Chapter 4
The Concept of 'Bringing Your Own Device' in Scaffolded and Augmented Education

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Abstract Location-based games have enabled new opportunities for augmenting the traditional learning space. In a time when most students have their own smartphones, the concept of bringing your own device (BYOD) also seems promising in educational settings. However, playing at random in augmented reality environments will not automatically bring curriculum-aligned learning outcomes. This chapter analyses and discusses how the combination of BYOD and augmented reality gaming might be scaffolded to support collaborative curriculum-aligned learning. The overall research strategy was a case-study approach with Affordance theory, Social Constructivism and BYOD as theoretical assumptions for deductive analysis. The case units were two outdoor sessions for middle school students with curriculum-aligned assignments in Mathematics and Social Science solved by playing the augmented reality game Pokémon GO. Data have been collected by video recordings of the outdoor sessions with spy glasses and a handheld camera. Results indicate that the augmented reality environment stimulates active learning, but that there like in traditional learning, is a need for scaffolding to achieve the stated learning outcomes.

4.1 Introduction

The combination of location-based augmented reality games and mobile devices has opened up new opportunities for augmenting the traditional orchestration of teaching and learning activities (Akçayır and Akçayır 2017; Chen 2017). A frequently used augmented reality game in educational settings is Niantic's Pokémon GO, but there are other augmented reality games to consider as well, where one example is the recently released Wizards Unite. To build on a popular game seems like a wise

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choice, but the critical factor for positive learning outcomes is how the game is used and scaffolded (Ruiz-Ariza et al. 2019; Mozelius et al. 2019).

In many countries today, a majority of students have their own mobile devices and an interesting idea is that students utilise their personally-owned technology devices in school activities. There are several research studies reporting on successful examples of students bringing their own devices to teaching and learning sessions (Song 2014; Song and Wen 2018). However, to implement the concept of bringing your own device (BYOD) in educational settings also raises new questions such as security challenges, teacher acceptance and parental acceptance (McLean 2016; Kiger and Herro 2015).

BYOD in education has often been presented as a one-to-one concept, with the problem of possible exclusion of students from certain socio-economic groups (Bathon 2013; McLean 2016). On the contrary, students sharing mobile devices might be a way to orchestrate collaborative learning (Mozelius et al. 2017).

There are several studies on how location-based games can be combined with the BYOD concept in education (Herro et al. 2013; Xanthopoulos and Xinogalos 2018). Less has been studied about the affordances that emerge in the interplay between students and applied BYOD sessions with augmented reality games. This study had a focus on affordances that might support collaborative learning in primary school learning activities.

The aim of our study was to analyse and describe the interplay between aspects of students, mobile devices, augmented reality applications and the design of collaborative educational settings. The research question was as follows: 'Which affordances emerge in the interplay of BYOD and augmented reality in scaffolded and collaborative middle school educational settings?'.

4.2 Theoretical Assumptions

In this study, the theoretical assumptions for a deductive analysis and discussion have been the BYOD concept, Social Constructivism and the Affordance theory.

4.2.1 Bring Your Own Device

Traditionally, companies and organisations have provided the necessary information technology, but this is a changing phenomenon (Caldwell 2012). The idea of bringing your own device (BYOD) got a breakthrough in 2009 when the world-wide IT-company Intel encouraged their employees to bring their own laptops, tablets and mobile phones to work (Govinfo-Security n.d.). BYOD started in the IT-industry and is still mostly used at companies, but the trend has also reached the educational sector with the use of BYOD both in higher education (Afreen 2014), as well as in primary school (Song 2014).

New BYOD could be defined as 'the practice of people bringing their own laptops, tablets, smartphones, or other mobile devices with them to learning or work environments' (Johnson et al. 2016, p. 36). The role of BYOD in education is much the same, and according to a survey conducted in the UK and the US 85% of the answering institutes allowed staff and students to access the school network. However, the percentage of BYOD in primary school settings was lower (Afreen 2014). Another challenge for primary school is how to involve parents and as suggested by Kiger and Herro (2015), create concrete parental guidelines.

The concept of BYOD has often been presented as a one-to-one technology design with one device per student (Cardoza and Tunks 2014; McLean 2016). There are also studies discussing if the use of BYOD might aggravate the digital divide between different socio-economic and geographical groups (Motlik 2008; Siani 2017), but as found in the study by Adhikari et al. (2016), access to mobile devices do not necessarily have to be a critical barrier. A one-to-one design would certainly have a strong potential to transform the traditional classroom and extending learning from school only into other environments. To blur the boundaries between formal and informal learning spaces is an interesting challenge (Liu et al. 2014), but another essential and well-discussed idea is to support collaborative learning (Falloon 2015). Might the concept of students sharing a mobile device stimulate interplay and collaborative learning?

4.2.2 Social Perspectives and Collaborative Learning

Collaborative learning has its roots in social theories of learning dating back to among other the sociocultural ideas developed by Vygotsky and the ideas of pragmatist philosophers such as Dewey in the early twentieth century. Nevertheless, its impact was minor until it received wider attention in the 1980s. An emergence that coincided with the deemphasizing of cognitive perspectives of learning in the research of educational technologies. Collaborative learning builds on the idea that learning fundamentally is a social phenomenon. Such learning includes human beings' interplay with the surrounding world and other humans. This interplay involves the purposeful application of technologies. Such purposeful application of technologies turns them into tools for learning.

This interdependent relationship between humans and tools 'provide the link or bridge between the concrete actions carried out by individuals and groups, on the one hand, and cultural, institutional and historical settings, on the other hand'. Human application of tools also transforms the settings in which they are applied. This means that collaborative learning is an emerging phenomenon that depends on tools and cultural, ecological, historical and social aspects of settings in the surrounding world. Therefore, mobile technologies, such as location-based augmented reality games and mobile devices, act as tools that mediate the process of collaborative learning. Such world view and conceptualisation of learning suits well with human beings perceiving

of affordances in the surrounding environment. The next section goes deeper into affordance theory.

4.2.3 The Concept of Affordance

The concept of affordance was coined by Gibson (1979/1986) and concerns a relationship 'that refers to both the environment and the animal' (Gibson 1979/1986, p. 127). This conceptualisation is emphasised as a complementarity, a holistic non-dualistic world view. Such view emphasises affordances as a inseparable relationship between humans and the surrounding environment. The affordance supports and limits human actions in the surrounding environment and are relative to the individual. Nevertheless, the 'affordance is neither an objective property nor a subjective property; or it is both' (Gibson 1979/1986, p. 129). It is 'properties taken with reference to the observer' (Gibson 1979/1986, p. 143).

Moreover, it is both related to the environment and the behaviour of an individual, including being both physical and psychical. In the concept, Gibson emphasised a world view, where aspects of culture and nature are linked to the environment. Meaning that it is not possible to divide human actions in the world into different environments. In practice, an affordance assists the human being in their perceiving of the world by simultaneously co-perceive themselves. Human beings learn to perceive affordances of things for both themselves and other persons. This process leads to socialisation into the surrounding society. In other words, the students' actions while playing location-based games are emphasised as being inseparable from the surrounding environment.

The concept of affordance is related to the ability of the observer to perceive the surrounding environment (Rietveld and Kiverstein 2014). While Shaw et al. (1982) apply the concept of effectivity, Snow (1992) use the concept of aptitude to discuss this relationship. However, Greeno's (1994) concept of ability is chosen in the conceptualisation of affordance in this chapter. He discussed the inseparable relationship between affordances and abilities and highlighted that affordances relate attributes of things in the surrounding environment, to the activities of agents with various abilities. Moreover, he also claims that ability relates attributes of agents to an activity 'with something in the environment that has some affordance' (Greeno 1994, p. 338). By this, he meant that affordances and abilities co-define each other.

Rietveld and Kiverstein (2014) emphasises that affordances could be discussed as a sociocultural phenomenon embedded in human activities. Such a link emphasises the link between abilities as affordances emerging through human participation in sociocultural practices. The consequence for understanding the playing of location-based games is the need to understand such activity from a sociocultural perspective, including an emphasis on various abilities to perceive affordances.

4.3 Method and Data Collection

The used research strategy was the case-study approach, with the two outdoor learning sessions using BYOD and augmented reality games as the case units. Main participants in the mobile outdoor activities were students and teachers from a fifth-grade class and a sixth-grade class. Furthermore, researchers from the Mid Sweden University participated as observers in the teaching and learning sessions. The location-based augmented reality game that was used on students' smartphones in the outdoor activities was Pokémon GO. Students played the game and solved assignments in small groups of three to four students with one smartphone per group.

Both learning sessions, one in mathematics and one in social science, were orchestrated as walks that used existing PokéStops in the local environments. When a student group passed one of the stops, the teacher tried to attract the students' attention. Students had been instructed beforehand to prepare for specific tasks that all were related to either social science or mathematics. An example is that they had to make calculations related to both Pokémon GO and real-world objects in the vicinity. One group counted the number of cars during the walk. In addition to the pre-planned assignments, the gaming sessions also included more spontaneous discussions. After completing the orchestrated activities, teachers and students met in their classrooms for follow-up activities. In the follow-up lessons, teachers brought up various issues that arose during the walks and gaming sessions.

To answer the research questions data were collected by video recordings of the activities in the outdoor sessions. During the activities, teachers and researchers wore spy glasses to capture collaborations and communications from the various wearers' perspectives. One of the researchers recorded the group activities with a handheld video camera to get a more complete overall picture of the various perspectives collected with the spy glasses. The analysis of the recorded video material has also been compared to the finding from an earlier analysis of the same sessions (Mozelius et al. 2017).

4.4 Findings and Discussions

The data analysis had a focus on affordances that emerge while applying BYOD in scaffolded, collaborative and augmented educational settings and which affordances that emerge in the interplay of BYOD and augmented reality. Results have been divided into four various categories of affordance: *task-ability*, *social-ability*, *teach-ability* and *knowledge-ability.* These affordances were found both by teachers and by students in the recordings from spy glasses and the handheld camera. How this might lead to a deeper understanding of collaborative learning in primary school activities is described and problematised in the categories below.

4.4.1 Task-Ability

Video recordings from the spy glasses show how students often shift focus in their mobile phones, zapping between the game and other apps. Initially, the main attention is on the game, but later this change to things such as maps and social media. In the videos from the spy glasses, it is obvious it is also very obvious how the students shift focus from the 'mobile space' to the real world. In the students' interplay, there are moments of competition with comparisons of numbers of caught Pokémon monsters, numbers of thrown balls and achieved levels in the Pokémon GO game.

//They jointly walk forward on the sidewalk.

Gustav - oh look look look, a pokémon / he starts to run.

Gustav - Yeahhhh, I caught it !!!

Robert- but hey listen, don't show the car their number. (he means by the camera in the spy glasses).

Gustav - yeah I caught a pokemon !!!! I got 100 Xp and three candies and a hundred pokemon go.

//They stop.

Thomas - I see a 'Sikhir'.

Chris - but who doesn't have a Sikhir? (goes next to Samson, who holds the mobile phone).

Gustav - Yes! Gotcha!!!!

Furthermore, the gaming had several breakdowns due to failing connections, discharged batteries and non-functioning GPS signals. The latter issue leads to the problem of PokéStops that are out of reach. This negative aspect of affordances that resulting in limitations rather than possibilities was also recognised both by teachers and students.

4.4.2 Social-Ability

This category is closely aligned to the task-ability category that is described above. An example of when these affordances overlap is when the students identify opportunities that consider the game itself and want to share their results and compare with others. As a result of walking in small groups sharing a mobile, discussions arise about other topics than the content in the lesson. The sharing of a mobile device also led to agreements where everyone in the group should be involved in the catching of Pokémon monsters. In the thesis by Walldén Hillström (2014) the discussions around a shared mobile device are compared to the discussions around a campfire.

By sharing a mobile, students identify each other as social affordances and the benefits of collaboration. The videos not only show student collaboration for successful gaming but also students collaborating to answer the questions from the teacher:

Teacher - What's the name of this PokéStop? //beside the Bertil Malmberg statue (Fig. 4.1)

Fig. 4.1 The statue of Bertil Malmberg as seen in the Pokémon GO app (GPS coordinates: 62.6310, 17.9459)

> Victor, Roger and Thomas gathers around the mobile that Samson carries searching for the name of the PokéStop.
>
> Victor - Click on it now!
>
> Roger Yes, I know.
>
> And Roger answers the teacher - Bertil Malmberg!

The sharing of a device seems to create social affordances that probably would not have occurred in a one-to-one orchestration. At the same time, the BYOD sharing initiates somehow peripheral discussions where students lose their immediate focus on the learning activity. However, discussions and collaboration are seldom completely focused, and peripheral discussions can be an important part of learning.

4.4.3 Knowledge-Ability

During the walking sessions, the students and the teacher passes a series of knowledge affordances that are associated with the PokéStops. This can be identified in the videos

as dialogues where the teacher asks questions to the students to catch their attention on the emerging affordances. Students perceive, as seen in the excerpt below, that mobile phones offer knowledge-seeking that could answer the questions that are asked by the teacher.

> Teacher - What's the name of the PokéStop then? Do you know the name?
>
> Victor reading on the mobile screen, exclaims, - The Franzén monument! (See Fig. 4.2).

There are also questions and dialogues about things in the real-world surroundings that are not mapped to the game world. It seems that the walking lesson structure makes students identify affordances of the knowledge-ability category when the teacher perceives the surroundings as a knowledge affordance.

> Teacher – What do you say, what kind of house has this been earlier? Anyone that knows that?
>
> Gustav – A fire station.

These affordances in the knowledge-ability category are mostly perceived by the teacher, and that the teacher later tries to communicate this to the students. However,

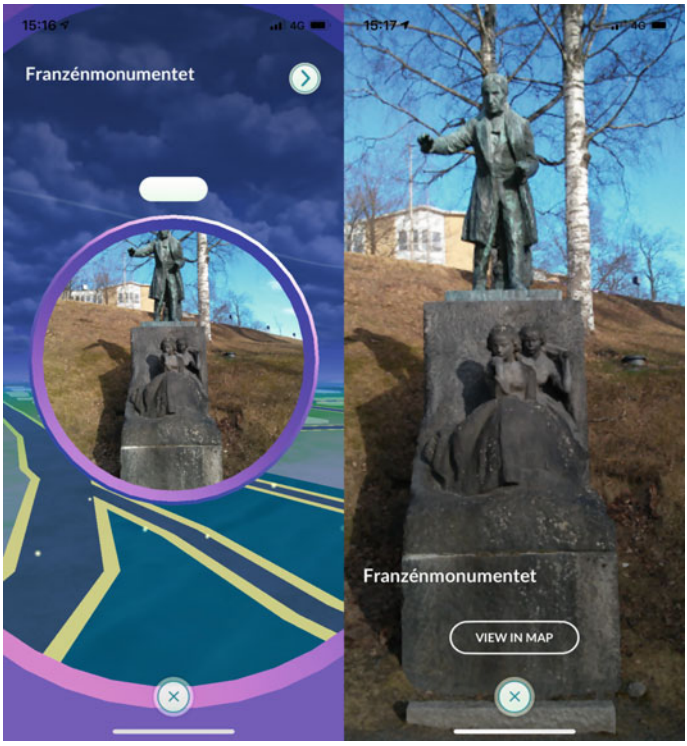

Fig. 4.2 The statue of Frans Mikael Franzén and his muses as seen in the Pokémon GO app (GPS coordinates: 62.6303, 17.9470)

the video clips show some knowledge affordances that are directly perceived by the students. Through the gameplay, students need to keep track of how the game world corresponds to the virtual, otherwise, they would not find the virtual PokéStops that are mapped to real-world objects.

4.4.4 Teach-Ability

During the walking lesson, the teacher finds interesting affordances in the mobile. The teacher also uses the game content as teaching content by asking questions to the students. An example of a Pokémom GO related question is the one about how long it would take to hatch a five km egg at a certain walking speed. In this situation, the teacher uses a teaching affordance in the game to enhance students' understanding of a specific phenomenon. This is a way of creating interplay between the game and the teacher's teacha-bility, which is different from Pokémon GO gaming during students' spare time.

Victor - /…/Oh, you got a five kilometer egg!

Teacher – Then you have to walk five kilometers. How long would that take?

4.4.5 General Discussion

These different types of affordances co-exist in various ways and are at different occasions super- respectively subordinated each other. The focus for this chapter has been to analyse and describe the affordances that support collaborative learning in middle school educational settings emerging from the interplay between augmented reality and the concept of BYOD. These emerging affordances are the ones that have been perceived by the participants in the walking sessions, based on the conducted video analysis where the choice of these aspects has been a deliberate perspective. The aspects can be seen as categories, but affordances are defined individually with a student and a teacher perspective.

The perceiving of affordances aligned to knowledge-ability was understood in the analysis as the teacher perceiving affordances that later were mediated to the students. This was often mediated by questions from the teacher to the students, for affordances that appeared and were perceived in the Pokémon GO game. For the type of affordances related to the game, gaming success or gaming failure categorised as task-ability it was, on the other hand, the students that perceived the affordances and mediated them to the teacher. This constructs an image of a teaching and learning session where the teacher's knowledge authority sometimes is on the same level as the students', a phenomenon that seems to inspire the students to challenge the teacher's leadership.

Furthermore, the video analysis identified a change or development of task-ability aspects towards knowledge-ability in the sequences where students could find answers to teacher questions in the game. Affordances that in the analysis have been categorised as teach-ability were perceived by the teacher, and that these affordances emerge from the didactic resources that the teacher uses to enhance the students' understanding of a phenomenon. The analysis also identified several aspects of social-ability that emerge when students perceiving of task-ability affordances creates a social space for interplay. The same goes for affordances of knowledge-ability that creates social interplay where students talk and discuss with each other. The collaborative aspect lays in the fact that individuals perceived affordance shares affordance.

A walking session is characterised by transitions between different spaces and different subjects. During a traditional activity in a classroom, transitions are often something that is disturbing. In newly built modern schools, walls are often replaced by large transparent glass sections as well as doors with large glass windows (de Laval et al. 2019). In these flexible solutions, the transitions between lessons have become such a big problem that has led to a reconstruction of more closed traditional classrooms. Compared with this study, where the teaching and learning activities are located in a local open environment, there are no findings that indicate any problematic transitions. Transitions between individual and collaborative activities, as well as transitions between different subjects such as Mathematics, History and Swedish, seem to have run smoothly. Furthermore, the idea of BYOD as a mobile phone to play an augmented reality game was perceived as a supporting affordance by both the teacher and by the students.

It can be claimed that the results from this study exemplify how a learning activity is situated in an augmented educational context, outside the traditional school premises. The boundless flexibility that this implies might provide too wide and unfocused affordances for the students. However, through the augmented reality and the mobile game world, there is attention directed towards the interplay between students and the teacher. The perceived affordances reinforce collaborative learning in this augmented educational setting. An important condition for the perceiving of such affordances is the interplay between the student, the teacher and the mobile and the surroundings in both the augmented and the real world.

Without the teacher in the previous study, there is a completely different interplay, and likewise without the students or without the mobile. The primary contribution of this study is a counterimage to the perception of technology replacing the teacher. Authors claim that involving the concepts of BYOD and augmented reality in middle school outdoor activities rather would increase the importance of the teacher. At the same time, the students' interplay in an augmented reality stimulates and encourages the idea of collaborative learning.

4.5 Conclusion

One of the more positive findings in this study was that this mobile, game-based, augmented reality setting seemed to stimulate students to engage in collaborative activities. The categories of affordance that the analysis resulted in show that interplay is of crucial importance. Knowledge-ability requires interplay between students and teachers in order for students to perceive opportunities for the knowledge-based affordances. Furthermore, teaching-ability requires students to be present to interact with the teacher, otherwise, the teacher does not perceive the opportunities to teach. It is clear that affordance can be understood and discussed as a sociocultural phenomenon embedded in human activities (Rietveld and Kiverstein 2014).

The analysis of the video clips also confirms the idea that several students sharing a device can support interplay, discussions and collaborative learning. In some orchestrations of BYOD for education, a one-to-one setup might be important, but this must not be seen as a condition for teaching and learning activities. As discussed by Kernutt (2018), one-to-one arrangements can sometimes tend to replace human interplay with technology and disturb the 'campfire talk' that spontaneously occurs when a group of students gathers around a shared device.

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