

Classroom Disruptions and Classroom Management in Learning Factory Settings at Vocational Schools

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Abstract

Context: As part of vocational education and training, learning factories are a new, hands-on learning setting in which students can create products with realistic digital manufacturing equipment while still in vocational school. Given their novelty, learning factories have not yet been studied with respect to whether special classroom management may be needed. One key aspect of classroom management for teachers is the dealing with classroom disruptions. The aim of this study is to investigate what types of classroom disruptions occur in learning factories and how teachers deal with them.

Methods: To close the existing research gap, a guideline-based, semi-structured interview study with seven teachers from the federal state of Baden-Württemberg, Germany, was conducted. The interviews were analyzed with a qualitative content analysis using the software MAXQDA.

Findings: The findings show that in this new setting, established strategies for mitigating classroom disruptions can be adapted and applied. Teachers were found to use and optimize their existing abilities to ensure learning success and were able to protect the monetary value of the factory against certain disruptions. Mutual trust between teachers and students, as well as teachers utilizing strategies according to their personality, were mentioned as the most important factors in ensuring success in this context.

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Conclusion: Learning factories as a new learning environment in vocational schools do not seem to require specific classroom management approaches. As a result, their use can be safely expanded. Teachers value the possibility of teaching in this special setting while seeing that there are new possible ways of disruptions. Nevertheless, the interviewees feel themselves prepared for these new challenges, using their already established repertoire of strategies, adapting them, if necessary, to this new setting. To do this, teachers need to systemize and understand disruptions inside their classrooms. So far, research is lacking systemizations for classroom disruptions in digital settings like learning factories. This study extends the research landscape with an adaption of an already existing construct.

Keywords: Classroom Management, Student Behaviour, Interview, VET, Vocational Education and Training

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 learning factories (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 digitization (European Union, 2020; Kultusministerkonferenz, 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.

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.

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" (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 systemizations: (a) Systemizations that weigh the severity of disruptions against each other and (b) systemizations that group disruptions without weighing them (Meinokat & Wagner, 2024). Examples can be found in table 1 and table 2.

Table 1: Categories for Separating Systematizations (Meinokat & Wagner, 2024)

<i>Biller (1979)</i>	<i>Lohmann (2011)</i>	<i>Winkel (2011)</i>
- Minor faults	- Verbal disruptions	- Disciplinary disruptions
- (In)direct disruptions	- Lack of willingness to learn	- Provocation and aggression
- Unrecoverable disruptions	- Motoric restlessness	- Permanent acoustic and visual disruptions, as well as restlessness and concentration
- Unavoidable disruptions	- Aggressive behavior	- Disruptions from outside the class
		- Refusal to learn and passivity
		- Missing motivation
		- Neurotic disorders

Table 2: Severity Weighting Systematizations (Meinokat & Wagner, 2024)

<i>Severity</i>	<i>Cogswell et al. (2020)</i>	<i>Rattay et al. (2018)</i>	<i>Scherzinger and Wettstein (2019)</i>
High	- High-level classroom disruption	- Conduct disorders - Behavioral problems - Impossibility - Interruption	- Aggressive
low	- Low-level classroom disruption	- Impairment	- Nonaggressive

In terms of digital settings, where LFs are located in, so far only one systemization for disruptions exists: The Student Online Misbehavior scale (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 & Wagner, 2024) with three more categories: *Technical errors*, *operating errors*, and *illicit social behavior*.

2.2 Vocational Education in Germany and Learning Factories

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

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.3 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:

- RQ1: What types of classroom disruptions occur in LFs?
- RQ2: What preventive and interventive measures do teachers use to deal with classroom disruptions in LFs?

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.

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 3: Overview of Participants

<i>Alias</i>	<i>General teaching experience in years</i>	<i>LF teaching experience in years</i>
A	25	5
B	20	4
C	14	5
D	12	1
E	20	2
F	9	5
G	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 if 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.

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. 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: Interview Guide

RQ1	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?
RQ2	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?

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 Findings

The results are presented here according to the research questions.

4.1 Types of Classroom Disruptions in Learning Factories (RQ1)

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.

4.1.1 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" (Teacher D, lines 22 – 28). 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 C, 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" (Teacher C, lines 355 – 358). 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" (Teacher C, lines 247 – 248). 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" (Teacher D, lines 248 – 250). 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" (Teacher

A, lines 178 – 180). 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" (Teacher D, lines 196 – 197). Teacher F 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" (Teacher G, lines 129 – 130) led to the non-functionality of the LF and therefore to a disrupted classroom.

Teacher A also mentioned *tardiness*, and that time was limited when learning practically and within an LF. Therefore, "if they arrive late" (Teacher A, line 192), 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.

4.1.2 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 Teacher F (lines 215 – 217): "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 Teacher G 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.

Teacher G 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" (Teacher G, lines 56 – 57) 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.

4.2 Preventive and Interventive Measures (RQ2)

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.

4.2.1 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" (Teacher C, line 74). 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" (Teacher G, lines 261 – 262).

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" (Teacher C, line 37) before entering the LF, as well as earning some opportunities to explore what the LF had to offer (Teacher B).

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" (Teacher B, line 217), the motivation could be held up high, and frustration could be minimized, all leading to an overall more fruitful learning experience (Teachers A, B, and D). 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 B and C (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 C and F 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.

4.2.2 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.
(Teacher F, lines 183 – 186)

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 A, C, D, F, and G.

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 Teacher B 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" (Teacher B, lines 245 – 248).

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. (Teacher C, lines 316 – 324)

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.

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 systemization, which further confirms its applicability (Table 5).

Table 5: 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 6 shows how the existing research relates to this new separation, based on the disruptions reported in this study.

Table 6: Separation of Classroom Disruptions

<i>Classroom disruptions caused by human behavior or interaction</i>	<i>Classroom disruptions caused by external aspects</i>
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.

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, Sections 2.1 and 2.2). 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. Systemizations 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.

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 RQ2 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 reevaluation 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 if 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.

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 digitization (European Union, 2020; Kultusministerkonferenz, 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 systemizations 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.

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