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## **A Making project at school as a nexus of practice: from interdisciplinarity to zones of identification**

Despite an abundance of research on collaboration between participants with different disciplinary backgrounds, there is less research available on researchers' reflections on their working process. This study sheds light on the interdisciplinary work of a research group in the context of a Making project involving design and digital fabrication at school. Nexus analysis is used as a research strategy. The research material includes researchers' reflective writing, a video recording of their group discussion and their participatory observations throughout their longstanding collaboration surrounding the short-term Making project. The findings highlight the diversity and roles of the key social actors, and how their historical bodies and discourses in place related to doing research in academia are relevant for the actual Making project at school. The study provides implications for methodological development, interdisciplinary work and for carrying out projects with participants beyond university.

**Keywords:** academia, interdisciplinarity, Making, nexus analysis, schools

**Asiasanat:** akateeminen yhteisö, tieteidenvälisyys, värkkäys, neksusanalyysi, koulut

## 1 Introduction

The idea of collaboration between different disciplines has been increasingly discussed from the 19<sup>th</sup> century onwards and actively encouraged since the 1970s in university discourse as a solution to tackle the challenging and intricate problems of modern times (Voskamp 1986; Klein 2007). Practitioners in universities know, however, that such work is not necessarily straightforward. Rather, it emerges as a complex ecosystem that involves the interplay between people, places and discourses here and now, but also across distant timescales and places (Scollon & Scollon 2003, 2004; Hult 2017). In research that relies on transformative and constructivist worldviews, the researcher's voice is not usually faded out (Creswell 2013). However, studies focusing on researchers' own reflections on the intricacies of collaboration between disciplines are still scarce. This study addresses researchers' perspectives in relation to conducting a Making project at school as an interdisciplinary venture.

The Making project was executed in collaboration with a Finnish school for basic education. 'Making' refers here to creative production of artefacts in 'makerspaces,' communities of practice, by people who find digital and physical forums to share their processes and products with others (Halverson & Sheridan 2014: 496). Considering the Finnish school, Making involves familiar aspects due to project-based and collaborative learning approaches that have been submerged in the curriculum for a long time (Jaatinen & Lindfors 2019), e.g., through the integration of school subjects to advance entrepreneurship and intercultural awareness. However, the form of Making evolving in a specific type of makerspaces, i.e. Fab Labs (spaces for digital fabrication), is not widespread yet in Finland despite the increasing interest among educators and researchers. There may be devices for digital fabrication such as 3D printers available in schools and homes, but full-fledged Fab Labs can only be found in a few localities in the country – three in the south and three in the north (<http://www.fablabs.io>).

The interdisciplinary group of authors has worked together for more than ten years investigating children's and young people's technology-rich everyday life, approaching the topic with the lenses of their disciplinary backgrounds in (Applied) Language Studies (LS) on the one hand, and Information Systems (IS) and Human-Computer Interaction (HCI) on the other. The group has conducted numerous projects and studies applying nexus analysis (Scollon & Scollon 2004), which is the approach adopted here as well. An important thread in the group's work has also been continuous theoretical and methodological reflection concerning the nature of academic life, discipline-related differences and similarities as well as the boundaries of academic communities. This study takes a special look at one of the recent projects on Making at school. As Making involving digital fabrication in the Fab Lab was not a familiar activity to any of the participants as a school venture – neither for the researchers nor for the teachers and pupils – the project generated lively discussion

and negotiation of meanings, thus providing an interesting forum for examining the interdisciplinary collaboration of the research group.

This study sheds light on the following question: How does conducting a Making project at school emerge as a nexus of practice for the researchers? The analysis entails making sense of the complexity of planning, executing and researching such a project and the discourses circulating the nexus of practice. This also involves reflecting on the researchers' long-term trajectories placing themselves in the zone of identification with the nexus of practice in focus (Scollon & Scollon 2004: 153, 156). The analysis draws on the understanding that social action emerges as an interplay of historical bodies of the participants, interaction orders among them as well as discourses in place (Scollon & Scollon 2004: 9). The Making project at school serves as a boundary object (Star & Griesemer 1989; Wenger 1998) for making sense of the wider scales and situated intricacies of interdisciplinary work. The study provides implications for research collaboration and for organising participatory projects in schools.

## 2 Background for the study

The call for joining forces from different disciplinary backgrounds has been voiced since the 1970s, characterised over the years as multi-, inter- or transdisciplinary depending on the nature of the collaboration. Disciplines may draw on knowledge from others but stay within their own boundaries (multidisciplinarity), interact with each other towards a coordinated and coherent whole (interdisciplinarity), or transcend traditional boundaries (transdisciplinarity) (Choi & Pak 2006: 351). These terms may also be approached as boundary objects involving several interpretations and functioning as tools in academic discourse (cf. Martinviita 2017 on the notion of community as a boundary object).

There is an abundance of in-depth qualitative, interpretive research available on research entailing collaboration among multiple disciplines (see e.g. Lawrence 2006; Karasti et al. 2010; Iivari 2019). Autoethnographic research has also arisen on 'doing research'. In these studies, researchers have been addressing their identity development, often at an early phase in their career (e.g., Cunningham & Carmichael 2018), or they have been legitimating their qualitative approaches (e.g., Roger et al. 2018). Nexus analysis as a research strategy assumes researchers' attachment to the nexus of practice, which requires the researchers' contemplations on their position in the nexus of practice they are studying (Scollon & Scollon 2004).

Although an ideal quality for research may be transdisciplinarity, collaboration in real academic life often suffers from tensions due to short-term projects and staff contracts, struggle for funding as well as disciplinary and institutional cultures (Ylijoki 2003). Yoo et al. (2018) suggest that short-term partnerships in research

should be complemented with alternative models involving longstanding collaboration. They consider collaborative reflection as a powerful practice in strengthening common ground in terms of purpose, spirit of innovation as well as mutual trust and commitment to ongoing relationships. Reserving extended time for face-to-face conversation concerning these areas pays off in reducing disciplinary crosstalk and hidden misunderstandings (see Kirk-Lawlor & Allred 2017).

Academic communities have been described as communities of practice (Lave & Wenger 1991; Wenger et al. 2002), or as affinity spaces (Gee 2007). In these communities, the research process is constituted across time and space evolving through diverse sites of engagement conceived as space/time stations or landmark events (de Saint-Georges 2005: 156). Research collaboration may take different forms with members contributing to varying degrees in the joint effort (Wenger et al. 2002). As Russell and Kelly (2002) suggest referring to Breuer (2000), research collaboration involves intellectual and emotional comfort, individual interest in a certain phenomenon and attraction to certain roles or environments. Further, researchers may be enabled or confined by professional associations of different kinds, e.g., institutional frameworks or scientific disciplines, which reflect wider cultural norms (Russell & Kelly 2002). The degree of commitment and contribution to reach a shared goal may vary considerably in the case of individual participants, but showing respect and valuing their passion are needed (Gee 2007; Gee & Hayes 2011: 69–71).

The nexus of practice for the researchers of this study was conducting a Making project at school. Making, based on constructionism (Harel & Papert 1991; Papert & Harel 1991), is seen to promote twenty-first-century skills through collaboration and design in shared workspaces (Halverson & Sheridan 2014; Iivari et al. 2017). The aims of the maker movement are in accordance with the Finnish curriculum, especially with reference to transversal competences related to information and communication technology (ICT), critical thinking as well as work life and entrepreneurship, among others (Finnish National Board of Education 2016). Transversal competences are integrated among the goals of all teaching but especially within such learning modules that cross school subjects. These learning modules are, thus, appropriate platforms for design and Making, and through that, natural sites for collaboration with researchers interested in the topics. Schools welcome opportunities to participate in projects organised in partnership with the university within these cross-subject modules as they are a new element in Finnish basic education considering their compulsory status in recent curricula (Finnish National Board of Education 2016). Conducting Making projects within and beyond schools inherently involves collaboration between participants with different disciplinary backgrounds (e.g., Norouzi et al. 2019). Such projects thus provide fruitful possibilities to study interdisciplinary work from the perspective of the involved researchers or from the viewpoint of collaboration between different disciplines.

### 3 Research approach

In this study, the emphasis is on the researchers' (i.e., the authors') reflective stance and the entanglement of discourses circulating the nexus of practice, of conducting a Making project at school. Nexus analysis was chosen as a research strategy as it is suited for studying complex phenomena reaching from situated action to wider, even societal angles, also with a long-term emphasis (Scollon & Scollon 2004). It also involves the researchers examining their own positions in and historical trajectories to the nexus of practice as participants of the same nexus. Special attention is paid to how the researchers' long-term trajectories leading to the project have evolved over time, what researchers' zones of identification with this nexus of practice are (Scollon & Scollon 2004: 153, 156). The analysis also sheds light on what kinds of discourses are circulating the researchers' sense-making of academic practice in relation to planning and executing the interdisciplinary Making project.

#### 3.1 Nexus analysis as a research strategy

Nexus analysis is the methodological arm of mediated discourse analysis (Scollon & de Saint-Georges 2011). Hult (2017: 89) characterises it as a meta-methodology for guiding the integration of theories and methods when discursive flows within and across social actions are being mapped in research. Nexus analysis entails seeing social action as mediated (Wertsch 1998), always emerging at the intersection of three aspects: 1) the interaction order between participants in a particular site of engagement, 2) their historical bodies or experiences and accustomed practices, and 3) discourses in place, the discourses evoked in situ, echoing the past and projecting the future (Scollon & Scollon 2004: 9–14). Nexus analysis takes an ethnographic stance on social action and proceeds by engaging, navigating and changing the nexus of practice (Scollon & Scollon 2004: 9).

Engaging the nexus of practice, the linkage of repeatable mediated actions recognised by a social group (Scollon 2001: 150), is the opening task of nexus analysis. This involves the researcher's ethnographic engagement and data collection (Larsen & Raudaskoski 2019: 13). At its simplest, researchers need to be explicit about their position in the social world and the social issues they want to address through the research (Scollon & Scollon 2004: 83). Researchers thus place themselves in a zone of identification with the nexus of practice under study (Scollon & Scollon 2004: 9). In navigating the nexus of practice, the researchers organise and analyse the data (Larsen & Raudaskoski 2019: 13) mapping the (semiotic) cycles of discourse, of people and of mediational means (Scollon & Scollon 2004: 9, 84). Tracing the transformations of these cycles over time is also relevant in doing nexus analysis (Scollon 2007), making change visible (Scollon & Scollon 2004). The analysis thus focuses not only on situated micro-scale actions but also circumferences their wider timescales

and places, zooming in and zooming out (Scollon & Scollon 2004; Nicolini 2010; Hult 2017).

As a research strategy, nexus analysis can be seen to align with a transformative worldview as it entails a participatory approach and an interest in contributing to positive change (Scollon & de Saint-Georges 2011; Creswell 2013). As the researchers need to become acknowledged as legitimate members in the nexus of practice being studied, their presence already is transformative of the nexus of practice (Scollon & Scollon 2004). The researcher can even take the position of an activist and try to contribute to the transformation of practice more strongly. Analysing discourses and participants' motives for social action may be tools in triggering change (Scollon & Scollon 2004: 41). Considering the focus of this study, conducting a Making project at school, change could be desirable in many ways, e.g., to advance learning and (in-service) teacher education, to develop methods of collaboration between university and school, to contribute to methodological improvements in academia and to a more profound understanding of the complexity of the phenomenon under scrutiny. In relation to our self-reflective interest, an important aspect of change would be to develop our professional identities and working methods, for example.

### 3.2 Research material and the research process

The research material consists of different types of data. The researchers' individual observations have accumulated over time, during the years of collaboration. Project documentation and research data have also been gathered from eight collaborative projects since 2008, leading to 15 publications. This material from previous projects was only used for scene setting for this paper. For capturing individual experiences and trajectories leading to the project, research material was generated through individual reflective writing. The researchers were invited to contemplate their research trajectories and anticipated future, methodological emphases and discourses, challenges and success in the Making project, and their links to other researchers (approx. 3800 words in total). Next, a group meeting was organised where the researchers continued elaborating the themes of the writing activity (video recording, ca. 90 minutes).

The analysis started by going through the written reflections and identifying nodes of importance, i.e., themes interesting from the perspective of the research questions. These nodes were organised into clusters that reflected the main discourses at work. Next, the transcript for the group discussion was examined. As the researchers had continued contemplating the themes raised in the written reflections, similar discourses were identified. The analysis was then finetuned based on our observations and theoretical understandings (Elliot 2018) including the concepts of interaction order, historical body and discourses in place (Scollon & Scollon 2004). The ethical guidelines and criteria of the Finnish National Board for Research

Integrity (2019) were followed during the study, including gaining participants' informed consent.

## 4 The nexus of practice of conducting a Making project at school

In the following, the results of the study are discussed. The analysis foregrounded the nexus of practice of conducting a Making project at school as a complex entanglement of diverse actions, discourses and participants. This nexus involved researchers gradually gaining a foothold in academia and the school, finding affinity spaces and means to increase their agency as well as balancing between control and enablement in managing the activities with the school pupils.

The interpretations are based not only on the analysis of group discussions and reflective writings but also on researchers' personal experiences and observations of life in academia across a long-term timescale, with special reference to the Making project conducted with the school. In the extracts in this section, only the English versions of the original Finnish are given for reasons of space and the nature of analysis, which does not deal with a detailed linguistic level.

### 4.1 Gaining a foothold in academia and the school

Considering the researchers' zone of identification with the nexus of practice of conducting a Making project at school, their reflections in the written texts and the discussions shed light on their career trajectories tracing back to the times of entering academia. Once within, they have shaped their professional paths as a result of personal preferences, random courses of action, disciplinary trends, societally prevalent discourses, and calls for funding of interest. Increasing experience and awareness of the community practices and widening networks have given resources for gaining footholds in academia as established researchers.

Having established a multidisciplinary research group a decade ago, the researchers started their collaboration in research. The central themes for research were defined as children and young people, participation, and technology-rich everyday life. Schools were a natural environment for the research group to enter with projects where these aspects would meet and allow examination using nexus analysis as a shared research strategy. After carrying out projects of different kinds over years, the research group turned its focus on Making in education at school, especially design projects drawing on digital fabrication in a Fab Lab (Halverson & Sheridan 2014; Iivari et al. 2020). Therefore, planning, organising, and putting into

practice one such project with a Finnish school was chosen for closer scrutiny in this study.

As portrayed above, the researchers have over the years put an effort in elaborating together their understandings related to their research interest and their methodological stance in connection to their research projects. Events that have advanced their research such as writing funding applications, doing data analysis and planning future actions, have served as space/time stations (de Saint-Georges 2005) through which it has been possible to develop shared understandings, work on research outputs (e.g., publications), and consequently, gain a stronger foothold in academia.

As for gaining a foothold concretely at a local comprehensive school for conducting the Making project with their pupils, access was achieved through earlier contacts with whom there was a shared history and mutual trust based on previous pedagogic projects. After a negotiation of practical and curricular nature, a class of ninth graders (14–15 years) and their teachers from a multidisciplinary learning module were recruited. A team of master's students (four from IS/HCI and one from LS) conducted the practical work in the school supported by the researchers. The analysis puts the Making project at school into focus, but engaging, navigating and changing the nexus of practice can be seen to work across two timescales: the life cycle of the school project and the life cycle of the multidisciplinary research group providing the environment for the researchers to carry out this small-scale project with pupils.

## 4.2 Finding affinity spaces and developing agency

When researchers engage in social action, their historical bodies, anticipated and enacted interaction orders as well as discourses in place shape that action, but social action also shapes their historical bodies as academics (Lave & Wenger 1991; Scollon & Scollon 2004). In their accounts, the researchers constructed their longstanding collaboration as an affinity space, where participants engaged in activities with varying degrees of involvement having a broadly defined shared goal beside their discipline-specific interests (Gee 2007; Gee & Hayes 2011: 69–71). How the researchers have advanced to the current situation in an established position in academia was characterised as a flux of sometimes arbitrary, sometimes purposeful contacts and events in life. This was also characterised as ongoing sense making about the configurations of academia as an environment for research. Considering the research group providing an affinity space for the researchers to fulfil their goals, confidential relationships were brought up as being important:

- 1) Researcher 1: <research group> has been a very important community for me where I have felt I can confidentially talk about anything and also discuss engaging in science in different fields. (reflective writing)

In nexus-analytical terms, Example 1 suggests a balanced interaction order in the research group where the members can freely engage in negotiation for meanings and identity work.

In their reflective writing and the group discussion, researchers also foregrounded their agency as emerging from growing self-confidence when learning about the perspectives of other researchers and the push from actors more distant but powerful in the field. Examples of such actors are represented through international bodies such as UNESCO, the OECD, the European Commission, the Ministry of Education and Culture in Finland as well as the Finnish National Agency for Education. Although the presence of these collective actors is not explicit in the daily life of academia, it is still influential through various evaluation criteria and recommendations that give direction to funding, and consequently to the academic discourses in place.

Academic life was brought about as largely strategic balancing, the researchers competing for funding and legitimation for doing research in the way they wish. This involves either adapting to the tradition, withdrawing from it, or maybe taking an active role in transforming it. The university was described as a field of tensions, strategic work or even a battlefield to gain position and resources such as funding. Nevertheless, the research group was seen to provide a safe space for sharing feelings and understandings about academic life.

Experience from longstanding collaboration and the research material suggest that the conventions of the academic community are not necessarily shared even within one discipline, which poses an individual researcher with potential challenges in terms of doing research and writing research reports. The researcher may also have to struggle with tensions related to motivations for research, whether it is driven by one's own genuine interest or pushed forward by external forces. The feeling of personal meaning may develop when the focus of study becomes clearer:

- 2) Researcher 2: yes well. originally it certainly had to do with funding or they almost sort of ordered research about it, but it became interesting for me when it became clear that it's no digital fabrication, but it's maker culture that in fact is the thing after which it was possible to see that this is actually interesting (group discussion)

Participation in the Maker culture is here identified as the source of motivation for bringing together various groups of participants in Making projects at the university and at school.

The analysis shed light on how the diverse aspects of doing research and finding one's way in academia have become submerged in the research group members' historical bodies as researchers (Scollon & Scollon 2004). The researchers' wide range of interests and experiences, opportunities and challenges have led to the delineation of the research interest as it is now, children and technology, social action and practices as well as nexus analysis as a research approach. These form the premises for carrying out the Making project at a school. The next section zooms in on the practicalities of the project by discussing how participation in the project shaped out.

### **4.3 Balancing between control and enablement - forces influencing the Making project at school**

Research projects as concrete manifestations of researchers' interests are in the centre of collaboration, characterised by complexity and flux, as researchers shape collaboration and collaboration shapes research. The material from the researchers made it possible to trace a range of people, discourses, places, and mediational means that have contributed to the shaping of the Making project, even before its planning phase. When research is viewed as participatory social action, nexus analysis brings into the foreground the fluidity of the participants' roles and responsibilities, as they are viewed as emergent and constantly changing at the crossroads of discourses in place and social action (Scollon & Scollon 2004; see also de Saint-Georges 2005).

Negotiating the language practices of the Making project is an example of ongoing transformation moving from anticipations to performance, changing the nature of the nexus of practice (de Saint-Georges 2005). At school, Finnish is the primary language except for foreign language lessons. As English was one of the subjects included in the multidisciplinary module, the plan was to use English in the project. However, in the classroom sessions, some uncertainty and discussion arose regarding language practices, and the working language quickly switched to Finnish due to the IS/HCI students' lacking experience in using English in project guidance. In this way, the nexus of practice changed its nature from what was anticipated in terms of aligning the Making activities more strongly with the multidisciplinary goals of the curriculum. This example shows how the entanglement of participants with their mutual relationships and historical bodies (experiences, accustomed practices) may lead to an abundance of aspects that need to be negotiated to reach a shared understanding about roles and responsibilities as well as the goal of the activities. In other words, the nexus of practice is never stable, but changeable depending on the configurations of the participants' historical bodies, interaction orders and discourses in place.

Another example of how researchers shape collaboration and collaboration shapes research concerns balancing between being in control and enabling genui-

ne participation for the participants (cf. Sense 2006) that as a topic emerged in the researchers' reflections after the Making project, entailing lengthy discussions of what kinds of methods or principles could or should be used in leading the project activities in class, and by whom. For example, as the university students implemented the Making project with the pupils, one concern for the researchers was how they in general manage in that position:

- 3) Researcher 3: but anyways when we throw them to wolves so to say, our students, so it isn't really a wonder that they don't ...  
Researcher 4: yes, perhaps it just is such a new way for the pupils to think that they just don't understand however thoroughly you explain and however many times, it just is such a new thing for them (group discussion)

The extreme case formulation (Pomerantz 1986) of university students being 'thrown to the wolves' when they had to lead the activities in class highlights how the work in the classroom should be organized and whether it should be planned more carefully. If the university students' academic background is in IS or HCI, they do not typically have pedagogical training or experience, but rather, their expertise in project management and the Making process provides the starting point. On the other hand, as the second researcher in the extract foregrounds, it is also the novelty of the Making approach in the school for all the participants that may cause confusion about how to handle the situations where the design process is advanced. Although the school pupils are familiar with a range of interaction orders common at school such as the panopticon (e.g., the teacher as the hub for interaction), they may not be able to anticipate what is expected from them in a Making class, as they lack prior experience of it (see Scollon & Scollon 2004: 45). In other words, this is a matter of the participants' historical bodies (experiences, knowledge and accustomed practices) and how they contribute to the anticipations and performance of interaction orders in situ (de Saint-Georges 2005), and whether, for example, the university students are treated as legitimate actors by others, rather than how expertise should be enacted in class.

As regards using certain principles in planning and organizing the activities in a project, the researchers weighed the affordances and restrictions of these in many ways. The following comment voices in the most explicit way in the data the conflicting forces of controlling or guiding participation in different ways, on the one hand, or allowing it to evolve more freely, on the other hand.

- 4) Researcher 2: it's kind of difficult that one does not quite know what to think about the whole thing, or you see the both sides of it, but when we have sometimes viewed video recordings from our design sessions led by our students, and then someone in the group has commented that didn't you have clear methods to use, that is the way to succeed, so of course our reaction has been in those situations that you know the classroom is like that, it is not the method that makes

you happy, but then on the other hand, we all are experienced teachers here and I have developed my teaching over the years and I can say that my course, when I have changed certain things, then those courses have become better (group discussion)

As the quote reveals, some practitioners put emphasis on the fluent process of design relying on a specific kind of guidance (*didn't you have clear methods to use, that is the way to succeed*). However, having a *method*, pedagogical or design-based, does not solve anything on its own (*it is not the method that makes you happy*). The issue is rather the situated events and interactions guiding the work often in unexpected ways.

Research projects are highly dependent on the favourable attitude of research participants. Different types of multidisciplinary learning projects, involving also innovation and design have been common in the educational field for a long time (Iivari et al. 2017; Jaatinen & Lindfors 2019). As they are in the latest national curriculum a mandatory element (Finnish National Board of Education 2016), opportunities for collaboration with partners beyond the school are valued. This was also the case with the teachers and pupils taking part in the Making project as observation and the research materials indicate.

The degree of teachers' participation in collaborative projects may be influenced by infrastructural aspects, such as the traditional subject-based timetable, and the methods for calculating teachers' workload. If little or no working time is reserved for planning and carrying out projects with many stakeholders, individual teachers have to make decisions regarding their level of commitment and participation based on their own interest. In the current project, the teachers were occasionally available in class, but the main actors were the project group members and the pupils. In the group discussion, the researchers contemplated these issues in relation to teachers' participation. They concluded that the expectations of the researchers with a background in a nexus-analytical participatory approach and the expectations of the schoolteachers with their institutional conventions do not necessarily meet. If these expectations are not voiced, it may be difficult for the teachers to envision their role and place in the activities. This issue calls for the participatory stance in nexus analysis to generate situations with the participants to negotiate meanings and share understandings as a mediational means for change (Scollon & Scollon 2004).

As for the pupils' contribution in ensuring the success of the project, a delicate balance between concrete actions for control and enablement needs to be reached. In the research materials, this aspect generated lively discussion. Much of the pupils' activity in the classroom and the university Fab Lab had, at first sight, appeared as unrelated to the Making process. The pupils seemed to be having fun, joking and hanging out with their peers, only marginally engaging in the design project that was supposed to be the backbone of the course. However, paying special attention to the evolving interaction from a situated perspective had started to foreground

how all the participants were multimodally advancing the design process (e.g., Goodwin 2000). Humour and laughter were, in fact, used as resources when negotiating competence, division of labour, legitimating design ideas as well as balancing between the official project task and other orientations (see Iivari et al. 2020). The observations and the research materials suggest that the pupils indeed valued the chance to participate in the project. In an interview, the pupils recognised the importance of their own actions for the success or failure of the project, e.g. recounting how they could have been more active in carrying out the Making project, even though they managed to carry out the project successfully.

The examples discussed in this section show how the practical Making project at school emerged as a boundary object for us as researchers, enabling reflection on our own (interdisciplinary) ways of working in research projects, pondering the trajectories leading to the current situation, questioning and legitimating choices made, often based on disciplinary viewpoints, and finding improved ways of working for the future projects.

## 5 Discussion and conclusion

This nexus analytical study examined the intricacies of research collaboration by focusing on the nexus of practice of conducting a Making project at school, a boundary object facilitating researchers' meaning negotiation from multiple perspectives (Star & Griesemer 1989; Wenger 1998; Scollon & Scollon 2004). The analysis showed how interdisciplinary collaboration emerges as a semiotic ecosystem of a range of actors, contextual circumstances and discourses across diverse timescales and places (Scollon & Scollon 2004: 106–107).

The findings revealed a multitude of participants both from the school and the university, each having their life experiences, backgrounds, motivations and desires, i.e., historical bodies, shaping their engagement in the project. More distant actors having their impact through funding bodies, international organisations, the government, and school administration have their reach to the nexus of practice as well. Various societal discourses as well as disciplinary systems with their delicate power configurations shape the project further (see also Iivari 2019). Figure 1 illustrates this complexity as arising from the interplay of historical bodies, interaction orders and discourses in place.

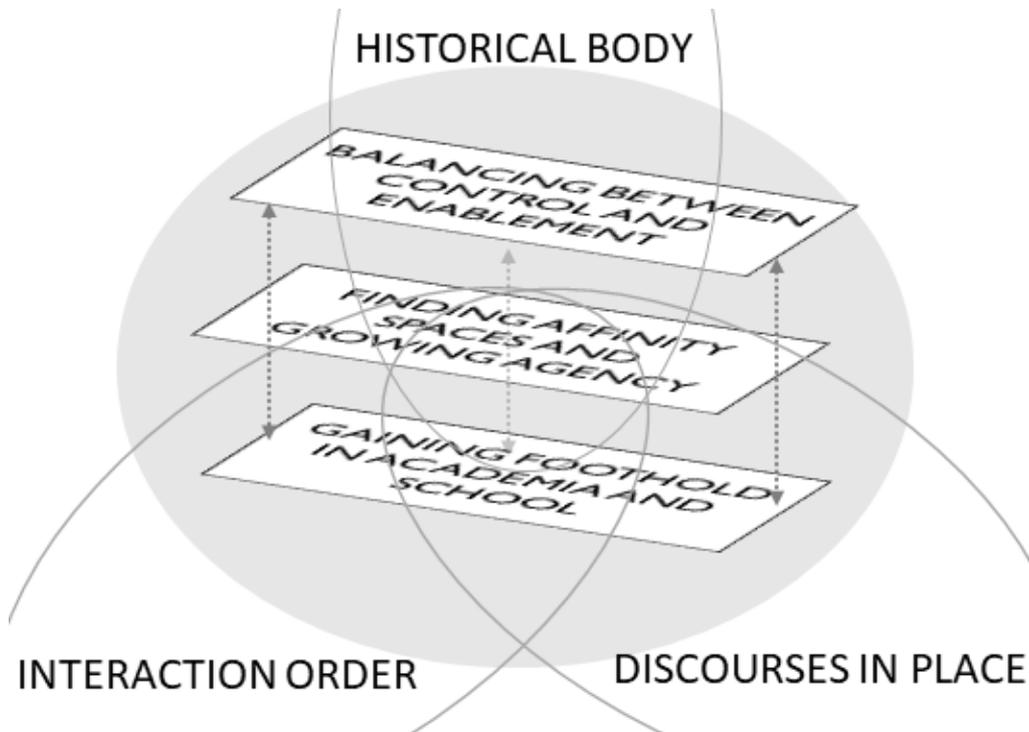


FIGURE 1. A Making project at school as a nexus of practice.

One of the relevant social actions identified in the nexus of practice of conducting a Making project at school was related to gaining a foothold as a researcher in academia and in the chosen environments for research (see section 4.1). This issue was not described as belonging to the initial phases of the career path only but as always present and in flux. When zooming in towards the Making project, actions related to finding affinity spaces and growing agency were identified (see section 4.2). As awareness about the field and networks becomes broader and stronger, self-confidence may grow, and it is possible to experience the push from different areas of governance as a resource rather than as a force that hinders one's activity. Thus, researchers' agency as empowered actors in academia arises from a growing understanding of the complexity of that ecosystem. It also helps in identifying relevant research environments, in this case one that combines the classroom and the Maker culture. Zooming in further still, the Making project was characterised as an act of balancing between control and enablement (see section 4.3). This was related

both to handling the situations at the school and the Fab Lab where the Making project was accomplished, and to managing the complexities on a long-term basis.

The study offers practical implications for research collaboration and organizing participatory projects in schools and with participants beyond university. In terms of research collaboration across disciplines inside the university, establishing and maintaining personal relationships, trust, and mutual understanding is crucial. All this entails delicate and power-laden negotiation and strategizing as well as a considerable amount of time (see also Gee 2007; Gee & Hayes 2011; Kirk-Lawlor & Allred 2017; Yoo et al. 2018). As for collaboration with participants beyond the university, discourses on the structural renewal and work culture of Finnish school echoed in the researchers' talk about the challenges of school engagement in the project. Researchers organising projects need to consider the complex entanglement of aspects having an impact on people's possibilities to commit themselves to participation. As with any participants, a careful consideration of and open dialogue on the underlying assumptions and aims as well as on the potential reservations and challenges involved in the design and Making projects is needed. This would allow everyone involved to elaborate and establish their personal zone of identification in the joint effort.

In all, the findings reveal the complexity of aspects related to this type of project, ranging from longer term infrastructuring (see also Iivari 2019) to in situ interactions in the classroom (see also Iivari et al. 2020). Therefore, as argued above, it would be important to understand and appreciate the classroom as a complex microcosmos, as "a multifaceted constellation of people, objects, tools, relationships, discourses, as a stage with particular performances" (Iivari et al. 2020). In implementing participatory projects in the classroom, new kinds of interaction orders are emerging. They require pedagogical attention from the perspective of guidance as the activities in a Making project may proceed differently in comparison to the approaches familiar for the participants.

Methodologically, nexus analysis was a helpful tool in exploring and understanding the nexus of practice under study from the perspectives of participants, their historical trajectories, and the discourses in place, reaching also across wider timescales and places. This study explored academic partnership that has lasted for over ten years. The findings make it clear that what is called interdisciplinary research is not a straightforward activity, but a matter of longstanding commitment to joint sense making rendering disciplinary conventions transparent and negotiable. More emphasis should therefore be given in future research on researchers' reflections on different types of academic collaboration, both short-term and long-term, and their motivations and goals for such collaboration. Likewise, the microcosmos of the classroom and the perspectives of all participants involved should be included in this effort. In this work, it would be particularly important to consider the participants' zone of identification and their affinity spaces. From the practical perspective, the

analysis provided an abundance of aspects to be considered when planning new Making projects, which are still a new phenomenon not only for pupils and teachers, but also for researchers. Whether aiming at interdisciplinary, multidisciplinary or transdisciplinary collaboration, more emphasis should be put on researchers working towards their zones of identification with the nexus of practice of interest, to better understand academic practices and discourses in flux.

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