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RESEARCH ARTICLE



Breakdowns and breakthroughs. Handling challenging moments in university teaching

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ABSTRACT

Research on Higher Education (HE) documents a plethora of applicable teaching practices and improvements focused on better instructional planning. Yet, what happens when carefully crafted plans must be abandoned due to something unforeseen? This study documents teaching situations when things do not work as expected, where moments of breakdown alter a planned pedagogical course of action. Analysing these moments and their aftermath directs attention to empirical events rendering visible some overlooked, but revealing aspects of HE teaching. We conducted a qualitative study into the characteristics of breakdowns and how teachers handle such situations. University teachers from different disciplinary backgrounds and academic positions were interviewed about teaching experiences they found challenging. From our nine semi-structured interviews, three were selected for this paper. Inspired by methodology from Science and Technology Studies (STS), breakdowns are theorised as analytically generative moments for understanding ways in which technology, subject knowledge, and teacher-student relations, are intertwined. We offer terminology for discussing breakdowns and how elements of teaching practice can transmute and recombine into novel forms of practice. The study provides evidence relating to how breakdowns manifested in multiple ways, and despite abruptness and threats of disjointedness, gave rise to improved interaction, methodological development, and long-term learning. Three key phases are identified: *breakdown*, *remobilisation* and *re-stabilisation*. Further, rendered visible are ways in which teaching relies on material complexities and interdependencies. Breakdowns were sources of trouble, tension, and discouragement, but also facilitated instructional creativity opening space for unanticipated and inventive approaches to teaching (breakthroughs).

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Introduction

Research on Higher Education (HE) provides strong documentation on the quality and variation of teaching practices (Hofer, Nistor, and Scheibenzuber 2021; Trigwell and Prosser 2020). Key to this research has often been to document mundane practices that worked well, usually with a view to improving them. However, teaching in HE institutions can be both complex and troubling when things do not work as expected. Teaching an academic discipline is complex because it means

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teaching a highly specific way of viewing the world through disciplinary abstractions and representations (Laurillard 2002). Taking an interest in occasions when university teaching does not run smoothly, this paper studies ways in which moments of breakdown can function as catalysts for instructional creativity, development, and change. Presenting three breakdown situations allows us to analyse causes and consequences, and how teachers handled them. Focusing on breakdowns directs attention to empirical events characterised by dynamic complexity and highly skilled handling of difficulties. This carries theoretical importance as they render visible aspects of university teaching seldom described and analysed. Underlying our empirical study are questions such as: What actually happened when a carefully crafted plan had to be abandoned, when communication or available technology could not salvage it? Did the sessions end? If not, how did they pull through; how were these troublesome situations handled, skilfully or otherwise, and with what constituents and consequences? To guide our analysis two sets of research questions (RQs) were developed:

RQ1. What characterised the breakdown? What broke (down) and how: Can we identify causes or similarities across contexts?

RQ2. In what manners did the teachers handle the situation: Did they continue teaching, and if so why and how, and with what consequences?

Searching the Education Science literature since the 1960s, we found few published analyses of breakdown. Thus, to analyse the empirical material, we adopted and adapted methodology from the field of Science and Technology Studies (STS). Applying an STS approach enables us to develop elements of theory/terminology closely based on empirical analysis of breaking points in educational contexts. Complexities and patchworks of entanglement are illuminated in how elements of teaching practice can dissolve and recombine into new and inventive forms of practice. Our application of STS methodology thus adds to the HE literature a new layer of understanding, besides broadening the range of educational experiences reported and theorised upon.

Within the Educational Sciences, Fenwick (2010) noted: 'The relative lack of attention to STS concepts and methods among educational researchers is surprising' (86). More recently, studies have appeared employing theories and methodologies from STS, particularly from approaches such as Actor-Network Theory (ANT). Breakdowns however, are rarely addressed. Exceptions include some empirical studies in research on educational technologies applying STS/ANT-methodologies: Adams and Thompson (2016), Alirezabeigi, Masschelein, and Decuypere (2020), and Pischetola, de Miranda, and Albuquerque (2021). In referring to Bruno Latour, a prominent contributor and pioneer within STS and ANT, Adams and Thompson stress the importance of studying breakdowns as 'heuristic devices' since breakdowns make material relations observable, and 'the socio-materiality of the researcher's data more visible' (2016, 51). Inspired by Adams' and Thompson, Alirezabeigi, Masschelein, and Decuypere (2020) employ breakdowns as a 'methodological heuristic device' (2020, 193) using STS concepts to 'break down breakdowns' (2020, 196) in an analysis of procedures and network connections at an elementary school. Four breakdowns, each of which breaks a routine, are portrayed and analysed. The authors conclude that the 'digital doings' and re-orderings of the classroom's physical and 'spatio-temporal' space can be characterised as 'plastic and poly-synchronous' (2020, 193). Pischetola, de Miranda, and Albuquerque (2021) draw on this study and its heuristic methodology in analysing an online meeting at a Brazilian university during the Covid-19 pandemic. The article exposes a range of entanglements and how a less-than-smooth use of digital technologies becomes visible. The breakdown itself (the pandemic), takes place externally to the empirical situation being analysed. These studies have pioneered paying attention to breakdowns in the Education literature. What remain to be developed however, are in-depth studies of socio-material interactions and entanglements in HE revealed by real breakdown situations, including analysis of their causes and consequences.

Next, we present methodological concepts from STS as the theoretical and historical grounds for our analytic approach. Then, the empirical data is explored, and strands of analysis are drawn together in the Conclusions.

Theoretical framework and methodological approach

In the multidisciplinary research area of STS, breakdowns have long been an object of study, both empirically and as a subject of substantial theoretical debate. STS theory sees connectedness potentially everywhere, and breakdowns are theorised as analytically generative moments enabling a deeper understanding of the *interconnectedness* of actors, knowledge and materiality (for an introduction, see Felt et al. 2017). When breakdowns occur, the strengths, positions and visibilities of interconnected parts are tested.

The concept of breakdown in STS – an historical outline

Educational research using STS and socio-material approaches, have studied processes of networking and forms of interplay between humans and non-humans, their entanglements, and multiplicity (for an overview, see Fenwick and Edwards 2010; Gorur et al. 2019). Empirical studies are pivotal in developing theory, as ‘if you want to understand STS – and STS theory – you need to read it through its cases’ (Law 2017, 32). Understanding the premises from which STS and its amalgam of approaches operate can enrich Educational research. For deepened conceptual understanding, we briefly summarise the philosophical history of the concept of breakdown within STS.

Some of the first work appeared in the 1960s/70s within the ‘Sociotechnical School’ and the ‘Strong Program’ of the Sociology of Scientific Knowledge. By the 1990s, STS had become a recognised research approach in many European universities with leading scholars such as Madeleine Akrich and Bruno Latour making substantial theoretical-methodological contributions placing empirical studies at the core. ‘The question of “breakdown” is relevant ... because it can only be understood as a part of practice – that is, as the collapse of the relationship between a piece of apparatus and its use’ (Akrich 1992, 224, n.12). Soon studies appeared in fields such as Social Construction of Technology, ANT/Material Semiotics, and Feminist studies. STS scholars Donald MacKenzie and John Law point to how breakdowns may be total or ‘partially and temporarily’ (MacKenzie 2004, 325) as ‘bits and pieces assembled *pro tem* into an order, are constantly liable to break down’ (Law 1992, 386). Within feminist critique of ANT, particular attention is given to a multiplicity of perspectives and experiences, as well as discursive and material aspects of breakdowns. In theorising empirical and structural dimensions of breakdowns, Judith Butler refers to MacKenzie, stating: ‘... we seek to consider situations of performative breakdown, when the effects of a performative operation fail to work’ (2010, 150).

In a study of technical breakdowns, Gerhard Fischer explored breakdowns as sources for creative exploration, and argued: ‘... people’s creativity unfolds in response to experiencing breakdowns in their activities’ (1994, 220). Like Fischer (1994), STS scholar and feminist Donna Haraway (e.g. 1989) refers to Terry Winograd who highlights how breakdowns assist in creating new possibilities for action by making non-obvious relations visible.

Breakdowns play a central role in human understanding. A breakdown is not a negative situation to be avoided, but a situation of non-obviousness, in which some aspect of the network of tools that we are engaged in using is brought forth to visibility ... A breakdown reveals the nexus of relations necessary for us to accomplish our task ... to provide a space of possibilities for action when they occur. (Winograd 1992, 65)

An invisible–visible dimension

Invisibility was theorised as sociologically relevant in Strauss and Star’s pioneering conceptualisations of ‘silent’ work and objects (Star and Strauss 1999). Star and Ruhleder’s (1996) influential analyses of technical systems and infrastructure further examines their functions, transformations, and failures. Key points are that when objects, (as parts of) an infrastructure or system, work as planned, they recede from attention, unapparent, running in the background as a ‘standard’ designed to make the operation appear smooth and trouble-free.

Another classic is Bruno Latour's work on how interwoven clusters of technical objects form silent relations, often transparent in use, only to become visible and troublesome during moments of breakdown (Latour 1999, 2005). The 'opaqueness of objects is discovered when something breaks down. Ahead of this, technical objects ... [are] silent and opaque' (Latour 1999, 183). After a breakdown there might be a 'shift' where actors and objects are organised in new ways with new goals, and modified meanings:

Take, for instance an overhead projector. It is a point in a sequence of action (in a lecture, say), a silent and mute intermediary taken for granted, completely determined by its function. Now suppose the projector breaks down ... [and] the repairmen swarm around it, adjusting this lens, tightening that bulb, we remember that the projector is made of several parts, each with its role and function and its relatively independent goals. Whereas a moment before the projector scarcely existed, now even its parts have individual existence ... [A] shift has occurred ... [as] translations they had to go through may become visible. (Latour 1999, 184–)

In the STS theories present above, theory and methodology are seen as deeply intertwined, supporting new forms of analytic clarity and creativity in understanding educational contexts. In educational practice, moments of breakdown anecdotally occur, but have until now been subject to scant theoretical treatment.

Method and methodological design

To examine breakdown empirically, we conducted a study of how relations between teacher and students, subject knowledge, and materiality occurred *in situ*. The intention was not to derive generalisable findings at the empirical level, but to enrich educational theory by developing a vocabulary for breakdowns closely based on empirical findings. In this way, we bring the radical position of the empirical in STS theory to Education research.

The study design was approved by the Norwegian Centre for Research Data (NSD, 782859) in 2019 and 2020 (extension), and meets the applicable ethical criteria including informed consent and voluntary participation.

Semi-structured interviews were conducted with nine university teachers from a range of disciplinary backgrounds and positions at various faculties at a Norwegian university. Apart from one Professor, eight were at the time temporarily employed as Research Fellows, Post Doctors, or Assistant Professors. Each received an email stating our purposes, including our interest in teaching situations that did not go as planned. With one exception, the informants were aged 35–45 years. The interviews, which lasted 1–2 hours, were audio-recorded and conducted with one informant and two researchers (the authors).

Interviews were transcribed in full by the authors, primarily using f4transkript software. All transcripts were anonymised and compared, analysed, and discussed between the authors. NVivo software was used to systematise data.

The interviews were conversational in nature, and informants were frequently prompted to elaborate on points they mentioned spontaneously. Informants were invited to think of one or two teaching experiences where something did not work according to plan. We exemplified that this could be some sort of interruption, disruption, or technical hiccup, but indicated no expectation as to what happened next. All situations were described and selected by the teachers as significant moments in their teaching history, and depicted in terms such as pivotal, unexpected, challenging, or troublesome. In analysing these situations, we use the term breakdown. They took place during lectures, in teacher-led seminars, or clinical training sessions.

For the present analysis, a subset of three interviews were written up as 'mini cases' or empirical examples documenting moments of breakdown, and their consequences. The three examples illustrate different types of breakdown, and include online versus co-located teaching, and a range of material resources and disciplinary affiliations. In example A and B, the quotes are our translations from the Norwegian transcripts.

From breakdowns to breakthroughs. Teachers' significant moments

To understand the specific contexts of each breakdown, we include citations from the corresponding informant (Teacher A, B, and C). We identify characteristics and constituents of the breakdowns as to what broke down, and how, as well as their similarities and differences (RQ1). We also point to common stages, features, and processes. As indicated in the sub headings, the differences relate to specific linkages and forms of interaction between human, material, and educational constituents. Then we delve into our second research question (RQ2), on how the teachers responded to and handled the situations.

Teaching transposed. A techno-material breakdown

In a double lecture on a theatre play from ancient Greece, the teacher's aim was for students to understand and discern the richness of the original staging of the play relative to its later adaptations. She had prepared a special 'video, custom made for teaching' (Teacher A) comprising an historically accurate reconstruction of the play. As the entire lesson plan was based on this video, 'I had done much preparation for talking about the play, the machinery, and the technology'.

A key point was conveying to students the richness of the original performances of the play; at its outdoor site, with powerful dramatic effects, age-appropriate musical instruments, and a massive on-site audience. The reconstruction conveyed the complex management of the totality of dramatic effects through original means.

At the beginning of the lecture, the teacher clicked the USB-disk on her pc to access the video, but it refused to work. Disbelief! I 'clicked on the video, but it did not work. *It did not work!* So, we brought in an expert to try again, as it [had] worked the night before'. Despite an hour of effort, the 'expert' got nowhere. The chain of technical elements normally expected to work as a single apparatus, appeared incongruous, clashing, and conflicting. As time passed, this techno-educational breakdown made the situation stressful and irreversible, leaving the teacher with disrupted plans and the loss of a pedagogical centrepiece. In trying to monitor the technician's efforts while communicating with the students, the teacher recalls getting deeply frustrated.

I kept one eye on the video and one eye on the students while talking [about the play], registering that [the technician] was not able to fix it – I started sweating. My face got red, and I felt very hot, particularly the forehead, and with a burning in my throat and chest. However, nothing helped, and he kept on and on. I looked at my watch and nearly half the time had passed.

The teacher's frustration and embarrassment grew. In spite of discomfort, panic and despair, she managed to turn the situation by evoking the breadth of her disciplinary understanding of the play's historical, cultural, and geographical contexts, in combination with another topic: contemporary politics.

I saw that [the students] were still very engaged. They were listening to me, looking intensely at me, and kept nodding. So, I opened the floor asking questions ... realising I had to change methods ... I had to turn around, swapping around my knowledge of the play, and add more interpretations. Then I started breathing, felt I got calmer, not so hot anymore. I told the students 'We'll just speak together – open up for dialogue instead, because the video is not going to work'. At that point, I felt very calm, relaxed, the stress was almost gone. I saw that they breathed too. Then, we started on a different path.

The teacher was able to resume teaching by *remobilising* previously unconnected issues, functions, and interpretations of the subject material. New connections between the original play and the overall aims for the teaching session were established, while inviting the students to discuss issues and dilemmas from the newly created perspective. In this, the students witnessed her regaining control and followed her lead. The effects of missing or broken links were mended. After evident trouble, balance was restored. Through their visible engagement, the students displayed interest, care, and concern in participating in the re-enactment and rebuilding of the teaching-learning encounter. 'It worked really well; there was an animated discussion of these [contemporary]

interpretations – which I had not planned’. So, in an analytic dimension, she altered her approach, involving the students as peripheral participants in creating novel forms of knowledge.

Her descriptions reveal that the initial problem stemmed from complex clusters of interlocked technology, each with hardware and software programmed to connect, recognise each other and co-operate. Yet, certain programs (e.g. File Explorer and Media Player) abruptly failed to do so due to problems with the USB e-format, encrypted disk space, lack of laptop ports, and unexpected mismatches of infrastructural standards. When asked why with her educational centrepiece failing she did not simply cancel the lecture, she explained:

I don't think students deserve coming to a lesson which doesn't work. We [teachers] are responsible when we are *there*. I had not prepared a Plan B, but because I knew so much about this play and Greek theatre, I could just keep talking, despite being unprepared. It's our responsibility as teachers to ensure students always learn something, each time they come and listen to us. This is why I got sweaty and was at a loss what to do, I just had to invent things as I went along.

In short, the teacher's salvaging consisted of transposing the original plan into new meanings and instructional methods, achieved by mobilising additional resources and refocusing on the overall educational aim. The teacher described the effect of this mobilising process as an important *breakthrough*. All achieved on-the-fly, and under multiple sources of pressure (being in a public place, time running, student expectations, etc.). The breakdown was caused by unexpected mismatches of infrastructural standards and their interrelated technical devices. The incident has close parallels to and expands on Latour's example (above) of an overhead projector where previously hidden parts become visible at breakdown. Until the moment of breakdown, unnoticed parts of the technical apparatus, as well as the designed, generic, infrastructure expected to support its coordinating functions failed, and instead emerged as troublesome and conflicting. The failure of capacity and compatibility was specific to time and place, and the digital devices in the room. The intended compatibility did not suffice to ensure actual compatibility. In other words, the promise of 'the generic' clashed with the recalcitrance of 'the specific'.

Failures of technical compatibility broke the chain of conditions necessary for teaching-as-planned, and caused a pedagogical and educational crisis. Technical compatibilities are often relied on in contemporary pedagogies, taking for granted the abilities and success of a combination of active heterogeneous elements where and when needed.

Unexpected disappearances. A techno-pedagogical breakdown

At the start of the Covid-19 pandemic, a sudden, mandatory transition to online teaching was itself a breakdown on a massive collective scale. Example B zooms in on a microcosm of unexpected effects as teacher and students alike struggled to adjust to these sudden changes. Previous sessions of the course had taken place in a physical room where students were familiar with the topics, with each other and the teacher, and with the pedagogies employed. This session was the last in a series of seminars: 'I'm sure it was the very first online course for many, and we were all figuring it out as we went along' (Teacher B). At the start, 25 students had logged in to work on a set of questions for reviewing literature and to 'make some kind of small presentation'. In the online setting, however, students unexpectedly disappeared, one by one logging off or displaying a black zoom-screen.

... people would write a message: 'Hey, I'm sorry, something came up, I have to go'. But some of them were people I've been working with all semester, so it was hard not to take it personally ... [The students' task was simple] like 'answer this question'. So, I called on somebody to answer the question, [there] was background noise, and he said: 'Oh, I'm sorry, I'm having trouble connecting, there's technical problems' – but then all of a sudden it ... became clear that he was in a grocery store, and he was at the cash register. I just found that terribly disheartening, and ... I do not know what kind of failure that was, but it was one in a long series of failures. People just didn't manage to remember the literature, or to have opinions. It was a whole lot of *dead zone*, partially technical. I also had trouble with putting slides up, sharing screens and things ... [I felt] disheartened in an emotional and physical sense, and a significant evacuation of motivation to continue the session.

The key breakdown here relates to students' withdrawal and how this happened. The sudden change of scene to online teaching prevented him from engaging the students into the commitment he had been accustomed to achieving:

In a live classroom setting, I would have so many more tools at my disposal. Just eye contact makes a huge difference ... not sure I really realised what a central tool that was in my toolbox before it was suddenly taken away.

The shift made him face black screens, which he felt was frustrating. A 'series of failures', partially technical and pedagogical, and the uncertainty of the students' whereabouts, complicated the teacher's effort to facilitate online collaboration and presentation. In re-counting this breakdown of enmeshed techno-pedagogical objects and objectives with respect to common norms, online etiquette, and mutual trust, he experienced:

a disagreement about where we [were] going to end up ... [as we] really relied on social interaction, expectations and norms. Lots of these are [not sufficiently ingrained or] missing in the digital environment – mak[ing] the teaching ... exceptionally *woundable* to things going wrong ... [a] *wound-ability*.

This wound-ability not only comprised a socio-technical dis-ability, but also brought a lack in shared responsibility, causing a grim, but silent 'chain reaction': 'when 50% leave the class, it's *very visible*, disappointing, and easy to feel as though there is a kind of *critical mass* – once everybody sees a number of people drop off, it becomes more acceptable to do so'.

As these *material and pedagogical ruptures* unfolded, the core of the teaching-learning fell apart despite most technical tools and infrastructure working as designed to do. As some students had their cameras turned off, 'muted' themselves, or left the session altogether, the students' presence and engagement was rendered unaccountable to the teacher. This destabilised mutual trust, a principal element in any teaching situation, facilitated by the ease with which students (deliberately or not) muted their sound or picture. In terms of theory, the students actively made themselves mute observers, invisible to the teacher and thus out of his pedagogical vision for the session, causing a breach with his 'toolbox' for engaging students into learning.

Towards the end, the teacher and the four remaining visibly active students decided to work together on previous exam questions, which revived enthusiasm. In spite of the frustrations:

it was a really rich experience. I think the people who stayed got a lot out of it ... [they] quickly composed arguments ... [and] came up with their own exam questions, and then we chose three ... [to] work on.

Even after feeling disheartened the teacher managed to mobilise a new approach to his material resources and collaboration with the students. When asked why he did not give up altogether, he pondered and replied: 'I find it difficult to differentiate between my contractual obligation and pure stubbornness'.

Again, in example B as in A, we see a teacher who at the point of breakdown let go of their plan by shifting to their overall, more abstract educational idea for the session. This opened the opportunity for creating a new approach. The abstraction in example B was to the overall aim of preparing the students for their exam. This permitted letting go of a plenary session with students presenting their literature reviews, instead creating a novel way of joint work on exam questions. The shift gave rise to a mobilisation of aims and materials, though still using the (video) technology that facilitated and expedited the breakdown. Both examples provide a window into troublesome teaching situations and how they got back on track, while demonstrating a breakthrough in using different methodological approaches and materials. The altering of plans and practices provided new meanings and significance to socio-material relations and practices. From stability before the breakdown, through remobilisation – a new stability was achieved, which we term *re-stabilisation*.

Example B illuminates how a single socio-technical detail (cameras switched off) can give rise to a substantial break despite the technical infrastructure functioning as designed. Key techno-educational elements ceased to perform their basic function of facilitating interaction. The gradual technical-visual withdrawal of students posed a challenge to the pedagogy of recurrent partaking and

conjoint communication. While possibly an effect of inexperience in video-based classroom interaction, insufficiencies of the devices they were using (e.g. mobile phones, tablets or PCs), and students being unprepared, nevertheless this exposed a socio-technical vulnerability requiring a cultural-technical repair, and a distressed teacher feeling discouraged and disheartened. The challenging situation forced both the teacher and his students 'out of their comfort zone' (Hofer, Nistor, and Scheibenzuber 2021, 8).

The moments of breakdown in example A and B ended the sense of opaqueness and the *silence* of specific objects as components in a socio-technical infrastructure by making their non-functioning highly apparent. In the terminology of Latour (1999, 2005), rather than accepting their background positions they became objects of action and attention. This opened a possibility to explore and reorganise material relations and resources. Educationally, this is significant as the breakdowns made the teachers aware of previously hidden or unobserved links, paths, or dependencies between teaching, instructional materials, and design environments. Also apparent in example B are the interdependencies between liability, socio-technical vulnerability, and 'techno-educational creativity'. In recognising and learning to understand these links, interferences, and intermediaries, it was possible to trace and reuse their capabilities and abilities.

Our third example scrutinises a breakdown in a clinical teaching situation exposing complex constituents in learning to perform medical examinations, with consequences for the practice of giving instruction.

Hands-on teaching. An application-confidence breakdown

Eight medical students, their teacher (a medical doctor), and a patient (volunteer) are in a hospital room ready for bedside teaching – all well drilled in the extreme levels of precision of hospital medicine. In the interview, the teacher explained that at this point, the students had spent almost 2 years working with theoretical knowledge, such as learning anatomy detail by heart to reproduce it upon request. Now, they were to demonstrate their clinical (practical) skills, one group at a time, meeting real patients pre-surgery.

The complexity is substantial; large amounts of decontextualised knowledge is to be made relevant to the problems of real patients, enabling them to implement and 'integrate it, the purpose of it. It's kind of – from theory to practice' (Teacher C). The students were not informed of the patient's diagnosis; finding one was their educational challenge. A student was asked to examine the patient. Her hands were on the patient's abdomen, touching and checking the intestines and the innards of the stomach. The teacher noticed that she made a critical mistake and corrected her tactile examination technique. This happened a few times as she repeated the mistakes. Then all of a sudden, an instruction received what to him was a surprising response: Tears! The student started questioning her own capacity. 'I corrected her a few times – and she started crying. I think she said something along the lines of: "I have completely misunderstood, I'm doing everything wrong" ... It was a pretty challenging situation'.

At that point, and to the bewilderment of all, the supposedly mute element in this setting spoke up: The patient. Instantly, the emotionally strained impasse dissolved and the situation turned.

This was the first time I got such a reaction from a student, but ... I think it resolved very well thanks to a very balanced elderly lady – the patient herself – who was very supportive and made no fuss of it, saying: 'Don't think about it, we all – everything is difficult in the beginning'. She made the situation less dramatic – which I tried too, and the student calmed down.

The teacher did not need to do much except calming the situation and displaying acceptance of another's salvaging work. In short, the set of conditions turned as the teacher permitted this intervention and built on it – sanctioning it as a step forward. 'The situation resolved, and the session continued – though it wasn't pleasant – actually, it was very uncomfortable'.

Example C then, continued to expose interlinked elements of teaching, though of a different kind: Technical devices were not directly involved, except for the technology of medical science

diagnostics and organisational routine. A previously invisible relation between formal knowledge, self-confidence, and hands-on skills broke open, triggered by the teacher's efforts to instruct and guide the hands of the student. What broke was the taken-for-granted flow of theoretical knowledge-to-skilled performance. This became evident to the teacher only when the process halted and the linkages broke. One part manifested as tears: a bodily reaction imbued with factual subject knowledge, emerging as a material-semiotic dimension. As Haraway (1989, 12) wrote: '[B]odies as objects of knowledge are material-semiotic generative nodes. Their *boundaries* materialise in social interaction'. In this, several layers are interwoven: the expectations of skilled performance in a public situation in a hospital; an adjoining but silent group of students observing; the application of memorised diagnostic knowledge, and the paucity of prior hands-on clinical skills training. Breakdowns are a trial of strength (Latour 1999) reordering constituents. Despite distress and the complexity of the situation, the new manifestation of material-semiotic parts provided an opportunity to redefine and reorganise the teaching and its instructional methods.

Handling breakdowns

Our analysis so far has explored how breakdown in chains of technological-material-human relations render visible, and thus theorisable, new aspects of HE teaching. In handling the evolving situation with sensitivity, as well as recontextualising an array of resources into repurposed pedagogical methods and materials, the teachers emerge as skilled and highly committed to teaching. Through processes of remobilising and re-stabilising, teaching sessions were salvaged while re-framing the educational setting in inventive ways. As such, the examples also illustrate various kinds of breakthrough. For their analysis, we searched Educational research using the terms breakthrough or breakdown but found no empirical studies of how the one can lead to the other.

Remobilisation and salvaging the teaching-learning situation

Remobilisation of educational approaches, materials, and resources, meant setting in motion other methods, subject knowledge, or student involvement than planned. This opened possibilities for salvaging the situation. Walking out of the session was never an option: When asked why they did not give up, Teacher A replied that failing to teach is to fail at her responsibilities and educational ethos, while Teacher B referred to contractual obligations and persistence. Despite feeling unwell, uncomfortable or disheartened, they all stayed calm as they on-the-spot remobilised resources and reorganised their plans for the session.

Suchman 1987 was an early analysis of how a belief in making things work through detailed planning could crash with real-life action as situated and responsive to change. In our empirical data, such responsiveness appeared in various ways and with different timings. From Teacher A, we adopted and applied the notion of *turn* as analytical lens. The notion aided in detecting modifications, connections and the redefinitions of plans, goals and functions, as 'link[s] that did not exist before ... modifies the original [plan]' (Latour 1999, 179). The teachers' adjustments included a mustering and reorganising of (re)sources. Each new turn or shift with its consequent mobilisations can be conceptualised as processes of *remobilisation*. Without remobilisation of matter and direction, the breakdown could have terminated the session. In order to proceed, the situation necessitated rounds of mobilising and combining heterogeneous elements – some existing, some new – for fulfilling the educational aims of each session. The concept of remobilisation also expresses the building of new practices requiring an openness to the possibility of components being de-/re-coupled.

In example A, the teacher described her methodological 'turn' as a need to move on, which created a new pedagogical focus. This required disciplinary and teaching skills at high levels. Remobilisation took place when she used her substantial in-depth conceptual and contextual subject knowledge to present new perspectives on the topic and new avenues for analysis together with

the students. By opening the floor for discussion, she invited the students to actively partake in salvaging and re-stabilising the teaching-learning situation. From moments of chaos and calamity, equilibrium was re-established.

Remobilisation in example B turned the breakdown around as the teacher redirected attention toward exam questions as a rescue operation, involving novel resources for joint work with the remaining students. By switching approaches, the teacher re-stabilised the seminar and re-established mutual trust.

In example C, the teacher changed approaches through two timelines: a more passive line of action within the session, and profound reflection later resulting in a change of method. The patient's intervention initiated remobilisation through a rechannelling of focus, responsibility, and attention from patient to student – to which the teacher displayed support. It further demonstrates the intervention of a putative 'mute' element in the teaching-learning network; the patient (object of teaching) who against expectations steps out of her role, mobilising herself into action and into speech. Not only does she speak, but speaks wisely. The teacher's remobilisation later articulated as critical self-reflection leading to adjustments in his guidance of clinical skill.

Alongside these aspects, the breakdowns all expose vulnerabilities in the teacher-student-materiality relations. The primary location of the materiality in example A and B, is in the technologies (and bodies); while in C, it is teacher discovery of student vulnerability in the transition from abstract knowledge to material, embodied action. For the teachers, all situations testify to some level of stress and frustration yet, from vulnerability and volatility, new educational ideas, aims, approaches and understandings manifested.

Re-stabilisation and risk

Each breakdown was confusing to the teacher, who faced the real possibility of a collapse in some basic constituents and conditions for teaching. Even at these low points however, some components and capabilities remained relatively stable, hiding from attention their ordinariness. In example A, despite stress and technical impasse, the teacher-student relation remained stable across the lesson. In example B and C, the teacher-student relation partially broke, but became re-established.

From an STS perspective, however, stability is not a (permanent) state but always temporary; an achievement of ending a breakdown situation by the reordering of plans, components, and capacities. Any order, including a reordering, may be subject to new breakdowns.

In our study, the effect of remobilisation was one of continuity and restabilising the situation, in which several contributors participated. Not through the original plans, but despite them. The teachers' actions and efforts emerged as (improvised but) trustworthy. This was a major achievement, which enabled teaching to continue in a transformed and transformative way.

Re-stabilisation also signified the regaining of strength and balance, leading to feelings of relief and contentment.

Conclusions

The study has documented examples of breakdown in mundane teaching practices in HE, analysing characteristics and how teachers acted to handle them. Our contributions can be found at two levels: Empirical findings and methodological development. Empirically, analysing breakdowns has exposed details of socio-material interdependencies upon which teaching relies, and how teachers remobilised educational and material resources and re-established new versions of the teaching sessions.

The breakdowns brought forth ruptures in linkages on which the teaching depended, like socio-technical infrastructures and in-the-situation relation to the students. They exposed interconnectivity and dependencies between materials, actions and reactions – for instance in ways technology, in-depth subject knowledge, commitment, and bodily reactions, are intertwined. We were told of

confusion and bewilderment, but further: Differing expectations, broken confidences, discontent, and discontinuity in the habitual practices of teaching-as-planned.

Our analysis theorises breakdowns as sources of trouble, tension, and discouragement, but also of instructional creativity opening space for unanticipated and inventive approaches to teaching. Each breakdown relates to ways in which interlinked material objects and knowledge structures failed or broke, were cast aside, or coupled to new items. When the breakdowns occurred, various forms of re-articulation, modification, and renewed mobilisation was required. Three key phases were identified: the breakdown, followed by processes of remobilisation, and re-stabilisation. Through processes of remobilising, new stability was achieved. The terminology for discussing these issues was inspired by STS methodology and developed through bottom-up (inductive) theorising on teachers' work.

To handle the situation the teachers remobilised a range of intertwined heterogeneous elements, including subject knowledge and technology. The teachers took on much strain, stress, and responsibility for addressing and trying to solve the situation. This included the choice to stay, due to a more overall aim. In other words, the situation-specific instructional methods were transposed into a renewed context to salvage some greater and meaningful educational purpose. Through their readiness to abandon plans and relate to the specifics of the breakdowns, the teachers responded sensitively to the situation, and creatively recontextualised a heterogeneous array of resources into pedagogical methods and materials appropriate to the emerging situation. These were breakthroughs, as processes of remobilising and re-stabilisation actively restored teaching while re-framing the educational setting. Despite the abruptness of breakdown and the real threat of disjointedness, teaching continued.

In summary, the breakdowns manifested in multiple ways and with multiple effects, including long-term learning on the part of the teacher, and development of new or improved instructional methods and materials. As such, they were manifestations of originality, resourcefulness, and methodological development, all rooted in a strong commitment to the teaching situation.

Implications for practice from this study include conceptually and practically preparing university teachers for the potential of unforeseen, troubling situations. Academic Development can support teachers in recognising, documenting and discussing breakdowns and their consequences with colleagues and developers of technical design.

Through empirical analysis, our study of breakdowns has generated insight into overlooked aspects of teaching in HE, revealing their complexities and patchworks of entanglement. Applying an STS inspired analysis in HE has illuminated how elements of teaching can break down and be recombined into novel forms of practice. In terms of theory, we have proposed analysis of breakdowns as a relevant methodology for HE, demonstrating how it enables analyses of under-theorised aspects of teaching. Further research is needed to develop the area.

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