80.

Gaming as Epistemic Practice

Heidrun Allert (Kiel University), Christoph Richter (Kiel University), & Marten Friedrichsen (Kiel University)

Abstract

This paper explores into the *constitutive entanglement* of material (also digital) *artifacts* and *activities* of collaborative learning. Drawing on examples of students building the "University of the Future" in the virtual world of *Minecraft*, we depict how the epistemic function and the material qualities of the shared artifact are intertwined with the students' efforts to articulate and transform their ideas and conception of the subject matter (the conception of higher education which underlies the "University of the Future"). Challenging techno-centric as well as human-centered notions of technology, we argue for an emergent nature of epistemic artifacts.

Introduction

The importance of shared artifacts as means to create common understanding, to ground discourse and to advance novel ideas has been widely acknowledged in the learning sciences (e.g. Stahl et al, 2014). Despite this fact and the proliferation of theoretical accounts that emphasize the socio-material dimension of educational processes (e.g. Fenwick, Edwards & Sawchuk, 2011) there is only limited insight on the interplay of the material nature of artifacts and the epistemic practices they are used in. Current research is still inclined to make a sharp distinction between artifacts as material objects with inherent and fairly stable properties (techno-centric) and the way these artifacts are used and made sense of by human actors (human-centered). Yet, both of these perspectives block sight for what Orlikowski (2007) has called the "constitutive entanglement" of the social and the material and therefore the fact that "practice is always bound with materiality" (p. 1436). The aim of this paper is to elaborate and provide illustrative examples on the constitutive entanglement of shared artifacts and students' articulation and transformation of concepts in a open-ended, and creative learning process. The examples we analyze are taken from a design experiment on the use of a virtual environment for the collaborative development of innovative conceptions of higher education. In the respective course students were asked to advance their concept of higher education through building the 'University of the Future' in the virtual world of *Minecraft* (http://minecraft.net).Drawing on recordings of students' activities, we depict how the role of the artifacts created by the students is not predetermined but in constant flux while at the same time bound and shaped by its enacted material properties. The examples also show that the materiality of an environment such as *Minecraft,* is crucial to the understanding of respective learning practices. The

contributions of this paper are threefold. First, on the conceptual level we elaborate on the constitutive entanglement of material artifacts and practice, including digital artifacts. Second, in providing examples on the collaborative use of artifacts in an educational setting, we raise awareness for the situated and relational nature of materiality. Third, we discuss the room for pedagogical intervention against the backdrop of artifacts that are in constant flux.

The Constitutive Entanglement of Artifacts and (Learning) Practices

Current conceptions of (knowledge) artifacts are facing two major challenges. The first challenge relates to the question of the impact of technologies and artifacts on human action and the users' role in their appropriation and utilization. Authors such as Hörning (2001) and Orlikowski (2007) have argued that the prevailing conceptions either adopt a techno-centric perspective, stressing the intentions and functionalities inscribed into an artifact, or emphasized the dynamic and situated nature of humans interacting with technology, relativizing the momentum of the artifact itself. Both of these perspectives are however limiting as they see the social and material as two distinct spheres and ignore their "*constitutive entanglement* in everyday life" (Orlikowski, 2007, p. 1437). Following Orlikowski (2007) the constitutive entanglement goes beyond the idea of a reciprocal interaction between the social actors and the material world, but presupposes that humans and artifacts are co-constitutive. Asking students to advance their conception of the *future of higher education* in the virtual world of *Minecraft*, from this perspective, hence has to be understood as a truly transactional process in which the participants enact the technology in a way they deem productive without knowing where this process will actually take them. The second challenge relates to the material qualities of artifacts, especially when talking about a digital gaming environment such as *Minecraft*. Even though conceptual frameworks such as 'activity theory', 'distributed cognition', and 'actor-network theory' have stressed the notion of materiality, they tend to conceive artifacts as vehicles of information or as tools with inscribed policies. In doing so, they bypass the question of what makes up their materiality. Toward this end Leonardi (2010) suggested a relational conception of materiality, according to which materiality is not premised on physical substance or matter but can be "defined in terms of practical instantiation or significance" (p. 11). According to this definition artifacts, including digital ones, are 'material' if they instantiate an otherwise abstract idea or make a difference to the situation at stake and are pertinent to the task at hand. Students' creation of the 'University of the Future' in *Minecraft* therefore not only takes place in a material (even though largely virtual) environment, in that the software is significant to the situation, but also results in a material outcome in that the students' creations are supposed to instantiate their abstract conceptions. To account for the constitutive entanglement of students' practices and the artifacts they are creating and using, i.e. the virtual worlds they are building, we adopt a relational conception of an (knowledge) artifact's function and qualities. According to this conception (cf. Figure 1), the (epistemic) function of an artifact and its qualities are not static attributes but are dynamically related to the transactions the artifact is used in and hence with reference to the actors involved and the object of interest the transaction is focused on.

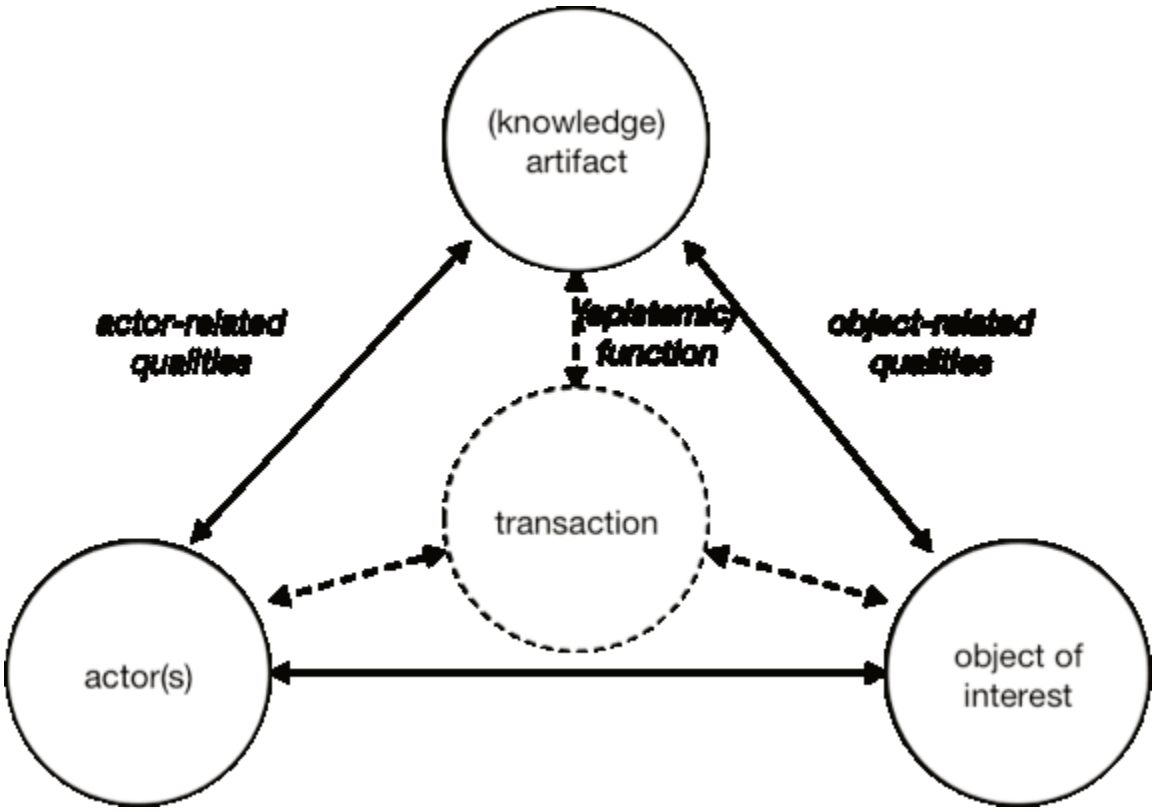


Figure 1. Function and qualities of an (knowledge) artifact as relational properties.

Knowledge artifacts hence can be used not only as means to convey information or establish a common ground, but also to explore and experience possible worlds as well as to probe and test assumptions about a given subject matter and raise new questions. Due to the material nature of transactions, the creation and use of artifacts is inevitably shaped by the particular medium used, be it physical or digital. Consequently, the epistemic function of knowledge artifacts is not just a matter of its creators' ingenuity, but also of the media used. Furthermore, this conception of knowledge artifacts gives room for the creation of entities, which transcend what already exists or is known. Knowledge artifacts in this sense are 'productive things', in that they are not mere representations of something else, but itself material instantiations of the unfolding epistemic object (cf. Knorr Cetina, 2001). As such they are both resistant as they cannot be formed arbitrarily as well as excessive in that they are amenable to open-ended processes of reinterpretation and reuse (Richter & Allert, 2016). Our interest is in the way *shared artifacts* and students' *conception of higher education* are constitutively entangled in their efforts to create the 'University of the Future' in the virtual world of *Minecraft*. Toward this end the intent of our research is twofold. First, we aim to trace the epistemic role of *Minecraft* enacted by the students', whether it is used (a) as a representational device to convey (pre-)established ideas, (b) as a means for communication in order to ground the participants joint discourse, and/or (c) as an epistemic object in its own right that is essentially "open, question-generating and complex" (Knorr Cetina, 2001, p. 181). Second, we aim to explore how the epistemic function is shaped by or related to the material qualities of *Minecraft,* be it in the way that it affords or constrains certain transactions or that it renders certain feature more or less significant.

Case Study: Context, Educational Setting and Method

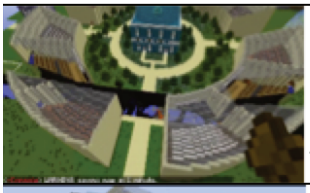
To explore the constitutive entanglement of the work on a shared artifact with students' articulation and transformation of concepts, we draw on three events of collaborative interaction in a bachelor-course on media education and educational computer science, which took place in winter term 2014/2015. As part of this course on digital-game-based learning, the students were asked to build a model of the 'University of the Future' in the virtual world of *Minecraft*. The activities were carried out in four groups of four to five students from the study programs of Educational Science as well as Computer Science and lasted for two months. Prior to the work in *Minecraft*, the students had been asked to reflect on their experience and perception of the university, using the "*Stanford 2025*" project as a trigger for discussion (stanford2025.com/). The students were introduced to *Minecraft* and taught the basic movement and actions in the virtual environment. Each group was provided with their own workstation, consisting of an interactive whiteboard and a PC. Using the university's wireless LAN, students were also able to access *Minecraft* on their own devices on campus. During contact hours the lecturer and an assistant provided feedback and technical assistance. To ease and speed up the building process, students were also provided with *WorldEdit*, which allows the creation of geometrical figures by using commands, in addition to the manual arrangement of the virtual building blocks. The groups were assigned specific building areas, but were also able to visit the other group's sites by using the teleportation hotspots in *Minecraft*. *Minecraft* was chosen as a virtual and game-based construction environment, as it is fairly easy to learn and use, enabling students to quickly start building their own models in a collaborative manner. From a pedagogical perspective the use of *Minecraft* was based on two premises. First, it was assumed that being forced to articulate their ideas for the future of higher education, in an uncommon format would allow students to spot and take up otherwise implicit ideas and conceptions. Second, it was assumed that the collaborative affordances of the environment and the assignment, would render salient potential differences in the participants' conceptions and therefore trigger for further reflection. As part of a larger design experiment the activities of all four groups were recorded during those course sessions in which *Minecraft* was actively used. To trace students' interactions throughout the physical and the virtual environment, video and audio recordings of the groups within the seminar rooms were combined with recordings of the activities in *Minecraft*, capturing the view that was actually shared via the interactive whiteboard. The recorded data was imported to Transana (transana.org/) and synchronized to align the video and audio data as well as the footage from the virtual camera. To explore into the epistemic role and material qualities of Minecraft in relation to students design decisions, the recorded material was screened for situations in which students were collaboratively talking about a *design decision* to be made or in which they were deliberating on a *design decision* they already made. Respective situations are of particular interest for the current analysis in that they require the students to, implicitly or explicitly, reason about the relevant qualities of the university of the future and how these could be materialized in *Minecraft*. Three sequences, in which students made active use of *Minecraft* while simultaneously pondering on specific design decisions, where selected for in-depth analysis.

Findings: Students Moves and Interactions

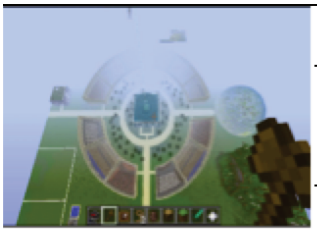
In the following we present and discuss three excerpts of students' discourse while constructing their vision for the "University of the Future" in *Minecraft*. For each sequence we provide the footage from the virtual camera available to the students on the interactive whiteboard next to the transcript of their discussion.

Sequence 1 (Group 1, 05.02.2015, Runtime: 0:24:10 – 0:26:21)

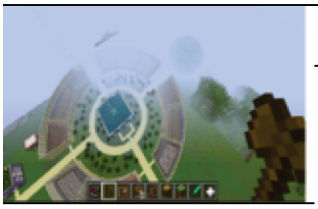
The following discussion occurred in the last regular session of group 1. The group already created a campus and buildings, making extensive use of the *Minecraft* and *WorldEdit* software. In this sequence they discuss how to integrate additional buildings as well as the overall layout of the campus.



S 4:	I would like to ask you, whether, I am just about to, I have placed the administration buildings here, S2? And now the question is whether we, the walkways are marked as blue, whether we draw an additional circle here and place the residential buildings along the circle, like this, or/ [S4 takes out a tablet which shows the outline of the campus area]	1 2 3 4 5
S3:	But that would definitely mean crossing the area of the soccer field.	6
S4:	Or whether we will go squarish, that means we place a walkway right here and there and then the houses/	7 8
S2:	Well, I would say, that we don't place the walkways using a specific pattern, instead, we should arrange them according to the buildings and the walkways placed in between. So that it does not, so that it looks more organic than like a planned city somehow.	9 10 11 12
S3:	But a planned city is kind of cool. I mean our prototype actually is a planned city. It is indeed.	13 14
S2:	Yes, but we do not have to use the visual style of a planned city, you know?	15
S4:	This is what I'm trying to do.	16
S2:	So, this is basically my idea, if you do not agree/	17
S3:	If everything is nicely ordered/	18
S2:	Then we may go ahead with your ideas.	19
S4:	Ok, so what do you think? Round or squarish?	20
S2:	Oh hey, take a look. I have built a huge tennis court overhere!	21
S3:	Actually I don't know, squarish or round – that is the question.	22
S1:	But this would mean that we have some space left in the front, right?	23



	Where we could yet build something, e.g. a daycare facility for children. In front of, between lecture and/	24 25
S3:	Ok, so if we go for an edged solution [referring to the actual image of *MC* displayed on the interactive whiteboard] basically surrounding the circle with a square, there is not much space left, as this and the daycare center and residential buildings will be placed in the corner.	26 27 28 29
S4:	So we have to set up a circle, which means I probably have to remove this building again.	30 31
S3:	And the sports ground would need to be moved out a bit, most probably also the forum. I do not know, should we do this manually? So, that we a little bit/	32 33
S4:	Yes, but placing them anywhere?	34
S3:	Yea, not just anywhere, but that we, er, when we now draw the circle or a square, we would have to rearrange and relocate so many things that it would again be tedious and kind of dangerous. I would prefer to say, that we can still disassemble the opposing corners of the residential buildings later.	35 36 37 38
S4:	Fine, I am beginning to insert them somewhere.	39
S3:	Yes, indeed.	40
S4:	I am eager to see how this is going to affect the visual appearance of our prototype.	41 42
S3:	But I'd be glad to not remove the forum from its' current position any more. I would want the middle part, the forum, one could also, if necessary, remove this building a bit to the back but that doesn't have to be, but/	43 44 45



The questions the students are dealing with are entangled with the affordances of the virtual world, which eases the creation of geometric layouts. Design decisions are taken step by step as the group

raises questions through bringing forward the artifact. In this sequence the artifact is used as an epistemic object rather than a means of representation, in that its creation generates new questions in an open-ended process of inquiry. The arguments the group brings forward concern spatial aspects and geometrical forms and structures ("circle", "square", "round"," squarish"), but are not related to conceptions of higher education. While the artifact enforces decision-making, the students also treat the artifact as a means for communication ("my idea", "your idea"). Furthermore, S4 assigns the artifact to work as an epistemic object as it allows for insights no other representation can provide (neither his mind nor a previous draft): "I am eager to see how this is going to affect the visual appearance of our prototype" (41). While there is hardly any direct interaction with *Minecraft* during the discussion, the students are well aware of the kind of manipulations supported by the software.

Sequence 2 (Group 4, 05.02.2015, Runtime: 0:31:20 – 0:32:23)

This sequence also took place during the last regular session. Different parts of the group's virtual campus are already finalized and the group is now reviewing the changes and additions made since their last joint meeting. The discussion focuses on the buildings created by S9.

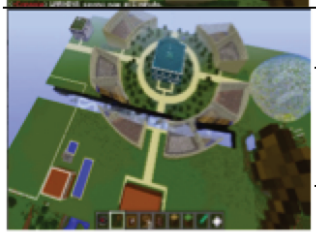
S5:	This looks really good.	1
S8:	It matches the color of our buildings.	2
S5:	Do you still want to put up a sign there that says 'House for one person'?	3
S9:	I just wrote 'student housing'. I do not know if we were going to elaborate on this in the course presentation.	4 5
S6:	I think it is totally fine. 'Student village'.	6
S9:	I do not know if this is enough.	7
	Do we want to build additional dormitories for the University? Or do you think this does work as an indication?	8 9
S5:	That's good enough.	10
S9:	That we have different lifestyles, different housing complexes/	11
S6:	We could still set up a 'true' dormitory with 20 beds or something like that, right?	12 13
S9:	Yes I think, I figured out a bit of what Student 5 was talking about. She was saying that, if she was building a university, she would do a [inaudible] in order to express our individuality.	14 15 16
S5:	What would I do?	17
S9:	If you were building a university, you would design village-like because we wanted to be so individual, I came up with the idea that a student hall with a huge capacity for students to live in does not represent our idea of individuality.	18 19 20 21

In this sequence the group aims to narrow down an idea developed before. They already have a common history of developing the prototype and are aiming to ensure a common understanding, which they want to represent in the prototype to be communicated to others. The group treats the prototype as a means to represent a pre-established idea, whereas the artifact enforces a translation of their ideas into the digital medium. The idea is first represented in words and is then supposed to be materialized in *Minecraft* in order to be communicated to others. At the beginning of the sequence they doubt that the prototype already fully conveys the idea, which was established in the group, to others. By their design decision (line 3: "do you still want to put up a sign"), they want to make sure, that the idea is represented

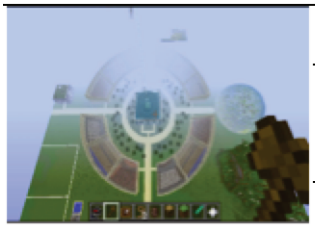
unambiguously. However, at the end of the sequence, there is a notable shift in the way the artifact is used. In line 16 a quality is mentioned (*individuality*) which cannot directly be translated into the given medium. They refer to it as "our idea of individuality". The prototype now works as means to negotiate understanding to ground the participants' joint discourse. They ask each other how their idea of *being individual* can be materialized in the prototype and aim to avoid misunderstandings. In this sequence, the role of the artifact is multifunctional and in flux as the analytical problem becomes more complex. The notion of individuality, the students deem relevant, cannot be directly translated into the world of *Minecraft* (even if the students argue they could) but needs to be transformed in order to be materialized. The artifact calls for transformation even if the students suppose to be able to represent an abstract idea presented with words. Nevertheless, the group does not form arguments of how an individual lifestyle relates to learning and teaching.

Sequence 3 (Group 2, 08.01.2015, Runtime: 0:02:49 – 0:06:22)

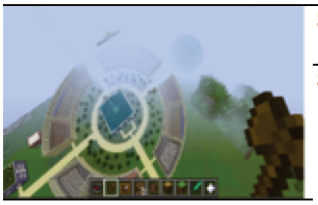
The following sequence took place right in the beginning of the building phase. The students had already created a map of the envisioned campus on paper and are now discussing on how to realize their ideas in *Minecraft*.



S4:	I would like to ask you, whether, I am just about to, I have placed the administration buildings here, S2? And now the question is whether we, the walkways are marked as blue, whether we draw an additional circle here and place the residential buildings along the circle, like this, or/ [S4 takes out a tablet which shows the outline of the campus area]	1 2 3 4 5
S3:	But that would definitely mean crossing the area of the soccer field.	6
S4:	Or whether we will go squarish, that means we place a walkway right here and there and then the houses/	7 8
S2:	Well, I would say, that we don't place the walkways using a specific pattern, instead, we should arrange them according to the buildings and the walkways placed in between. So that it does not, so that it looks more organic than like a planned city somehow.	9 10 11 12
S3:	But a planned city is kind of cool. I mean our prototype actually is a planned city. It is indeed.	13 14
S2:	Yes, but we do not have to use the visual style of a planned city, you know?	15
S4:	This is what I'm trying to do.	16
S2:	So, this is basically my idea, if you do not agree/	17
S3:	If everything is nicely ordered/	18
S2:	Then we may go ahead with your ideas.	19
S4:	Ok, so what do you think? Round or squarish?	20
S2:	Oh hey, take a look. I have built a huge tennis court overhere!	21
S3:	Actually I don't know, squarish or round – that is the question.	22
S1:	But this would mean that we have some space left in the front, right?	23



	Where we could yet build something, e.g. a daycare facility for children. In front of, between lecture and/	24 25
S3:	Ok, so if we go for an edged solution [referring to the actual image of *MC* displayed on the interactive whiteboard] basically surrounding the circle with a square, there is not much space left, as this and the daycare center and residential buildings will be placed in the corner.	26 27 28 29
S4:	So we have to set up a circle, which means I probably have to remove this building again.	30 31
S3:	And the sports ground would need to be moved out a bit, most probably also the forum. I do not know, should we do this manually? So, that we a little bit/	32 33
S4:	Yes, but placing them anywhere?	34
S3:	Yea, not just anywhere, but that we, er, when we now draw the circle or a square, we would have to rearrange and relocate so many things that it would again be tedious and kind of dangerous. I would prefer to say, that we can still disassemble the opposing corners of the residential buildings later.	35 36 37 38
S4:	Fine, I am beginning to insert them somewhere.	39
S3:	Yes, indeed.	40
S4:	I am eager to see how this is going to affect the visual appearance of our prototype.	41 42
S3:	But I'd be glad to not remove the forum from its' current position any more. I would want the middle part, the forum, one could also, if necessary, remove this building a bit to the back but that doesn't have to be, but/	43 44 45



In this sequence the students aim to represent their previously drafted ideas within the virtual world of *Minecraft*. Their discussion is based on their assumption that they will use the artifact as a representational device to reproduce (or reproduce partially) their pre-established idea (using words like "indicate", "correspond", "not final or complete"). "Not complete" implies that it could be complete – thus, even if it does not correspond, they implicitly presume that they could distinguish whether it will correspond or not. According to their arguments, building is only a question of adapting their pre-established idea to the specific scale, perspective and available space presented in *Minecraft*. As space can be enhanced subsequently in the virtual world, the group contends that they only have to choose a starting point: their discussion is based on the assumption that, if only the specific perspective and scale presented in *Minecraft* is understood well enough and if handling is figured out and if only the first step will be taken, they will be able to construct step by step what they already have in mind, translating it directly to the perspective presented in *Minecraft*. The idea is well established with words and in an outline on paper. The words used in the group discussion are quite common (and perfectly denote contemporary/typical universities) as long as they refer to their pre-established idea (such as "faculty", "administration building" and "canteen"). But as soon as their process becomes transactional, being confronted with *Minecraft's* materiality, they are not able to advance their knowledge object. Whenever they aim to start building they lack words. At the end of the sequence, there is no material outcome and prototype created within the virtual world. They did not manage to materialize any of the issues they discussed. Whenever they aim to materialize the verbal matter, questions arise which cannot be well addressed with the given words.

Conclusions and Implications

The creation and work on shared artifacts is essential to many forms of collaborative learning. This also holds for the use of virtual gaming environments such as *Minecraft*, which are already used as creative sandboxes for educational purposes and collaborative assignments (cf. Robinson, 2014).

However, without a clear understanding of the constitutive entanglement of material artifacts and the epistemic practices they are used in, it is difficult to assess the utility of respective environments and to device fruitful pedagogical strategies. The examples discussed in this paper illustrate that the material artifacts neither determine students' practices in any straightforward manner nor are they fully at the students' disposal and can be formed arbitrarily. Both, the function as well as material qualities are not static attributes, but bound to their actual utilization. As indicated, the artifacts do not simply fulfill an envisaged function, such as to represent students' preconceived ideas about the university, but they might give rise to new questions due to their material form and corresponding resistance. In precluding direct translations, for example of abstract notions such as *individuality,* the material artifact can trigger more in depths elaborations and reflections. At the same time, the perceived qualities of the artifact might also foreground certain aspects, while masking others, such as the static and structural over procedural dimension in *Minecraft*. However, the creation and work on shared artifacts might be a necessary condition for collaboration, but not a sufficient one for learning. As I evident in the examples, students' discourse entailed hardly any substantial argument for or against a certain design decision. As a consequence, asking students to create a shared artifact and to materialize their idea, does not ensure that the artifact becomes an epistemic object for articulating and transforming conceptions in the subject matter. In contrast to deterministic perspectives and a technicist form of education, it is also not a question of choosing the right material or artifacts to trigger the intended type of discourse. Instead, becoming serious about the constitutive entanglement of the material and the social requires the teacher to become sensitive to the processes of transaction in which the students are enrolled and to query into and challenge students' argumentation in relation to the artifacts they are creating and the ideas they are materializing. An educational perspective then entails not simply to define the materials to be used („using the gaming environment") but to become aware and responsive to the material qualities that emerge from the practices we and our students are involved in. In our further data analysis we focus on students' arguments regarding their conception of the subject matter (pragmatic, social and pedagogical issues of higher education).

References

Fenwick, T., Edwards, R., & Sawchuck, P. (2011). *Emerging Approaches to Educational Research – Tracing the sociomaterial*. Milton Park: Routledge.

Hörning, K.H. (2001). *Experten des Alltags*. Weilerswist: Velbrück.

Knorr Cetina, K. (2001). Objectual Practice. In: T. R. Schatzki, K. Knorr Cetina & E. von Savigny (eds.). *The Practice Turn in Contemporary Theory (pp. 175-188).* London, NY: Routledge.

Leornardi, P.M. (2010). Digital materiality? How artifacts without matter, matter. *First Monday, June 2010,* Online available at: http://firstmonday.org/ojs/index.php/fm/article/view/3036/2567.

Orlikowski, W.J. (2007). Sociomaterial Practices: Exploring Technology at Work. *Organization Studies 28*(9), 1435-1448.

Richter, C., & Allert, H. (2016). A practice-oriented perspective on collaborative creative design. *International Journal of Design Creativity and Innovation, 4*(3-4), 195-205.

Robinson, K. (2014). Games, Problem Based Learning and Minecraft. *The Journal of Digital Learning and Teaching Victoria*, *1*(1), 33-45.

Stahl, G., Ludvigsen, S., Law, N., & Cress, U. (2014). CSCL artifacts. *International Journal of Computer-Supported Collaborative L*