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The educational technologist as a variety-handler

Videoconferencing for remote music lessons as a case in point

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Abstract In this work, we theorise the role of the educational technologist in an educational institution as a *"variety-handler"*. That is, we theorise the educational technologist as responsible for the orchestration of educational and technical resources, namely tools, either to attenuate systemic variety or amplify regulative variety at a certain level of recursion. To do so, we carried out a single case study that focused on the work of the educational technologist in a Music College. The educational technologist provided support to an accordion teacher and his student in remote music lessons. We collected qualitative data from the practice of the educational technologist and the experience of both the teacher and the student over six months (mainly observations and interviews) and we analyzed them building on research from managerial cybernetics, in particular, Stafford Beer's Viable System Model (VSM). Our case study indicates that, depending on the context, the educational technologist may overtake many roles, such as be a designer, technician, researcher, planner and so on. But the central role is that of handling variety in order to avoid disruption that could potentially affect the lesson negatively.

Keywords educational technologist · viable system model · managerial cybernetics · Stafford Beer · videoconferencing

Introduction: Who is the educational technologist?

We live in a time where visions of the future of education are invariably tied to technological innovation. Whether it is Artificial Intelligence (AI), Virtual Reality (VR) and Augmented Reality (AR) or the Internet of Things (IoT), it seems impossible to design for educational change in the current educational landscape without referring to technologies. This, at least on paper, bears the potential of revolutionizing how we conceive the provision of education – no

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matter the level or the subject area we aim to address. The educational technologist is one of the main characters in the narratives about how technology can change the provision of education. The main goal of this work is to provide a theoretical treatment, which will contribute to answering one crucial question: *Who is the educational technologist?*

A brief historical survey shows that discussions around "who is the educational technologist?" were already present throughout the sixties and seventies – well before the advent of the internet. That is not surprising, as visions of technologically-enhanced education dominated much of the discussion around the future of education itself since the first part of the 20th century, when the technology of the day – be it movies, radio, or television – invariably inspired school reformers, educators, policy-makers, etc. to bring about changes in the educational system (Cuban, 1986).

Already in the Sixties, discussions around the role of the educational technologist arose. For example, in an article published in 1968 in the magazine "Educational technology" Charles Slack pointed out that educational technology is a writer's trade and that educational technologists are in the end *workbook writers* (Slack, 1968). Not without a hint of irony for the profession he himself was representing, Slack took issue with the tendency of his time to come up with "fancy names" for describing the educational technologist such as instructional programmers, material specialists, multimedia audio-visualists, etc.

A decade later, Philippe C. Duchastel published a short essay called "On being an educational technologist", in which he argued that educational technology is far from being a monolith (Duchastel, 1978). That is why the role of the educational technologist can be hardly defined. Here again not without a hint of irony, Duchastel goes on listing some fifteen different roles that the educational technologist is supposed to take on. Those are: designer, resource-person, innovator, product quality verifier, editor, evaluator, student, preacher, only competent educator, diplomat, problem-solver, consolidator, theoretician, researcher as the number-cruncher, researcher II as the field-researcher. Indeed, to Duchastel that is somehow a caricature of the educational technologist, but it shows a multifaceted reality and a multiplicity of perspectives, which to some extent is a trademark of the kind of business educational technology is dealing with.

Around the same period David Mitchell in an article called "The Discernible Educational Technologist" pointed to the necessity of going beyond the identification of existing functionaries to define role expectations (Mitchell, 1975). Conversely, he proposed to identify those from a "conceptual analysis of the terms technology and educational technology" (Mitchell, 1975, p. 308). To Mitchell educational technology deals with "concepts and problems of a system nature" (Mitchell, 1975, p. 323) and "dynamic systems in all branches of education", and that would require "a new kind of educator". Eventually he identified five functions, which are: learning consultant, learning resources manager, materials producer, systems developer, educational planner. Those

are not far from the "caricature" provided by Duchastel. The overall image provided is still variegated.

Fast forward, in the second half of the Nineties, Judith Davidson conducted a three-year study (Davidson, 2003), in which she observed educational technologists in different schools. She concluded that the educational technologist is a sort of hybrid, which borrows bits and pieces from existing roles within the educational organization such as the technician, teacher, school specialist, administrator and district curriculum specialist. Some twenty years later, Davidson too concluded that the educational technologist points to a "new kind of educator" (p. 747), whose role is to integrate "leadership and instruction and exists interdependently with school and colleagues". **More recently, the term "educational technologist" has been associated with that of *instructional technologist*: the person who focuses on designing and providing solutions to learning and performance problems in a technology-based learning environment (Tennyson, 2001, p. 356). Instructional technologists are not just technicians, but they are also supposed to be familiar with learning theories (Imzirli & Kurt, 2009). The view that the educational technologist is essentially an instructional technologist is endorsed by Ritzhaupt and colleagues (Ritzhaupt, Martin, Pastore, & Kang, 2018), who developed a survey regarding the kind of competence required to become an educational technologist. Based on theme analysis conducted on 205 job announcements, eighty-five (85) competencies related to multimedia emerged. Those concerned areas such as methods and theories of instruction, soft skills and the ability to work collaboratively in teams. The idea that educational technologists undertake different roles in different context is also supported by Fox and Sumner, who reported that the educational technologist should also be ready to work in different communities (Fox & Sumner, 2014).**

Kowch (Kowch, 2005) and later Davies (Davies, 2010) introduced the idea that the role of the educational technologist should be linked to school leadership. Accordingly, the role of educational technologist concerns more with how to bring (technical) change into the institution. While endorsing this view, Davies acknowledged the lack of empirical data to support the claim (p. 59).

The educational technologist seems to be invested in a strategic role, which is that of integrating technology into the classroom (Lorenz, Kikkas, & Laanpere, 2014) and being the catalyser of a paradigmatic change in the current educational landscape (Aslan & Reigeluth, 2013). That is echoed in Mayes and colleagues, who argued that the educational technologist eventually covers different roles, which deal with design, development, implementation and evaluation (Mayes, Natividad, & Spector, 2015). In the same vain, Hung and Jeng acknowledged that educational technologists should possess technical know-how to navigate through what they call "technical complexity", while at the same time being ready to exploit

learning opportunities provided by new technologies (Wei-Chen Hung & Jeng, 2013).

More recently, in analysing the feedback from 134 Estonian teachers working side by side with an educational technologist in devising robot supported math lessons, Leoste and Heidmets reported that the educational technologist played a technical support role. They also suggested that the educational technologist should nonetheless have basic knowledge about the topic at hand (Leoste & Heidmets, 2019).

A different perspective was discussed by Selwyn (Selwyn, 2011), who described the role of the educational technologist as the one of "finding ways to make these technology-based improvements happen". Selwyn, though, expressed skepticism towards this view, which is deemed to be overly optimistic. He called for a more pessimistic stance towards the actual capacity of educational technologists to change educational institutions. However, he argued that an alternative view is possible the moment in which we direct our attention to the "imaginations of educational technologists away from some of the wilder 'science fictions"' (p. 717).

Interestingly, in all the cases described above, the role of the educational technologist is not discussed in relation to a broader view, that is, a *philosophy of technology*, which Langdon Winner defines as the critical examination of "the nature and significance of artificial aids to human activity" (Winner, 1987, p. 7). In this regard we have not really made significant steps forward, if compared to Mitchell's agenda back in the Seventies. Notwithstanding the fact that technology continues to dominate the discourse of the present and future of education, there seems to be little interest in bringing about a more nuanced theoretical understanding as to the role of such a central and strategic figure, namely, the educational technologist. This might be the reflection of what Oliver claimed to be "the conspicuous absence of theories of technology within the field" of educational technology (Oliver, 2013). While according to Oliver "lively debates about technology" are provided in neighbouring fields such as philosophy of technology, mainstream educational technology very much relies on "common-sense understandings of what technology is and how it can be used, rather than to theorise it" (Oliver, 2013, p. 33). The majority of studies conducted in the field define the technology deployed in a given learning activity as the independent variable (Johnson, 2019) and therefore tend to focus on the "effects" of technology "while keeping everything else constant" (Papert, 1987).

The lack of theorising biases further elaborations towards a vision of technology in education that is essentially instrumentalist and technology-centered. This oversimplifies the process behind the appropriation of technology (Selwyn, 2016; Henderson, Henderson, & Romeo, 2015). It tends, for example, to conflate technological innovation with teaching innovation (Witte, 2007): "technology as designed" with "technology as in-use" (Aagaard, 2017). It also assumes that the pedagogical nature of technology – be it an application or a

learning environment – can be identified *ex ante* by looking at the pedagogical principles being incorporated into the technology *by design* (Hamilton & Friesen, 2013) regardless of its actual *instantiation* and the context of application.

This work takes Oliver's claim about the need of theorising seriously. Our aim is to theorise the role of the educational technologist. We attempt to do that in the light of a vocabulary born out of research in the field of managerial cybernetics: notably, the work of Stafford Beer (Beer, 1974, 1981a, 1981b, 1983, 1984). We believe that Stafford Beer's theorisations will prove to be insightful in trying to provide a stake in the ground.

To that end, we use the single case study approach to inform a theoretical approach to the question concerning who the educational technologist is and to provide an ethnographically rich demonstration of the role of the educational technologist as a variety handler. By that we mean that the main strategic role of the educational technologist is to help find ways of managing the different options that technological innovation brings about either by attenuating the amount variety in the system or amplifying our ability to absorb it. The case study explores the work practice of an educational technologist in a Music College in order to support an accordion teacher and his student establishing remote lessons.

The paper proceeds as follows: we will provide a succinct description of Stafford Beer's Viable System Model (VSM) in Section 1, which will constitute the basic vocabulary to start with. We will then move on by presenting our case study in Section 2. In Section 3 we will discuss the case study in the light of the VSM putting forward several claims as to the role of the educational technologist.

1 The Viable System Model: Terms and definitions

In this part of the paper, we try to present the basic components of what we can refer to as Stafford Beer's Viable System Model (VSM), which is a *thinking tool*. This means that it is not a reflection of reality but something to be deployed in order to increase our understanding of reality itself. Beer has touched upon the VSM in several of his works (see for example (Beer, 1981a). Other authors, both in managerial cybernetics as well as other fields, have interpreted and built on his work. Leonard (Leonard, 1999), for example, interpreting Beer and the VSM, has suggested that "if there are accepted criteria of performance, [the VSM] can be used to diagnose whether the management infrastructure is well adapted to fulfil its duties and where there are gaps or lags". Orengo (Orengo, 2016) suggests that the VSM is a niche "tool". In his study based on observations from practical applications of the VSM, systematically collected by him, he states that VSM is not known by many, it is rarely used in practice (compared with the instruments of classical organization theory), and it is not taught systematically in management pro-

grams, whether they are academic or not. Orengo's work is geared towards a "smoother pass from the early adopters to the early majority." (*ibidem*) To that end he suggests "not to overstretch the VSM as "the better organization method". Instead, the VSM should be refocused on the rather abstract balancing of varieties." (Orengo, 2016, p. 269) The current study contributes to Orengo's call for a wider application of the VSM, for variety handling is exactly the theoretical niche it is aiming to put in practice.

As for applying the VSM in research on educational technology, it is a rare combination. Discussing viable "ways of being" with technology, Johnson and Liber (Johnson & Liber, 2008) present the Personal Learning Environment as a practical intervention concerning the organization of technology in education. Using the VSM, they identify different regulatory mechanisms that are responsible for maintaining viability for learners, and how physical engagement with tools is of fundamental importance in learners being able to manage their learning environment. While Johnson and Liber (Johnson & Liber, 2008, p. 4) were most concerned with "how the learner can steer themselves in a complex technological domain", the current work adds to how an educational technologist could help and foster where needed, by helping students and teachers navigate the influx of tools so they could focus on the learning and teaching process as much as possible and release their individual potential.

1.1 Viable system, systemic variety and levels of recursion

A crucial insight that we can draw from managerial cybernetics is the idea that an educational institution such as a college or university is not a machine-like entity but a *dynamic system* (Beer, 1974), whose core activities concern the organization and coordination of learning and teaching activities (Johnson, 2019). Like any other dynamic system, an educational institution should be *viable*. Viability essentially means that the institution in question is able to accomplish the very goal it has been assigned to *over a period of time* accommodating and/or adapting to changes and facing challenges. In turn, the viability of the institution as a system depends on managing what is termed "systemic variety", which is defined as the number of the possible states that the system can assume (Beer, 1974). Systemic variety gives a sort of measure of the complexity of a system and it is expressed at *different levels of recursion* within the institution itself. Those different levels of recursion are comparable to Russian dolls in the sense that they show the same very pattern at different levels – from macro to micro, e.g., the institutional level, the classroom level down to the teacher-student and student-student relationship. Within each and every level of recursion we can identify *regulatory relationships*, which essentially defines who is regulating and what or who is *regulated* in the system.

1.2 Only variety absorbs variety and the two variety-handling operations

The major managerial innovation provided by Beer's work is related to the way in which systemic variety *should* and *could* be handled. Here, Beer refers to the so-called "Law of Requisite Variety" or simply "Ashby's Law" – named after its discoverer – which states that *only variety absorbs variety* (Ashby, 1957). What does this mean? This means that in order to manage (or regulate) a system, that is, to achieve its viability, the management (or the regulator) of that system should *absorb* its variety. If variety is not absorbed, the system may easily become unstable and eventually fall in disgrace.

Beer identified two main *operations* that the management of a system – the regulator – has at disposal. On the one hand, we can *attenuate* systemic variety. That is an important operation, because the variety in the system will always exceed the amount of variety that we can ever actually handle. Attenuation, which essentially means reducing variety, can indeed be done in many ways. For example, in a school or university students and teachers do not decide to meet randomly. There is in fact a timetable *prescribing* when they meet. Knowledge is organized in subjects and curricula, which both students and teachers should conform to. The learning tools that are purchased can only be a fraction of those that are available. Teachers are those who received a license from the state, and not anybody. And so on and so forth.

Attenuation of variety is not the only operation available to the management, although – it is worth noting – we tend to identify the management of a system with doing the attenuation, especially when efficiency is prioritized over freedom and autonomy. The attenuation of variety can be done up to a certain extent, because Ashby's law will exert itself presenting challenges to the management at the different levels of recursion. For example, a rigid curriculum will reduce the autonomy of lecturers and teachers to handle their teaching, which, in turn, may contribute to growing their frustration and unhappiness. A rigid division in subjects may potentially hinder the ability to develop knowledge about transdisciplinary issues emerging in society. Teaching methods that do not see students as active meaning-makers may have a negative impact not only on their performance, but also their engagement as well as the relevance of what they learn.

In general, attenuation of systemic variety may lead to a drastic reduction of individual freedom of expression, which, in turn, may produce various negative outcomes (e.g. alienation, stress, burnout, low performance) affecting what people can do, receive and give. To avoid all these negative consequences resulting from failing to absorb systemic variety, attenuation should be compensated by, or done in conjunction with, another *variety-handling* operation, which Beer termed *amplification of regulative variety*. Lecturers and students, for example, may agree to spend more hours on learning activities that would promote students' engagement by tapping into their own interests. That, though, would require to *amplify* lecturers' ability to deal with such a change, which would call for more variety to handle. For example, some lec-

turers may see their workload reduced so as to have more time for preparing inquiry-based lessons or attending training courses, if available.

More in general, the management of the system should apply both attenuators and amplifiers in the right place, at the right moment, at different levels of recursion, and be able to devise strategies, which are inevitably a combination of these two basic operations – attenuation of systemic variety and amplification or regulative variety.

1.3 Proliferation of variety

Interestingly, the total amount of variety present within an institution is subjected to change over time. Variety can *proliferate* due to changes happening in society, which are *external* to the educational institutions. It goes without saying that a major source of proliferation of systemic variety is technological change, which is our main concern in this article. Computers have become way cheaper than in the past, new devices have entered the educational scene (e.g. iPads, affordable AR/VR headsets, smartphones), plenty of applications and online resources are available at one's fingerprints thanks to the Web revolution. Even to the most distracted observer technological change has had the main effect of increasing *the number of options available* (Johnson, 2019). It is worth noting, though, that an increase of options does not automatically translate into substantial improvements or positive changes. Having more options essentially means *more to handle*. Or, to stick to Cybernetic jargon, more *systemic variety* to absorb for the management of the system. Interestingly, the "tools" to handle variety remain the same. Those are attenuators and amplifiers: that is, we can either attenuate or amplify. Or a combination of the two. In turn, the way in which we handle variety may lead us to a viable configuration or instability.

1.4 Theorising the role (and significance) of the educational technologist in an educational organization

Having stated the problem concerning how to make educational institutions viable and the importance of the two basic operations for handling variety, namely, attenuators and amplifications, we focus on the role of the educational technologist. The question we aim to address is: how can we interpret the role of the educational technologist within an educational institution in the light of the cybernetic vocabulary introduced in Section 1?

Let us start from educational technology. In the light of what we have described so far educational technology can be re-conceptualized as a practical as well as theoretical venture, whose main purpose is to provide our educational institutions with the *resources* to handle variety at the different levels of recursion. That essentially means to find the proper tools and use them in order to scaffold attenuation and amplification *when* and *where* needed for

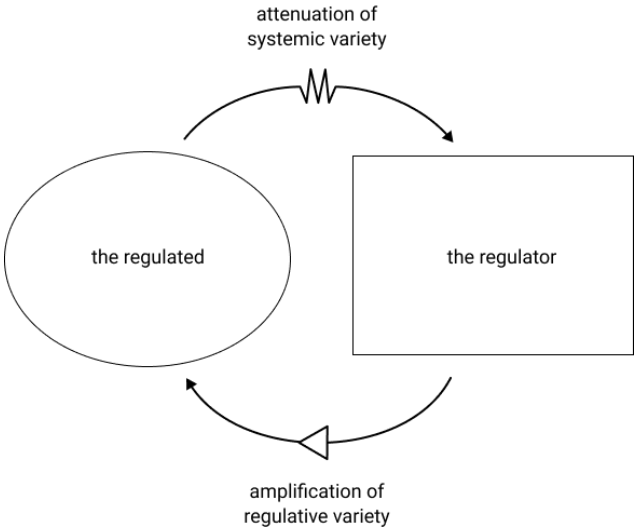

Fig. 1: Variety-handling operations

supporting teaching and learning. By "tools" we refer to any external resource that comes to help us accomplish a certain task. So, the word – at least in the context of this paper – defines the way we appropriate technologies, rather than a particular type of technology, say, a laptop or a tablet. Indeed, both laptops and tablets can become tools. But that is not because of some intrinsic features that they would have, but because of the interaction with the users. From this re-conceptualization of the potential interpretation of educational technology, it follows that the educational technologist can be viewed as the figure (or role) within an educational organization, who is appointed to organize the selection of resources, e.g., tools either to attenuate systemic variety or amplify regulative variety at different levels of recursion. Figure 1 depicts the role of the educational technologist.

What the figure provides is a brief sketch, which needs to be substantiated by what we may refer to as *rich descriptions* from the field. This will allow us to pinpoint the practical implications of defining the educational technologist as a variety handler. It is worth stressing here that the VSM should be considered as a thinking tool or, to put it another way, it has a *heuristic* role. In the following section, we present a case study in order to illustrate concretely the following: a) how the VSM can contribute to reaching a better understanding related to the role of the educational technologist and, b) the heuristic value of the model itself.

2 A case study: videoconferencing for remote music lessons

Our case study investigates a particular practical challenge faced by the educational technologist of [**concealed under anonymity**] Music College in the city of [**concealed under anonymity**] – Paul [**real name concealed under anonymity**], who is also one of the authors of this paper. The challenge in question regarded establishing a viable way of handling a videoconferencing equipment for remote, regular, one-to-one music tuition, which involved an accordion student and his teacher.

The challenge was brought up to the attention of the educational technologist of the college at the beginning of the 2017/2018 academic year by the accordion student himself, when the difficulty of having regular face-to-face meetings forced the student-teacher pair to think of an alternative which would involve video-conferencing. The teacher had moved to a remote location recently and could not be physically present in the Music College where the student was studying as frequently as before Still, the student wanted to continue working with that particular teacher until graduating in June 2019. Failed attempts from the pair's side to use Skype[1] led them to contact the educational technologist of the college to find a solution that would allow them to overcome the geographical barriers.

The duration of the case study spanned over a period of seven months: from the beginning of October 2017, when the challenge was taken up by the educational technologist, to mid April 2018, when the "system" eventually reached stability.

2.1 Methodology

The methodology that was deployed is the single case study approach. Such an approach aims at exploring a real-life situation involving a person or a group of person over time in a systematic way (Creswell, 2013). The selection of the case to investigate does not necessarily have to be representative of a given population, rather, it is selected on the basis of its potentiality to generate insights around a certain topic (Flyvbjerg, 2001; Siggelkow, 2007). In this sense, the single case study approach is also used in the context of the present paper for generating theory (Glaser & Strauss, 2013; Eisenhardt & Graebner, 2007). While it cannot provide the foundation for empirical extrapolation, the single case study approach helps generate general statements that refer to "transfactual conditions" and "the more or less universal preconditions for an object to be what it is". In other words, such generalizations allow us to move from the domain of the empirical to "the domain of structures and mechanisms"(Danermark, Ekström, & Karlsson, 2019, pp. 76-77). They are also called "analytic generalizations" (Yin, 2019) and

[1] https://www.skype.com/en/

the underlying logic is not *inductive* but *abductive* (Timmermans & Tavory, 2012).

The case study presented here aims to document and demonstrate how an educational technologist handled variety in a specific real-life setting. For this purpose the case study was built around the educational technologist of the college, who, as mentioned above, is one of the authors of this paper and was involved as a co-researcher in the study.

The occasion of such collaboration came about within the frame of the international master's programme in Educational Technology in [**concealed under anonymity**], in which the first author and second author agreed to participate respectively as thesis supervisor and supervisee. The pair held regular meetings from October 2017 onwards, in which they thoroughly discussed and agreed upon all fundamental aspects concerning the research process. The third author joined only after the data collection took place. So, she was involved in the discussion of the results and the writing phase.

Involving the educational technologist as part of the research was primarily justified in the light of the nature of the study. Co-researching is an approach that is based on the involvement of non-professional researchers in a given study with the aim of acquiring a different perspective on the matter under investigation (Hartley & Benington, 2000; Bergold & Thomas, 2012).

The events taken into consideration for the purpose of this study span over a period of roughly six months. The data collection was carried out by the second author himself, who throughout the entire duration of the study acted as an educational technologist. So, the data collection remained *to a large extent* organically embedded into his everyday work. The research methods in this case study were participant observation and semi-structured interviews. The agreement between the teacher, student and the educational technologist, when it all started in October, was that the educational technologist could (quietly) sit in the lesson, interfering as little as possible and conversing with the pair only at the beginning and end of a session, unless they specifically addressed him. Whenever possible, the educational technologist would be physically present at the student end of videoconferencing, setting up or helping to set up equipment and starting the video-conference with the teacher end. Once a lesson started, the educational technologist was observing, taking notes and photos, making video recordings. In addition to the photos he took and video clips he made, whenever they used the Zoom video-conferencing service[2], he could conveniently record the whole lesson. All that to better understand what works and what does not for the two accordionists and where the educational technologist could help improve their experience as soon as possible.

Altogether, between October 4th, 2017 and April 13th, 2018, the educational technologist was able to document eleven lessons. On one occasion, on March 31st, when the student took the lesson from home, he observed the lesson online. All sessions ran at about 90 minutes (see the Table in the Appendix).

[2] https://zoom.us/

To document technical setup details and collect notes as well as post-session comments from the pair, a collaborative Google Document[3] was created during the first lesson and shared with the group. When the educational technologist was occasionally unable to attend a lesson due to other commitments, the student filled in a brief technical questionnaire in the shared document and added notes on how the lesson had proceeded. The technical information that they always put down was a list of equipment used and internet connection parameters at both ends. From the very start the *trio* also had a Google Hangouts group chat[4]. The group chat was mainly used to coordinate lesson times, locations and the equipment used. In addition to observations, notes from the discussions and the information on the set up list, various video material also turned out to be a wealthy source of insights and data. Despite having observed most of the remote lessons live, as they happened, it was the recordings that enabled the educational technologist to discover additional facets related to both auditory and visual interaction, including instant reactions or comments when the emotion was still "hot".

In pursuit of more in-depth feedback, perceptions and reflections from the teacher and student, they were also interviewed individually on two occasions. The interviews were necessary for the following reasons. Firstly, quite often the post-lesson discussions were brief, since the student and/or the teacher would have to rush to their next commitment. Secondly, post-lesson group discussions would not reveal as many individual perceptions that one-to-one interviews to a neutral observer did. The final interviews were conducted once the trio had achieved an optimal setup for remote lessons. While the interim interview served more as a quick checkup on the situation the *trio* had reached by then, the final interview was more structured to be able to collect insight and status evaluation on as many facets of variety in videoconferencing (previously spotted or not) as possible. This data also contributed to defining what constitutes "viability" for the two musicians involved in remote tuition. Where the interpretation of a certain instance in one of the interview responses or other findings required double-checking, the educational technologist contacted the teacher or student via Google Documents and received clarifications. The latter applies also to where he asked the sound engineer to review some of his interpretations regarding audio equipment and quality. So, as mentioned earlier, we can safely say that the data collection was *to a certain extent* organically carried out as part of the educational technologist's everyday work.

As we noted, the authors regularly held meetings, during which they discussed what was happening in the case under investigation, which offered the chance to share initial observations and prompt reflections. In this sense, the analysis of the qualitative data collected was conducted by the team of the three authors, which provided the opportunity to test interpretations as well as generate insights. More specifically, data analysis proceeded in the *abductive* way as

[3] https://www.google.com/docs/about/

[4] https://hangouts.google.com/

described by Timmermans and colleague (Timmermans & Tavory, 2012): that implies an iterative *back-and-forth* between qualitative data and theory, which eventually generates the basis for the analytic generalizations we referred to above.

Indeed, we cannot deny that the double role that the second author came to assume affected the overall result, which is an inevitable and not so undesirable effect. What clearly diverged was what came after the study ended. That is, the analysis of the work done. This is important to stress in relation to the interpretation of the case in the light of the VSM. While the data collection was organic to the practical work conducted by the educational technologist in his everyday life, the next phase, that of analysis, engaged him in a different way. All authors became at this stage part of a dialogue where they repeatedly analysed the case to generate interpretations and theorisations, corroborate and verify them.

2.2 An Educational Technologist in action

In this section we are going to present what we may call "variety-handling" examples, which constitute the essence of our case study. At this stage, we focus on describing such examples trying to retain as much as possible the ethnographic details that characterize *lived experience*. As mentioned above, the necessity of videoconferencing or remote music tuition was pointed out by the student after a few failed attempts to achieve a satisfactory solution using Skype at the beginning of the academic year. So, the viability of the system would essentially mean that the learning and teaching activities would not be disrupted by any interference generated by using videoconferencing.

As this paper focuses on the educational technologist as a variety-handler, we will indeed present examples concerning the way in which he handled a number of situations, in which videoconferencing required his intervention in order to avoid disruptions, which would eventually lead to fatal outcomes, such as cancelling lessons or quitting the experiment altogether. So, the level of recursion identified saw the pair teacher-student as the regulator, and the online space for the music lesson was the regulated. This means that the regulator in this context is the student and teacher together as "Lesson", regulating the "online space" (OS). It would not fit the context of this case study to view the teacher alone as the regulator. Since "OS" is there to create (or mediate) a common sense of presence, where the two participants are interdependent on changes in variables at either end, it is important to have the teacher and student cooperate in "Lesson", defining their desired variables in "OS". Effectively, in the VSM of a remote lesson in the context of this case study, the teacher and student together can be viewed as management and "OE" as operations (Figure 2).

We organized the examples on the basis of six basic pedagogical exchanges as they appear during one-to-one music instrumental lessons. Such exchanges can be labeled as follows:

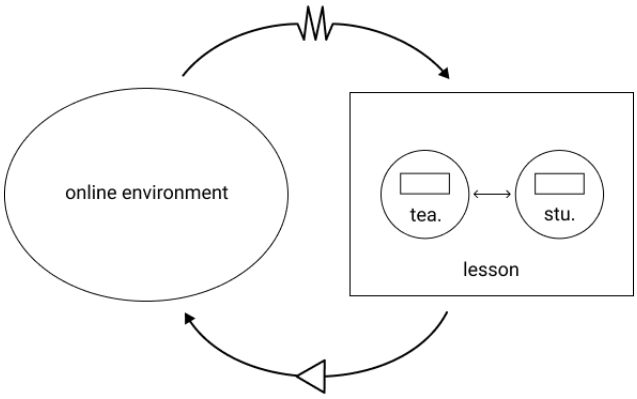

Fig. 2: The regulatory relationship for this case study

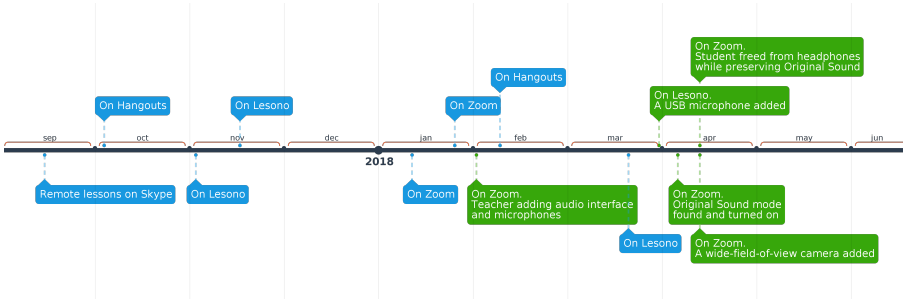

Fig. 3: Overview and timeline of the interventions

– student playing, teacher listening;
– teacher playing, student listening;
– teacher and student conversing;
– teacher and student playing together;
– student playing, teacher watching;
– teacher playing, student watching.

Figure 3 provides an overview and timeline of the interventions.

In presenting the examples, we will refer to the educational technologist by their first name.

2.2.1 Student playing, teacher listening

The core of one-to-one music instrumental lessons is the student playing to the teacher so that the teacher can assess the playing and give feedback. In the final interview, the student said that there had been no constraints to

his playing in remote lessons. He had the liberty to play just as he would in face-to-face lessons. However, remote lessons do pose a *challenge*: whether the sound gets across to the other end, and if it does, whether it is of acceptable quality. The major intervention in this area was to eventually provide the student with a USB microphone.

The microphone component at the student's end provides a clear example in which variety was attenuated in the system. To provide the student with a good mic required the help of the educational technologist. While the school could provide the student with a Focusrite 18-in-channel audio interface, Paul thought that purchasing a USB microphone would have made remote lessons much easier to manage for the student. In fact a audio interface 1 would be too complex for the student to manage on his own (March 9th), or the same device would be unpredictable as to whether it would work in Zoom on different computers, thus causing a loss of time at the beginning of lessons (That is what happened on two occasions – January 26th and February 2nd).

Interestingly, the specific model that was eventually purchased (Rode NT-USB) was something that the owner of Lesono[5], a videoconferencing service designed for music instrumental tuition, had recommended to Paul in an e-mail exchange as their number one choice among different USB microphones. The USB microphone eventually increased student self-sufficiency in managing remote lessons where he would not have the educational technologist or the sound engineer available for technical support.

The quality of the sound produced was of course for the receiving end, the teacher, to evaluate. Looking back at the whole process, from when the experiment started in October, the teacher had not been expressing criticism of the quality of sound he received in remote lessons. He usually commented on the sound as being "very good." However, based on observations and having re-listened to what some of the videoconferencing audio sounded like, Paul realized that the teacher – as an experienced accordion teacher – would be more concerned with the sound or tone quality only after a student has made certain fundamental progress in instrument or repertoire mastery. The teacher concurred with this interpretation. When asked in the final interview about the sound quality in the last two remote lessons where the student had the USB microphone and Original Sound was turned on in Zoom, he said he was happy with the sound, as it is natural and all frequencies are coming through.

2.2.2 Teacher playing, student listening

Similarly to the student, the teacher also found (in the May 6th interview) that compared to face-to-face lessons, there were no constraints to him playing his instrument in remote lessons. As was the case with the student playing and the teacher listening, here again the major problem had to do with the quality of sound that was put into "the machine" and reached the other end. What Paul observed and discussed with the student after two lessons on Zoom in January

[5] https://lesono.com/

is that although most of the playing in the lessons is done by the student (for the teacher to assess and give feedback) it is also important that any playing done by the teacher – be it corrections or examples – would came across as naturally as possible for the student to understand and process. Interestingly, until February, the teacher had played into a microphone integrated into his iPad or Windows laptop. It was specifically in the January 12th and 26th lessons where the student said he was not happy with how the teacher sounded via Zoom. The audio volume was automatically turned down in Zoom when the teacher was playing loud. In order to ascertain whether it is Zoom's audio enhancement which is interfering with the sound, Paul wanted to rule out the teacher's iPad microphone as the culprit. To this end, Paul asked the teacher if he could join the next remote lesson (February 2nd) using an external microphone and audio interface connected to his Windows laptop. He could do that, and this particular lesson on Zoom confirmed that one can have the best audio equipment connected but a speech-oriented video-conferencing software will turn your sound into something tinny and distorted, or in other words, *it will kill the music*.

The first solution was to change the videoconferencing software, switching from Zoom to Lesono, which was previously used in November. This solution was tested on two occasions during March. The sound quality was actually better than that experienced by the pair in Zoom. While a solution was apparently found, Paul contacted the Zoom support team to see if they could provide something similar to Music Mode which is a feature of Polycom videoconferencing. That was also due to the fact that the student had also reported that the picture quality in Lesono was not as good as in Zoom. After further inspection of the settings in Zoom and a live chat with a supportive representative at Zoom, the solution to the problem was found: Zoom support representative advised Paul that "Preserve Original Sound" would be the best option in that regard, and shared a link to Zoom's web page which states that the Original Sound option "allows you to preserve the sound from your microphone without using Zoom's echo cancellation and audio-enhancing features[6]." The change was implemented in a lesson on the 6th of April.

Reviewing the impact of the Original Sound feature on Zoom's sound quality confirmed that one of the audio-enhancing technologies, automatic gain control (AGC) was the one causing sound problems in January and early February. This featured was consequently turned off. AGC is included in web conferencing services to improve the user experience in bi-directional voice calls and it "compensates for either audio or video input level changes by boosting or lowering incoming signals to match a preset level." (Polycom, 2011, p. 6) For the student this meant that the natural dynamic range of music played by the teacher was destroyed when using Zoom without Original Sound. The student himself confirmed in the April 30th interview that sound-wise everything that could or should come through, is now coming through thanks to Original

[6] From: https://support.zoom.us/hc/en-us/articles/115003279466-Preserve-Original-Sound [last accessed 20 June 2019]

Fig. 4: April 6th. The debut of Zoom's Original Sound. The student having to manage headphones for incoming audio

Sound. Since the teacher concurred, the trio decided to continue using Zoom after two successful lessons in April with the Original Sound turned on at both ends.

Interestingly, turning the Original Sound mode on forced the student to use headphones for avoiding echo, since the echo cancellation features were now disabled. And that created another problem. Unlike his teacher, the student prefers not to wear headphones when in a lesson, because headphones prevent him from properly playing the instrument. With headphones on he cannot hear the details of how his instrument sounds in the room. Thus, headphones limit him from listening to and assessing the full "feedback" from his instrument while he is playing. In one lesson, Paul observed that the student would put headphones on or hold them by his right ear every time the teacher talked or played him something and he would put them aside before he himself started playing (Figure 4). It was inconvenient and somewhat messy for the student.

On one occasion, Paul spotted in the April 6th lesson an instance where the student was about to start playing and the teacher wanted to specify his instructions but since the student had already put headphones aside, he could not hear the teacher. Nor could he see the teacher with his eyes already on the keys. Four minutes later the teacher noticed (and mentioned) that the student had lost his focus when finishing a piece of music because he had already been thinking about grabbing the headphones, in order to receive the teacher's feedback. The student agreed about having had that distracted moment. Hence, our challenge for the next lesson at the student end was to try and facilitate listening on speakers while avoiding anything from the speakers

Fig. 5: April 13th. The student freed from headphones

being caught by the microphone and thus ending up back at the teacher's end (audio feedback).

The possible solution to this problem was to optimally position the speakers and the microphone where a headphones-free situation is desired. In our first run, which followed the lesson of the 6th of April with such a setup, the teacher reported only minor audio feedback looping back to him when he was playing. He did not find it disturbing. Other people may not be so tolerant though. What contributed to the relative success of piloting headphones-free monitoring was that the student's favourite, easy-to-use Rode NT-USB is a cardioid microphone, meaning it captures sound less on the back and sides and more from the front. Hence, all had to be done was to make sure the speakers are located far enough behind the microphone (Figure 5).

2.2.3 Teacher and student talking, conversing

Conversations between the teacher and the student, especially towards or at the end of a lesson, is another natural part of their cooperation, creating a safe atmosphere and building the relationship between the master and the apprentice. While the conversations have not been hindered by technology in remote lessons, the teacher outlined in the final interview that talking to the student has not been working for them as well as it has in face-to-face lessons for the reason already presented in this section – the student prefers not to have headphones on when he plays the instrument. As discussed earlier, although the April 13th lesson yielded promising results, Paul will, together with the sound engineer, continue establishing a viable solution for headphones-free monitor-

ing for situations where echo cancellation is disabled in the videoconferencing service for the sake of audio that is as unprocessed as possible.[7]

2.2.4 Teacher and student playing together

In face-to-face lessons, teacher and student are used to playing together. However, as the teacher pointed out in the final interview, that is something that did not materialize in remote lessons. That is due to latency (or delay) generated by network traffic, the videoconferencing service and equipment involved in the session. The delay that was experienced in remote lessons on different services has varied between about 0.5 and 1.5 seconds. Which is enough to prevent the pair from getting in synch. The teacher also stated that if he could play together with the student in remote lessons, to him there would be no difference between face-to-face and remote lessons.

In this case the intervention revolved around trying to minimise latency by a Peer to Peer connection on Zoom between the teacher and the student in one of the last sessions. That option came after Paul consulted Zoom support representatives. The idea of Peer to Peer connection on Zoom is that it allows users to directly connect to one another in a two-person meeting. Unfortunately, the effect of a direct connection between two ends of a videoconference did not materialise, at least not at first attempt. When trying to play together, the teacher and student experienced the usual latency that they have become used to. They estimated the delay at about one second.

It is worth noting that establishing low latency connections between two locations with the aim of making music together is possible. Yet it requires a different setup and equipment (e.g. LoLa), which Paul tried but ruled out due to its intensive use of resources: time, people, equipment and network bandwidth required.

2.2.5 Student playing, teacher watching

At the outset, it was agreed that the trio would try and find a setup that is (among other qualities) mobile, meaning not tied to a specific location and thus offering both the teacher and student the freedom and flexibility in agreeing a time and place for their lessons. This approach implies that participants could use their own computers and, ideally, would not have to buy new ones. However, web cameras integrated to laptops or tablets, especially to older ones, tend to mediate only a restricted field of view (e.g. "talking head") at relatively low video resolution (e.g. 360p or 480p). The former especially had caused some camera management for the student in remote lessons where only his computer's integrated camera would be available. He could either show himself as a talking head with the top of his accordion also visible, or, when the teacher wanted to follow the whole instrument, the student had to adjust

[7] The Original Sound mode is now available in Zoom in a way where one actually retains echo-cancellation, if he/she wishes to.

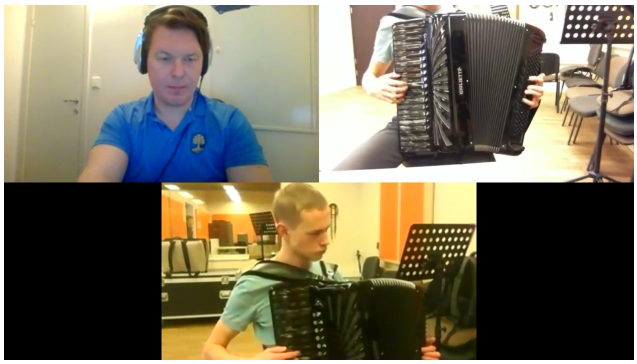

Fig. 6: February 2nd. Examples of what integrated web cameras can mediate. Clockwise from top left corner: teacher laptop, school laptop, student laptop (screenshot from the Zoom recording)

the laptop's lid to crop his face out of the video feed (Figure 6). For Paul, the student having to adjust the camera is a distraction Paul could help remove. Camera management at the student end is an example of systemic variety similar to where he was busy managing the headphones (discussed earlier in this section). Without such things to manage, the student would have more freedom and thus could better focus in remote lessons.

As for the receiving end, that is the teacher watching how the student is playing, the teacher, after a few lessons, suggested it would be nice if he received two video feeds, one with the student and the other with the keys (the hands). In the post-lesson discussion on April 6th the student supported the teacher's idea, confirming it was somewhat weird to keep managing his camera feed (and to be present in lessons with his head hidden). Paul promised a solution for the next session which would be in a week.

Having done some research on the internet regarding different fields of view in web cameras, Paul decided to buy for the school and take to the April 13th lesson an external 1080p resolution web camera with a wide, 90-degree field of view and autofocus (Figure 7. The idea was to check if, for the teacher, that one alone would do the job of two mid-range web cameras with a narrower field of view.

The teacher's feedback after the lesson was positive. He said he was able to see the student and the whole instrument in one frame, confirming the investment in the new camera had been worthwhile. The success with the webcam prompted the teacher to ask if he could remotely zoom in to get a closer visual on the student's hands. The main reason for this is that all the keys on the student's accordion are black, as opposed to the teacher's black and white keys, providing more contrast. In a post-lesson discussion between the teacher, student and Paul, they agreed that an immediate remedy for the challenge would be to place the camera closer to the student or have the student move closer to the camera. However, the latter would also mean moving closer to the microphone, potentially causing distortion. This goes to

Fig. 7: April 13th. The Logitech C930e web camera connected to the student laptop, providing a 90-degree field of view (screenshot from the Zoom recording)

show that it is all about balancing the positioning of different equipment and keeping the other participant informed of changes perceived at either end of the videoconference.

However, a solution was found, as in the Zoom video-conferencing service, the user can allow another user to take control of his/her camera during a meeting. Hence, Paul adjusted to what the teacher needed and added the ability to zoom in to his arsenal for future remote lessons.

2.2.6 Teacher playing, student watching

Similarly to the student, when working with an integrated web camera (either in his laptop or iPad) the teacher was able to produce only a limited field of screen view. In his May 6th interview with Paul, when looking back at the seven-month exploration, the teacher said he had not really been paying attention to how his picture came across, and that the student had not brought it up with him either. This is where the teacher seems to have been a bit too critical of himself since an example from the January 12th lesson (which Paul spotted when reviewing the recordings) demonstrates that he is quite aware of the limited field of view of his camera. At least for an accordion. He stands up to demonstrate for the student a certain left hand technique. However, as he expands the accordion, his left hand almost leaves the frame. He was limited by the technology available to him.

The student did not bring up the limited field of view in the teacher camera after the January 12th lesson. However, in the final interview, when looking back over the seven months, he said that in the future he would definitely prefer a wider field of view and a sharper picture to come through from the teacher end. He needs to see the whole instrument when the teacher is playing. This student feedback, as well as my observations, confirm the need for the teacher to deploy a better web camera. Preferably as good as the one the student end successfully deployed since April 13th. This suggestion has been forwarded to the teacher.

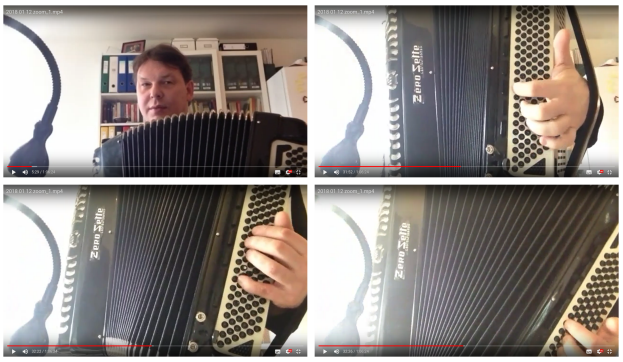

Fig. 8: January 12th. iPad's camera at the teacher end. His left hand moving out of frame due to camera's narrow field of view (screenshots from the Zoom recording)

3 Towards theorising the role of the educational technologist

We have argued that any educational institution or organization is subject to change and that a major source of change is technological change, which implies an increase of the variety within a system. Or, even more simply, there are more ways of doing things, namely, options. The term "proliferation of variety" is the cybernetic vocabulary for this. The case that we presented in this regard is paradigmatic. While in the past there were no other options than to physically meet up in the same place, now students and lecturers can potentially arrange their teaching and learning activities while being physically apart. That means, incidentally, that students as well as lecturers no longer need to be physically located in the same city, region or even country. Also, they can meet up while being at home, in a bar, at the airport, etc. Essentially, they can be located wherever they can get a decent internet connection, which is increasingly everywhere. That is particularly advantageous, when teacher and student face a geographical challenge as in the case presented.

Technology does provide new options. Yet the possibilities to do things in different ways does not automatically translate into an actual improvement or viable solution. Having more options makes it harder to choose which one to select. Which implies that uncertainty increases (Johnson, 2019). That is exactly what happened at the beginning of our story. The accordion student contacted the educational technologist after a few unsatisfactory attempts to conduct music lessons remotely. In our vocabulary that was precisely a *failure in handling variety* and is also the reason why the educational technologist was called in (and rightly so). The software the pair chose in fact *attenuated variety* so that the learning experience was fatally impoverished, as the system "lesson" was essentially disrupted.

What the educational technologist achieved in our case was to help the pair handle their regulative variety by amplifying it. That meant, for example, choosing an alternative to Skype (namely, Lesono and Zoom), managing

the different settings that each of these tools provided (e.g. how the software handles bandwidth, the audio, etc.), the different pieces of equipment used by the pair (e.g. microphones, webcams, laptops and tablets) and the different setups (e.g. the position of microphones, webcams, etc.).

We may argue that what the educational technologist did was helping to handle the delicate balance between attenuation and amplification. Every single choice had repercussions at some level, according to the amount of variety available to the pair *for better or worse*. We have already mentioned that Skype – the very first video-conferencing tool that the pair deployed – reduced the quality of the interaction up to a point that the normal course of the lessons was fatally disrupted. That actually meant a drastic *attenuation* of the kind of variety that is normally experienced (and thus taken for granted) in face-to-face interaction, which we desperately need in order to coordinate our activities. A better online conferencing tool was needed. That is, one that would not cut down the variety of clues that teacher and student can communicate to each other.

The same occurred with the default setting of Zoom. As we have seen, the default settings were (and they are usually) set to maximize speech-oriented audio. That meant that the pair could not fully hear the entire range of sound and pitch produced. With the default settings in place, both teacher and student were unable to properly receive each other's performance. Again, that was a drastic attenuation of variety for both student and teacher, on the wrong side, which meant attenuating regulative variety, reducing the exchange of info and lowering the quality of exchange. What was eventually done was to turn on the original sound mode, which increased the variety available for the pair.

Conversely, attenuation of systemic variety was needed, and thus actively pursued, with the purchase of a USB mic. Instead of fiddling with the audio mixer along with the possible different setups at the beginning of each lesson, the student had the chance to use a piece of equipment, which would merely require to be plugged in. That "gear" attenuated systemic variety for the student for good reasons on the right side, since the USB mic does not require as much attention as the audio mixer. That attenuation helped the student remain focused on learning-related activities.

Another example was a wide-angle webcam, which allowed the teacher to capture the entire sequence of movements performed by the accordion student, allowing for the amplification of the teacher's regulative variety in a context crucial for him. And that was done without increasing the amount of systemic variety for the teacher to handle, which would have been easily the case if two webcams had been installed.

Amplification of the teacher's regulative variety also concerned the case when the educational technologist informed the teacher about the possibility of gaining control of the student's webcam so as to allow him to zoom in and zoom out, when he considered it pedagogically relevant (e.g. to collect better information). The technology of choice allowed the teacher to amplify his regulative variety.

We have also seen how echo-cancellation features provided by Zoom forced the student to wear headphones, which, in turn, hindered the possibility for the student to hear himself playing. That would count as an attenuation of the student's regulative variety. Even more interestingly, the solution initially found – taking off the headphones while playing and putting one on when receiving the teacher's feedback, made things even worse. That would count as an increase of systemic variety to manage for the pair. As we noted above, the student held the headphones by one hand only. Which translated into the likelihood of taking the headphones off *before* the teacher had actually finished providing his feedback. The delicate handling of amplification and attenuation of variety was successfully achieved by setting up microphones in the right place so as to avoid interference and any annoying echo. The pair still experienced a bit of echo, but that was kept under a certain threshold and therefore it was perceived as manageable.

To summarize, we may say that the educational technologist came to install the proper attenuators and amplifiers in order to avoid any further disruption – due to unmanaged systemic variety – that would badly affect the lesson, whether because the regulative variety available was not enough or, on the contrary, because systemic variety was more than the pair could possibly handle. This implies a different vision on technology in the educational institution: as we mentioned in Section 1.4, the tools can be seen as those external resources that are deployed in the educational institution to handle the balance between attenuation and amplification of variety. In other words, tools are essentially either attenuators or amplifiers. The main role of the educational technologist is to help the institution to place them in the right place, at the right moment.

This last consideration brings us back to technocratism. As we have seen the role of the educational technologist was *not* to integrate (new) technologies into the lesson. As we noted, the level of recursion identified was the remote lesson. At that level of recursion, teacher and student were the *regulators*, while the online space for making video-conferencing possible *the regulated*. This is the reason why the problem with technocratism did not arise. What we have seen in our case is that choosing the right piece of technology turned out to be fundamental. Almost all interventions required the use of technology. However, since the teacher and student were the regulators, the whole system revolved around *their* pedagogical aims. *Only then* the educational technologist came in to help them manage systemic variety and their regulative variety in such a way as to allow the pursuit of their goals. And that was done with the help of the tools.

Conversely, the problem with a technology-centered approach – as mentioned above – is that it would imply the educational technologist becomes the regulator and the different technologies have the upper hand in enforcing certain goals, which might have been in the end external to the very pedagogical relationship established between teacher and student(s). That would have meant looking at technology as "an active agent in the educational process", working independently for the achievement of certain desired "pedagogical

conditions" (Hamilton & Friesen, 2013, p. 5) and in which lecturers as well as students would be passive beneficiaries (Aagaard, 2017).

4 Conclusion

The case presented aims to support us in documenting the kind of work done by the educational technologist at a certain level of recursion. Choosing a specific level of recursion inevitably implies a focus on certain emerging dynamics, while leaving others out. In addition, we dealt with music tuition, which still remains a rather peculiar form in the educational landscape, as it is performed in a way rarely reproduced elsewhere. That is, this kind of one-to-one kind tutoring is extremely rare in other educational domains.

Interestingly, we may also argue that depending on the level of recursion, the role of variety-handling could have been taken on by a person not specifically employed with the title of educational technologist. At least in theory - the role could be taken on by a teacher or by the teacher and their students. For example, the lecturers may involve their students in selecting the apps to use and thus distributing the task of handling variety, which is in the end what defines the educational technologist.

Incidentally, the fact that the role played by the educational technologist varies seems to explain why, at least historically speaking, the educational technologist has been associated with a plethora of different and heterogeneous figures, as the aforementioned Duchastel and Mitchell illustrate (Mitchell, 1975; Duchastel, 1978). Depending on the context, and level of recursions addressed, the educational technologist can be a designer, manager, researcher, planner, etc. As the main point developed within this paper suggests, it is the handling of variety that seems to give coherence to all these activities. So, even in our case it seems to be quite evident, since the educational technologist had in fact embodied different functions. He was, for example, a technician, as he was mostly involved in consulting the pair as to which tool to use. However, he also acted as a researcher, often having to inquire into the different technical solutions, and observing and monitoring the situation as it unfolded.

Additionally, and to return to the list provided by Duchastel (Duchastel, 1978), he was also an innovator, a resource-person, an evaluator, a product quality verifier, a problem-solver and field-researcher. Due to the particular level of recursion we addressed in this paper, the educational technologist did not appear to have any substantial role in designing learning activities. Yet he did have a fundamental role in co-designing the *online environment*, in which the pair carried out their own activities.

While the present study has shown how an educational technologist handled variety, we inevitably focused on a particular level of recursion. That means that we did not provide an empirical demonstration of how variety can be handled in other different contexts, that is, when other levels of recursion are considered. Considering other levels of recursion could provide further practical demonstrations of the main idea put forward in this paper. For ex-

ample, what kind of dynamics would we observe, if we chose the classroom as the level of recursion? Would we see teachers acquiring a more prominent role in choosing the different technologies? Would the educational technologist be more involved in actual teaching activities? What would the role of the management be, if we chose the school as the level of recursion? What kind of problems with dealing with variety would we able to detect?

Indeed, all those questions require further empirical investigation, but they also show the intellectual fecundity of the approach developed in this paper.

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6 Funding

Not applicable

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Appendices

Types of data collected in remote lessons

Lesson	4/10	3/11	17/11	12/01	26/01	2/02	9/03	21/03	31/03	6/04	13/04
Observation	x	x		x	x	x		x	x	x	x
Participant comments	x	x	x	x	x	x	x	x	x	x	x
Photos	x	x		x	x	x		x	x	x	x
Video clips	x	x		x	x			x	x		x
Full lesson video rec.				x	x	x	x		x	x	x
Setup spec.	x	x	x	x	x	x		x	x	x	x