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University Teachers' Agency in Relation to Technology Use in Teaching: A Quantitative Investigation

La agencia de los profesores universitarios en relación con el uso de la tecnología en la enseñanza: una investigación cuantitativa

Liv Nøhr; lsnl@ind.ku.dk; University of Copenhagen (Denmark)

Maria Hvid Stenalt; mariahs@ikl.aau.dk; Aalborg University (Denmark)

Danielle Hagood; dh@ind.ku.dk; University of Copenhagen (Denmark)

Abstract

This study investigates Danish university teachers' agency in using digital technologies in teaching. Furthermore, it explores how teachers' conduct and experienced constraints are connected to different dimensions of teachers' agency.

The paper is based on survey responses from 344 teachers about their agentic will and power to influence aspects of technology usage in teaching. Using an exploratory factor analysis, we identify three distinct factors and their relations: 1) wanting to control digital data and having the power to do so is distinct from 2) teachers' power and will to control the technologies adopted and 3) how technologies are applied in teaching. Furthermore, all factors correlate with the teachers' conduct (extent to which technology facilitates education interactions), while there are factor-specific patterns to the constraints (e.g., time, experience).

The results provide a basis for revisiting teachers' role in university decision-making. We include a discussion on the entangledness of agency across institutional levels.

Keywords: *agency, ed-tech, data, digital education, learning technologies, higher education*

Resumen

Este estudio investiga la agencia de los docentes universitarios daneses en el uso de las tecnologías digitales en la enseñanza. Además, explora cómo la conducta de los docentes y las limitaciones experimentadas están conectadas con diferentes dimensiones de su agencia.

Este trabajo se basa en las respuestas a una encuesta realizada a 344 docentes de una universidad danesa, sobre su voluntad y poder 'agentivos' para influir en aspectos del uso de la tecnología en la enseñanza. Mediante un análisis factorial exploratorio, identificamos tres factores y sus relaciones: 1) querer controlar los datos digitales y el poder para hacerlo, que es distinto del (2) poder y la voluntad de los docentes para controlar las tecnologías adoptadas y 3) la forma en que se aplican las tecnologías en la enseñanza. Además, todos los factores se correlacionan con la conducta de los docentes (hasta qué punto la tecnología facilita las interacciones educativas), mientras que existen patrones específicos de los factores en cuanto a las limitaciones (como por ejemplo: tiempo, experiencia).

Los resultados proporcionan una base para revisar el papel de los docentes en la toma de decisiones universitarias. Incluimos un debate sobre el entrelazamiento de la agencia en los distintos niveles institucionales.

Keywords: *agencia, ed-tech, datos, educación digital, tecnologías del aprendizaje, enseñanza superior*

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1. INTRODUCTION

Increasingly, teachi<ng in higher education relies on digital technologies that are organised by institutional infrastructures and managed by administrators. This shift brings with it the demand for data security and transparency in digital platforms, the need for access to local support for both technical and pedagogical learning design, and the proliferation of online teaching and learning materials (Selwyn et al., 2020). Decisions addressing these demands are mostly made at organisational levels which teachers cannot influence; however, those decisions still impact teachers' teaching choices. Ultimately, the way digital technology is implemented can constrain teachers' agency in digital teaching.

Studies of teaching in higher education during COVID-19 illustrate such constraints. For instance, Watermeyer and colleagues (2021) found that higher education teachers experienced significant 'afflictions' on their professional roles as teachers and private lives in transitioning to online teaching. In this vein, the majority of studies from this period show that using digital technologies required teachers to invest significant time and effort as well as renegotiate teaching practices. Moreover, discussions of societal surveillance capitalism call for a bigger responsibility towards the choice of technology (Dijck et al., 2019; Fawns, 2022; Zuboff, 2019). The combination of hardship, investment and surveillance issues could lead to what Draper and Turow (2019) frame as 'digital resignation'—where teachers respond with inaction and resignation in the face of difficult situations they believe they cannot combat.

Thus, in a progressively digitized educational system, understanding teachers' agency in relation to technology usage is crucial. Most existing studies, however, focus on how to use technologies effectively, while few explores teachers as agents seeking to act meaningfully under limiting constraints. The current study aims to update the existing literature with a focus on exploring teachers' capacity to exert influence and make choices and decisions about digital technologies for teaching and learning. The conceptual framework guiding this study is the relational conceptualisation of agency (Damşa et al., 2021). Thus, we do not suggest that agency is an individual's capacity or ability. Instead, the framing of agency proposed conceptualises agency as an emergent phenomenon, achieved in concrete settings and dependent on the 'interplay of individual efforts, available resources and contextual and structural factors as they come together in particular and, in a sense, always unique situations' (Biesta & Tedder, 2007, p. 137). Also, we take seriously 'the intentional projects of the individual' and how these projects are enabled and constrained, as suggested by Ashwin (2012, p. 21), by paying attention to teachers' agentic orientation (will), which concerns the way teachers 'relate to past, present and future in making choices of action and interaction' (Klemenčič, 2015, p. 16) and teachers' agentic possibility (power), which is teachers' 'perceived power to achieve intended outcomes in a particular context of action and interaction' (ibid.). Finally, we take seriously possible constraints to teachers' agency, such as lack of time and inadequate technical and pedagogical support.

This study draws on a survey of university teachers in Denmark to increase the understanding of what teachers want to be able to influence concerning their technology use. We are guided by the following research questions:

1. What are the characteristics of teachers' agency in the context of technology use in higher education teaching?

2. How are different characteristics of agency related to teachers' conduct?
3. How are different characteristics of agency related to teachers' experiences of constraints?

We operationalize teachers' *conduct* as teachers' use of technologically-supported educational interactions (TSEI), which includes receiving feedback from the students, giving feedback to the students, and testing their competencies and skills. We operationalize *constraints* as known challenges to teaching, which includes lack of time and inadequate technical and pedagogical support (Damşa et al., 2021).

To answer the research questions, we begin with an overview of research on the relationship between teachers' agency and technology (Section 2). Next, we explain why Denmark is an interesting context to investigate teachers' agency in relation to technology and outline our study methods (Section 3). We then present our results with a particular emphasis on the agency dimensions explored and the relation to teachers' use of digital educational interactions, support, and experience (Section 4). Finally, we conclude with a discussion of our findings and limitations (Section 5) and the implications for educational practice (Section 6).

2. TEACHING, TECHNOGY, AND AGENCY

To understand the relationship between higher education teachers and technology, a dominant focus has been the delegation of agency between humans (such as teachers) and nonhumans (such as technologies). From this focus, two simplistic understandings have been presented concerned with educational technology: the essentialist and the instrumentalist (Hamilton & Friesen, 2013). The essentialist understanding delegates agency to the technical object, due to its proclaimed power to realize student learning. The instrumentalist perspective delegates agency to humans, presenting technology as a means to achieve teachers' goals. Tim Fawns outlines this division as a false dichotomy between "pedagogical first" and "technology first" positions (Fawns, 2022). While both positions exist in technology positive and negative versions, Fawns suggests that they reduce the complexity of the problems they aim to solve (Fawns, 2022, p. 712). Instead, he argues that technology, users, and the social context surrounding them all are shaping the situation and determining the activity (Fawns, 2022; Winner, 1980). In this perspective, pedagogical methods and technology, together with the purposes, context and values of teachers, students, and other stakeholders, constitute pedagogy (Fawns, 2022, p. 714).

Additionally, Fawns places a responsibility on both teachers and the institutions to understand not only the functionality of included technologies but also the potential harms (Fawns, 2022, p. 721). In this view, (digital) pedagogy becomes a dance that involves everyday practice in the classrooms and more abstract things such as data ethics or knowledge of technological affordances. This includes understanding how data is collected, interpreted, and used. Differences in who has access to such information and what it can be used for has been discussed extensively under conceptions of "data capitalism" (West, 2019) and "surveillance capitalism" (Zuboff, 2019). Both terms address the profit by tech companies who sell predictions of conduct from data traces. As education is a public good, it is at odds with data *capitalism*, but surveillance- or data capitalism are introduced through the emphasis on data traces in new technologies (Williamson et al., 2020). Furthermore, while technologies

depending on behavioral data often are presented as neutral, they amplify power distributions in terms of who has access to both understanding and deciding what the technologies should do and which data those decisions should be based on (boyd & Crawford, 2012; Whitman, 2020).

2.1.Teachers' Agency

In educational studies, agency often refers to human's capability to navigate, influence and take responsibility in their environments (Klemenčič, 2015). Agentic humans can propose and change their environment. For example, Vähäsantanen et al. (2019, p. 270) refer to teachers' professional agency as encompassing the notion that "professionals exert influence, make choices and decisions, and engage in negotiations regarding work, and the professional self." Other conceptualisations of agency focus more on teachers' pedagogical actions and beliefs, thus entailing a strong focus on teachers as pedagogical experts responsible for managing a learning environment and being a resource for others' learning (Edwards, 2005). This is the case for Soini et al. (2015, p. 642) who explore schoolteachers' sense of professional agency in the classroom and argue that it consists of "teacher's motivation to learn about teaching continuously, their efficacy beliefs about their learning as teachers, and intentional activities for facilitating and managing learning in everyday pedagogical practices in the various professional contexts of their work." While teacher agency has been linked to schools' agendas and teacher education, research on teachers' agency in higher education (Kusters et al., 2023) is limited, particularly of agency within a digital teaching contexts (Marín et al., 2020; Stenalt, 2021).

2.2.Agency in Digital Education

Turning to studies of higher education teachers' agency in digital contexts, Damşa and coauthors (2021) offer valuable insight into teacher agency in digital contexts of education. Drawing on two conceptualisations of agency, they define teachers' agency as "the capacity of people to act upon their ideas and plans to transform current thinking or practice" (p. 3). First, Damşa and colleagues build on Emirbayer & Mische's (1998) distinction of three temporal dimensions of agency: iterational (capitalizing on routines and past knowledge), projective (orienting towards the future, not merely replicating what is known), and practical-evaluative (involving momentary judgements of how to act and the efforts involved based on the available cultural, structural, and material resources). Second, they suggest a correspondence between the projective dimension and what Virkkunnen (2006) describes as transformative agency, involving engagement with conflicts. From Haapasaari and colleagues (2016) they included six dimensions of agency, with different degrees of transformation, include resisting and criticising current activity (low transformative agency), envisioning new patterns and models (tentative transformative agency) and taking meaningful actions enabling change (high transformative agency).

In their study, Damşa and colleagues (2021) surveyed university teachers in Norway and identified three teacher profiles based on their use (action) of new online teaching methods, software, and support. They identified that previous experience with digital education is important, as most teachers with low action (78%) or medium action (72%) had no experience. In comparison, only 50% of the teachers with high action had no experience. The study also

found that a lower proportion of teachers with high action had challenges with online teaching compared to the other two profiles. Further, based on teachers' qualitative responses in the survey, they identified a correspondence between teachers' action-level and agency manifestations. While transformative agency is desirable, Damşa and colleagues' work illustrates that constraints should be accounted for and that even actions resulting in no transformation represent agency.

In prior work, Stenalt and co-authors (2023) explored Danish university teachers' agency in relation to digital technology use. Drawing on qualitative survey data, they recognised eight benefits of technology use perceived by teachers: regulating, logistics, participatory, compositional, disinhibition, mirroring, personalisation and augmenting. This study also study identified five teacher values that appear to underpin these benefits: relational commitment, mediator of knowledge, facilitator of student learning, stability and simplicity. A critical implication of this is that while teachers are expected to transform teaching through digital elements, teachers' values underpinning such actions might be oriented towards the iterational and practical-evaluative dimension of agency. Consequentially, transforming teaching and learning through digital technologies is constrained by existing practices and beliefs.

3. METHOD

3.1.The Danish Context

The present study is based on survey data collected in February 2022 at a large Danish campus-based university. Denmark provides an interesting case to explore new dilemmas for university teachers' agency. Indeed, Denmark stands out in a global comparison due to the high degree to which the government records information about intimate aspects of citizens' lives, such as their residence, marriage, or children (CPR-kontoret). While Danes face a lot of governmental monitoring, they also put a high degree of trust in the government compared to other data collectors. A recent survey on Danes' knowledge of data collection showed that only 29% are worried about the state having data about them compared to 55% who are worried about data held by corporations (Analyse & tal, 2023). The same distrust of corporations is shown as 63% of Danes experience data collection in the workplace, but only 1 out of 10 finds that to be positive (Tænketanken Mandag Morgen et al., 2023).

Additionally, Danish universities have prioritised integrating information and communication technology since the government set out goals for more ambitious use of technology in 2007, and the amplification of this through contracts between state and universities in 2015 (Tømte et al., 2019). This has also led to economic support for using digital tools in education that is echoed in the universities through digital strategies, which underline the interest in using more educational technology in the teaching. However, in the materials from the universities, it is common to find notions indicating that the inclusion of educational technology tech should be due to didactical reasons rather than for technical reasons, implicitly placing decision-making responsibility on the teachers (e.g., Roskilde University, 2019).

The present study stems from a broader research project born out of a university strategy to further integrate digital technologies in higher education teaching to support student learning. The project coincided with the period where COVID-19 required teachers to teach online. The

broader project received support from the university to survey the scope of teachers' experiences with digital technology and teaching. This paper reports on a sub-survey within this project concerned with teacher agency.

3.2.Participants

Participants were recruited by e-mail, with 6,001 employees identified as teaching the previous semester according to the university's learning management system (LMS) receiving a survey invitation. In total, 749 teachers (13% of those emailed) responded to the survey. Notably, teaching roles can be assigned to non-teachers in order to access the LMS's technical functionalities. Due to this, the target sample of actual teachers is significantly smaller than our actual sample, which artificially lowers our response rate.

We excluded responses if the respondent had not taught in the present semester (N = 21). Of the 728 eligible respondents, 344 answered the survey sections pertinent to this article. Due to the limited size of respondents and the explorative nature of the investigation, we allowed the sample size of the graphical examination of the factors and teachers' TSEI and experienced constraints to differ, depending on the responses for the specific items.

Based on administration data, we know the number of courses taught within each faculty. Participants also reported which faculty they taught in. From this, we estimated the response rate within each faculty: Humanities (16%), Theology (15%), Science (14%), Social Science (14%), Law (12%), Health and Medical Sciences (9%). Some teachers teach in multiple faculties but were asked to respond based on the faculty in which they taught most. This may artificially lower our faculty-specific response rates but allows for comparing agency and teaching experiences across faculties.

3.3.Survey Questions

The questions outlined below were presented to participants in either English or Danish based on their preferences (see translation in Appendix).

3.3.1. Agency

Based on our conceptual framework, we focused on teachers' intentional projects and how these are enabled and constrained. Hence, we paid attention to teachers' agentic orientation (will) and possibility (power) and included six questions to survey these two dimensions of in three contexts (digital technologies, digital teaching, and digital data). Table 1 below shows how these questions align these two dimensions of agency in three contexts. Participants responded to these questions by rating their level of agreement on a five-point scale, from 1 (low) to 5 (high). These questions were framed in the local university context, with the statement: "The following questions concern your general experience of digital technology and platform use (such as [list of local LMS and technologies]) for and in teaching at [University]."

Table 1

Agency Questions

Context	Agency	Question
digital technologies	will	I want control over which digital technologies and platforms I adopt in my teaching
digital technologies	power	I can control which digital technologies and platforms I adopt in teaching
digital teaching	will	I want control over how to use digital technologies and platforms in my teaching
digital teaching	power	I can control how to use digital technologies and platforms in my teaching
digital data	will	I want control over what digital information and data about me others at [university] can access from my use of digital technologies and platforms such as [LMS].
digital data	power	I can control what digital information and data about me others at [university] can access from my use of digital technologies and platforms such as [LMS].

3.3.1 Conduct

We included six questions to survey teachers' conduct—that is, teachers' use of technologically-supported educational interactions (TSEI)—in three interaction types (receiving feedback from students, giving feedback to students, and allowing students to test their competencies and skills) both two contexts (inside and outside the classroom). Participants rated "the extent to which you have [TSEI] via online activities or tools [in/outside] the teaching situation" on a 5-point scale from 1 (low extent) to 5 (high extent). We aggregated across contexts to get an average rating for each TSEI type.

3.3.2. Constraints

We included 10 questions about constraints. First, we asked teachers to rate their online teaching experience on a 5-point scale from "no experience" to "extensive experience." Next, we asked teachers how often they experienced their own problems or spent time solving students' problems using digital tools in three contexts (HyFlex, online, and on-campus teaching). For these questions, teachers responded on a 5-point scale six times to rate their experience of these two problems across three contexts. Finally, teachers described the frequency of three constraints on a 5-point scale from 1 (never) to 5 (always): 1) How often is it difficult for you to find time to prepare for your teaching? 2) I regularly discuss pedagogy and teaching quality with my colleagues. And 3) I have access to technical and pedagogical support for my teaching. These 10 questions measure five different experienced constraints: teachers' experience with digital teaching formats, issues with technologies, access to support, discussions with colleagues, and limited time.

3.4.Analysis

To address the first research question—What are the characteristics of teachers' agency in the context of technology use in higher education teaching? —we conducted several analyses, including: describing question response patterns with descriptive statistics, conducting a one-way ANOVA to compare question response patterns, and an exploratory factor analysis (EFA) to identify characteristics (dimensions) of agency among the response patterns.

To address the second and third questions—How different characteristics of teachers' agency related to teachers' conduct (RQ 2) or teachers' experiences of constraints (RQ 3)—we used the characteristics (dimensions) of agency identified in response to the first research question and visualised the relationship between these characteristics and the questions related to teachers' conduct and experiences of constraints. These visualisations are based on linear-regression results. We use the visualisations to emphasise general patterns, resulting in a descriptive, visual analysis.

4. RESULTS

In this section, we present the results of the analysis, starting with the descriptive analysis of agency variables, followed by the exploratory factor analysis, and ending with the graphical investigation. For full item-text and summary statistics, see Appendix.

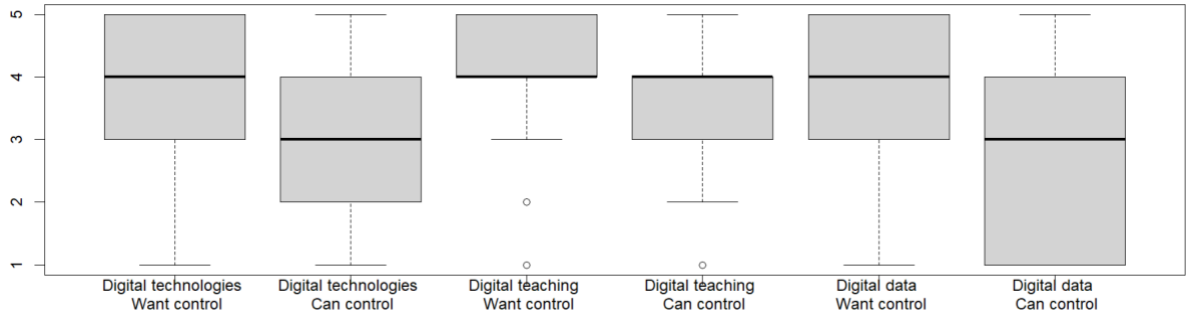
4.1.Characteristics of Teachers' Agency in Relation to Technology

4.1.1. Descriptive Analysis of Question Response Patterns

To characterise teachers' agency in the context of technology use in higher education teaching, Figure 1 shows how teachers answered the six questions regarding their experienced agency in relation to technology. On average, teachers rated their will ("want" questions) higher than their actual power ("can" questions). This was true in all three contexts we surveyed: digital technology (M_{want} = 4.09; M_{can} = 3.30), digital teaching (M_{want} = 4.23; M_{can} = 3.44), and digital data (M_{want} = 3.37; M_{can} = 2.70). Additionally, the response patterns to the two questions concerning digital data stand out. First, on average, ratings regarding digital data (both will and power) were lower compared to digital technology and teaching. Second, for digital data, control ("can") had a much wider response range (IQR = 3) compared to the other questions (which had IQRs ranging from 1 to 2). The visual patterns and differences illustrated in Figure 1 were confirmed by a one-way ANOVA comparing the mean responses between questions $F(5, 2058) = 73.38$, $p < .001$, and the patterns discussed above are all significant at the $p < .05$ level based on a TukeyHSD post-hoc analysis.

Figure 1

Distribution of Agency-Items



In addition to responses on the 5-point scale, respondents could select "don't know" or "do not wish to reply." While those choosing "do not wish to reply" were excluded from analysis, there is an interesting pattern to examine. For the questions related to digital technologies and digital teachings between 18 and 33 participants selected "don't know" on each question. But many more participants selected "don't know" in response to the digital data questions: N_{want} = 93 and N_{can} = 182, respectively. These were the most ("can") and second-most ("will") selected response option, for the questions relating to digital data.

4.1.2. Exploratory Factor Analysis

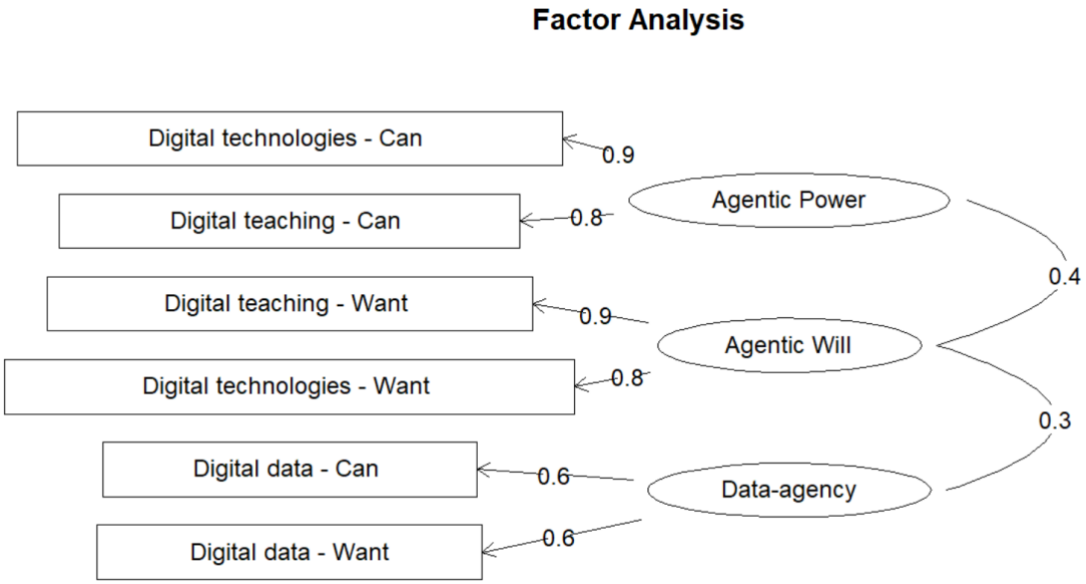
In addition to analyzing the response patterns among agency-related questions, we also conducted an exploratory factor analysis (EFA) to identify possible characteristics of agency. Because the six questions were written to survey two dimensions of teachers' agency (agentic orientation and possibility) across three contexts (digital technologies, digital teaching, and digital data), plausible EFA results include finding two agency dimensions or three context dimensions. However, this is not what we observed.

As shown in Figure 2, we found three dimensions related to teachers' agency in relation to technology: agentic power, agentic will, and data agency. The first dimension, *Agentic Power,* includes what teachers *can* change regarding digital technologies and digital teaching (□□= .86). The second dimension, *Agentic Will,* includes what teachers *want to* change regarding digital technologies and digital teaching (□□= .84). Neither power nor will related questions regarding digital data are a part of these dimensions. Instead, they appear in a third dimension, *Data Agency,* includes both will- and power-related questions regarding digital data (□□= .49).

We determined the data were acceptable for an EFA based on: a robust ratio 57:1 respondents to questions, no restriction of range for all questions (min = 1; max =5), acceptable question response distributions with ranges of skew between -1.35 and 0.17 and kurtosis between -1.19 and 1.58, and exceeding the sampling adequacy threshold (KMO = .68). Both Eigenvalues ≥1 and Scree plots based on parallel analysis suggested a three-factor solutions. We extracted the three factors described above using principal axis factoring and oblique rotation.

Figure 2

Factor-Structure of Agency Construct



4.2.Teachers' Conduct & Experience of Constraints

Using the three dimensions of agency identified through the EFA, we explored how these three characteristics of teachers' agency—agentic power, agentic will, and data agency—relate to the teachers' conduct (TSEI) and constraints.

Regarding teachers' conduct, Figure 3 shows the relationship between each dimension of teacher agency and conduct. The plots show a general pattern (N = 279–295) in which scoring higher in the three agency dimensions is associated with more technology-supported educational interactions (TSEI). The relationships shown in Figure 3 (β = 0.11–0.28) correspond to small effect sizes (R^2 = 0.02 – 0.11).

Regarding teachers' experienced constraints, Figure 4 shows the relationship between each dimension of teacher agency and various constraints: issues with technologies, teachers' experience with digital teaching formats, access to support, and limited time. Concerning technology issues, teachers who experience issues more frequently tend to have higher data agency (N = 330, β = 0.31, R^2 = 0.01). Concerning experience, teachers with greater experience tends to have higher agentic power and agentic will (N = 344, β = 0.33–0.27, R^2 = 0.03—0.01). Concerning support, the relationship to factors depends on the measurement of support; teachers with access to technological- and pedagogical support experienced higher agentic power (N = 321, β = 0.30 - 0.37, R^2 = 0.02), while teachers with access to discussions with colleagues experienced higher agentic will (N = 321, β = 0.31 – 0.49, R^2 = 0.03). Concerning time, we did not observe a relationship between limited time and the dimensions of agency.

Figure 3

Factors and Technology-Supported Educational Interactions

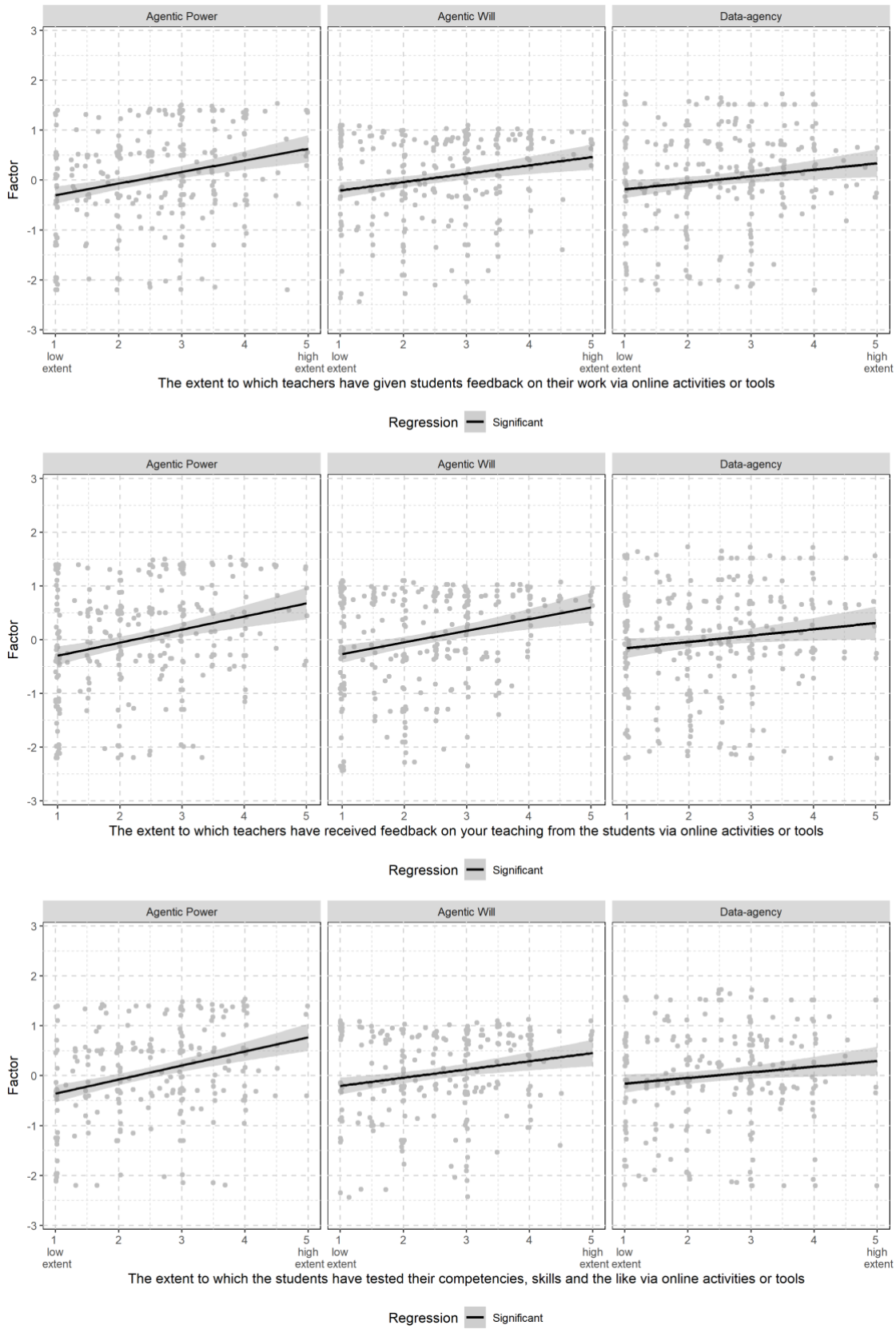
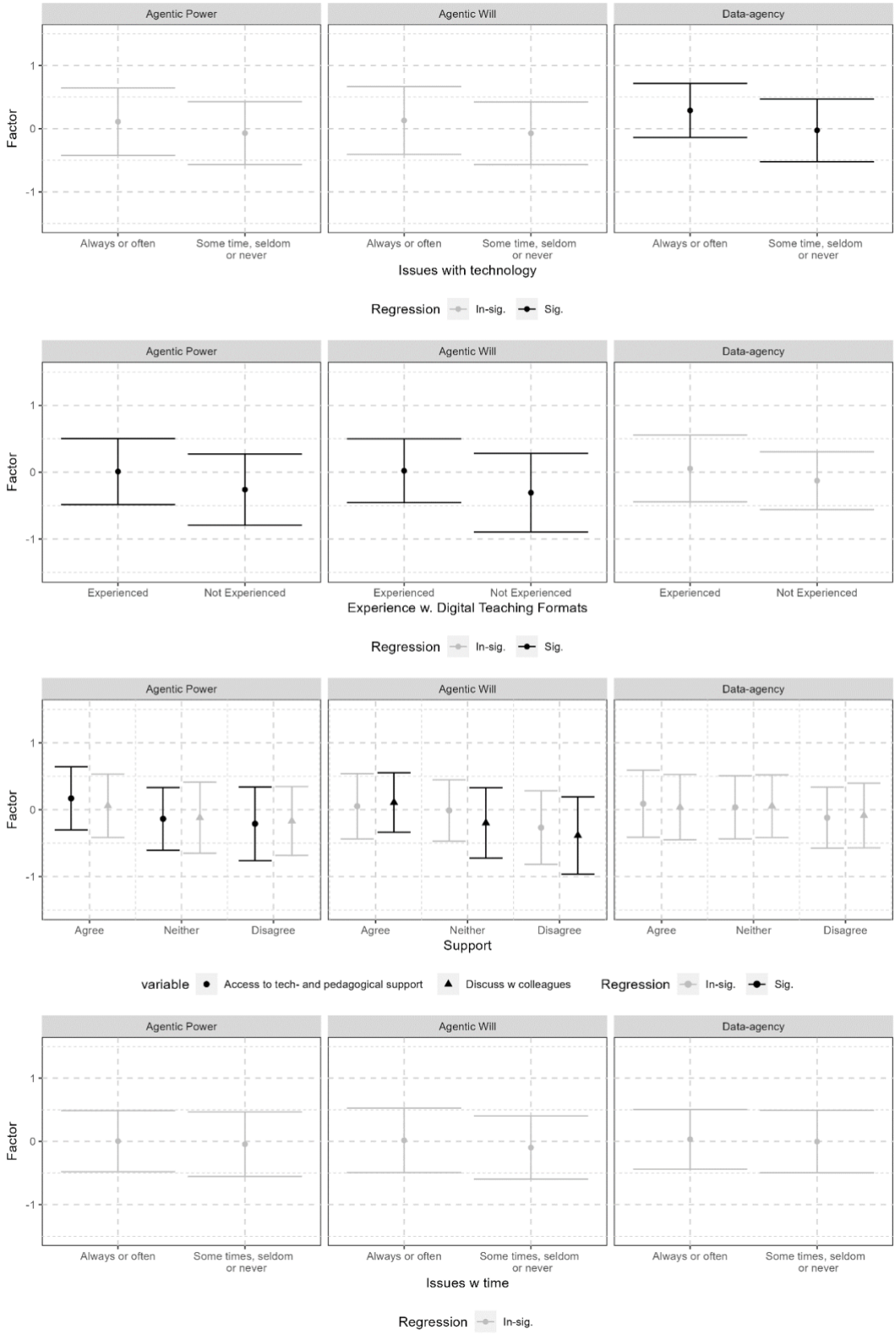


Figure 4

Factors and Constraints



5. DISCUSSION

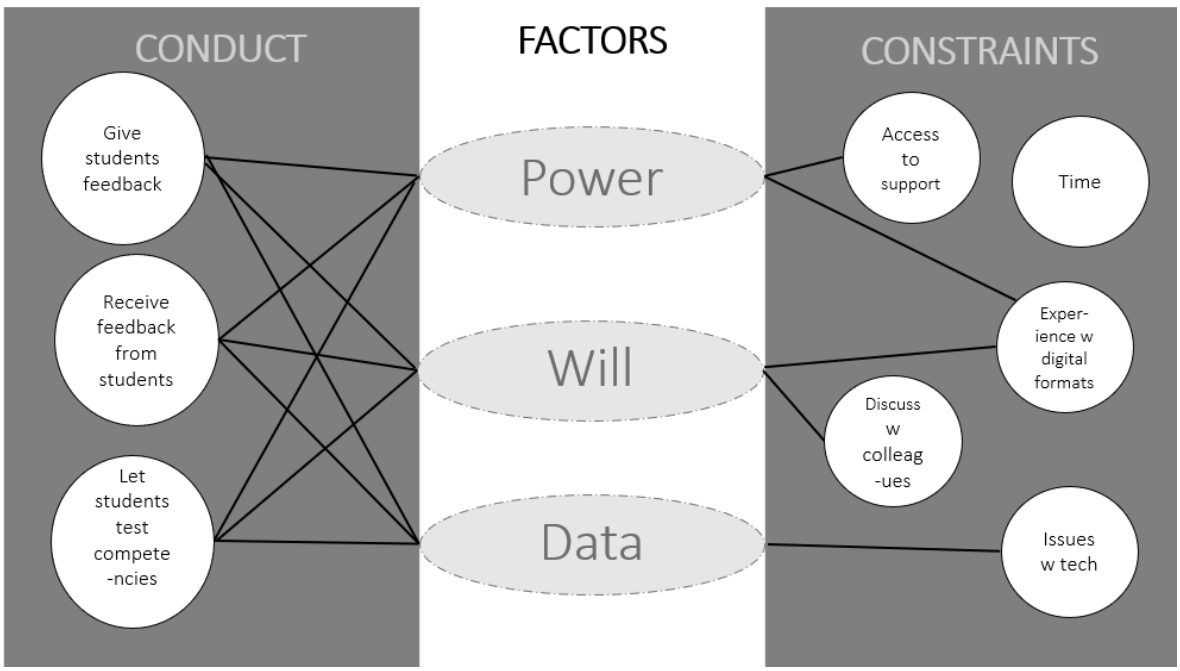
In this section we will showcase the overall relationships identified in the study, relate the findings to the literature, and discuss limitations in our study.

5.1.Our Model of Teacher Agency in Relation to Conduct and Constraints

Figure 5 outlines the characteristics of agency (dimensions) suggested by exploratory factor analysis (power, will, and data) and shows how these relate to teacher conduct and experience of constraints. We observed that most teachers wanted to control which digital technologies to adopt and how to apply them. Furthermore, teachers were less interested in and less able to control data compared to the other digital contexts we surveyed. Across all three digital contexts, teachers desire to influence technology adoption and applications was higher than their actual ability to do so.

Figure 5

Factors, Conduct, and Constraints



We observed an overall positive relationship between all dimensions of teachers' agency and use of technology-supported educational interactions (TSEI). This echoes the findings from Damşa and colleagues (2021). However, regarding the relationships between teachers' agency and constraints, the patterns we observe differ from their findings. While Damşa and coauthors (2021) summarize relationships between all aspects of agency and the various constraints, the patterns we observed are more varied. We also find that experience (specifically lack of experience) is the only constraint related to both agentic power and will. While it seems plausible that having experience increases teachers' self-efficacy and positively affects their agentic power and will, it remains unclear why there isn't a similar pattern for data. Regarding discussions with colleagues, this aspect may operate as a source of teachers' agentic orientation ("will")— allowing teachers to mirror peers' practices and expand their conceptions

of what is possible in practice. Regarding access to support and issues with technology, one could expect they would affect the same agency dimension, but we found them to be relatively unrelated. Indeed, access to support was related to agentic power, which suggests that this resource can be used to gain control of educational technology. Experiencing issues with technology was on the other hand related to data-agency. We did not observe a similar effect for limited time. One explanation could be that most teachers have similarly limited time, so there is not a strong effect on agency. Further research is needed to confirm these relationships and the direction of influence between agency and constraints.

5.2.Relation to Prior Research

The empirical material presented illustrates that teachers experience high levels of agentic power and will. As such, our findings challenge the perspective that limiting the selections of technology available to teachers, opting for top-down implementation strategies, and using technologies that constrain interactional opportunities (Selwyn et al., 2020; Tømte et al., 2019) limits teachers' agency. How do we make sense of this discrepancy? We propose to understand this schism as a matter of proxy agency (Bandura, 2001). Indeed, when teachers have limited direct power to influence a situation or practice they may rely on others to act on their behalf. The premises of proxy agency is that teachers are able to influence those acting on their behalf. In other words, teachers channel their agency to people they trust empowered to act in contexts where teachers have limited power. In support of this interpretation, Kusters and colleagues also found that university teachers' agency is related to a micro-level, teachers' own courses, but hardly at the level of the community and the university (Kusters et al., 2023). Thus, use of digital technology requires distributed forms of agency.

What about digital data then? As mentioned in the introduction, digital data presents a case where control and access cut across several institutional levels, but never rests with the teachers. Typically, data-related decisions operate on an organizational level, further away from the teachers and their own practice. This may explain why we observed different response patterns to data compared to digital technologies and teaching. This might also be a reason for it being captured on another factor in our model. Future research should investigate the role of digital data from a teacher perspective and its effect on teachers' agency.

Our survey responses highlight the extent to which teachers experience agency when using digital technology in teaching. Most teachers conveyed high levels of agency will and -power towards digital technology. At the same time, literature has reported low levels of digital technology use among academics (Mercader & Gairín, 2020). How are we to interpret this? Assuming that teachers in this Danish case are being situated as experts of teaching and learning with the expertise to include digital technology when it is meaningful to student learning, the concept of agency can explain why teachers' low use of technology makes sense. If teachers truly do not see a meaningful purpose for using technology, they have the power to resist technology and reduce the presence of technology to an absolute minimum. This is however conditioned on the role teachers have as experts, as evident in the Danish case. Further research is needed to explore the relationship between different agency manifestations and their scope of actions, depending on the role teachers are given in their local context.

5.3.Limitations

Our study has several limitations. First, the data is based on questions that have a similar sounding wording, which could be affecting the created dimensions. The high number of people answering "don't know" indicate that there might be an interesting additional dimension in terms of what people know about their prospects for control. The affiliated reduction in respondents causes potential power issues in the statistical tests related to the graphical investigation. Thus, while the questions have enabled insight into the theme in focus, we encourage researchers in the field to further understanding the teachers' agency by adding nuances related to the construct and expanding the dimensions examined.

Second, some caution must be exercised in formulating digital technologies and surveillance questions. Obstacles to such questions include the context and nature of the knowledge teachers have about technologies. Oftentimes, this will be influenced by their local context and based on their practical knowledge with specific technologies. Furthermore, as described in section 3.1, recent surveys shows that Danes underestimate their understanding of data and data-collection, which is in line with the high number of people responding "don't know" to items in the digital data-context. A recommendation may be to conduct studies on the faculty or department level to accommodate this.

Third, despite correlations between TSEI and constraints, we cannot know the potential causal direction of the relationship. While our data allowed us to explore dimensions of agency, future studies might engage in various research methods, including observations and interviews, to investigate how this is enacted in practice and gain a deeper understanding of the phenomenon.

Finally, the Danish higher education context provides a particular case to understand academic autonomy in teaching. It is characterized by top-down approaches to digital technologies in education and a high degree of government-based data collection. Based on a relational approach to agency, generalizations of our findings are outside the scope of our study. Indeed, power relations may come across and affect teachers in diverse ways in other HE contexts. Thus, we encourage researchers to replicate our study to explore how teachers' agency unfold in other countries.

6. CONCLUDING REMARKS

In this study, we explored university teachers' agency in relation to digital technologies for teaching. By focusing on teachers' will and power towards this aspect of teaching, we hope to have contributed to identifying aspects of teachers' agency in digital teaching and making it clear that digital teaching is not only the responsibility of teachers. Instead, higher education institutions should look beyond teachers' responsibility of teaching and into the institutional spaces to further teachers' digital agency.

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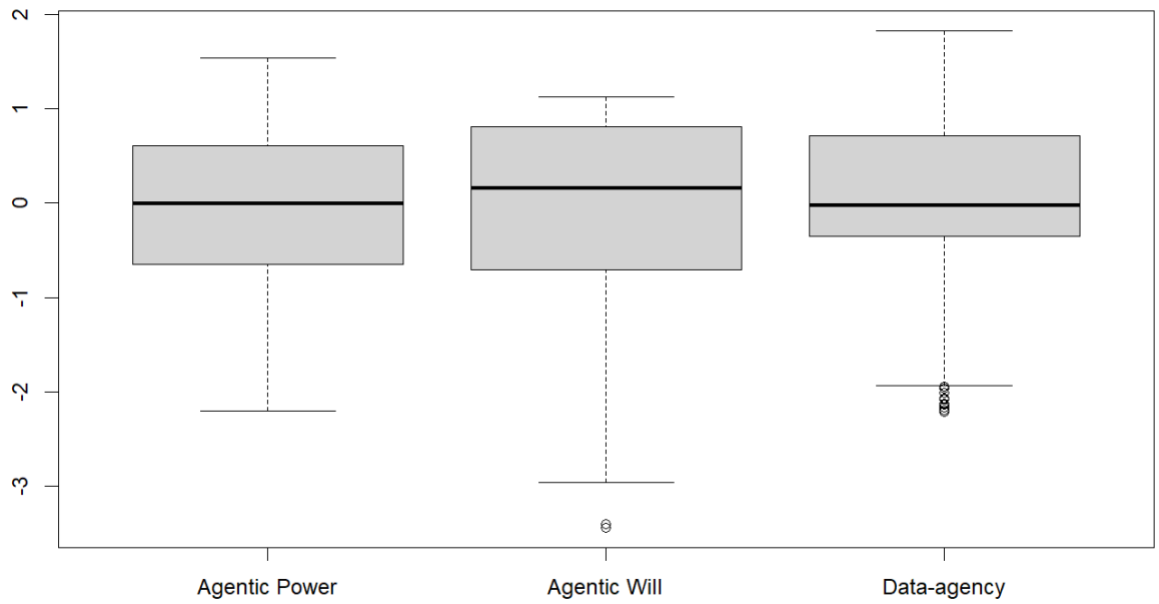
8. Appendix

Questions for agency-scale, constraints, and for TSEI in Danish and English

English	Danish
Agency Items	
I want control over which digital technologies and platforms I adopt in my teaching	Jeg vil bestemme, hvilke digitale teknologier og platforme jeginddrager i min undervisning
I can control which digital technologies and platforms I adopt in teaching	Jeg kan bestemme, hvilke digitale teknologier og platforme jeg inddrager i min undervisning
I want control over how to use digital technologies and platforms in my teaching	Jeg vil bestemme, hvordan jeg skal bruge digitale teknologier og platforme i min undervisning
I can control how to use digital technologies and platforms in my teaching	Jeg kan bestemme, hvordan jeg skal bruge digitale teknologier og platforme i min undervisning
I want control over what digital information and data about me others at [university] can access from my use of digital technologies and platforms such as [LMS].	Jeg vil kontrollere, hvilke digitale informationer og data, som andre på [universitet] kan tilgå på baggrund af min brug af digitale teknologier og platforme som f.eks. [LMS]
I can control what digital information and data about me others at [university] can access from my use of digital technologies and platforms such as [LMS].	Jeg kan kontrollere, hvilke digitale informationer og data, som andre på [universitet] kan tilgå på baggrund af min brug af digitale teknologier og platforme som f.eks. [LMS]
Technologically-Supported Educational Interaction-items	
The extent to which you have received feedback on your teaching from the students via online activities or tools in the teaching situation?	I hvilken grad har du modtaget feedback på din undervisning fra de studerende via online aktviteter eller værktøjer i undervisningen?
The extent to which you have received feedback on your teaching from the students via online activities or tools outside the teaching situation	I hvilken grad har du modtaget feedback på din undervisning fra de studerende via online aktviteter eller værktøjer uden for undervisningen?
The extent to which you have given students feedback on their work via online activities or tools in the teaching situation	I hvilken grad har du givet de studerende feedback på deres arbejde via online aktiviteter eller værktøjer i undervisningen?
The extent to which you have given students feedback on their work via online activities or tools outside the teaching situation	I hvilken grad har du givet de studerende feedback på deres arbejde via online aktiviteter eller værktøjer uden for undervisningen?
The extent to which the students have tested their competencies, skills, and the like via online activities in the teaching situation	I hvilken grad har de studerende afprøvet deres kompetencer, færdigheder og lignende via online aktiviteter eller værktøjer i undervisningen?
The extent to which the students have tested their competencies, skills, and the like via online activities outside the teaching situation	I hvilken grad har de studerende afprøvet deres kompetencer, færdigheder og lignende via online aktiviteter eller værktøjer uden for undervisningen?
Constraints	
How often did you experience the following problems in your [HyFlex/Online/Campus]-teaching during fall 2021? Technical problems in connection with your own use of digital tools in [HyFlex/Online/ Campus] teaching? [5-point Likert scale]	Hvor ofte oplevede du følgende problemer i forhold til din [HyFlex/online/campus]-undervisning i efteråret 2021? Problemer med de digitale værktøjer, som du anvendte?
How often did you experience the following problems in your [HyFlex/Online/Campus]-teaching during fall 2021? Spend time on solving students' technical problems in connection with their use of digital	Hvor ofte oplevede du følgende problemer i forhold til din [HyFlex/ online/campus]-undervisning i efteråret 2021? Bruge tid på at løse de studerendes problemer med de digitale værktøjer, de skulle anvende?

English	Danish
tools in your [HyFlex/Online/ Campus] teaching? [5-point Likert scale]	
What best describes your experience with online teaching methods? Extensive experience / Some experience / A Little experience / Knowledge of / No experience / Don't know / Prefer not to disclose	Hvad beskriver bedst din erfaring med digitale undervisningsformer? Stor erfaring / Nogen erfaring / Lidt erfaring / Kendskab til / Ingen erfaring / Ved ikke / Ønsker ikke at Svare
How often is it difficult for you to find time to prepare for your teaching? Always / Often / Sometimes / Rarely / Never /Don't know / Prefer not to disclose	For hvert udsagn bedes du angive, hvor ofte du oplever det problem, der beskrives. Problemer med at finde tid til at forberede din Undervisning. Altid / Ofte / Nogle gange / Sjældent / Aldrig / Ved ikke / Ønsker ikke at svare
I regularly discuss pedagogy and teaching quality with my colleagues Strongly agree / Agree / Neither agree nor disagrees / Disagree / Strongly disagree / Don't know / Prefer not to disclose	Jeg diskuterer løbende pædagogik og undervisningskvalitet med mine kolleger Meget enig / Enig / Hverken enig eller uenig / Uenig / Meget uenig / Ved ikke / Ønsker ikke at svare
I have access to technical and pedagogical support for my teaching Strongly agree / Agree / Neither agree nor disagrees / Disagree / Strongly disagree / Don't know / Prefer not to disclose	Jeg har adgang til teknisk og pædagogisk support til min undervisning Meget enig / Enig / Hverken enig eller uenig / Uenig / Meget uenig / Ved ikke / Ønsker ikke at Svare

Factor-distribution



Distribution of variables for sub-analysis

Access to support

	Access to technical and pedagogical support	n	%
1	Agree	140	43.6
2	Disagree	74	23.1
3	Neither agree nor disagree	107	33.3

Access to discussions with colleagues

	Discussions with colleagues	n	%
1	Agree	192	59.8
2	Disagree	48	14.9
3	Neither agree nor disagree	81	25.2

Constraints experienced with technology (how often in teaching)

	Constraints experienced with technology	n	%
1	Always or often	48	14.5
2	Sometimes, seldom or never	282	85.5

Experience with digital teaching formats

	Experience	n	%
1	Experienced – high	266	77.6
2	Experienced – less	77	22.4

Issues with not having enough time for teaching

	Issues with time	n	%
1	Always or often	123	36.9
2	Sometimes, seldom or never	210	63.1

Technologically supported educational interactions

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
Receive feedback	4	295	2.32	1.07	2.25	2.24	1.11	1	5	4	0.45	-0.63	0.06
Give students feedback	5	293	2.39	1.15	2.33	2.31	1.48	1	5	4	0.38	-0.82	0.07
Students' get to test competencies	6	279	2.39	1.15	2.25	2.31	1.48	1	5	4	0.37	-0.88	0.07