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Researching Young Children's Engagement and Learning in Makerspaces : Insights from Post-Vygotskian and Post-Human Perspectives

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2 Researching young children's engagement and learning in makerspaces

Insights from post-Vygotskian and post-human perspectives

Michalis Kontopodis and Kristiina Kumpulainen

Vignette: Niklas engaging with virtual reality technologies

Niklas (pseudonym), a 5-year-old boy, participates in a virtual reality workshop, one form of makerspace associated with FabLab Berlin. Niklas is interested in video games, computers and painting and there seems to be plenty of these materials and technologies around. Interestingly, there is also a toy, an Avakai wooden doll (made by the digital toy startup company Vaikai), with no gender-specific characteristics, which produces a great variety of sounds every time it is involved in some movement, aiming to communicate emotions (in Vaikai terms). Niklas is asked to create a world for that wooden doll, on or with cardboard and with a variety of other tools such as scissors, paint and pencils that are provided. Then he is also asked to create a similar environment for the doll using virtual reality tools. Other boys are present, including his older brother, who has just managed to paint in fine detail his own version of a virtual environment for the doll.

Niklas can see the doll on the desk alongside the painting materials as well as the doll's virtual replication within the pre-designed virtual environment on a 2D laptop screen. For 3D vision he is required to wear an HTC VIVE headset, which is connected through cables to two controllers, one for each hand, as well as a set of sensors and a data processing unit. When he does that, he can no longer see anything off-screen.

While Niklas tries the HTC VIVE headset, he steps on the (offline/off-screen) cable connecting it to the processing unit and almost falls on the floor. The facilitator – a woman in her 30s – quickly catches him so that he doesn't fall and moves the cable further away so that Niklas can focus on the virtual environment as it appears through the HTC VIVE headset. Then the facilitator invites Niklas to use the mouse, select a

virtual brush and move it in a certain direction so as to further paint, modify and develop the doll's virtual environment. The facilitator explains to Niklas that he can move his whole body and even walk around if needed for the painting, but within the provided virtual room space, which is marked by virtual walls. Two minutes later, Niklas is crossing the virtual wall, which means that he also moves out of the offline/off-screen marked workshop area; without realising it he slightly touches a (real) chair with his back, which he couldn't have seen as he was wearing the HTC VIVE headset. This gives him a shock – the facilitator intervenes again, Niklas removes the headset, with everybody – him and the other boys – bursting into laughter.

Even if this ethnographic vignette is brief, it nevertheless raises complex theoretical issues, with no easy answers:

- Who is initiating and leading the activity? How and why is Niklas involved in the activity? What meanings, motives and affects are at stake? Do age, gender and ethnicity mediate Niklas's activity, and if yes, how?
- What are the possibilities and constraints entailed in this particular socio-material arrangement (facilitators + Niklas + other children + doll + software + PC + virtual reality headset + cables + sensors + controllers + chairs)? Do humans or Other-than-humans determine what is going to happen next? Does the design of the offline and online space and the design of the toys and technologies available matter? To what extent? How?
- How are broader contexts (e.g. institutional, cultural, societal) relevant for making sense of this particular scene?

The aim of the present chapter is to take this brief example as a point of departure and explore post-Vygotskian and post-human perspectives to investigate and make sense of young children's play and learning in makerspaces. We will also consider how these two perspectives can come into dialogue and provide both alternative and complementary answers to our enquiries into young children and makerspaces. In particular, we will consider some of the core constructs stemming from (post-)Vygotskian and post-humanist approaches to understanding children's engagement and learning with new technologies in makerspaces.

Post-Vygotskian perspectives

Making as culturally and historically situated activity

One could argue that everything in the vignette described above has *a meaning* situated in a specific cultural-historical context in space and time. Niklas is a German male name. *Dolls* entail meaning and can be attributed *roles* matching their design. *Computers, sensors, headsets* entail meaning as well: for example, Niklas was aware, as he explained in a follow-up interview, that these were expensive technologies that he could not have at home. Therefore, participating in this workshop was supposed to be a unique experience. Indeed, this is a

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workshop that is culturally-historically situated in an educational setting, within which children, adults and other people are undertaking certain roles and expected to engage in certain forms of action with the help of available tools, but not in others (cf. van Oers, Elbers, Wardekker and van der Veer, 2008). The workshop would be defined as successful, from the perspective of the facilitator, if Niklas was keen to attend future events and, subsequently, learn to participate in maker activity while moving from peripheral participation to more active and even transformative engagement (Lave and Wenger, 1991; Stetsenko, 2016).

Post-Vygotskian approaches provide researchers with one potential tool for researching children's engagement and learning in makerspaces as culturally and historically situated activities. According to Engeström (1987), human activity is always situated within communities that are mediated by culturally and historically derived rules and divisions of labour. Furthermore, the object of an activity, leading to an outcome, is shaped by the goals and intentions of the people taking part in the activity and by their use of culturally and historically derived artefacts or tools, both conceptual and material. The ontological premise of Engeström's theory is that activity is always dynamic and that change within a system is also inevitable as the result of people's actions. Hence, the whole activity system can also change and develop as a result of people's activity. For that reason, the analysis of activity systems in makerspaces needs to take into account various levels of analysis, including individuals' engagements in the activity, relational interactions between and across people and available artefacts or tools, as well as the institutional context nested within a system. It is the tool-mediated interactions, and specifically tensions and contradictions that emerge in and across these different spheres of activity, that can help us investigate and understand what is going on in maker activities as a dynamic and multi-layered whole and how this activity can contribute to the learning and transformation of both individuals and communities (cf. also Kumpulainen and Erstad, 2016).

Making as a tool-mediated activity

Our vignette of Niklas and his activity in the makerspace shows how he is eventually motivated to engage in the activity and make use of available *meanings*, *signs* and *tools* in order to perform a concrete task with the doll and virtual painting, following his brother's engagement in the same activity. At the same time, Niklas may be entangled within broader cultural-historical

contradictions regarding, for example, values on *gender* – as boys are expected to participate more in makerspaces than girls – or values related to social class and ethnicity – as playing with expensive technologies that cannot be available at home had a certain symbolic significance and was referred to by Niklas’s mother as a reason for her bringing Niklas to the virtual reality workshop.

According to Vygotskian and post-Vygotskian approaches, when these contradictions cause so-called “developmental crises” or “dramatic events” (Veresov, 2004; Kontopodis, 2012), the child then makes use of psychological and environmental resources in order to overcome the contradictions at stake and engage in new modes of functioning, either by appropriating existing *meanings* or creating new ones – thus development happens. This development is at the same time psychological *and* cultural-historical: Vygotskian and post-Vygotskian approaches to teaching, learning and development (in their various versions cf. Daniels, Cole and Wertsch, 2007; Stetsenko, 2016) have indeed thoroughly studied how signs and mediating tools – in our case the HTC VIVE headset and virtual painting tools – mediate the communication between adults or experienced peers and less experienced children; at the same time, signs and mediating tools shape one’s *inner speech* and so-called higher psychological processes such as thinking and imagination:

[E]very function in the cultural development of the child appears on the stage twice, that is, on two planes, first, the social, then the psychological, first between people as an intermental category, then within the child as an intramental category. This pertains equally to voluntary attention, to logical memory, to the formation of concepts, and to the development of will. We are justified in considering the thesis presented as a law, but it is understood that the transition from outside inward transforms the process itself, changes its structure and functions. Genetically, social relations, real relations of people, stand behind all the higher functions and their relations. From this, one of the basic principles of our will is the principle of division of functions among people, the division into two of what is now merged into one, the experimental unfolding of a higher mental process into the drama that occurs among people. For this reason, we might term the basic result to which the history of the cultural development of the child leads us as sociogenesis of higher forms of behaviour.

(Vygotsky, 1931/1997, p.106)

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Vygotsky described three phases in the child's developmental process: (a) the social situation of development, (b) the new formation which is typified by a contradiction between the child's current capabilities and his/her needs and desires as well as the demands and possibilities of the environment, and (c) the outcome in new functions. In order to overcome the contradiction between his/her capabilities and desires, the child needs to mobilise intra-psychological maturing processes in relation to cultural psychological and material tools. A structural change in the organisation of functions is brought about by the process of the child overcoming the existing contradiction within his/her activity (Chaiklin, 2003; Kontopodis and Newnham, 2011).

A much-disputed concept in this framework is the Vygotskian notion of the Zone of Proximal Development (Vygotsky, 1930–34/1998). Chaiklin has reviewed all of Vygotsky's texts in which this term appears and questions the definition of the term, since Vygotsky himself does not provide it and there is no outline of a theory for the Zone of Proximal Development (Chaiklin, 2003). Chaiklin argues against the various "common-sense" interpretations of the Zone of Proximal Development and their implications for educational practice. The main features of the Zone of Proximal Development as summarised by Chaiklin are the following: a) it involves the whole child; b) development is concerned with the relationships between psychological functions and not the psychological functions as such; c) development takes place as a qualitative change in these relationships; d) change is brought about by the child's actions in the social situation of development; and e) each age period is characterised by a leading activity/contradiction that organises the child's actions through which new functions develop (Chaiklin, 2003, p.50). New functions in the aforementioned case would entail the links between on-screen painting and off-screen bodily movements within a given space and frame.

While conceiving of child development as a cultural-historical phenomenon, Vygotsky also posed the question as to how human history can lead to a new type of society and a new type of human being (Vygotsky, 1930–34/1998). Concepts such as *appropriation*, and *active subjectivity*, have been central in this undertaking. The notion of *active subjectivity* implies that children as well as scientists or teachers act according to their own intentions and motivations, actively participating in defining how signs and tools are used and meanings are appropriated.

Active subjectivity can thus transform a given social situation so that new meanings and new practices emerge (Kumpulainen, Kajamaa and Rajala, 2018, 2019). Niklas could, in the longer term, create new meanings and new ways of *VR design, making* or *hacking* in this frame or participate in such creative processes in collaboration with others, which also explains how civilisations develop. In Russian, the term “mediating activity” emphasises exactly the generation of novelty in every developmental process (as opposed to the term “mediated activity”). Being in the world is transforming the world, not adapting to it, and human development is the process of purposeful transformation of the world (Stetsenko, 2016). Critical educational and critical psychological research (Holzkamp, 1995; Williams, Billington, Goodley and Corcoran, 2017) has been much inspired by Vygotsky as well as by the entire Soviet school of psychology (Davydov, 2008; Leont’ev, 1978; Lompscher and Galperin, 1972) in this frame.

Making as play and creativity

The makerspace context of Niklas’s activity also implies a space for creative and playful activity in which something new and personally meaningful can be created by the participants with the help of available artefacts and tools (Honey and Kanter, 2013; Kumpulainen, Karttunen, Jurola and Mikkola, 2014). Ideally, makerspaces prescribe a model of learning-by-doing in which children and older people too can work on creative design projects that are personally and/or collectively meaningful. The possibility to play with material objects is considered to act as “social glue” for people to come together and engage in collaborative and creative endeavours (e.g. Honey and Kanter, 2013; Ingold, 2013). Making activities hence account for a complex set of socially and materially mediated practices that encompass not only processes of creating specific artefacts supported by a wide range of tools, but also emotional, relational and cultural processes surrounding their use and construction (Kumpulainen, 2017).

Vygotsky paid particular attention in his developmental theory to emotions and saw play as the cornerstone of development:

“An idea that has become an affect, a concept that has turned into a passion” – this ideal of Spinoza’s finds its prototype in play, which is the realm of spontaneity and freedom... In short, play gives the child a new form of desires, i.e. teaches him to desire by relating his desires to a fictitious “I” – to his role in the game and its rules. Therefore, a child’s greatest achievements are possible in play – achievements that tomorrow will become his average level of real action and his morality.

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(Vygotsky, 1933/2002, online)

For Vygotsky (1978), the foundation of play arises from children's desires that cannot be met in the moment. Hence, to fulfil their motives, children invent imaginary situations, i.e. play activity, to meet their needs. Vygotsky also argued that children's play, although imaginary, is mediated by rule-based behaviours embedded in their everyday lives. Play hence requires children to abstract and translate the meaning of their real-life practices to their imagined scenarios in play activity. For Vygotsky, such abstraction from concrete to imaginary requires children's use of a *pivot* – an action or object that carries meaning from real life into imaginary play activity. Through the use of such pivots, children begin to exert self-control by regulating their own activity according to the rules of their imaginary play. Hence, for Vygotsky, play performs two important developmental functions: It contributes to children's development of mental representation and self-regulation (Vygotsky, 1978).

In makerspaces, children are afforded opportunities for play and playful interactions with various new (e.g. digital technologies and media) and more traditional tools and artefacts (e.g. associated with craftsmanship, such as woodwork or textiles). Makerspaces hence provide a fascinating context to research children's play and the genealogy of creative practice in general, and how these mediate the learning and development of children, i.e. what they learn to know (cognition) and how they see themselves (identity), as well as how these playful and creative activities shape their relationships, roles and positions with others, as well as their communities and cultures. Here, acknowledging the situated, embodied and multimodal elements of thinking and learning creates conceptual bases for researching children's maker activities as cultural practice. Overall, a focus on the creative and playful dimensions in maker activities can lead to novel investigations and insights in which cognition, affect and bodily activity and knowing are examined in unison and no longer divorced (Roth and Jornet, 2016).

Next, we turn to discussing the post-humanist perspective and its contribution to researching the materiality of making and makerspaces. In so doing, we want to extend our discussions on the meaning of tool-mediation and materiality in, and for, children's creative and playful activity and potential development in makerspaces. We will also consider how the post-humanist perspective can advance our thinking of children's engagement and learning in makerspaces.

Exploring ongoing action from a post-humanist perspective

One could argue that the term *mediation* offers quite fertile ground to begin analysing Niklas's activity in the scene above. Yet, it might not actually disclose what exactly it is supposed to reveal: the involvement of *mediating tools and devices* in ongoing action (e.g. VR headset, software, cables, doll, sensors, controllers). When Niklas moves his (off-screen) body, moves the controller by moving his (off-screen) hand or presses a certain (off-screen) key, there is action on the computer screen as well as on the screen of the VR headset. The two systems (on/off-screen) are interlinked through Niklas's actions, which in turn are mediated by the controllers, sensors, processing unit and software. Further mediators may entail cables, the broader spatial arrangement, verbal directions by the facilitator or by other children etc.

How virtual reality technologies work is not of importance to the average modern-day user; they are usually *black-boxed*. Little is known about how the processing unit processes recorded data, the coding behind a rather user-friendly painting interface or the multiple connections between all the different parts (cables, sensors, controllers, PC, headset). When Niklas literally steps *on* the cable and metaphorically *out of* the virtual reality environment, some of this black-boxing is reversed – but not for long. The *composition* of all these mediating means does not only impact on the outcomes produced (let's say a 3D virtual interface design), it also impacts on Niklas, as well, by *radically transforming* not only his actions and responses to the screened and mechanic effects but also his *intentions*.

This is the most crucial aspect: the *actor-network* of Niklas + software + controllers + sensors + computer + doll + headset does not just do *more of* or *better* what Niklas would do anyway, it does *different* things and *translates* the activity at stake in ways that neither Niklas *nor* the software program (and its developers) would have necessarily envisaged in advance. From a post-humanist perspective, the contingency and unpredictability of this dynamic *ordering* of humans and Other-than-humans cannot be reduced to any single part – let alone to the agency or intentions of a single human agent – if such a distinct “human” agent exists at all. A “programme of action” emerges symmetrically in this context: it refers as much to the intentions of human beings as to the functions of artefacts, without invoking an a priori distinction between humans and Other-than-humans. The original programme of action is thus “translated” or “transformed” through *technical mediation* into a new one. Both the machines and the person change in the course of mediated action: neither has an “essence”; they have existence, they exist, and they are transformed in their relation to one another. The dimension of *time* is significant here: the software and the computer have obviously been developed by

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humans; however, their intentionalities are *delegated* to other actors and thereby *transformed* over multiple layers of time that cannot easily be traced back or reconstructed.

Latour (1994, pp.32–39) identifies four different yet interrelated modes of technical mediation in this frame:

- “translation” of an intention or a programme of action into another one, as described above
- “composition”, i.e. relating things that were previously different or unrelated
- “black-boxing”, which renders invisible the intermingling of humans and non-humans but becomes reversed when actor-networks fail to work and the various parts of the actor-network are revealed
- “delegation” of action from an actor-network to another one (e.g. from a developer team to software).

According to Latour, all these modes of mediation work *through* humans and Other-than-humans *symmetrically* without humans having a central role – as other paradigms would presume. As a result, no action can be traced back to distinct individual or collective human intentions – “the universe is agential intra-activity in its becoming” as Karen Barad writes:

...the universe is agential intra-activity in its becoming. The primary ontological units are not “things” but phenomena – dynamic topological reconfigurings/ entanglements/ relationalities/ (re)articulations. And the primary semantic units are not “words” but material-discursive practices through which boundaries are constituted. This dynamism *is* agency. Agency is not an attribute but the ongoing reconfigurings of the world.

(Barad, 2003, p.18)

As Karen Barad (2003) postulates, when thinking in terms of becoming, no subjects and objects are presupposed, agency is distributed, matter matters in its intra-active becoming on the basis of which objectivity and subjectivity emerge (see also Law and Moser, 1999). In this frame, terms such as “becoming”, which implies open-ended processes, are preferred over terms such as “development” or “learning”, which often imply a final stage of equilibrium (Reinertsen, 2016). While (post-)Vygotskian research emphasises the *purposefulness* of human activity, post-humanist analysis shifts the focus to the rather *unpredictable and messy* process of the translation of multiple intentionalities into action (and vice versa). In both cases action is *mediated* – yet, *orderings* or attempts at *ordering*, as John Law (1992) explains, is a term that emphasises the dynamic, messy and open-ended character of everydayness as well as the co-existence and potential conjunction of heterogeneous orderings. Such an approach is opposed

to the proposition that culture, history, learning or development can be understood in terms of one single order. Relationality, in its radical post-humanist version, presumes the reality of infinitude:

Relations are based on an alternative ontology, time and space, and on an inclusive rather than an exclusive or oppositional logic. The key to this different logic is a distinction between finitude and infinitude. Whereas oppositions presume the existence of finite terms, relationality presumes the reality of infinitude. In an experience of relationality, subjecthood is suspended; there are no finite terms, but, rather, the undefinable non-oppositional difference of wholeness.

(Metcalf and Game, 2008, p.191)

Such a perspective does not of course imply absolute relativism and political neutrality – rather, the opposite: across the various streams of post-humanism (Actor-Network Theory, post-phenomenology, post-ANT, post-feminist scholarship cf. Fox and Alldred, 2016), much attention is paid to the knowledge and values incorporated in technology. Design, technoscience, architecture and socio-material arrangements in general are not considered to be neutral: even if their use entails uncertainty, they enable certain things to happen and prevent other things from happening. Acknowledging this has led to long discussions in the field of *Science & Technology Studies* on the broader politics of technoscience and the implications for children and childhood (Lee, 2013; Snaza and Weaver, 2015).

Yet, instead of discussing politics from “out-there” – i.e. from a distanced and disembodied perspective often implied in post-/Vygotskian scholarship, when taking seriously the notion of “mediation”, researchers cannot be seen as neutral entities external to the research procedure looking at the results from the balcony of the world as if their presence had no impact on the data. On the contrary, researchers may be sharing motivations, values and collaborating with a few people and not with others, and situated in socio-material arrangements, enabled as well as bound by semiotic, material, spatial and temporal orderings, that shape their roles and interactions with the research participants and materials. Researchers therefore contribute (not always consciously) to the complex dynamics of continuity and change in the mediated orderings that they explore (Hasse, 2015; Kontopodis and Perret-Clermont, 2015).

Seen from this perspective, the question is not how Niklas develops – as an individual – but how to experiment with one’s body, i.e. with the socio-material orderings within which children/researchers/facilitators are embedded so that fundamentally new sets of relations

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emerge that eventually escape various layers of existing knowledge-power relations – be they racial, gendered, age-related, capitalist, geo-political etc. (cf. Murris, 2016; Taylor and Hughes, 2016).

Conclusions

In our chapter, we have introduced insights into some core notions and conceptual thinking behind post-Vygotskian perspectives and post-humanistic approaches that we believe can help us to research and make sense of children's play and learning in makerspaces situated in and across various sociocultural contexts, such as in cultural and educational institutions. At the same time, we understand that our introduction is in many ways limited and ambitious in scope – not the least since the commonalities and differences between post-Vygotskian and post-humanist approaches have been little explored in existing literature. The few exceptions that have addressed such contrastive and comparative analysis include the article by Bruno Latour on interobjectivity (1996) and the debate it opened in the journal *Mind, Culture, and Activity* (Miettinen, 1999), the work by Estrid Sørensen on the *Materiality of Learning* (2009), the study by David Middleton and Steve Brown on remembering and forgetting (Middleton and Brown, 2005) and the research on *Fabricating Human Development* by Michalis Kontopodis (2009), as well as recent theoretical work by Alex Levant (2017).

According to our still emerging analytic interpretation of these theoretical perspectives, we would like to emphasise that:

- Both perspectives focus on dynamic processes as opposed to more linear models of nature-driven development (cf. Piaget, 1936/1977).
- Both perspectives draw attention to tool-mediation and action as pivotal elements of creativity, play, development and transformation.
- Both perspectives pay much attention to conflicting or multiple intentionalities and the generation of novelty – yet they do that in different ways.
- While fostering creativity, playfulness and experimentation with regard to technology, both perspectives invite us to be rather sceptical of popular understandings of commercial entrepreneurship and direct our attention to broader societal and ecological problems of our era, and to the complexity technology-in-the-making may entail in alleviating these.

Taken together, we believe that post-Vygotskian perspectives along with post-humanist approaches can guide our empirical research on makerspaces in several worthwhile ways, helping us understand maker activities and makerspaces as dynamic and complex social, cultural and material practices, situated across space and time. For example, *a personal level*

of analysis will help us unpack the varied intentions, interests and identities that children bring into play, learning and maker activities, as well as those which they develop in interaction with Others (including Other-than-humans) during their engagement. This level of analysis will also address the diverse ways in which children respond to the demands and opportunities that maker activities impose on and offer to their learning and development. At the interpersonal level, we can investigate the pedagogical interactions and practices that arise in makerspaces between children, facilitators and the various artefacts as *enabled* and *constrained* by the design of the socio-material environment (on-/off-screen). At the institutional level, we can explore how the cultural-historical context and the rules and values of the institution, in which the makerspace is situated, are *interlinked with* and *materialised in* complex socio-technical arrangements that mediate the nature of maker activities, including children's play and learning.

We want to end our chapter with a quote by [M. Fischer \(2009\)](#) who, for us, powerfully summarises various elements present in maker activities worthy of our research attention in our efforts to understand individual and cultural practices and transformations situated in makerspaces designed for children and their communities.

Culture is...

- 1) that relational (circa 1848),
 - 2) complex whole (1870s),
 - 3) whose parts cannot be changed without affecting other parts (circa 1914),
 - 4) mediated through powerful and power-laden symbolic forms (1930),
 - 5) whose multiplicities and performatively negotiated character (1960)
 - 6) are transformed by alternative positions, organizational forms and leveraging of symbolic systems (1980s),
 - 7) as well as by emergent new technosciences, media and biotechnical relations (circa 2005).
- ([Fischer, 2009](#), p.1)

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