T25, T28, T30, T31);
- Refereeing, such as using *digital scoreboards* (T23);
- Taking *measurements* (e.g., speed or pulse) with *apps* and providing feedback (T26).

One teacher (T24) noted that students could create personalized training programs during class, drawing *inspiration from online resources* and “recording themselves or using apps in this regard” (T24).

4.4.5 Discussion

4.4.5.1 Enhancing Existing Categorizations

Without considering digital media, the existing PER framework by Wolters and Gebken (2005), combined with strategies reported by various authors (Brophy, 1996; Fellner & Payer, 2021; Hietzge, 2005; Klingen, 2003; Klupsch-Sahlmann, 2005; Lüpke, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters, 2021; Wolters & Gebken, 2005), provides a foundation for incorporating this study’s findings. Teacher-reported strategies can be categorized within the *institutional*, *classroom*, or *relationship dimensions*. Furthermore, nearly all reported strategies align with strategies in the literature, thus connecting the collected strategies to the three dimensions. Figure 4.6 (p. 98), Figure 4.7 (p. 99) and Figure 4.8 (p. 99) illustrate this concept and present a preliminary model.

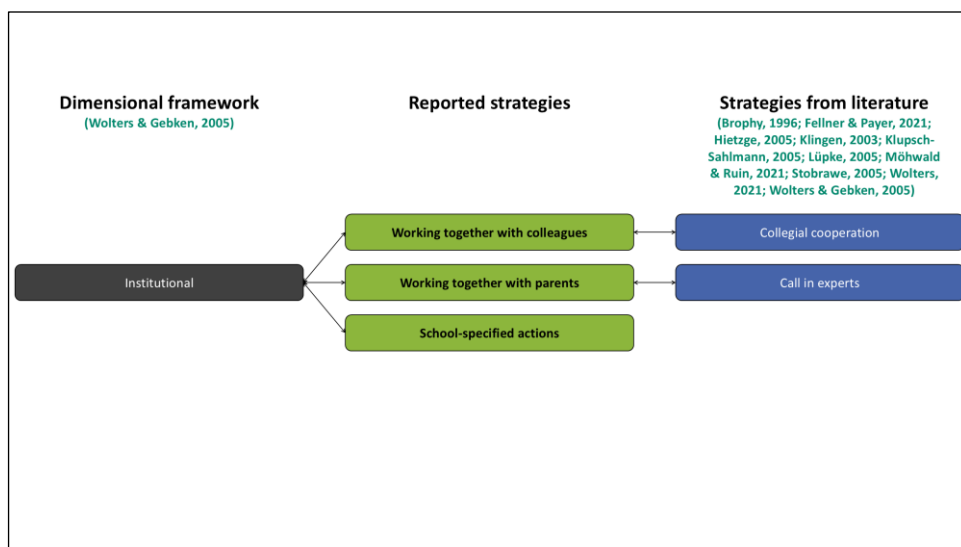


Figure 4.6: The Empirical Connection between Wolters and Gebken's (2005) Framework to Strategies found in Literature – Institutional Dimension

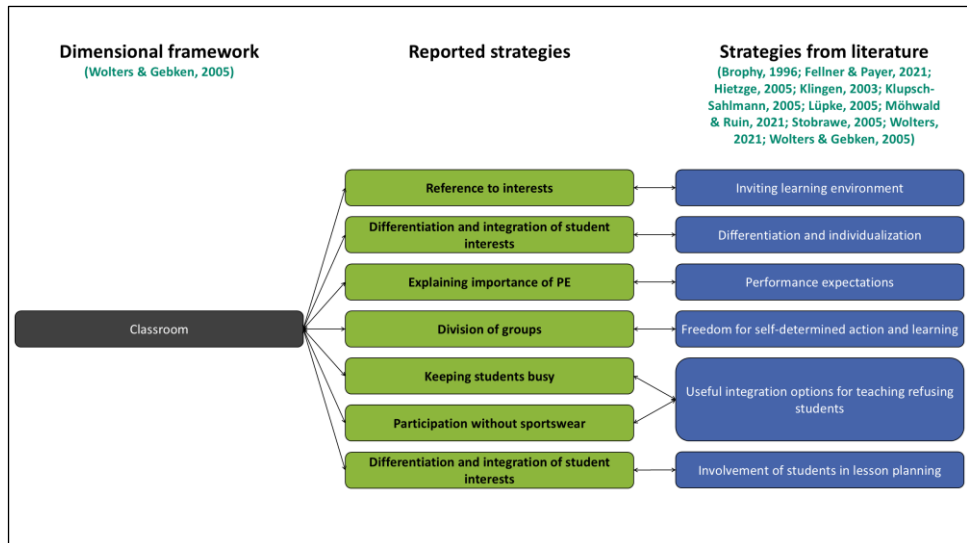


Figure 4.7: The Empirical Connection between Wolters and Gebken's (2005) Framework to Strategies found in Literature – Classroom Dimension

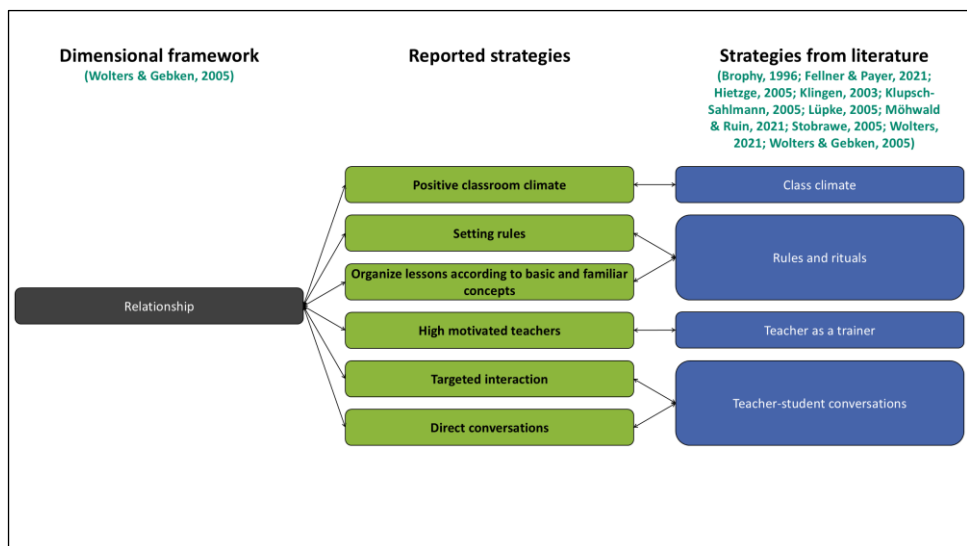


Figure 4.8: The Empirical Connection between Wolters and Gebken's (2005) Framework to Strategies found in Literature – Relationship Dimension

The existing three-dimensional framework by Wolters and Gebken (2005) effectively categorized the responses. Institutionally, collegial cooperation and expert consultation (Klupsch-Sahlmann, 2005; Wolters & Gebken, 2005) were reflected in *teachers working with colleagues and parents*. Conversely, teachers (T24, T25, T27) mentioned *school-specified actions*, which, while not connected to existing strategies, clearly belong to the institutional dimension, thus expanding the existing body of strategies. Seeing that school-specified actions are reported by the teachers but not supported by literature suggests that there are other, yet unknown, strategies for dealing with PER.

Within the classroom dimension, creating inviting learning environments (Fellner & Payer, 2021) was linked to *teachers addressing student interests*. Differentiation and individualization (Hietzge, 2005; Stobrawe, 2005; Wolters & Gebken, 2005) were evident in teachers' *differentiated approaches* and *integration of student interests*. *Explaining the importance of PE*, as one teacher did by emphasizing movement experiences over grades (T27), relates to addressing performance expectations (Hietzge, 2005). Self-regulated *group division* (T30) reflects, in part, the freedom for self-determined action and learning (Fellner & Payer, 2021). *Keeping students engaged*, even *without sports-wear*, aligns with strategies for integrating refusing students (Fellner & Payer, 2021; Klingen, 2003; Lüpke, 2005; Wolters, 2021). While *differentiation and interest integration* were previously categorized, they also relate to involving students in lesson planning (Fellner & Payer, 2021; Klupsch-Sahlmann, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters & Gebken, 2005). Interestingly, the classroom dimension includes more strategies than the previously discussed institutional dimension. It can be assumed that teachers have been able to acquire more strategies over time within their didactic and methodological possibilities for dealing with PER due to their experience. Further, it is possible that teachers expand their repertoire faster than new possibilities are communicated or provided by the school.

In the relationship dimension, the importance of a *positive classroom climate*, as highlighted by teachers, is consistent with Fellner and Payer (2021). The teachers' emphasis on *motivation* (T24) connects to teachers in function of a trainer (Klingen, 2003; Wolters & Gebken, 2005). Rules and rituals (Fellner & Payer, 2021; Möhwald & Ruin, 2021; Wolters & Gebken, 2005) were reflected in teachers *setting rules* and organizing lessons around *familiar concepts*. The teacher-student conversation (Hietzge, 2005; Klingen, 2003; Wolters & Gebken, 2005) was evident in teachers' *targeted interaction* and *direct conversations* with students. Teachers reported more strategies in the relationship dimension than in the institutional dimension, but fewer than in the classroom dimension. This difference likely derives from teachers having greater autonomy to shape their classroom environment and choose communication strategies compared to actions

dictated by school policy. Wolters and Gebken’s (2005) framework positions the three dimensions as equal. However, regarding influence, these dimensions likely differ for teachers. Teachers presumably have the most direct influence on the classroom dimension, as they are responsible for creating and managing the didactic setting. Their influence on student interaction is shared with the students themselves. Furthermore, teacher influence appears to diminish when strategies are predetermined by school authorities. This study did not explicitly address this concept, suggesting a potential avenue for future research.

Interestingly, a variety of methods (Fellner & Payer, 2021) and appropriate responses to disruptions (Brophy, 1996; Klingen, 2003; Wolters & Gebken, 2005) were not explicitly mentioned. This may be due to their implicit nature. Variety of methods is inherent in differentiated approaches, and responding to disruptions is central to the study’s focus. Therefore, the relevance of these strategies is not in question.

This overview addresses RQ_{D1}, demonstrating the diverse strategies teachers use, aligning with existing categorizations in the literature. This study represents the first attempt in international research to connect Wolters and Gebken’s (2005) framework with a collection of strategies from the literature and support this connection with empirical findings. The resulting preliminary model can serve as a foundation for future investigations, though it is not exhaustive. Critically, it enables linking the complex set of strategies for dealing with PER to other areas, such as digital media use.

4.4.5.2 Dealing with PER Through Digital Media

As discussed, teachers use diverse strategies to manage PER. Digital media can support or enable some of these strategies. Examining this connection, it can be seen that arguments were primarily made within the classroom dimension. No reported digital media directly connected to *institutional* or *relational* strategies. Therefore, only the *classroom* dimension and its strategies will be focus of further discussion.

Teachers use the term *digital media* broadly and adapt its application to specific situations, consistent with previous research showing that teachers expand and optimize existing strategies and views through digitalization (Meinokat & Wagner, 2024). They appear less strict in their selection and application of digital media as long as it achieves the desired outcome: reduced PER. As the term digital media was not defined prior to interviews, teachers mentioned diverse types: *hardware* (tablets, smartphones, digital boards), *software* (digital station cards, videos, video delay programs, apps, online surveys, internet use), and *methods* like flipped classrooms. Some of these align with existing research: Mödinger et al. (2021) research video use on tablets; Krick and Nowak

(2022) focus on smartphone and tablet apps; and Raab (2021) relates to methodological choices like flipped classrooms or internet research. Having a closer look at the different categories of digital media mentioned by the teachers, it can be seen that the responses are consistent with current literature.

Table 4.19: Digital Media used in Various Strategies for Dealing with PER

	Tablet / Smartphone	Digital Boards	Digital Station Cards	Video (Delay Program)	Apps	Online Survey	Internet Research	Flipped Classroom
Inviting learning environment (Fellner & Payer, 2021)	X		X	X				
Differentiation and individualization (Hietzge, 2005; Stobrawe, 2005; Wolters & Gebken, 2005)				X				
Performance expectations (Hietzge, 2005)				X	X			X
Freedom for self-determined action and learning (Fellner & Payer, 2021)	X		X	X	X		X	X
Useful integration options for teaching refusing students (Fellner & Payer, 2021; Klingen, 2003; Lüpke, 2005; Wolters, 2021)		X		X	X		X	X
Involvement of students in lesson planning (Fellner & Payer, 2021; Klupsch-Sahlmann, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters & Gebken, 2005)						X	X	

Hardware like tablets, smartphones, and digital boards can support creating inviting learning environments and provide opportunities for self-directed learning. They can also facilitate integrating typically passive students, encouraging active participation and potentially reducing PER (Wolters & Gebken, 2005).

Software like digital station cards allows for self-determined action and learning (Fellner & Payer, 2021) while creating an inviting learning environment. Combined with apps for tracking, measuring, or organizing (Krick & Nowak, 2022), they support strategies like addressing performance expectations or integrating students. Videos, as mentioned by Mödinger et al. (2021), were seen as motivating. Recording and analyzing videos connects to multiple strategies: creating an inviting environment, differentiation, individualization, and integration. It also provides transparent performance feedback. Online surveys (T21, T22) can actively involve students in lesson planning, while internet research allows for planning involvement, participation even without sportswear, and self-directed learning. Teachers see diverse possibilities in using software to address PER.

Flipped classrooms (T26) occupy a unique position. As a methodological teaching approach, it raises the question of whether it constitutes a strategy itself. As a digital medium in this study, it allows students to prepare for lessons and performances beforehand, self-direct their learning, and participate in PE without directly performing. Therefore, flipped classrooms can also be used to address PER. Table 4.19 (p. 102) summarizes the extracted connections between digital media and classroom strategies.

Restructuring Table 4.19 (p. 102) to focus on *method*, *hardware*, and *software* reveals that all strategies in the classroom dimension were associated with software use. Some strategies also involved hardware and/or the flipped classroom method. Thus, the interviewed teachers demonstrated the highest strategic diversity using software to address PER. While combinations with other categories are evident (Figure 4.9, p. 104), it is notable that no classroom strategy appears to be implemented exclusively through hardware or flipped classrooms. Teachers can consistently address how digital media are used to deal with PER through software and expand from there. While the preliminary model for strategies (Figure 4.6, p. 98; Figure 4.7, p. 99; Figure 4.8, p. 99) showed teachers perceiving their highest strategic influence in the classroom, this specialized analysis of digital media influence suggests a preference for software solutions. Similar to the distribution of general strategies, this may be related to the ease of access. Depending on existing knowledge and comfort with digitalization, accessing and experimenting with new software may be simpler for teachers than, for instance, acquiring new hardware. As exploratory research, this study not only lays the groundwork for

model generation regarding general PER strategies, but also sets the stage for future research examining the concept and selection of digital media in greater detail.

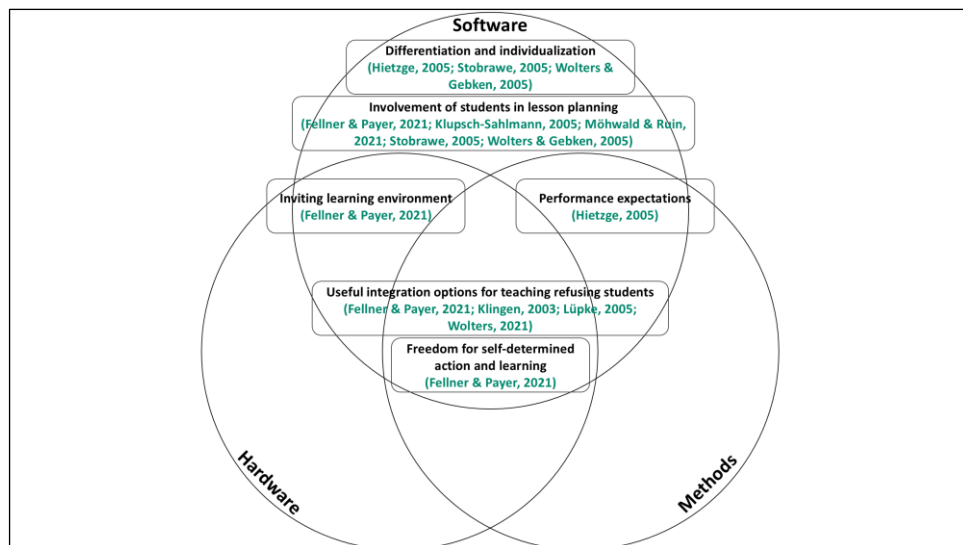


Figure 4.9: Classroom Dimension Strategies for Dealing with PER Systemized by Digital Media Category

Within a broader educational context, the applicability of this concept extends beyond PE. As previously demonstrated, teachers' integration of digital media is primarily guided by pedagogical intent rather than subject-specific constraints. Research across diverse disciplines underscores the perceived criticality of effective digital media utilization (Meinokat & Wagner, 2024). Examining the deployment of digital media to address PER corroborates this consensus among PE instructors. Despite the unique characteristics often attributed to PE, this study reveals a consistent influence of digitalization across subjects, necessitating a comprehensive discussion of the general impact of digital media within education.

Consistent with the observed comparability to general education and digital media, interviewed teachers acknowledged potential drawbacks. Yet, the inherent tension between physical activity and screen time was not perceived as problematic, as teachers emphasized the intentional use of digital media to augment movement opportunities. While some teachers noted a potential increase in refusal behavior when digital media options were available (e.g., video review filming), this was not attributed to digitalization itself. Rather, refusal was linked to potential external distractions overshadowing

lesson engagement. Notably, infrastructural limitations, such as connectivity or device issues, were not cited. The study's design, focusing specifically on PER, likely influenced this emphasis.

4.4.5.3 Limitations and Future Directions

The answers of 11 participants allow for generating insights into PER, particularly in conjunction with digital media. Due to the low number of participants, this exploratory approach cannot provide definitive answers, but interviewing teachers confirmed and expanded current research, linking teacher responses to digital settings. However, the often-criticized focus on teachers in classroom management and disruption research (Meinokat & Wagner, 2022, 2024) calls for incorporating student and stakeholder perspectives in future research. Especially the perspective of students will be beneficial to investigate in this regard since PER addresses student behavior and should therefore include the perspective of the students in question. Furthermore, it is important to consider follow-up quantitative evaluation studies and modifications of the derived model approach. The discussion was able to develop model approximations that require further refinement. Not only is a larger data basis required for this, but a clearer definition of the term digital media is also necessary for a more detailed consideration of the topic and the development of larger models.

As seen in the framework, international research on the topic of PER is missing. This study, conducted in Germany with only German teachers, provides an opportunity to broaden the field into international research, urging for international enhancement. It is important to acknowledge differences in educational systems worldwide. Combining decades-old research on classroom management and disruptions with new digital possibilities means that differences in educational systems, social structures, stakeholder priorities, and other factors significantly impact this topic. Therefore, this study leaves questions open for future international research. Even a closer look at the German system reveals gaps, such as different school types, student age groups, or participant social backgrounds. This already becomes clear within this study by the fact that the question of why teachers used certain digital media for certain strategies cannot be answered. Future research can start here.

As the discussion shows, existing research can be combined. However, it has also been shown that the existing framework of Wolters and Gebken (2005) can be questioned against the background of a possible gradation of the dimensions with regard to their influenceability by the teacher. While the focus and data basis of this study cannot answer this question, it provides a further starting point for subsequent research. This

can be followed by further research that takes up the model approximations from the discussion as a basis for developing tangible aids for teachers. The aforementioned focus on a more precise definition of the term digital media could be one of the other conceivable ways of putting this into concrete terms. In addition to the teachers' perspectives, the learners' point of views may also be interesting in this context.

Finally, this study could not determine whether digital media are more beneficial or a greater source of disruption. As existing research suggests, choosing the right approach and focusing on creating a beneficial learning environment for all participants is crucial. Using digital media simply because it is available should be carefully considered (Meinokat & Wagner, 2024).

4.4.6 Conclusion

Physical education refusal (PER) is a subject-specific type of classroom disruption (Möhwald & Ruin, 2021; Wolters & Gebken, 2005). Effective classroom management, including structured approaches to disruptions, is crucial for enhancing learning outcomes (Marquez et al., 2016) and supporting teacher well-being (Kokkinos, 2007; Rajendran et al., 2020). Teacher responses to PER typically fall within institutional, classroom, and relationship dimensions (Wolters & Gebken, 2005). Various authors (Brophy, 1996; Fellner & Payer, 2021; Hietzge, 2005; Klingen, 2003; Klupsch-Sahlmann, 2005; Lüpke, 2005; Möhwald & Ruin, 2021; Stobrawe, 2005; Wolters, 2021; Wolters & Gebken, 2005) have reported potential strategies for addressing PER. This study provides the first empirical basis in international research for linking these strategies to the dimensional framework. The resulting preliminary model can inform future research. Furthermore, existing research has not fully explored the increasing significance of digitalization. This study offers novel insights into teachers' understanding of digital media and how they implement PER strategies using these tools. In general, teachers tend to favor classroom-based strategies within their methodological-didactic approach, often implemented through software solutions. These findings highlight several avenues for future research, including cross-cultural comparisons of educational systems, further model refinement, and the development of practical guidance for teachers.

4.5 What Bothers Students? Students' Perceptions of Classroom Disruptions in Digitally Supported Mathematics Lessons⁹

Pierre Meinokat, Katharina Funk and Ingo Wagner

4.5.1 Introduction

Dealing with classroom disruptions is an essential part of teachers' daily classroom management (Durak & Saritepeci, 2017). On average, every 42 seconds, a classroom disruption occurs (Wettstein & Scherzinger, 2018), depending on the subject. Research on classroom disruptions in physical education mentions 1.2 disruptions per minute (Maddeh et al., 2015), while studies on the subject of mathematics are aligned with general research on classroom disruptions, with different frequencies of occurrences and varying perceptions being reported (Jordan et al., 2017). Despite the existence of different perspectives on the issue, research shows that disruptions in general threaten students' academic success (Marquez et al., 2016) and teachers' physical health (Rajendran et al., 2020; Scherzinger & Wettstein, 2019). As one possible way to deal with these challenges, political leaders and other stakeholders have begun to focus on the digitalization¹⁰ of education (European Union, 2020; KMK, 2021, 2024). Researchers are therefore facing the task of navigating through the different perceptions and understandings of classroom disruptions (Scherzinger et al., 2016; Scherzinger & Wettstein, 2019) in rather new and rapidly developing digital settings (Daniel, 2020). At present, the point of view of students remains underrepresented (Meinokat & Wagner, 2024).

4.5.2 Theoretical Framework

For a sufficient understanding of the present topic, it is necessary to obtain a clear understanding of the concept of classroom disruptions and to provide a general overview of existing research in the area of mathematics.

⁹ Meinokat, P., Funk, K., & Wagner, I. (under review). What Bothers Students? Students' Perceptions on Classroom Disruptions in Digitally Supported Mathematics Lessons. *Learning Environments Research*.

¹⁰ Digitalization refers to the process of integrating digital technology into school settings. This is not to be confused with digitization, the process of converting analog data into a digital format (Gradillas & Thomas, 2023).

4.5.2.1 Classroom Disruptions – a Part of Classroom Management

Research on the management of classrooms and groups extends back to the work of Kounin (1970) and is today known as the study of *classroom management*. Over the past few decades, many understandings of this term have emerged. Today, the term classroom management generally refers to the different aspects that a teacher needs to pay attention to in order to keep the classroom and the lesson running smoothly (Mulvahill, 2018). In this vein, Durak and Saritepeci (2017, p. 443) have identified five such aspects of management:

- Management of the physical structure of the classroom,
- Teaching management,
- Time management,
- Management of intra-classroom relationships, and
- Behavior management.

The heterogeneous body of research on classroom management (Meinokat & Wagner, 2022) is also accompanied by diverse understandings of the term *classroom disruption*. Definitions like “anything that interrupts or could interrupt the process or the relationship structure of teaching situations”¹¹ (Biller, 1979, p. 28), “behavior a reasonable person would view as being likely to substantially or repeatedly interfere with conduct of a class” (Stockton University, 2001, p. 1), and “general issues hindering students’ and teachers’ classroom work” (Belt & Belt, 2017, p. 55) demonstrate that the general understanding of classroom disruptions is that they entail those actions that make the teaching-learning process temporarily impossible.

Research on classroom disruptions has sought not only to define the term, but also to structure the way in which such disruptions are conceptualized or systemized from the perspective of a teacher or an external observer. Two different types of categorization can be found (Meinokat & Wagner, 2024): categorizations that weigh disruptions according to their severity (Cogswell et al., 2020; Rattay et al., 2018; Scherzinger & Wettstein, 2019) and those that sort disruptions into non-ordered categories (Biller, 1979; Dobmeier & Moran, 2008; Ho, 2004; Hoffman & Lee, 2014; Lohmann, 2011; Nolting, 2023; Winkel, 2011). None of these categorizations are focused on digitally supported classrooms. Thus far, only one categorization has been developed to account for classroom disruptions in a digital setting: the Student Online Misbehavior Scale (SOMs) by Li and Titsworth (2015), which was later enhanced by Meinokat and Wagner

¹¹ Translated by the author.

(2024). In this model, there are seven categories of disruptions: *seeking unallowed assistance* (cheating), *internet slacking* (distracting yourself from given tasks), *aggressiveness* (physically or psychologically aggressive behavior of a student), *lack of communication* (missing verbal exchanges between students and teachers, as well as among students), *illicit social behavior* (behavior that is not in accordance with the teachers' expectations), *technical errors* (e.g., crashing PCs), and *operating errors* (intentional or unintentional mistakes made by a user).

4.5.2.2 Research on Disruptions in Mathematics

In the section above, the current state of research on the topic of classroom disruptions has been presented. However, in considering the notion of digitalization, as well as the specific domain of mathematics instruction, the following areas require further investigation: *classroom disruptions in mathematics lessons*, *digitalization in mathematics*, and *classroom disruptions in digitally supported mathematics lessons*.

Classroom Disruptions in Mathematics Lessons

To date, research on the topic of classroom disruptions in mathematics has either been conducted as part of general research on classroom management or has focused on the impact of disruptions on certain aspects of classroom success, such as student performance (Erzinger et al., 2021; Heyer & Standop, 2020; Klusmann et al., 2006; Koyuncu, 2021; Ma & Willms, 2004; Marder et al., 2023; Rakoczy, 2006) (see overview in Table 8.3 in Appendix).

As Koyuncu (2021), Ma and Willms (2004), and Marder et al. (2023) have shown, there is a correlation between students' performance in mathematics and their disruptive behavior. Specifically, high performers in mathematics show less disruptive behavior than lower performers (Koyuncu, 2021). Furthermore, students have been shown to be concerned about disruptions in their classrooms (Ma & Willms, 2004). The number of disruptions perceived by a student correlates negatively with their performance in mathematics (Marder et al., 2023), even though there are different perceptions of what a classroom disruption amounts to (Heyer & Standop, 2020). However, not only are high performers affected. As Erzinger et al. (2021) have shown, students in less disrupted lessons are more likely to successfully obtain basic mathematics skills. Less disrupted classes also support motivational aspects of the classroom (Rakoczy, 2006). Interestingly, according to Klusmann et al. (2006), disruptions are not related to the teacher's teaching personality type. However, Marder et al. (2023) have suggested that teachers who have strong monitoring activities, as a form of lowering disruptive behavior, actually have a negative impact on students' mathematics performance.

Digitalization in General Education

Through its Digital Education Action Plan, the European Union (2020) has recommended the implementation of digital media in daily school education. In the case of Germany, the KMK, the association of ministers responsible for education in the individual federal states, has consistently pushed for a focus on digital settings (KMK, 2017a, 2021, 2024). These demands have become an increasing priority, not least due to the pandemic and the associated accelerated digitalization of teaching (Cho et al., 2020; Daniel, 2020), but also through the increased presence of artificial intelligence (AI) in everyday life. First, though, it is necessary to have a clear understanding of the term digital setting. According to Meinokat and Wagner (2022), the term digital setting refers to three kinds of settings: online settings, digitally supported face-to-face settings, and blended settings. In the case of school education, digital settings would include online classes (conducted via Zoom, BigBlueButton, etc.), as well as classes inside the school that are supported by digital tools (tablets, projectors, etc.) and hybrid settings (e.g. learning management systems). Some school subjects are more closely linked to digital media than other subjects due to their content. An example is the comparison of physical education (Maddeh et al., 2015) and learning factories in vocational education (Meinokat & Wagner, 2025).

Digitalization in Mathematics

Several studies have investigated digitally supported mathematics classes. Aqda et al. (2011), as well as Suson and Ermac (2020), have shown that digital media can be used in mathematics lessons to foster and improve students' mathematical understanding and the effectiveness of the teaching. Furthermore, the use of digital media may strengthen students' visual understanding of mathematical relationships (Suson & Ermac, 2020). More generally, a digitally supported mathematics class can profit from easier learning processes (Aqda et al., 2011; Stein et al., 2020; Suson & Ermac, 2020). For instance, students' motivation can be increased through the proper use of digital media (Hwang et al., 2020; Stein et al., 2020), while Es-Sajjade and Paas (2020) did not find increased motivation in their study through digital media alone. However, they were able to increase student performance using a gamification-driven approach. These findings are supported by the work of Hwang et al. (2020), who have demonstrated that the use of an interactive app can increase mathematical performance. In light of such evidence,

the German Center for Mathematics Teacher Education¹² has summarized the potential of digital media use in mathematics lessons, as shown in Table 4.20 (p. 111).

Table 4.20: Didactic Potential of Digital Media for Mathematics Teaching according to the DZLM (2019)¹³

Digital Media...
... make it easier to discover mathematics.
... make complexity manageable.
... help to develop basic ideas and promote understanding.
... help with structuring.
... provide informative and adaptive feedback.
... facilitate the fit between action and mental operation.
... promote operational computing strategies with multi-touch technologies.

Classroom Disruptions in Digitally Supported Mathematics Classes

As outlined above, some research has been conducted on classroom disruptions in mathematics classes and the potential application of digital media in such contexts (Baumert et al., 1997, 2008; Helmke, 2008; Helmke et al., 2000; Kunter & Baumert, 2007; Makarova et al., 2014; Marder et al., 2023; Wettstein, Ramseier, et al., 2016; Wettstein, Scherzinger, et al., 2016). However, a focus on the link between these two areas is missing in the literature. This article attempts to fill this research gap in a structured but explorative way. It should also be noted that research on how students perceive their mathematics lessons when they are digitally supported is scarce, as are studies on what students think about classroom disruptions in this setting. To shed light on these areas of concern, the following two main research questions were investigated:

- RQ_{E1}: How are digitally supported mathematics classes perceived by students?
- RQ_{E2}: What makes students feel disrupted in digitally supported mathematics classes?

¹² This title is translated from the German name, Deutsches Zentrum für Lehrkräftebildung Mathematik (DZLM)

¹³ Translated by the author.

4.5.3 Methods

To answer this, a quantitative questionnaire study was conducted between June and December 2023.

4.5.3.1 Participants

The non-probabilistic sample consisted of 254 students from various secondary schools¹⁴ in the federal state of Baden-Württemberg in Germany. Schools and principals were contacted based on prior as well as personal contact with the authors. Eligible mathematics teachers were informed about the intention of the study by means of a standardized letter. The classes that were willing to answer the questionnaire were provided with all the information relevant to data protection. The consent of the respective legal guardians was obtained, and the questionnaire was distributed in a paper-based form on site in the schools.

Of the participants, 124 identified as female (48.8%), 117 as male (46.1%), nine as other (3.5%), and four (1.6%) did not answer the question. The students were, on average, 14.09 years of age ($n = 248$, $SD = 1.492$), having a median age of 14; the youngest participant was 11 ($n = 1$), and the oldest was 17 ($n = 6$). A total of 51 (20.1%) students were in Grade 7, 74 (29.1%) in Grade 8, 97 (38.2%) in Grade 10, and 26 (10.2%) in Grade 11, with six (2.4%) not responding.

4.5.3.2 Questionnaire Development

Since there is no existing questionnaire for classroom disruptions in digitally supported mathematics classes, this study developed one based on existing quantitative research. The developed questionnaire can be seen in Table 8.4 (Appendix). No items were adopted from literature without changes. The items from the questionnaire were partially based on the literature summarized in Table 8.4 (Appendix). The majority of the items were ordinal scaled using a five-item Likert scale. The print version of the questionnaire was developed using Microsoft Word.

4.5.3.3 Approach and Analysis

The authors entered the results of the questionnaires themselves into SPSS Version 30. For better accountability and uniformity, all items were recoded in one direction of impact, so that a lower score on the Likert scale produced a desirable result in terms of

¹⁴ Students were from the Gymnasium, the highest level of school in secondary education in Germany.

low disruption and enjoyment of teaching. Since the original questionnaire was carried out in German, the items and answers were translated into English by the authors with the assistance of the online translator DeepL. Using SPSS a descriptive analysis as well as a multiple linear regression was conducted. The requirements for this are outlined below.

A graphical analysis showed the progression of items to be around $y = 0$; therefore, no linear relation between the variables was found. The studentized deleted residuals (SDR) were between -3 and 3 ($n = 228$), and Cook's distance was < 1 . Therefore, no outliers were found. Pearson's correlation was $< .7$ for all scale combinations. Collinearity statistics for the coefficients showed tolerance levels $> .1$ and variance influence factors (VIF) < 10 for each variable. Therefore, no indication of multicollinearity was evident. Histogram and P-P plots showed a normal distribution of the residuals. To rule out autocorrelations, the residuals must be independent of each other. Since the data collected in this study were not hierarchically related to each other, and there was no time series study, it could be assumed that the residuals were independent. The results of the Breusch-Pagan test indicated that homoscedasticity was present ($\text{Chi}^2 = 2.526$, $p = .112$). Therefore, a standard error distortion could be ruled out.

4.5.4 Results

When examining bivariate correlations between the items, some strongly significant ($p < .001$) correlations were recognizable. For example, the students' feelings of being disrupted due to the teacher explaining things too quickly correlated with the students not knowing what they had to do ($r = .609$, $p < .001$, $n = 248$). It was also found that digital media that were not properly loaded delayed the progress of lessons ($r = .636$, $p < .001$, $n = 249$), as did internet problems ($r = .638$, $p < .001$, $n = 246$). Based on a general overview of these correlations as well as semantically identical orientations of items in the questionnaire and the aforementioned state of existing research, the following scales were derived:

- Student's feeling of being disrupted (SC_DIS)
- Perceived enjoyment of mathematics classes (SC_JOY)
- Behavior of classmates (SC_CLA)
- Behavior of the teacher (SC_TEA)
- Technical issues and preparation (SC_TEC)
- Student's understanding of given assignments (SC_UND)
- Experienced level of quietness in the classroom (SC_QUI)

- Self-reported level of attentiveness in lessons (SC_ATT)
- Self-reported intentional misuse of digital media (SC_INT)

Details of the scales can be found in Table 4.21 (p. 114).

Table 4.21: Details of the Scales formed

Scale (SC_)	Number of Items	Items	Cronbach's α	Example Item:
DIS	12	2, 5, 11, 16, 18, 21, 24, 33, 35, 38, 40, 42	.798	Item 2: "I feel disrupted in my math lessons."
JOY	2	54, 55	.837	Item 54: "I enjoy the subject of mathematics."
CLA	5	3, 6 – 8, 46	.590	Item 6: "During partner work with digital media (e.g. tablet, smartphone, or computer [PC]/laptop) in mathematics lessons, my partner distracts me."
TEA	8	4, 12, 13, 17, 19, 23, 25, 29	.549	Item 12: Before using digital media (e.g., tablets, programs such as GeoGebra, learning videos, and learning apps like Mathebattle) in mathematics lessons, our math teacher explains the most important functions in detail.
TEC	5	10, 36, 37, 39, 41	.721	Item 36: "Digital media (e.g., tablets) are not charged in mathematics lessons."
UND	6	14, 15, 20, 22, 26, 45	.587	Item 14: "The introduction to the function/use of digital media (e.g., showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) by the mathematics teacher is difficult to understand."
QUI	2	27, 30	.681	Item 27: "When providing additional explanations in particularly difficult situations via a digital medium (e.g. learning video or visualization), it is quiet in the classroom."
ATT	4	28, 31, 44, 51	.544	Item 44: "In mathematics lessons, I work attentively when using digital media (e.g., tablets, smartphones, or computers [PC]/laptops)."
INT	5	47-50, 52	.802	Item 49: "When using digital media (e.g., tablets, smartphones, or computers [PC]/laptops) in mathematics lessons, I am looking for unauthorized help/solutions."

According to George and Mallery (2024), the scales SC_JOY and SC_INT show a good internal consistency ($\alpha = .837$ and $.802$). Acceptable consistencies were reached for

SC_DIS ($\alpha = .798$) and SC_TEC ($\alpha = .721$). The scales SC_CLA ($\alpha = .590$), SC_TEA ($\alpha = .549$), SC_UND ($\alpha = .587$), SC_QUI ($\alpha = .681$), and SC_ATT ($\alpha = .544$) did not reach these high consistencies. Based on these scales and other items from the questionnaire, the RQs could be answered, as explained below.

4.5.4.1 How Students Perceive Digitally Supported Mathematics Classes (RQ_{E1})

Overall, the students confirmed that digital media were used in their mathematics lessons, ranging from sometimes up to often (5-level Likert scale ranging from always [1] to never [5], mean = 2.72, SD = 1.116, $n = 250$). Based on previous research, the students were asked specifically about their usage of computers/laptops, visualizers, smartphones, and tablets. It was found that tablets were used very often (mean = 1.90, SD = 1.138, $n = 248$), while the other digital media were used less often ($n = 248$, mean_{Computer/laptop} = 3.87, SD_{Computer/laptop} = 1.266, mean_{Visualizer} = 4.06, SD_{Visualizer} = 1.427, mean_{Smartphone} = 4.26, SD_{Smartphone} = .839; Figure 4.10, p. 115).

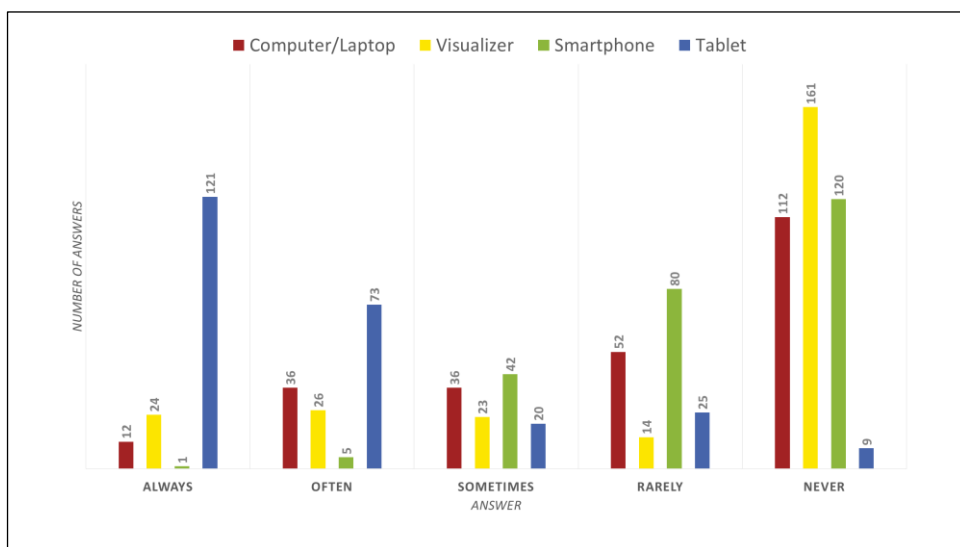


Figure 4.10: Use of Digital Media in Mathematics Lessons in Total Numbers

Furthermore, the students were asked to report other digital media used in their classes. Table 4.22 (p. 116) provides an overview of the media mentioned.

Table 4.22: Other Digital Media used in Mathematics Classes

Digital Media	How many Students mentioned it
Apple Pencil	3
Apple TV	4
Beamer	17
Digital blackboard/Smartboard	95
Learning movies	2
Overhead projector	4
Calculator	66
Virtual reality headset	3

In terms of the *feeling of being disrupted* (SC_DIS), students reported a mean of 2.036 (SD = .595, n = 254), which indicates a rather low level of disruption. Similar positive results were found for their *enjoyment of mathematics classes* (SC_JOY, mean = 2.392, SD = 1.244, n = 251), the *behavior of their classmates* (SC_CLA, mean = 2.211, SD = .638, n = 253), the *behavior of the teacher* (SC_TEA, mean = 2.373, SD = .553, n = 254), their *understanding of given assignments* (SC_UND, mean = 2.172, SD = .585, n = 253), and the *attentiveness of the students* (SC_ATT, mean = 2.188, SD = .623, n = 253). Slightly less positive results were reported for the number of *technical issues* (SC_TEC, mean = 2.511, SD = .784, n = 253) and the level of *quietness in the classroom* (SC_QUI, mean = 2.961, SD = .861, n = 233). In the case of self-reported *misuse of digital media*, the lowest scores and therefore the most desirable outcomes in terms of a smooth teaching experience were found (SC_INT, mean = 1.689, SD = .723, n = 248). This is summarized in Table 4.23 (p. 116).

Table 4.23: Statistics for Created Scales

	n	Mean	SD
SC_DIS	254	2.036	0.595
SC_JOY	251	2.392	1.244
SC_CLA	253	2.211	0.638
SC_TEA	254	2.373	0.553
SC_TEC	253	2.511	0.784
SC_UND	253	2.172	0.585
SC_QUI	233	2.961	0.861
SC_ATT	253	2.188	0.623
SC_INT	248	1.689	0.723

4.5.4.2 What Disrupts Students?

To explore what disrupts students in their digitally supported mathematics lessons, a multiple linear regression analysis was conducted. SC_DIS was the dependent variable, while all other scales were predictor variables (see overview in Table 4.21, p. 114).

Results of the Multiple Linear Regression Analysis

The regression analysis for RQ_{E2} showed significant results ($p < .001$). With an adjusted $R^2 = .550$, a variance explanation of 55% was indicated (Table 4.24, p. 117).

Table 4.24: Model Summary for the Multiple Linear Regression Analysis of the Feeling of being Disrupted

Dependent Variable	r	r ²	adjusted r ²	SE	p ¹⁵
SC_DIS	.752	.565	.550	.39571	< .001

Scales SC_CLA ($B = .264$, $p < .001$), SC_TEA ($B = .152$, $p = .014$), SC_TEC ($B = .365$, $p < .001$), and SC_UND ($B = .211$, $p < .001$) were all significant. As seen in Table 4.25 (p. 117), SC_CLA, SC_TEA, SC_TEC, and SC_UND showed a positive influence on the students' feeling of being disrupted.

Table 4.25: Coefficients for Enjoyment of Mathematics Classes

Predictor	n	Mean	SD	SE	B	p
SC_JOY	228	2.0689	.58961	.023	-.029	.220
SC_CLA	228	2.2191	0.62903	.050	.264	< .001
SC_TEA	228	2.334	0.53144	.061	.152	.014
SC_TEC	228	2.5398	0.78508	.039	.365	<.001
SC_UND	228	2.1513	0.58588	.059	.211	<.001
SC_QUI	226	2.9605	0.86065	.038	-.056	.141
SC_ATT	226	2.1689	0.59827	.057	-.018	.756
SC_INT	226	1.7143	0.73539	.041	-.006	.874

After repeating the analysis with only the four significant predictor variables, the results showed only small changes. The variance explanation R^2 decreased to .534 (53.4%), the

¹⁵ ANOVA

teacher's behavior was no longer significant ($B = .109$, $p = .051$), the regression coefficient B decreased for the behavior of classmates ($B = .229$, $p < .001$), and B increased for technical issues ($B = .395$, $p < .001$) and the students' understanding ($B = .161$, $p = .002$).

4.5.5 Discussion

The following section discusses the use of digital media in mathematics lessons (RQ_{E1}), as well as how the findings regarding the students' perspectives on classroom disruptions in mathematics (RQ_{E2}) contribute to existing research.

4.5.5.1 Use of Digital Media in Classes

The results indicated a generally moderate use of digital media, with a mean of 2.72, which supports reports on the overall increased use of digital media in Germany (Lorenz & Eickelmann, 2022). What is striking, though, is the strong imbalance in the distribution of the selected media. The students reported that tablets were the most used digital media. This is a result of the fostered usage of tablets in schools as an answer to home-schooling during the pandemic (Wohlfart & Wagner, 2022). The overall less frequent use of computers and visualizers might be explained by infrastructural conditions, like specific computer rooms in schools, whereas mathematics classes often take place in a standard classroom. The very low use of smartphones in classes would be connected to school rules, which often prohibit the use of smartphones inside the school building (Charles, 2012; Meinokat & Wagner, 2024). While these results seem rather confirming than surprising, the students' reported use of other digital media revealed some unexpected differences. The media mentioned, such as calculators or projectors, revealed that digital media are already so deeply embodied in daily school practice that they are not explicitly mentioned unless directly asked for. Others reported, like learning movies or overhead projectors, showed that there is still a need for a specification of what digital media is. Having in mind that digital media are already an integrational part of daily education (Meinokat & Wagner, 2022), this leaves the question of whether a distinction between media in general and digital media in classrooms is still relevant. Independent from such a distinction, the mean of 2.511 for SC_TEC, as the second lowest mean of all reported scales, shows the need for further improvement in the use of such digital media in terms of error-proneness and reliability.

4.5.5.2 Correlations and Unified Views

The significant bivariate item-correlations, with $r < .6$, showed plausible results, indicating well-formulated and effectively understood items. The correlation between the

students' understanding of assignments and the teachers' pace of instruction draws a relatable picture, as do the fact that a delay in progress is caused by digital media not being charged and internet/wi-fi issues.

In terms of bivariate scale correlations, multiple interesting and significant correlations were found. The behavior of classmates ($r = .459$) and technical issues ($r = .658$) were correlated with the students' feelings of being disrupted. In comparison with existing work on classroom disruptions, although mostly teacher-focused, the findings confirm the results reported elsewhere. For instance, Durak and Saritepeci (2017) have mentioned the management of behavior and teaching management as core parts of classroom management for teachers. Assuming that teachers strive for disruption-free lessons, and that the perceptions of teachers and students are at least similar, a feeling of disruption for these reasons seems plausible. Furthermore, the correlation between the level of attentiveness of the students and the level of quietness inside the classroom ($r = .499$), which can be interpreted as students being more attentive when it is quiet in the classroom, was also consistent with previous views on disruptions experienced by students and teachers (Meinokat & Wagner, 2024). At least to a certain degree, teachers and students seem to agree on an understanding of what is disrupting.

4.5.5.3 Students' Points of View as Enhancing Existing Research

While the bivariate correlations were able to provide initial indications of the influences on disruptions from the students' points of view, only the multiple linear regression analysis made interwoven observation and interpretation possible. The results need to be interpreted with caution due to the explorative character of this study. Nevertheless, the significant variance clarification of 55% with four significant predictor variables indicates that these four scales were relevant factors that influenced the students' feelings of being disrupted. Therefore, *classmate behavior* (SC_CLA) that disrupts students during their work with digital media can be said to consist of students talking loudly, eating, being late, having a different working pace, or switching between media rapidly. Likewise, disruptive *teacher behavior* (SC_TEA) consists of teachers being late, interrupting working phases, admonishing loudly or giving unclear explanations, and providing demonstrations that are not meeting students' expectations. Long preparation times, digital media not being charged, and internet/wi-fi/access problems were disruptive as *technical issues* (SC_TEC). Other disruptions included problems occurring through *misunderstanding* (SC_UND), as when instructions are difficult to understand or too rapidly provided, work assignments are not comprehensive, or additional explanations in difficult situations are missing. Figure 4.11 (p. 120) visualizes the impacting factors.

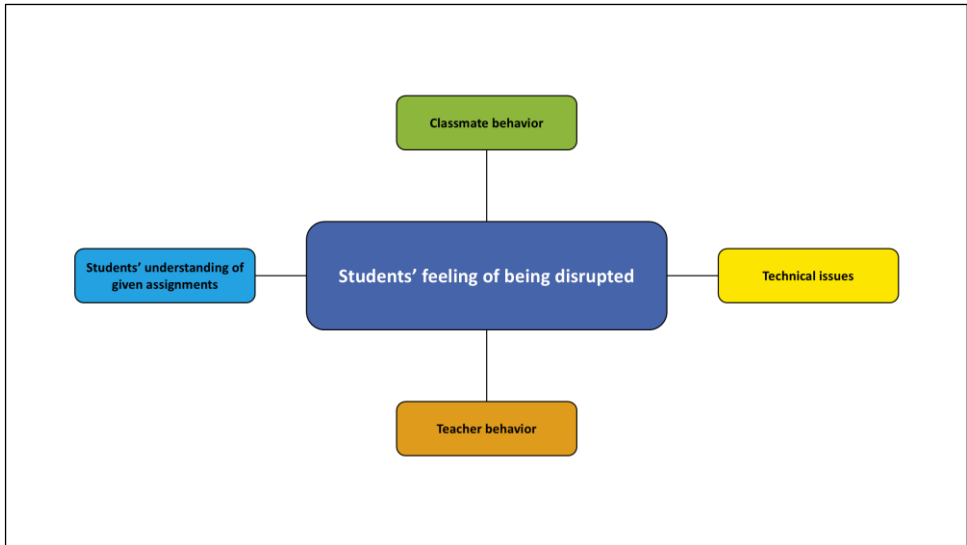


Figure 4.11: Categories for What Disrupts Students

As mentioned above, research on the categorizations of classroom disruptions in digital settings is limited. The SOMs by Li and Titsworth (2015), later enhanced by Meinokat and Wagner (2024), provided a first possible model for classifying classroom disruptions in such settings. However, the model is based on teacher-focused research, and studies focused solely on students have not yet been conducted. Therefore, a comparison to the above mentioned illustration promises interesting findings.

As shown in Figure 4.12 (p. 121), the two models partially overlap in the categories used. Specifically, *technical errors/issues* were mentioned in both cases. This shows that both teachers and students have experienced technical errors as a source of classroom disruptions in digitally supported lessons.

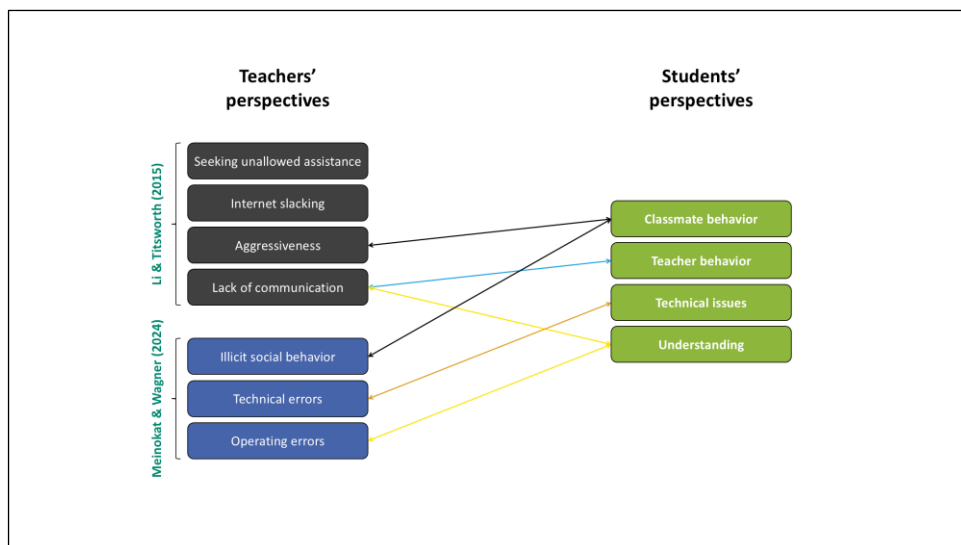


Figure 4.12: Connections Between Teachers' and Students' Perspectives

The reported category of *operating errors* (Meinokat & Wagner, 2024) could be related to student-reported *problems in understanding given assignments*. This leaves room for interpretation regarding whether the students did not understand the teachers' instructions themselves or if the instruction was unclear in the first place. Nevertheless, this indicates that mishaps in communication are a source of possible disruptions. This is why a teacher's reported *lack of such communication* can be connected to the students' understanding as well.

The category *illicit social behavior*, as reported by the teachers (Meinokat & Wagner, 2024), is a term generally used to refer to the behavior of students. Therefore, a connection to the *behavior of classmates* seems plausible. Twisting perspectives, it could also be possible for students to deem their teachers' behavior illicit. A weakness of existing models is the separation of aggressiveness and illicit social behavior, because aggressiveness can be considered a type of such behavior. A distinction between the two categories thus seems redundant.

No immediate connection between teachers' and students' points of view emerged with respect to the categories of *internet slacking* and *seeking unallowed assistance*. While slacking could be connected to the non-significant variable of student attentiveness, the issue of seeking unallowed assistance comes back to general rule setting within a class-

room, which is normally initiated by teachers and later acknowledged by the students (Charles, 2012).

In Figure 4.13 (p. 122), we can see categories for classroom disruptions as perceived by teachers and students. The results indicate no significant categories that are important only to the students. This, and the explorative character of this study, leaves room for further discussion. Specifically, the idea that teachers already know all the existing categories for possible disruptions from a students' point of view, and only adding categories for teachers, does not do justice to the complexity of disruptions in this setting. Further research is therefore needed.

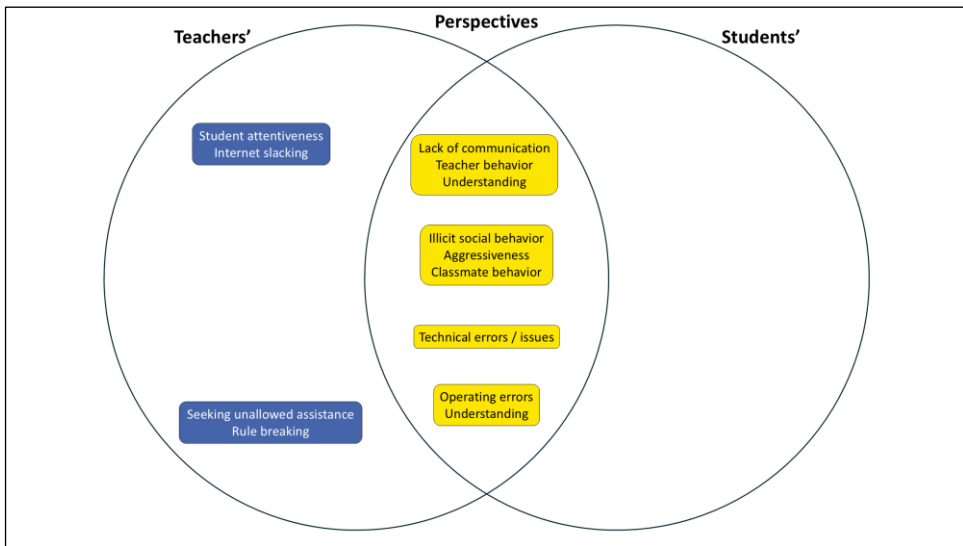


Figure 4.13: Categories for Classroom Disruptions from Different Perspectives

4.5.6 Future Research and Limitations

As mentioned in the discussion, further research is needed to get a clearer picture of students' understandings of classroom disruptions in digital settings. This goes along with a critical review of the existing model by Li and Titsworth (2015) as well as Meino-kat and Wagner (2024). Since this study was about mathematics classes conducted in a face-to-face setting and supported by digital media, other formats of digital teaching, such as online teaching or blended learning, could be examined in more detail. It would be interesting to see if disruptions change according to the specific setting, like they

partially do when switching from a non-digital to a digital setting. Furthermore, it would be interesting to see if students and teachers have a uniform understanding of such disruptions, regardless of the setting.

This study was an explorative attempt to gather students' points of view, therefore suffering from typical problems in developing research of this type. During the analysis, it was found that the questionnaire could be improved and enhanced in certain areas to develop a more robust version. Nevertheless, the developed model has established a good foundation for future research to build on and for teachers, as well as teacher educators. Future as well as practicing teachers may be able to use the gathered insights and use them in their daily preparation for classroom disruptions in school reality. To improve and support this transformation process, a follow-up study with a practical test of the findings would be helpful. Future studies could also address other limitations, such as the selected pool of participating schools, as well as the questioning of certain age groups and grades. On an analytical level, the created scales and overall model would benefit from further development.

4.5.7 Conclusion

Through an explorative attempt to gather students' points of view on the topic of classroom disruptions in digitally supported mathematics classes, this article answers the question of how students perceive the use of digital media in their mathematics lessons, and what factors influence these disruptions. The results show that the use of digital media in mathematics lessons may meet the students' expectations, but the specific media used vary. In particular, tablets are commonly used, and classrooms are often equipped with smartboards and projectors. However, other digital media are used less frequently. The results of the multiple linear regression analysis show that the behavior of classmates, the teacher's approach, technical issues, and a general understanding of given assignments all influence the level of disruption. In existing research on disruptions in comparable settings, teachers have reported similar categories. While it cannot be ruled out that other categories of disruptions may be significant from the student perspective, this study provides a basic framework that teachers can utilize to talk to their students about disruptions. This would allow them to determine the best course of action to take that would ensure that future lessons are less disrupted and that classes are more successful for everyone involved.

5 Discussion

The findings and results of the publications, in conjunction with the existing state of research, provide rich material for detailed discussion. In a structured manner, this discussion will address the three main research questions of this dissertation (RQ1 – RQ3) individually, before synthesizing the answers to generate a new categorization for classroom disruptions in digital settings. Following this, limitations and future directions of the dissertation as a whole will be discussed.

5.1 Current State of Research on Classroom Disruptions in Digital Settings

The elucidation of RQ1 requires a comprehensive overview of the core conceptual domains articulated in the dissertation's title: *classroom*, *disruptions*, and *digital settings*. Given the conceptual ambiguities identified in the findings, each of these domains will be addressed in turn. As demonstrated by the systematic literature review, research within these domains, particularly at their intersection, remains relatively underdeveloped (Meinokat & Wagner, 2022). Scholarly investigations in this area are characterized by diverse research designs, with a predominant focus on the teacher's perspective (Meinokat & Wagner, 2022, 2024). This inclination may be attributed to the logistical ease of accessing teachers for research purposes, compared to students, due to data privacy and legal considerations. Consequently, there is a pronounced need for a more robust incorporation of student perspectives in future research endeavors, a point which will be further discussed in the limitations (chapter 5.5, p. 138) and future directions (chapter 5.6, p. 141) chapters.

Concerning the term *classroom*, the interview studies provide strong support for its continued relevance as a foundational setting (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025). It represents the primary sphere of influence identified by teachers and encompasses the three identified modalities of digital settings: digitally enhanced face-to-face, online, and hybrid teaching and learning environments. Similarly, students perceive the classroom as their primary area of learning (Meinokat et al., under review). However, it is imperative to acknowledge that the behavioral dynamics of both teachers and students may vary across diverse didactic settings, including those outside traditional school environments.

The selection of the term *disruption* is supported by its prevalence in the literature, where disruptive situations are frequently discussed (Biller, 1979; Lohmann, 2011; Winkel, 2011). The term *disturbance* is often used synonymously. As established in the systematic literature review, this terminological choice facilitates a distinction from research focused on behavioral pathologies from a medical perspective (Meinokat & Wagner, 2022). Behavior management is a component of classroom management research (Durak & Saritepeci, 2017). While this research often addresses situational and behavioral dynamics, the explicit combination of the terms *classroom* and *disruption* allows for a more focused analysis of this phenomenon. It is noteworthy that existing definitions for classroom disruptions are primarily grounded in teacher and researcher perspectives, with a conspicuous absence of student-derived definitions of classroom disruptions within digital settings. Synthesizing insights from the studies, particularly those provided by students, classroom disruptions can be defined as situations, actions, and behaviors that (temporarily) interfere with the current goal(s) of a teaching and learning setting.

The terms *digitalization*, *technology*, *digital tools*, and *digital media* are frequently employed to describe *digital settings* in this dissertation. While digitalization is evidently an integral aspect of contemporary education, a comprehensive term is still needed to encompass the diverse possibilities arising from this phenomenon. The term digital setting was selected, aligning with the established use of digital to denote the process of digitalization, and setting, which is frequently used in didactic contexts. As observed in the review (Meinokat & Wagner, 2022), *digital teaching* and *digital settings* are often used synonymously, likely due to the teacher-centric focus of much research, given that teaching is the teacher's primary function. While the literature review delineates conceptual boundaries, the empirical findings from teacher and student studies suggest a need for a more refined perspective. Both teachers and students, when discussing digital media in their teaching and learning contexts, refer to a broad spectrum of entities, encompassing both hardware (computers, laptops, tablets, smartphones, and gadgets) and software (applications and platforms) (Meinokat et al., in press, under review; Meinokat & Wagner, 2024, 2025). Furthermore, didactic modalities such as blended learning are also included in this discourse (Meinokat et al., under review).

The questionnaire data and interview findings indicate that teachers and students emphasize hardware and software due to their accessibility (Meinokat et al., under review). This categorization appears to be intuitive, with teachers providing hardware and software solutions based on their perceived suitability. This suggests a need for a unified understanding of digital media and digital settings and raises the question of whether such clarification is deemed necessary by the participants themselves. The

interpretation of these terms is not inherently linked to the status of the individual (teacher or student), but rather to their personal understanding. A teacher who refers to their tablet as digital media and a student who mentions the same tablet when asked for digital tools are in agreement about the tablet itself. Moreover, each individual may experience the hardware and software used differently. This is demonstrated in the questionnaire study with students, who mention digital media that have long been integrated into their daily classes, such as overhead projectors or calculators (Meinokat et al., under review).

Given the scope of this dissertation, which includes both teacher and student perspectives, it is essential to consider digital learning as the student counterpart to digital teaching (Wohlfart & Wagner, 2023). Expanding upon the definition from the review, digital settings therefore encompass face-to-face teaching and learning enhanced by digital media (both hardware and software), online teaching and learning, which is based on a digital infrastructure, and hybrid teaching and learning, which combines aspects of the aforementioned areas. This definition is supported by the literature, which often uses digital settings and digital teaching and learning synonymously (Rosendahl & Wagner, 2024).

In response to RQ1, which seeks to delineate the current state of research, the synthesis of these understandings delivers an answer to this question while simultaneously raising further questions regarding the future trajectory of digital settings. The existing body of research still exhibits a notable gap in student-centric perspectives and necessitates refined conceptual distinctions. This dissertation addresses these lacunae, while simultaneously establishing a robust framework for future scholarly inquiry within this domain. It is plausible that digital settings will become so deeply embedded in daily school practices that they are no longer perceived as distinct entities. This evolution is supported by the generally positive outcomes reported for well-implemented digital integration. Existing categorizations can be refined, teachers perceive new pedagogical opportunities, and students share perspectives on disruptions with their teachers. This observation extends across various disciplines, from mathematics to physical education and vocational education.

5.2 How Teachers See and Deal with Classroom Disruptions in Digital Settings

To answer RQ2, the findings of three interview studies (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025) are synthesized. As previously mentioned, teachers exhibit varying understandings of classroom disruptions in digital settings (Meinokat & Wagner, 2024, 2025). Given that each teacher experiences situations differently, this variation is not surprising. Nevertheless, research has attempted to summarize how teachers perceive and address classroom disruptions (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025). Research in general has accompanied classroom management for a longer period than the demands related to digitalization in education (European Union, 2020; KMK, 2021) exist. Therefore, established categorizations, particularly older ones, do not account for digital settings. The only notable exception is the SOMs by Li and Titsworth (2015).

The categorizations of classroom disruptions that teachers can utilize to categorize and prioritize (Biller, 1979; Cogswell et al., 2020; Li & Titsworth, 2015; Lohmann, 2011; Rattay et al., 2018; Wettstein, Ramseier, et al., 2016; Winkel, 2011) provide a foundation for systematically analyzing problems. It is important to recognize that this research is teacher-focused, and the aforementioned categorizations heavily rely on the perspectives of teachers and researchers. This also makes them suitable for integrating findings from the interviews with teachers into these concepts. Based on these models and their own individual approaches, the teachers interviewed communicated various strategies for addressing disruptions, both preventively and interventionally (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025). Table 5.1 (p. 129) provides an overview of the mentioned strategies. In this table, strategies that were repeatedly reported were presented only once, for the sake of conciseness and clarity. It can be observed that multiple strategies are mentioned by teachers regardless of their profession. This aligns with general recommendations from the literature (Lohmann, 2011). Further, research that describes strategies on different levels of escalation (Cogswell et al., 2020; Rattay et al., 2018) is also corroborated by the findings of these studies. Strategies that are described as last resorts by the teachers (Meinokat & Wagner, 2024, 2025), such as the exclusion of students, serve as an example of this. Furthermore, the observation that certain strategies function both preventively and interventionally reinforces the cyclical nature of addressing disruptions (Figure 2.2, p. 9). This cyclicity underscores the often blurred distinction between the conclusion of an intervention and the commencement of preventive measures.

Table 5.1: Overview of Prevention and Intervention Strategies for Classroom Disruptions Reported by Teachers

Strategy	Prevention or Intervention	Based on Study
Using new abilities in digital settings and the administrative assignment of rights	Prevention	Interviews with teachers during the pandemic (Meinokat & Wagner, 2024)
Setting rules ¹²	Prevention	
Creating motivating / interesting classes ²	Prevention	
Involving parents ²	Prevention	
Adjusting own expectations	Prevention	
Verbal interventions ¹	Intervention	
Disabling functions / deleting posts	Intervention	
Improvising solutions ²	Intervention	
Make a break in class	Intervention	
Excluding students ¹	Intervention	
Being physically present as a teacher	Prevention	Interviews with vocational education teachers (Meinokat & Wagner, 2025)
Having a trustful relationship with the students ²	Prevention	
Having good knowledge about the students	Prevention	
Effectively arranging the didactical setting	Prevention	
Maintaining direct communication ²	Prevention	
Importance of being persistent and demonstrating stringency	Intervention	
Getting in contact with the companies	Intervention	
Collaborating with colleagues	Prevention	Interviews with PE teachers (Meinokat et al., in press)
Random group assignment	Prevention	
Using basic and familiar concepts	Prevention	
Being motivated	Prevention	
Emphasizing the multifaceted nature of PE	Intervention	
Targeted interaction	Intervention	

The confirmation of existing non-digital categorizations of classroom disruptions and strategies through findings gathered within a digital media context demonstrates that the integration of digitalization into this subject area is fluidly expanding the current state of research. Teachers describe using existing strategies and enhancing their didactic abilities to deal with disruptions by utilizing new (digital) possibilities (Meinokat & Wagner, 2024). As seen earlier, digitalization of education does not replace existing practices and systems, but gradually creates opportunities for enhancing them (Meinokat & Wagner, 2022, 2024, 2025). Consequently, it seems plausible and advisable to generate new categorizations based on existing ones, as done in this dissertation.

¹ Also reported in interviews with vocational education teachers

² Also reported in interviews with PE teachers

While the positive opportunities of digital media seem to prevail according to the teachers interviewed, some findings indicate a need for caution during the integration process. Teachers report about enhanced preparation time when using digital media for the first time (Meinokat & Wagner, 2024), explain the additional expenses involved when transitioning to a digital setting (while also reporting that the benefits outweigh the expenses) (Meinokat & Wagner, 2025), and advise against digitalization for the sake of digitalization itself (Meinokat et al., in press; Meinokat & Wagner, 2024). This underscores the need for differentiation, a requirement further emphasized by the distinct cultures of the various subjects. In settings like PE, where movement time is a crucial element, teachers carefully weigh the use of digital media against the backdrop of their subject's aims (Meinokat et al., in press). Where the implementation of digitalization is deemed beneficial, teachers are open to enhancing their teaching practices.

In addressing RQ2, this dissertation reveals that the digitalization of pedagogical practices introduces novel classroom disruptions for teachers, while simultaneously perpetuating existing disruptions, albeit potentially in modified forms. Concurrently, teachers demonstrate an ability to augment their strategies through the integration of digital media, thereby refining established patterns. While a generally positive appraisal of digitalization's impact on the educational system prevails, a critical and constructive caveat is issued regarding the necessity of maintaining focus on the specific goals of the respective subject discipline. This emphasis aligns with the teacher's perspective, and a targeted investigation into students' viewpoints is deemed essential.

5.3 Students' Perception on Classroom Disruptions in Digital Settings

To address RQ3, this dissertation draws upon findings from a quantitative student questionnaire (Meinokat et al., under review). This student-centric perspective is crucial, particularly given the prevailing teacher-focused orientation of existing research on classroom disruptions (Biller, 1979; Lawrence et al., 1983), both generally and within digital learning environments. As demonstrated by the historical evolution of classroom disruption definitions, there has been a shift from a teacher-centric focus to a more comprehensive understanding (Maddeh et al., 2015; Stockton University, 2001). Nevertheless, this disparity in research focus necessitates careful consideration when comparing the present study's results with the wider body of literature.

When prompted to articulate the digital aspects of their mathematics lessons, students identified a diverse array of digital media, mirroring the responses provided by teachers regarding their pedagogical use of digital media (Meinokat et al., under review; Meinokat & Wagner, 2024). This convergence underscores the individualistic and context-dependent interpretation of the term *digital media*. Nevertheless, it is evident that students routinely encounter those media that have been integrated into educational practices for an extended period, such as overhead projectors and calculators. Consequently, contemporary teaching and learning environments can arguably be characterized as digital settings. More recent technological integrations, such as tablets, were also emphasized by students in this study, thereby foregrounding the intensified role of digitalization in their educational experiences (Meinokat et al., under review). The results of this study suggest a tendency towards convergent perspectives between teachers and students regarding the integration of digital media.

Building upon this observation, it is pertinent to examine the specific aspects that students identify as disruptive within their digital classroom experiences. Based on the scales developed from the questionnaire (Meinokat et al., under review) (Table 4.21, p. 114), four primary factors appear to influence students' perceptions of disruption: the *behavior of classmates*, the *behavior of the teacher*, the *students' comprehension of assigned tasks*, and *technical issues* encountered during class. It is crucial to recognize that these four categories represent aggregations of potential classroom disruptions. For instance, disruptive classmate behavior may manifest as inappropriate verbalizations, divergent work speeds, or, more generally, actions that impede the learning process of the affected student. Similarly, teacher behavior may be perceived as disruptive when instructional activities, such as working phases, are interrupted, or when the teacher's actions deviate from student expectations. This aligns with Bräutigam's (2015) conceptualization of disruptions. The third category, task comprehension, is situated at the intersection of student and teacher agency, as disruptions arising from difficulties in understanding assignments can be attributed to factors such as inadequate teacher explanations, student inattention, or other contextual variables according to the teachers interviewed (Meinokat et al., in press; Meinokat & Wagner, 2024) and students asked (Meinokat et al., under review). The fourth category, technical issues, encompasses a broad spectrum of potential disruptions, ranging from uncharged tablets and unplanned software updates to connectivity problems, all of which are experienced by both students and teachers (Meinokat et al., under review; Meinokat & Wagner, 2024).

As previously noted, definitions of classroom disruptions are not typically formulated from, or explicitly referenced to, student perspectives. The findings and results of the aforementioned studies further highlight the necessity of this perspective, a point also

emphasized by stakeholders (OECD, 2019). While the results of the questionnaire do not enable the derivation of a comprehensive definition of classroom disruptions from the student standpoint, they do provide a foundation for advancing towards a more unified understanding. Based on the regression analysis, it can be inferred that students perceive classroom disruptions in digital settings as arising from challenges in interpersonal interactions with peers and teachers, as well as from difficulties related to instructional clarity and technical equipment functionality. To develop a more generalizable definition, it would be necessary to evaluate the students' learning objectives within the classroom context. This would facilitate the identification of discrepancies between expected and actual learning outcomes, as well as the analysis of the underlying causes and characteristics of these discrepancies. The four categories identified in this study represent initial steps towards characterizing these disruptions and exploring their potential causes.

Consequently, this dissertation delineates the student perception of classroom disruptions within digital mathematics lessons (RQ3) as a multifaceted construct, mirroring the intricate perspectives of teachers. While commonalities in comprehension between teachers and students are evident, an examination of the student perspective yields a more granular understanding of intra-classroom and intra-relational processes. The findings underscore the fundamental importance of student perception for future research, particularly in the development of a student-centric definition of classroom disruption. Despite the absence of a student-derived definition so far, the four categories of disruptions identified exhibit comparability with existing categorizations of disruptions in research. Consequently, a comparative analysis of teacher and student perspectives appears to be a promising avenue for further inquiry.

5.4 Classroom Disruptions in Digital Settings – a New Categorization

In the process of researching on the topic of classroom disruptions a range of categorizations in this field, both with and without explicit connections to digital settings, were examined. Cogswell et al. (2020), Rattay et al. (2018), and Scherzinger and Wettstein (2019) were selected as the foundation for a 2D graph (Figure 4.2, p. 59) due to the capacity of their categorization to classify specific situations within a scale-like structure. By relating these scales to one another, the 2D graph could be developed, enabling teachers (or other participants/observers of the situation) to contextualize and prioritize specific disruptive situations.

These specific situations were subsequently summarized into categories, drawing upon the work of several researchers, most notably Lohmann (2011), Winkel (2011), and Li and Titsworth (2015). In conjunction with findings from interview studies (Meinokat & Wagner, 2024, 2025), a set of categories for classroom disruptions in digital settings was established. Table 5.2 (p. 133) provides a summary of these categories, along with illustrative examples of specific disruptive situations.

Table 5.2: Categories for Classroom Disruptions with Examples

Authors	Category	Example
Lohmann (2011)	Verbal disruptions	Interjections and disruptive speech
	Lack of willingness to learn	Mental absence and lack of interest in subject
	Motoric restlessness	Running around in class without being asked
	Aggressive behavior	Outbursts of anger and attacks on other people
Winkel (2011)	Disciplinary disruptions	Violations of standards and rules
	Provocation and aggression	Aggressive actions such as intimidation
	Permanent acoustic and visual disruptions, as well as restlessness and missing concentration	Increases in visual and acoustic noise levels
	Disruptions from outside the class	Construction work, loudspeaker announcements
	Refusal to learn and passivity	Forgotten teaching materials or sportswear
	Missing motivation	Missing participation
	Neurotic disorders	Medical symptoms for disorders
Li and Titsworth (2015)	Seeking unallowed assistance	Asking mates for help where not allowed
	Internet slacking	Watching videos online instead of working
	Aggressiveness	Threatening other people
	Lack of communication	Not responding to questions
Meinokat and Wagner (2024, 2025)	Operating Errors	(Un-)Intentional misuse of media
	Technical Errors	Problems like missing connection or non-charged devices
	Illicit Social Behavior	Trying to sabotage situation
	Infrastructural Problems	Too little space for too many students

As evidenced during the interviews with vocational education teachers, some of these categories appear to be primarily attributable to human factors and interactions, while others seem to originate from external factors (Table 4.15, p. 82). This distinction is of

considerable interest to both teachers and researchers in understanding the etiology of classroom disruptions within digital settings.

In alignment with these understandings articulated by teachers and researchers, the set of disruption categories (Table 5.2, p. 133) is predominantly derived from their perspectives. However, by incorporating the perspective of students (Meinokat et al., under review), it is possible to observe similarities and overlaps between existing research on general classroom disruptions (Lohmann, 2011; Winkel, 2011), research on disruptions in digital settings (Li & Titsworth, 2015; Meinokat et al., in press; Meinokat & Wagner, 2024, 2025), and students’ perceptions of disruptions in digital settings (Meinokat et al., under review).

This comparative analysis enables, for the first time, the generation of a categorization for classroom disruptions in digital settings that integrates both teacher and student perspectives. Figure 5.1 (p. 134) illustrates the connections between categories derived from the literature and the newly developed categorization, where own research is marked in blue.

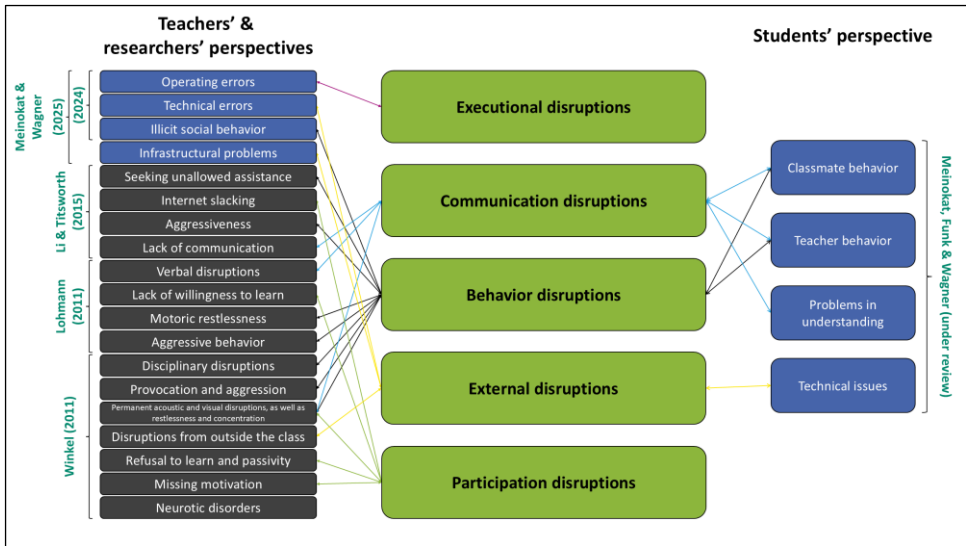


Figure 5.1: Linking Categories of Classroom Disruptions to the New Categorization

A combination of the two perspectives leads to the formation of five categories, which are fed by both spectrums. The five empirically derived categories for classroom disruption

tions in digital settings are: **executional disruptions**, **communication disruptions**, **behavior disruptions**, **external disruptions**, and **participation disruptions**.

The category of **executional disruptions** is based on the *operating errors* identified by Meinokat and Wagner (2024) and encompasses disruptions related to the mishandling of software or hardware, as well as both intentional and unintentional incorrect operation of media.

Communication disruptions were synthesized from the categories *verbal disruptions* (Lohmann, 2011), *permanent acoustic and visual disruptions* (Winkel, 2011), *lack of communication* (Li & Titsworth, 2015), *classmate behavior* (Meinokat et al., under review), *teacher behavior* (Meinokat et al., under review), and *problems in understanding* (Meinokat et al., under review). Disruptions in this category include, for instance, excessive loudness in class, miscommunication, and disagreements during collaborative work.

Behavior disruptions are derived from the categories *motoric restlessness* (Lohmann, 2011), *aggressive behavior* (Lohmann, 2011), *disciplinary disruptions* (Winkel, 2011), *provocation and aggression* (Winkel, 2011), *restlessness* (Winkel, 2011), *seeking unallowed assistance* (Li & Titsworth, 2015), *aggressiveness* (Li & Titsworth, 2015), *illicit social behavior* (Meinokat & Wagner, 2024), and *classmate and teacher behavior* (Meinokat et al., under review). This type of disruption is exemplified by rule-breaking, cheating, aggressive behavior towards others, or provocation within the classroom.

Findings from the interviews with vocational education teachers reveal the presence of disruptions rooted in circumstances external to the classroom (Meinokat & Wagner, 2025). Therefore, **external disruptions** unify the categories *disruptions from outside the class* (Winkel, 2011), *technical errors* (Meinokat & Wagner, 2024), *infrastructural problems* (Meinokat & Wagner, 2025), and *technical issues* (Meinokat et al., under review). Disruptions such as missing connections, uncharged media, distractions from outside the classroom, and limited physical space fall within this category.

Lohmann's (2011) *lack of willingness*, Winkel's (2011) *missing concentration*, *refusal to learn*, *passivity*, and *missing motivation*, as well as Li and Titsworth's (2015) *internet slacking*, contribute to the category of **participation disruptions**. Situations within this category include, for example, a lack of motivation, refusal to participate, or limited willingness to engage in assigned tasks.

These categories for classroom disruptions in digital settings are visualized in Figure 5.2 (p. 136).

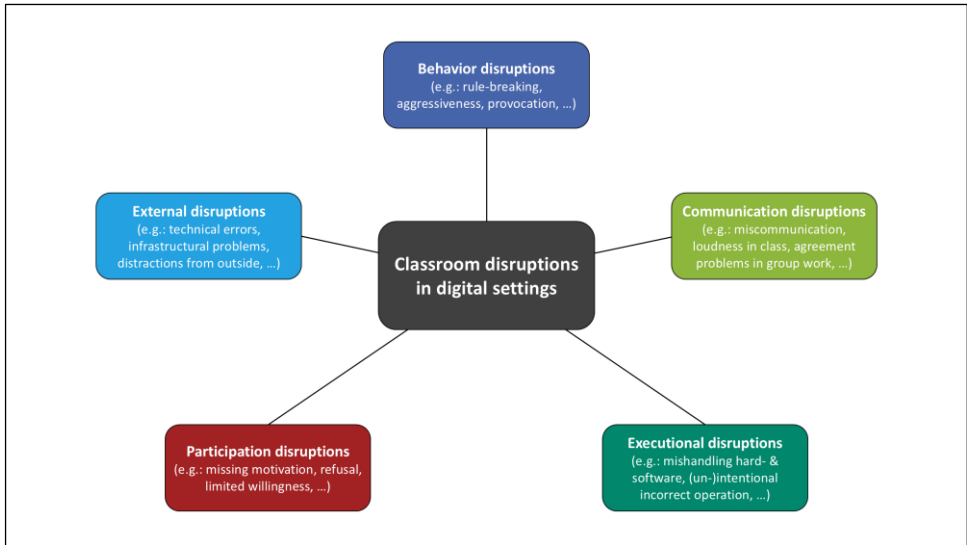


Figure 5.2: Categories for Classroom Disruptions in Digital Settings

As illustrated in Figure 5.1 (p. 134), the category *neurotic disorder* as posited by Winkel (2011) has been intentionally excluded from the developed categories of disruptions within digital settings. This exclusion is predicated on the initial delineation of this study, which explicitly omitted disruptions arising from medical indications (Meinokat & Wagner, 2022). Winkel’s (2011) conceptualization of this category aligns with a medical framework, thereby necessitating its exclusion from the present analysis.

It is observed that certain categories derived from both student and teacher perspectives exhibit connections to multiple newly established categories. Specifically, the categories *permanent acoustic and visual disruptions*, *restlessness*, and *missing concentration* from Winkel (2011), as well as *classmate behavior* and *teacher behavior* from Meinokat et al. (under review), demonstrate such interconnections. The teacher-derived category from Winkel (2011) encompasses a broad spectrum of disruptive phenomena, which are subsequently parsed and re-categorized within the newly developed categorization for digital settings. While this re-categorization is relatively straightforward for teacher-derived categories, the student-derived categories from Meinokat et al. (under review) present a more nuanced scenario. The categories *classmate behavior* and *teacher behavior* each encompass a diverse range of potential disruptions, which can be classified according to various criteria. Consequently, these categories exhibit connections to multiple other categories within the categorization.

A comparative analysis with other categorizations reveals that the newly developed category of *executional disruptions* is uniquely associated with *operating errors*, a category that emerged from interviews conducted with teachers regarding their pedagogical practices during the pandemic. During this period, educational activities were predominantly confined to online settings, thereby accentuating the reliance on digital media. This increased utilization of digital media resulted in the emergence of control-related challenges. Traditional categorizations, which predate the widespread adoption of digital media, do not account for the potential mishandling of such possibilities. It is plausible that this aspect of disruption has been previously overlooked, as the mishandling of calculators or other subject-specific tools can also serve as a source of disruption. The reported novelty (Meinokat & Wagner, 2024) and the pandemic-induced imperative for rapid integration (Cho et al., 2020; Daniel, 2020) may contribute to the heightened awareness of this form of disruption among students and teachers.

The categories *executional disruptions* and *participation disruptions* do not exhibit direct connections to the student perspective. This discrepancy may be attributed to the relatively limited data available from the student perspective. Specifically, only one study of this dissertation project has directly investigated students' perceptions of classroom disruptions (Meinokat et al., under review). Conversely, multiple teacher-focused studies have been incorporated into the development of the new categorization, necessitating the exclusion of certain categories derived from other researchers. This imbalance, as depicted in Figure 5.1 (p. 134), underscores the need for further research on the student perspective and may explain the quantitative disparity in connections between the newly developed categories and the student versus teacher perspectives.

The practical utility of this categorization warrants consideration. Future research endeavors will benefit from this updated framework. For practicing teachers and teacher education programs at universities, this categorization provides a valuable tool for analyzing and planning pedagogical activities. By retrospectively categorizing and structuring disruptions encountered during lessons, teachers can identify recurring patterns and adapt their didactic and methodological approaches accordingly. Furthermore, this categorization facilitates the comparability of disruptions, thereby enabling collaborative discussions among colleagues and further research. Finally, the simplified terminology employed in the categorization promotes a unified understanding of disruptions among students and teachers. Although this dissertation hereby offers demonstrable contributions, it is imperative to acknowledge and discuss its inherent limitations.

5.5 Limitations

While the proposed categorization offers the aforementioned opportunities for analysis and application, it is imperative to acknowledge the inherent limitations of this construct. Building upon this, the limitations of the entire dissertation project will also be discussed.

As previously articulated, the relative paucity of research on the student perspective constitutes a significant limitation, precluding a comprehensive counterbalance to the extensive body of research focused on teacher perceptions. This gap underscores the necessity for further investigations into student experiences, which may yield additional findings and results pertinent to this area of inquiry. It is conceivable that future research may identify more novel categories of disruptions from a student-centric viewpoint, potentially necessitating revisions to the current categorization. Consequently, the categorization presented herein should be regarded as preliminary and subject to refinement.

In comparison with the established conceptual framework, the newly developed categorization can be classified as a Type II categorization (where categories of disruptions co-exist unweighted), as delineated in Figure 2.1 (p. 7). This classification raises pertinent questions regarding the potential transformation of this construct into a Type I categorization (where disruptions are ranked according to severity). Addressing this question necessitates further empirical research on the categorization. At this juncture, this dissertation is limited to the proposal and development of the categorization, thereby requiring subsequent validation and elaboration.

A further salient limitation of both the categorization framework and the dissertation as a whole is the reliance on cross-sectional studies. While the categories developed are informed by literature that, in some instances, transcends cross-sectional designs, the validation of many of these categories necessitates longitudinal investigation. A cumulative dissertation, predicated on multiple scientific articles, affords the opportunity for iterative and progressive research. However, while this dissertation effectively integrates insights from diverse domains, including literature, teacher perspectives, and student perceptions, all findings and results are derived from cross-sectional studies. Although this approach facilitated the examination of multiple disciplines within a condensed timeframe, thereby enabling the development of a multi-perspective categorization, longitudinal studies would provide more nuanced insights into the long-term effects of disruptions, potential interrelationships between categories, and a more granular analysis of individual categories.

The adoption of a mixed-methods approach to the study of classroom disruptions in digital settings, while possessing inherent advantages for a cumulative dissertation, also introduces certain limitations. The heightened complexity of this approach necessitates strategic decisions regarding the inclusion of specific aspects. Consequently, certain perspectives, such as a medical perspective on disruptions, were deliberately excluded. Furthermore, qualitative and quantitative methodologies may diverge in terms of intentionality. For example, the qualitative interviews conducted with teachers provided rich insights and facilitated comparisons with existing research. Conversely, the quantitative questionnaire administered to students, while also yielding categorical data, would benefit from a more confirmatory research design. Both methodologies would be enhanced by complementary research designs, specifically, quantitative and confirmatory studies with teachers, and exploratory and qualitative studies with students. In this context, researchers are consistently encouraged to mitigate potential biases towards either research paradigm. This dissertation comprises three qualitative studies and one quantitative study, thereby necessitating careful consideration of potential biases during the analysis and interpretation of results. In addition, as with the teachers interviewed, no interest-based preference on the topic complex can be ruled out, whereby an attempt was made to counter this with available means of good scientific practice.

In terms of representativeness, it is noteworthy that hybrid settings, such as blended learning, are underrepresented in this study. Although both teachers and students were queried about digital settings, which encompass hybrid settings, the findings and results reveal a relative paucity of data pertaining to these settings. This observation may be attributed to the lower prevalence of hybrid settings compared to other modalities, as reported by both students and teachers. Nevertheless, it is plausible that increased utilization of hybrid settings may reveal disruptions that are not captured by the current categorization. Furthermore, the question arises regarding the extent to which representativeness is achievable. Given the variability in factors such as subject matter, school types, student ages, and others, it is important to acknowledge this limitation. The need for further research is evident, and it is imperative to state that this dissertation does not claim to be representative in a general sense.

A further limitation of all studies, with the exception of the systematic literature review, is the reliance on a literature framework that incorporates both international English-language literature and German-language literature. As previously stated, research on classroom disruptions is often subsumed within broader studies of classroom management. Consequently, dedicated research on classroom disruptions, which employs a variety of synonymous terms, is limited in the English-language literature. In Germany, the specific term *Unterrichtsstörung* appears to generate a higher volume of research on

this topic. It is plausible that variations in societal, social, and educational policy priorities across countries contribute to this disparity. Therefore, the dissemination of German-language research to the international research community is warranted. However, this also introduces limitations regarding the generalizability of results derived solely from the German education system to international contexts. It is noteworthy that such a limitation is not unique to, but certainly evident within, this dissertation project. This limitation highlights opportunities for expanding research to encompass diverse educational systems.

Regarding terminology, it is also pertinent to note a discernible increase in conceptual precision throughout the course of this project. Conceptual similarities, such as those between *digital media* and *digital tools*, or *systemization* and *categorization*, were addressed within the individual studies. Consequently, the terms digital media (encompassing digital tools) and categorization (as distinct from systemization) were employed. Due to this iterative process of refinement, this dissertation's initial precision was somewhat constrained.

Limitations specific to individual studies within this dissertation are detailed in their respective chapters. Nevertheless, the synthesis of these articles introduces additional limitations that warrant acknowledgment. Specifically, the review, interview studies, and questionnaire study are confined to specific school settings. It is plausible that different school settings may yield divergent outcomes. Furthermore, it would be beneficial to examine disruptions in other teaching and learning environments, such as sport clubs, non-formal learning environments in general, experiential education, or student laboratories. Findings from the research in LFs (Meinokat & Wagner, 2025) indicate promising avenues for future research, which may also benefit traditional school settings.

The limited number of participants in each interview study, as previously acknowledged, could be addressed by conducting studies that include both teachers and students. This approach would enhance comparability by examining shared experiences and would ensure the consideration of both perspectives. Finally, it is conceivable that the limited participant pool may reflect a self-selection bias, wherein only teachers with a pre-existing interest in digital media participated (Elston, 2021). Consequently, the findings and results of this dissertation may underestimate critical perspectives and demands.

Finally, a limitation inherent in this dissertation pertains to the fact that it represents the author's own synthesis of information. It would be unrealistic to assume that all limitations could be identified without overlooking certain areas or flaws. Therefore, a critical

perspective on this project is warranted, and the continuation of research in this field, as justified by the results of this project, should be pursued. In this context, a focused consideration of potential avenues for future research is essential.

5.6 Future Research

Future research could also address other limitations and explore areas not covered in this dissertation. Given the underrepresentation of student perspectives in research on classroom disruptions within digital settings, it is imperative to conduct further studies that prioritize the student experience. Quantitative research could contribute to the validation of the generated categories, while qualitative research could facilitate the development of new categories through the direct inclusion of students in the research process. Research designs such as participatory research should be considered.

Building upon this foundational work, future research could extend beyond the student perspective to encompass the broader development of classroom disruption categorization. Furthermore, beyond the validation previously discussed, empirical investigation into the application of this categorization within lesson planning and implementation is warranted. Scholarly inquiry can play a crucial role in refining and expanding upon the findings presented herein.

More broadly, future research could benefit from the adoption of diverse methodologies and the exploration of different educational contexts. Studies focusing on primary education, university settings, or specific educational levels could generate novel insights and facilitate comparative analyses across educational domains. Given the finding that different subjects experience distinct forms of disruptions, subject-specific research would also be beneficial.

The rapid and continuous evolution of digitalization necessitates ongoing research to update the findings of this dissertation. Emerging developments, such as the increasing integration of artificial intelligence (KMK, 2024), should be incorporated into educational research to ensure its relevance and currency. It cannot be precluded that novel forms of disruptions will emerge, potentially necessitating additions to the existing categorization framework or a re-evaluation of current conceptual structures.

Given the aforementioned limitations and the documented cultural variations, the focus of this research on German-speaking countries underscores the value of examining classroom disruptions in other social and educational contexts. Exploring this area in

other countries could yield valuable insights that can benefit the further development of effective tools for addressing classroom disruptions internationally. While this exploration invariably presupposes the classical teacher-student interaction, the evolving nature of teaching and learning processes could also lead to and benefit from other perspectives, such as student-student interactions or a focus on self-learning environments. It is important to incrementally expand the state of research. This dissertation represents an initial step in this broader endeavor, and the following section will provide a concise summary of its key findings and contributions.

6 Conclusion

This dissertation has endeavored to synthesize and analyze the multifaceted phenomenon of classroom disruptions within the increasingly prevalent digital educational landscape. By integrating insights from existing literature, teacher perspectives, and student experiences, a novel categorization of disruptions in digital settings has been proposed. This chapter will now provide a concise summary of the key findings and their implications.

Classroom disruptions, as a constituent element of classroom management, have been a subject of scholarly inquiry for several decades (Kounin, 1970; Sing Yun, 2023). Empirical research has consistently demonstrated the deleterious effects of classroom disruptions on teachers' physical and psychological well-being (Brouwers & Tomic, 2000; Gonzalez et al., 2015; Greene et al., 2002; Ingersoll, 2001; Kokkinos, 2007; Rajendran et al., 2020; Wettstein et al., 2021). Furthermore, disrupted classroom environments have been shown to negatively impact students' academic performance and achievement (Adeyemo, 2012; Marquez et al., 2016; Scherzinger & Wettstein, 2019; Talebi et al., 2015). While the topic of classroom disruptions warrants intensified research attention, educational settings worldwide have recently experienced an accelerated introduction to another potential challenge: digitalization. Stakeholders have advocated for the integration of digital media into educational practices (European Union, 2020; KMK, 2017b; U.S. Department of Education, 2017), thereby raising the question of how this intensified digitalization affects classroom disruptions.

This dissertation examined classroom disruptions within digital settings from multiple perspectives, addressing the following three research questions:

- RQ1: What is the current state of research on classroom disruptions in digital settings?
- RQ2: How do teachers address classroom disruptions in their digital teaching practices?
- RQ3: How do students perceive classroom disruptions in digitally supported learning settings?

A mixed-methods approach was employed to address these research questions. To ascertain the current state of research, a systematic literature review was conducted, adhering to the PRISMA statement (Moher et al., 2009). This was followed by three

qualitative interview studies involving teachers, focusing on their teaching experiences during the pandemic, their practices in learning factory settings at vocational education schools, and their strategies for addressing student refusal behavior in physical education. Semi-structured, guideline-based interview protocols were utilized, and data analysis was performed using qualitative content analysis, as outlined by Mayring (2014). The student perspective was elicited through a quantitative questionnaire examining classroom disruptions in digitally supported mathematics classes, with data analysis conducted using multiple linear regression.

Principal findings for RQ1 revealed a pronounced teacher-centric bias in existing research, with a corresponding underrepresentation of student perspectives. Additionally, conceptual ambiguities were identified in the terms classroom disruptions and digital settings. A variety of definitions and synonymous terms for classroom disruptions were observed, leading to a synthesized understanding that classroom disruptions are behaviors, situations and actions that (temporarily) impede the teaching and learning process (Meinokat & Wagner, 2022).

Similarly, diverse terms and interpretations were found in relation to digital settings. Through analysis and synthesis, digital settings were conceptualized as encompassing teaching and learning environments in digitally supported face-to-face classes, online teaching and learning modalities, and hybrid formats such as blended learning. It was also established that digitalization is already an integral component of contemporary education, with an anticipated increase in its integration (Meinokat & Wagner, 2022).

Research conducted to address RQ2 indicated that existing categorizations of classroom disruptions do not adequately account for the integration of digital media, with the notable exception of the Student Online Misbehavior scale developed by Li and Titsworth (2015). They identified four categories of disruptions: *seeking unallowed assistance*, *internet slacking*, *aggressiveness*, and *lack of communication*. Building upon the findings of three interview studies involving a total of 31 teachers, these four categories were expanded to include four additional categories: *operating errors*, *technical errors*, *illicit social behavior*, and *infrastructural problems* (Meinokat et al., in press; Meinokat & Wagner, 2024, 2025). The findings also demonstrated that teachers adapt to novel challenges and settings by refining their existing pedagogical strategies. In general, teachers recognized the potential of digital media to enhance classroom disruption management, while also emphasizing the importance of thoughtful and balanced integration (Meinokat et al., in press).

The student perspective, as elicited through the quantitative questionnaire, confirmed that digital media are already, and will continue to be, an integral part of contemporary education. Regarding RQ3, findings revealed a degree of convergence between student and teacher perceptions of classroom disruptions. Through regression analysis, four categories of disruptions were identified from the student perspective: *classmate behavior*, *teacher behavior*, *problems in understanding given assignments*, and *technical issues* (Meinokat et al., under review).

By synthesizing insights from these three distinct perspectives, it was possible to develop a novel categorization for classroom disruptions that incorporates the nuances of digital media and directly integrates the student perspective (Figure 5.2, p. 136). This categorization comprises five categories of disruptions: **behavior disruptions**, **communication disruptions**, **executorial disruptions**, **external disruptions**, and **participation disruptions**. The categories were defined and discussed, demonstrating the potential utility of this categorization for practicing teachers, teacher education programs, and future educational research.

As previously noted, the development of this categorization provides a foundation for future research. Subsequent studies could further examine and validate the proposed conceptual framework. Given the identified limitations regarding the focus on cross-sectional data and students' perspectives, it would be beneficial to combine validation studies with longitudinal research designs. Furthermore, the practical application of this categorization in teacher training and professional development could yield valuable insights for refinement, especially against the background of the demanded optimization of teaching practices in terms of successful teaching and learning (KMK, 2001; Tillmann, 2015). In light of the significance of the topic, as established in the introduction, it is of particular interest to examine how this research can contribute to the enhancement of teachers' mental well-being and students' academic achievement.

This dissertation has provided a systematic foundation for the examination of classroom disruptions in digital settings. It is essential for future studies to develop upon this framework. It is evident that digitalization precipitates new modalities of classroom disruption, while simultaneously affording opportunities to counteract both novel and pre-existing pedagogical challenges. The ongoing transformations in the digital realm, with their pervasive influence on all aspects of life, including education, and the (inter-)national social imperative for improvement, underscore the need for continuous optimization within this field. The advancement of existing research and the dissemination of new knowledge are essential to meet these demands. To this end, teachers and students engage daily in teaching and learning activities within their respective settings,

and this dissertation aims to enhance the understanding, analysis, and management of classroom disruptions within these digital settings.

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8 Appendix

Table 8.1: Overview of Reviewed Articles with Findings on Disruptions in Digital Teaching

Author(s):	Title:	Research design (RQ _{A2}) and digital tools used:	Main findings, statistical findings, and quantitative data:
Baker et al. (2016)	A Model for Online Support in Classroom Management: Perceptions of Beginning Teachers	Qualitative analysis of texts n = 6 pre-service teachers' online support (videos, etc.)	Different strategies in different situations for different participants RQ _{A1} : Disruptions, rule violations RQ _{A4.2} : Creating classroom routines; establishing positive relationships; professionalism RQ _{A4.3} : Non-verbal actions; private conversations; closed questions on students' behavior; early disengagement; quit taking it personally (QTIP)
Blundell et al. (2019)	Using Dual Systems Theory to Conceptualise Challenges to Routine When Transforming Pedagogy with Digital Technologies	Qualitative interviews and focus groups n = 6 teachers Personalized digital learning	Transforming practices with digital tools creates challenges RQ _{A1} : Digital technologies, digital learning RQ _{A4.1} : Digital tools themselves RQ _{A4.2} : Procedural routines; when teachers feel comfortable with their style of teaching
Boyaci (2010)	Pre-Service Teachers' Views on Web-Based Classroom Management	Qualitative interviews n = 20 pre-service teachers Web-based classroom management	Web-based environment seems to be more important than classroom management in general, giving more responsibility to students RQ _{A1} : Web-based, education via internet, technical, software RQ _{A4.1} : Lack of/limited communication RQ _{A4.2} : Permanent communication, teachers' participation
Bruhn et al. (2020)	The Effects of Data-Based, Individualized Interventions for Behavior	Mixed-methods approach with questionnaire and app data analysis n = 26 teachers and students App	Adaptions made through data-based individualized interventions are minimal Students significantly ($p < .001$) increased their percentage of positive behavior (PBB) by 19.40% RQ _{A1} : Data-based, technology-based; behavioral interventions, challenging/problem behavior RQ _{A4.3} : Student self-monitoring via app
Charles (2012)	Cell Phones: Rule-Setting, Rule-Breaking, and Relationships in Classrooms	Qualitative observations and interviews n = 10 teachers Cell phones	Rule-setting is important when dealing with new technologies. RQ _{A1} : Cell phones, social media, digital networks, mobile technologies; breaking rules, inappropriate behavior RQ _{A4.1} : Non-uniform rules RQ _{A4.2} : Developing a meta-awareness of discourse usage; clear understanding of rules
Heitink et al.	Eliciting Teachers'	Quantitative	Teacher style affects student success, and

(2017)	Technological Pedagogical Knowledge	questionnaire n = 29 teachers Video vignettes (inside clips: multiple tools like PCs/laptops, interactive whiteboards, mobile phones, tablets)	therefore teachers need more practice in their use of digital tools to feel comfortable RQ _{A1} : Information and communication technology (ICT); Behavior supportive adaptive teaching
Ho (2004)	A Comparison of Australian and Chinese Teachers' Attributions for Student Problem Behaviors	Quantitative questionnaire n = 473 teachers Video vignettes	Regardless of cultural background, teachers hold students responsible for misbehavior Problem behaviors differ across cultural backgrounds [F (3,1401) = 17.56, p < .05] RQ _{A1} : Student/common/inappropriate problem behaviors RQ _{A3} : Different types of problems (day-dreaming, talking, bullying, etc.) RQ _{AA.1} : Students' effort/family/ability
Homer et al. (2018)	Comparing Digital Badges-and-Points with Classroom Token Systems: Effects on Elementary School ESL Students' Classroom Behavior and English Learning	Mixed-methods approach with pre/post-tests, observations, surveys, and text analysis n = 120 students and teacher Online token system	Digital token system has positive impact on student behavior RQ _{A1} : Digital badges-and-point/token system; negative/off-task behavior RQ _{AA.2} : Using a digital token system The percentage of "nearly all of the students" following instructions went from 0% to 37.5% (in reading classes) and from 0% to 80% (in speaking classes) The percentage of "nearly all of the students" staying on task went from 0% to 18.8% (in reading classes) and from 0% to 70% (in speaking classes)
Hummel et al. (2015)	Collaboration Scripts for Master-ship Skills: Online Game about Classroom Dilemmas in Teacher Education	Mixed-methods approach with questionnaire and text analysis of feedback given n = 19 pre-service teachers Online game	Pre-service teacher collaborations are useful for dealing with disruptions RQ _{A1} : Online; classroom management dilemmas
Judge et al. (2013)	The Use of Visual-Based Simulated Environments in Teacher Preparation	Quantitative text analysis, focus groups, and questionnaire n = 6 pre-service teachers Virtual classroom simulation	Virtual simulations can help pre-service teachers practice for dealing with disruptions but are still technically limited All six participants had an increased usage of the "precise praise" strategy (from +1 to +9.33 in mean occurrences a session) Two participants decreased their usage of the "planned ignoring" strategy (-2 and -8.67 mean occurrences a session), while the other four increased their usage of it (+1, +5.33, +10.33, and +12.67) RQ _{A1} : Virtual technology/environment, mixed-reality; incompatible/disruptive/unengaged behavior, behavior management/disruptions

Kurz and Batarelo (2010)	Constructive Features of Video Cases to be used in Teacher Education	Qualitative text analysis of feedback given n = 27 pre-service teachers Video vignettes	Video cases can be used to evaluate classroom management strategies but not alone RQA1: Technology, video; students without discipline, disruptions
Li and Titsworth (2015)	Student Misbehaviors in Online Classrooms: Scale Development and Validation	Mixed-methods approach (2 studies with surveys) with teachers and students n varies Online classroom	Independent student learning tempts students to abuse technology. Communication with the teacher is important All 15 items within the SOMs are loaded significantly (from .48 to .98) Positive correlation between items and the number of online classes a student has taken: Cheating (.02); unallowed collaboration (.03); plagiarism (0.13); inattentiveness (.03); lack of critical thinking (.03); procrastination (.12); slacking over group work (.06); slacking over individual work (.04); nontextual aggressiveness (.20*); aggressiveness toward teachers (.13) Negative correlation between items and number of online classes a student has taken: Abusing technology (-.06); aggressiveness toward classmates (-.03); little communication with teacher (-.19*); little communication with classmates (-.01); no communication (-.02) RQA1: Online, technology; misbehavior, (in-)appropriate behavior RQA3: Student Online Misbehavior scale (SOMs): Seeking unallowed assistance (cheating, unallowed collaboration, plagiarism, abusing technology) Internet slacking (inattentiveness, lack of critical thinking, procrastination, slacking over group work/individual work) Aggressiveness (non-textual, toward teacher/classmates) Lack of communication (no/little communication with teacher/classmates) * p < .05
Moltudal et al. (2019)	The Relationship between Teachers' Perceived Classroom Management Abilities and Their Professional Digital Competence: Experiences from Upper Secondary Classrooms. A	Mixed-methods approach with interviews, focus groups, observations, and surveys n = 30 (qualitative); n = 2579 (quantitative) teachers, students, and school-related	Classroom management is becoming more important when digital tools are used RQA1: Digital competence, information and communication technology (ICT); non-academic use, crime-control RQA4.1: Lack of student self-discipline; increased teacher digital competence RQA4.2: Rules

	Qualitative Driven Mixed Method Study	persons Digital competence in general	
Muir et al. (2013)	Preparing Pre-Service Teachers for Classroom Practice in a Virtual World: A Pilot Study Using Second Life	Qualitative text analysis of feedback n = 8 pre-service teachers Virtual classroom simulation	Virtual simulations create opportunities to practice situations and simulate roles but are still technologically limited RQ _{A1} : computer-based, virtual classroom/world; classroom/student behavior (management)
Rosen and Beck-Hill (2012)	Intertwining Digital Content and a One-to-One Laptop Environment in Teaching and Learning: Lessons from the Time to Know Program	Mixed-methods approach with assessment scores, school records, questionnaires, and observations n = 496 teachers and students Laptops	One-to-one technology has potential to improve learning outcomes Disciplinary issues in experimental classes decreased by 62.5% and in control classes by 15.4% RQ _{A1} : technology, computers; disciplinary issues
Storch and Juarez-Paz (2019)	Efficacy of Cell Phones within Instructional Design: A Professor's Perspective	Qualitative interviews n = 10 teachers PCs/laptops (online interviews); cell phones	With preset behavioral expectations, benefits of cell-phone usage in classes are bigger than risks RQ _{A1} : cell phones; behavioral expectations RQ _{A4.1} : cell phones themselves RQ _{A4.2} : rules and policies; monitoring RQ _{A4.3} : giving warnings

Table 8.2: Forms of Digital Tools Used and their Associated School Level

Authors	Digital tool	Level of education	Level of class	Model of teaching
Baker et al. (2016)	Online forum used by pre-service teachers to discuss behavior	Primary and secondary education	Different, mostly unspecified level of class	Not given due to the fact that participants only describe their findings and strategies
Blundell et al. (2019)	Teachers' opinion after transferring their own classes into digital classes	Primary and secondary education	Different, sometimes unspecified level of class	Varying teaching models, mostly not described, as the teachers changed their teaching style
Boyaci (2010)	Pre-service teachers' opinions on web-based classroom management	Primary education	Unknown level of class	Not given
Bruhn et al. (2020)	Data-based, individualized interventions via app	Primary education	Unknown level of class	Face to face teaching, no more information
Charles (2012)	Cell-Phone usage in classes	Secondary education	10th & 11th grade	Face to face teaching, different teacher styles, no more information
Heitink et al. (2017)	Video-vignettes of teachers showing digital tools in classroom	Primary education	Different, unknown level of class	Face to face teaching, no more information given
Ho (2004)	Video-vignettes of teachers' reactions to problematic behavior	Secondary education	Different, unknown level of class	Face to Face teaching, Various, not mentioned teaching models
Homer et al. (2018)	Comparing a digital badges and points system to a non-digital version used in classroom	Primary education	1st to 4th grade	Face to face teaching, double-period lessons for 1st and 2nd grade, single lessons for 3rd and 4th grade
Hummel et al. (2015)	Comparing an online game version to the non-digital version of a game about classroom disruptions	University level	3rd year students	Half of the students worked in groups with the face to face version of the game, the other half worked in groups in the online version
Judge et al. (2013)	Virtual classroom-simulation	Secondary education	Unknown level of class	Online simulated face to face

				interaction with students
Kurz and Batarelo (2010)	Video-vignettes for training teachers	Primary and secondary education	Unknown level of class	Unknown teaching models in the video vignettes
Li and Titsworth (2015)	Online-classroom analysis and observation	University level	Unknown level of class	Online teaching, unknown further teaching model
Moltudal et al. (2019)	Study about teachers' digital competences and their ICT usage	Secondary education	Unknown level of class	Not given
Muir et al. (2013)	Virtual classroom simulation	Primary education	Unknown level of class	Online simulated face to face frontal teaching
Rosen and Beck (2012)	Laptop environment for students	Primary education	4th & 5th grade	Face to face teaching, no more information
Storch and Juarez (2019)	Cell-Phone usage in classes	University level	various, unknown level of class	Various, no information given

Table 8.3: Overview Research on Classroom Disruptions in Mathematic Lessons

Authors	Topics	Method	Results/Findings
Erzinger et al. (2021)	Achievement of basic skills and the quality of mathematics teaching from the students' perspective	Performance test and questionnaire	Less disruptive teaching increases the likelihood of achieving basic skills in mathematics
Heyer and Standop (2020)	Classroom disruptions from the perspective of teachers and students: Subjective perception and evaluation of situations in the classroom in the subjects of chemistry and mathematics	Questionnaire	- Different perceptions of classroom disruptions within the class - Differences between the frequency of the occurrence of disruptions and the subjective perception of being disrupted
Klusmann et al. (2006)	Perceived stress and teaching quality from the perspective of students and teachers	Survey	Disruptions in mathematics lessons are independent of the type of teacher
Koyuncu (2021)	Relationship between non-cognitive factors and math performance	Questionnaire and Data from TIMMS 2019	- Significant correlation between mathematics performance and attitudes towards mathematics and the structure of teaching - Students with low mathematics performance show undesirable behavior in class more often - Higher-achieving students exhibit less misbehavior and also have a more positive attitude towards mathematics
Ma and Willms (2004)	Disciplinary climate in school: characteristics and effects on performance in eighth grade	Questionnaire	- Classroom disruptions correlate most strongly with performance in mathematics, among other subjects - Students are concerned about disruptions in the classroom
Marder et al. (2023)	Effectiveness of classroom management including the disruptive behavior of students in mathematics lessons	Quantitative analysis from PISA 2003 and UNITAS	- Between the different classes, the disruptive behavior of students in class has a negative correlation with students' math performance - Within class: number of disruptive behaviors perceived by a student is negatively related to the individual student's math performance - Control of classroom disruptions and thus teachers' monitoring activities have a negative impact on students' math performance
Rakoczy (2006)	Motivational support in mathematics lessons	Video observation and questionnaire study	- Relationship between classroom disruptions and motivational support in mathematics lessons - Lessons with few disruptions can support motivation and can be supportive in more demanding teaching phases

Table 8.4: Questionnaire Items

Item Number	Label	Based on/adopted from: (self-development when no reference)	Type of measurement
1a	Which digital devices are used in math lessons? Computer (PC) / Laptop	Helmke et al. (2000)	ordinal, Likert-Scale (1) Never (2) Rarely (3) Sometimes (4) Often (5) Always
1b	Which digital devices are used in math lessons? Document Camera / Visualizer		
1c	Which digital devices are used in math lessons? Smartphone		
1d	Which digital devices are used in math lessons? Tablet		
1f	Which digital devices are used in math lessons? Other		
2	I feel disturbed in my math lessons.	Baumert et al. (2008), Marder et al. (2023), Makarova et al. (2014), Wettstein, Ramseier et al. (2016), Wettstein, Scherzinger and Wyler (2016)	ordinal, Likert-Scale (1) Never (2) Rarely (3) Sometimes (4) Often (5) Always
3	Behavior of my classmates (e.g. talking, eating, being late) in math lessons bothers me.		
4	My math teacher's behavior (e.g. being late, interrupting work phases, loud admonitions) bothers me.		
5	Other incidents in math lessons (e.g. missing materials, malfunctioning equipment, long practice periods) bother me.		
6	During partner work with a digital media (e.g. tablet, smartphone, computer (PC)/laptop) in mathematics lessons my partner distracts me.	Makarova et al. (2014)	
7	During partner work with a digital media (e.g. tablet, smartphone, computer (PC)/laptop) in mathematics lessons I feel disturbed by the different working pace (e.g. faster or slower) of my partner.		
8	During partner work with a digital media (e.g. tablet, smartphone, computer (PC)/laptop) in mathematics lessons I feel disturbed by the rapid testing of various tools (e.g. sliders, different views) by my partner.		

9	What other disruptions occur in mathematics lessons when using digital media in relation to shared work time with classmates or teachers?		Nominal
10	Preparing the use of digital media (e.g. distributing tablets, logging in to websites, opening the right application, switching on the device) in mathematics lessons takes a long time.	Baumert et al. (1997), Baumert et al. (2008)	ordinal, Likert-Scale (1) Never (2) Rarely (3) Sometimes (4) Often (5) Always
11	The long preparation for using digital media (e.g. distributing tablets, logging in to websites, opening the right application, switching on the device) in math lessons bothers me.	Baumert et al. (1997), Baumert et al. (2008)	
12	Before using digital media (e.g. tablets, apps and programs such as GeoGebra, learning videos, learning apps, Mathebattle) in mathematics lessons our math teacher explains the most important functions in plenary.		
13	Before using digital media (e.g. tablets, apps and programs such as GeoGebra, learning videos, learning apps, Mathebattle) in mathematics lessons our math teacher demonstrates the most important functions in plenary.		
14	The introduction to the function/use of digital media (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) by the mathematics teacher is difficult to understand.	Baumert et al. (2008)	
15	After introducing digital media (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) in math lessons, I know how they work.	Baumert et al. (2008)	
16	Incomprehensible/unclear introductions to the use/function of digital media (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) in math lessons bother me.	Baumert et al. (2008)	
17	The explanations on the use of digital media by the math teacher (e.g. showing and	Baumert et al. (1997), Baumert et al. (2008)	

	explaining the most important functions of GeoGebra, Desmos, Mathebattle) take too long.		
18	The long explanations on the use of digital media by the math teacher (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) bother me.	Baumert et al. (1997), Baumert et al. (2008)	
19	The explanations on the use of digital media by the math teacher (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) are too quick.	Baumert et al. (2008)	
20	Because the math teacher explains the use/function of digital media too quickly (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) I don't know what to do.	Baumert et al. (2008)	
21	Because the math teacher explains the use/function of digital media too quickly (e.g. showing and explaining the most important functions of GeoGebra, Desmos, Mathebattle) I feel disturbed.	Baumert et al. (2008)	
22	The work assignments for the use of digital applications (e.g. apps and programs such as GeoGebra, Mathebattle, learning apps, learning videos) in mathematics lessons are comprehensible.	Baumert et al. (2008)	
23	When using digital devices/applications (e.g. tablets, GeoGebra, Mathebattle, learning apps, learning videos) in math lessons, our math teacher gives us unclear work assignments so that I don't know what I have to do.	Baumert et al. (2008)	
24	Unclear work assignments when using digital applications (e.g. apps and programs such as GeoGebra, Mathebattle, learning apps, learning videos) in math lessons bother me.	Baumert et al. (2008)	
25	In particularly difficult situations, our math teacher provides us with additional explanations via digital media	Baumert et al. (2008)	

	(e.g. learning video, visualization).		
26	The additional provision of the explanation in particularly difficult situations with the help of a digital medium (e.g. learning video, visualization) helps my understanding.	Baumert et al. (2008)	
27	When providing additional explanations in particularly difficult situations via a digital medium (e.g. learning video, visualization) it is quiet in the classroom.	Helmke (2008)	
28	When providing additional explanations in particularly difficult situations via a digital medium (e.g. learning video, visualization) I am attentive.	Helmke (2008)	
29	Our mathematics teacher uses digital media in mathematics lessons to illustrate facts (e.g. 3D view of geometric solids in e.g. GeoGebra, visualizing reflections, illustrating the shifting of graphs).		
30	When using digital media in mathematics lessons to illustrate facts (e.g. 3D view of geometric solids in e.g. GeoGebra, visualizing reflections, illustrating the shifting of graphs) it is quiet in the classroom.	Helmke (2008)	
31	When using digital media in mathematics lessons to illustrate facts (e.g. 3D view of geometric solids in e.g. GeoGebra, visualizing reflections, illustrating the shifting of graphs) I am attentive.	Helmke (2008)	
32	Various digital devices/applications (e.g. tablet, Visualizer, GeoGebra, Mathebattle, Kahoot, PowerPoint) are used in mathematics lessons.		
33	The frequent switching between digital devices/applications (e.g. tablet, Visualizer, GeoGebra, Mathebattle, Kahoot, PowerPoint) within a math lesson bothers me.		
34	Various media (digital and non-digital media such as work-		

	sheets, blackboard) are used in mathematics lessons.		
35	The frequent switching of media (digital and non-digital) within a math lesson bothers me.		
36	Digital media (e.g. tablets) are not charged in mathematics lessons.		
37	Non-charged digital media (e.g. tablets) in math lessons delay the start of work.	Baumert et al. (1997), Baumert et al. (2008)	
38	Non-charged digital media (e.g. tablets) in math lessons bother me.	Baumert et al. (1997), Baumert et al. (2008)	
39	Internet problems (e.g. no WLAN, website not loading, slow connection) when using digital media in math lessons delay the start of work.	Baumert et al. (1997), Baumert et al. (2008)	
40	Internet problems (e.g. no WLAN, website not loading, slow connection) when using digital media in math lessons bother me.	Baumert et al. (1997), Baumert et al. (2008)	
41	Access problems (e.g. login data does not work, access to the website is blocked, tasks are not released) when using digital media in mathematics lessons delay the start of work.	Baumert et al. (1997), Baumert et al. (2008)	
42	Access problems (e.g. login data does not work, access to the website is blocked, tasks are not released) when using digital media in mathematics lessons bother me.	Baumert et al. (1997), Baumert et al. (2008)	
43	What other disruptions occur in mathematics lessons when using digital media in relation to the lessons themselves?		Nominal
44	In mathematics lessons, I work attentively when using digital media (e.g. tablets, smartphones, computers (PC)/laptops).	Helmke (2008)	ordinal, Likert-Scale (1) Never (2) Rarely (3) Sometimes (4) Often (5) Always
45	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathematics lessons it is clearly regulated what happens when the task is finished with the digital media	Helmke (2008)	
46	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathemat-	Baumert et al. (2008), Kunter and Baumert (2007), Makarova et al. (2014), Wettstein,	

	ics lessons people talk disturbingly loud.	Ramseier et al. (2016) Wettstein, Scherzinger and Wyler (2016)	
47	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathematics lessons I use the digital media after the tasks for other things (e.g. playing games, surfing the Internet or writing notes).	Baumert et al. (1997), Makarova et al. (2014), Wettstein, Ramseier et al. (2016) Wettstein, Scherzinger and Wyler (2016)	
48	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathematics lessons I distract myself with other activities (e.g. playing games, surfing the Internet or writing notes).	Baumert et al. (1997), Makarova et al. (2014), Wettstein, Ramseier et al. (2016) Wettstein, Scherzinger and Wyler (2016)	
49	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathematics lessons I am looking for unauthorized help/solutions.		
50	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathematics lessons I do not follow the instructions/work assignments of the math teacher.	Baumert et al. (2008)	
51	When using digital media (e.g. tablets, smartphones, computers (PC)/laptops) in mathematics lessons it takes a long time for us to calm down and start working.	Baumert et al. (1997)	
52	When using our own smartphones in math lessons, I write messages to classmates.	Baumert et al. (1997), Makarova et al. (2014), Wettstein, Ramseier et al. (2016) Wettstein, Scherzinger and Wyler (2016)	Nominal
53	What other behavior of classmates or teachers bothers you when using digital media in mathematics lessons?		
54	I enjoy the subject of mathematics.	Baumert et al. (2008)	
55	I like math the least of all subjects.	Baumert et al. (2008)	
56	I finished the last school year		Ordinal

	with the following grade in math.		
57	How old are you?		Scale
58	Gender		Nominal
59	Grade		Ordinal
60	What else I would like to say		nominal

INTERDISCIPLINARY DIDACTICS OF STEM SUBJECTS AND PHYSICAL EDUCATION

Classroom disruptions significantly impede student academic success and teacher well-being. Simultaneously, global education systems are increasingly digitalized, creating three distinct learning settings: digitally enhanced face-to-face, online, and hybrid. This raises a critical question: How does digitalization affect classroom disruptions?

To investigate this, this dissertation employs a mixed-methods approach, examining classroom disruptions in digital settings from the perspectives of academic literature, teachers, and students. Integrating these three viewpoints refines current categorizations of disruptions for the digital age. The findings identify five disruption categories in digital settings: behavioral, communication, executional, external, and participation disruptions. This novel categorization provides a foundation for future research on digitalization and education, benefiting both researchers and teachers.

