Student Re-Design of Deprived Neighbourhoods in *Minecraft*: Community-Driven Urban Development

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Abstract: This paper presents results from the three-year research and development project Cities at Play: Community Drive, where students in five 7th–9th grade classes, in collaboration with the Copenhagen City Council urban planners, used *Minecraft* and other digital and physical tools to redesign their deprived neighbourhood to generate solutions to problems in their local area. The overall aim was to understand how to integrate community-driven science and urban development in school education, in addition to identifying the knowledge and practices that emerged from the process. Our study presents survey data from two 7th grade classes (50 students 13–14 years of age) that developed *Minecraft* and LEGO models that re-designed their neighbourhood to solve local problems. The results show that, over the course of the project, students became aware of the authentic knowledge they possess about their urban area and that they are able to connect it to structural changes.

Introduction and background

For the past decade citizen science has been defined as involving laypeople in the production of science outside formal research institutions, with opportunities to do so growing due to web 2.0 technologies and other types of digital platforms (Delfanti, 2010). New digital platforms are changing the way laypeople are involved in technical and scientific processes and production that affect their lives. Games, for example, have played a central role in the study and development of platforms for authentic collaboration between laypeople and scientists (Good & Su, 2011).

Some major trends in the study and development of learning game formats in the past decade include exploration of how the game media can facilitate new approaches to authentic science and technical education. Examples of this are games in which players become urban planners, biologists or forensic experts drawing on the authentic tools, processes and values of specific professions (Shaffer, 2006; Squire & Klopfer, 2007; Magnussen, 2007). The motivation for developing this type of games stems from a critique of the teaching of standardised skills to children in today's school system (Gee, 2003). It is argued that few schools teach students how to create knowledge; instead, students are taught that knowledge is static and complete. This means that they become experts at consuming rather than producing new knowledge (Sawyer, 2006).

Digital platforms that invite students to participate in professional processes bring up the matter of whether students learn to work as a scientific expert or whether they learn how to be an expert. The answer may depend on various design elements of profession simulation games. First, the clients and experts students collaborate with in the games are fictional characters with fictional problems that need to be solved to play the game in school but that do not have relevance in the world outside school. Second, the fictional problems to be solved in these games often follow a linear path and have a clear starting and end point. This is clearly different from real-life professional problem solving, where the processes are more multidimensional. Finally, even though these types of games have been shown to support student creation of new process tools (Magnussen, 2007), the solutions are often pre-defined and already known by the teachers. This stands in contrast to the real-life open-ended tasks professionals face and that can be carried out in various ways, the chance of success or failure always an issue to be considered. Scientific discovery games address issues that exist outside a formal learning setting. The main goal of this type of game is to create a platform that motivates players to contribute to solving scientific problems. Yet the question remains open as to what students learn when they take part in authentic problem solving processes.

Where major trends have involved simulating authentic technical or scientific processes in game environments to encourage student learning about authentic science, scientific discovery games or citizen science games now focus on gamifying professional research or technical processes, allowing and motivating players to take part in generating results for authentic application in scientific research (Cooper, 2015; Dean et al., 2015).

The development of scientific discovery games within the past couple of years introduces new elements into game-based participation in a science classroom setting (Magnussen et al., 2014). The main goal of this category of games is to create a platform that enables and motivates players to contribute to solving scientific problems (Cooper et al., 2010). The most well recognised example of this class of games is *Foldit*, which is an online puzzle game where players participate in folding amino acid chains to form new protein structures (Good & Su, 2011). Studies show, however, that integrating games in authentic knowledge creation in science education can be complex. Previous studies on these types of learning environments (Magnussen et al., 2014) clearly indicate that using game media as a tool for conducting real-life problem solving and collaboration with real-life experts is potentially highly motivating for science students but can also be perceived as not addressing learning, leaving students feeling confused about the meaningfulness of being involved in a scientific field for which they do not possess the same expert skills as their professional scientific collaborators. The approach has the potential to introduce real-life problem solving into schools but it must be kept in mind that the initial expertise of students within the area of knowledge development and how this knowledge develops are a key aspect of community-driven science learning in school.

The goal of the City at Play project, where students collaborated with architects on developing models in the game *Minecraft* for redesigning their local urban space, was to further expand the scientific discovery game concept in an educational context. During our study students gained first-hand experience with creating new technical knowledge within the framework of professional architects. This community-driven science learning environment was based on the students' local knowledge and expertise about their under-privileged neighbourhood, as well as the theory and methods of the participating urban planners. Our main research objective was also to understand how student learning practices and knowledge developed during the City at Play course.

Methods in Cities at Play

The project Cities at Play described in this paper was developed in close collaboration with the Copenhagen City Council Social Services Department and ResearchLab: ICT and Design for Learning at Aalborg University in Copenhagen. The purpose of Cities at Play was to involve young people in deprived areas as experts in their own living environments and to educate them on the influence of structural factors on their welfare and well-being and in how to use game tools to apply their knowledge and ideas to recreate and strengthen their neighbourhoods. From the start the project was launched to define problems and introduce game-based methodological solutions for developing structural changes in neighbourhoods in deprived areas in Copenhagen, therefore including both social and educational objectives. The project aimed to provide authentic contributions to City Council urban development and planning as a starting point and, ultimately, in the realisation of some of the ideas contributed.

The methodology used in developing the components of Cities at Play followed a design-based research process involving various design cycles, interventions, analyses and redesign (Brown, 1992). Design-based research was applied as a methodological framework and various methods were employed in the development and study of the game-based community-driven urban planning environment. The project moved through two iterations in a design-based research process (Brown, 1992), which included involving an increasing number of school classes and departments in the Copenhagen City Council. The first iteration is described elsewhere (Magnussen & Elming, 2015), hence the focus of this paper is the second iteration, Cities at Play 2.

Study design, methods and data analysis

Cities at Play 2 included four teachers, two 7th grade classes and two 9th grade classes, thus involving 90 students aged 13–15 from a school in a deprived area in south Copenhagen, which was chosen as an area due to the high rate of unemployment and non-existing or low level of education of residents. The school is located in an area with older council housing that suffers problems involving gangs and drugs. A library, kindergartens and a nursing home are in the vicinity of the school. The project was conducted in the local library over a three-week period. The 7th and 9th grade classes each worked separately for one week on their models and then worked in parallel during the third week to finish their models for presentation. A mixed method approach where conducted where video observations were used to document the three weeks of student design sessions and focused on documenting the students' dialogue in the design process in order to understand how the various models were developed based on types of local technical knowledge (Onwuegbuzie & Leech, 2006). Video observations specifically focused on documenting the work of the students who were socially weak in school but showed a high degree of motivation for participating in changing their local area.

Pre and post-surveys were conducted to register: 1) student motivation for participation in the project, 2) local knowledge about their area and urban planning, 3) whether the course supported the 21st learning skills Real-world Problem Solving and Collaboration compared to what students defined as "every day school", 4) what the students viewed as making the course different from "everyday school" and 5) student understanding of their ability to structurally change their living conditions. The digital surveys contained opportunities to provide quantitative answers in order to create an overview of the students' knowledge and experiences, as well as the opportunity to supply qualitative answers in order to understand the background for the quantitative answers (ref survey method). The teachers gave their classes the surveys the day before the course started and on the day the course ended. We also conducted semi-structured qualitative interviews with teachers and students that focused on further understanding the possible outcomes and challenges of the project (Kvale, 1996). Qualitative data was analysed applying grounded theory as a data categorisation method, where themes were defined based on participant-defined concepts in perceived knowledge generation and learning practices (Strauss & Corbin, 1998).

This paper focuses on analysing the motivation and forms of knowledge in the two 7th grade classes, which worked on changing their neighbourhood, while the two 9th grade classes worked on changing a neighbourhood they were unfamiliar with. This paper specifically focuses on the 7th grade students' authentic local knowledge and the role it plays in the collaboration with professional urban planners.

Findings

The overall goal was to understand how to integrate community-driven science in school education with a focus on urban development. The research of the current study was to understand what motivation, knowledge and language emerged from the encounter between the principles of professional city changers and students with local authentic knowledge about the deprived area they lived in.

The design of Cities at Play: Community Drive comprises five phases and is based on experiences and results from previous studies of game-based innovation education and community-driven science games (Magnussen, 2011; Magnussen et al., 2014). As described in Table 1 the participating students went through various phases that involved finding inspiration, defining the potential and problems in their local area, developing ideas, building models in the game *Minecraft* and with other materials and presenting with feedback from professional architects and urban planners in various Copenhagen City Council departments.

Table 1: Phases in the students' development process in City at Play 2 (modification of IDEO, 2009)

Phases	Activity	Process
Phase 1 (Week 1)	Inspiration	Field trips to newly developed areas in the city, introduction to core concepts in urban planning by architects and urban planners
Phase 2 (Week 1)	Defining the potential and problems	Definition of core strengths and challenges in their local area
Phase 3 (Week 1)	Developing ideas	Development of ideas for solving local problems and strengthening its potential
Phase 4 (Weeks 1 & 2)	Modelling	Building models in *Minecraft*, LEGO and other digital and physical tools
Phase 5 (Week 2)	Presentation	Presentation of models for the head of the Department of Transport, Technology and Environment and Copenhagen City Council urban planners

Motivation: Identification of local problems and potentials

A primary research objective was to understand what motivated students in the course. In the initial part of phase 1 urban planners from Copenhagen city council presented students with the overall objective of their development work: to redesign their neighborhood to create more life and more connections to other parts of the city. It is well-known that fundamentally rethinking existing formats is challenging, even for experienced innovators and designers (IDEO, 2009). As a result this phase focused on bringing students out of their everyday setting to inspire them to think about new structural changes. In addition to being presented with professional urban architectural methods and theories for changing cities (Gehl, 2010), students participated in field trips to other neighborhoods that had undergone an urban transition. During phase 2, the problem definition phase of the four-day development process (see Table 1), students were asked to photo document their area, focusing on its strengths and weaknesses. This process, planned in collaboration with the urban architects, included using a photo mapping method of areas well-known in the field of professional urban planning.

The two 7th grade classes generally worked extremely intensively during the course of City at Play. When asked "What do you think about the City at Play course?" in the survey, the two 7th grade classes gave a positive response overall, with a total of 90% answering either "Excellent" (16%), "Really good" (58%) or "Good" (16%). The reasons behind their motivation were identified in the initial phase of the development process, where students had to identify the problems and potentials of their local area. In response to the question "Would you like to be a part of determining what Folehaven should look like and be like?", 90% answered "Yes, a little" (14%), "Yes" (31%) or "Yes, very much" (45%). The majority of students were thus motivated from the very beginning of the project to take part in the redesign of their area. In that regard, finding out what motivated the students to want to take part in changing their area was a central goal. Two additional exploratory questions were also asked about living in the neighbourhood Folehaven. In response to the first one, "How much do you agree with the statement: Folehaven is fine as it is and does not need to be changed?", a total of 65% either slightly disagreed (42%), disagreed (21%) or strongly disagreed (2%) with the statement. The percentage increased to 84% in the post-survey, which presented students with the same statement.

When asked why Folehaven was good or bad the majority of the qualitative answers focused on the criminal activities or feeling unsafe, which is indicated by statements such as: "Too much violence and trouble making", "There are many rumours about drugs and stabbings. It's a little unsafe at the moment" and "There are lots of criminals". There are, however, also replies that address the more positive social aspects of living in Folehaven, for example: "It depends on who what your personality is like or who you're with" and "Because I have some lovely people around me".

These results indicate that the students were highly motivated from the beginning of the project to change their area and that the overwhelming majority saw problems in their area that they were motivated to change.

Creating models: Real-world problem solving and community-driven urban development

The focus of phase 3, the idea phase, and phase 4, the modelling phase (see Table 1) was for students to develop ideas and game-based models of structural solutions to the problems identified in phase 2. Students were asked to list and draw designs to strengthen identified potentials and solve the identified problems of Folehaven. The questions for this task were: "How can you change Folehaven so potentials are strengthened or problems are solved?" Additionally the development of ideas and later models also (as described above) focused on creating life and new connections in the students' neighbourhood. In phase 4 students selected and developed physical LEGO models and digital game models. Overall these models were characterised either by an explicit focus on structurally solving specifically identified problem areas, such as rundown playgrounds, or by being more theoretical with conceptual plans and examples for changing the social life of or cohesion in Folehaven. One example of the latter type of model was mixed housing designed to lure socioeconomically advantaged families and singles or new types of experiences, such as a network of bike paths connecting areas with cafes and play and sports facilities, to create lively areas that would draw visitors from other parts of the city. The different models proved to have a variety of potential in the urban planning activities. The physical LEGO models were well-suited for creating an initial overview of the developed area. The game tools, on the other hand, allowed students to communicate first-hand experience about the area being developed (see Figure 1). The Danish Geodata Agency offers a complete open-source, geographical model of Denmark (http://eng.gst.dk/maps-topography/denmark-in-minecraft/), allowing students to download a 10x10 km area with all existing buildings and streets to redesign.

Figure 1. Students developing models in *Minecraft* and LEGO.

The research focus was to understand what new types of practices and knowledge developed in City at Play. As a result our study was designed to document whether the students experienced working with 21st

Century Learning Skills and a more open design intended to document types of knowledge or practices specific to City at Play and community-driven science. As a result the study design also centred on understanding if students felt they were working with the 21st Century Learning Skills Collaboration and Real World Problem Solving and whether we could detect a difference compared to what students defined as "everyday school". The pre-survey contained questions on whether the students experienced collaborating and solving real-world problems on a variety of levels in everyday school. They were asked whether more than two people worked together when they collaborated, if they made important decisions collaboratively and if the result of group work reflects a collaborative process. For real-world problem solving questions were asked whether they felt they experienced working with real-world problem solving in everyday school or in City at Play. Hence the pre-survey asked if they worked with "solving problems for people in the real world outside school" in everyday school and on what level, in addition to whether this required developing their own ideas or following teacher-defined stepwise processes. The post-survey included the same questions on collaboration and real-world problem solving but covered their participation in City at Play instead.

Our findings show that no significant difference exists between group work and collaborative practices in everyday school work versus City at Play, which may be due to how highly integrated group work and collaboration are in most subjects in primary school in Denmark. Dealing with real-world problems in everyday school education, however, differed significantly compared to practices in City at Play. At total of 7.5% of the students thus either strongly agreed (2.5%) or agreed (5%) that everyday school work often involved "solving problems for people in the real world outside school" compared to 76% for City at Play, where they either strongly agreed (23%) or agreed (53%) with this For City at Play, 78% of students that either strongly agreed (26%) or agreed (52%) that they "worked with developing new ideas that they presented to people outside school that needed them" while the percentage was 17.5% for everyday school education. These results indicate that a majority of students experienced working with real-world problem solving practices in City at Play compared to everyday school education. Student experience with City at Play practices were further examined based on the qualitative post-survey questions: "Were the problems you worked with in City at Play different from the problems you normally work with at school?" and "What was different in City at Play compared to everyday teaching?". Our analysis of their responses grouped them into a variety of themes that are presented in Table 2.

Table 2: Themes that emerged based on responses to the two post-survey questions on City at Play: "Were the problems you worked with in City at Play different from the problems you normally work with at school?" and "What was different in City at Play compared to everyday teaching?"

Themes	**Examples of student responses**
Changing things	"Yes, because we normally don't work with changing things", "Yes because we were working with changing something in our city, which is something we don't do in class"
Something in the real world	"It was something that could happen in the real world", "Yes, a lot, because it concerns the real world and it involved problems we could solve for the entire Folehaven neighbourhood", "Yes, because in school we do, for instance, grammar and math, while in City at Play we were supposed to help others make Folehaven a better place to be", "Yes, because in a way it did not involve problems related to school subjects but something in the real world"
About helping people, not just working for your own benefit	"In school we work more for our own benefit. In City at Play we made something that everybody could benefit from", "In school you need to improve your grades, here we needed to help other people … #Thatwasnew", "Yes, because we had to consider whether it would work because here it's all about people", "Yes, here you can do something for a group of people and not just do math", "We helped other people and not just ourselves", "We had to make something that would benefit other people"
Decided more	"We decided more", "What we had to make was not predetermined", "It's kind of good because we had to decide on what we needed to build and so on. It's not like that in daily teaching, where teachers have the right to decide", "We were allowed to determine/decide most things"
Using one's imagination and inventiveness	"We had to use our imaginations", "We don't usually talk to architects and invent things"
Being active	"We didn't sit down all the time", "You were free to choose what to do", "We got to move around and independently decide things, "We were active in City at Play"
Other tools	"We used other tools", "We had to play a game to do our assignment", "We were building with LEGO blocks and made models with them", "No books, a lot of collaboration"

During our analysis of their responses a variety of themes emerged concerning the project's methodological and educational approaches, which will be discussed further in the discussion section. A central aspect of understanding what knowledge the students brought into the project involved gaining an understanding of how students viewed their own knowledge about their local area in comparison with the local knowledge that urban planners participating in City at Play had. The pre-survey asked "Do you possess knowledge about Folehaven that the architects redeveloping Folehaven do not have?" In their responses, 9% answered either "Yes, I know a lot that they don't know" or "Yes, I know a bit more". This percentage changed to 45% in the post-survey (see figure 2).

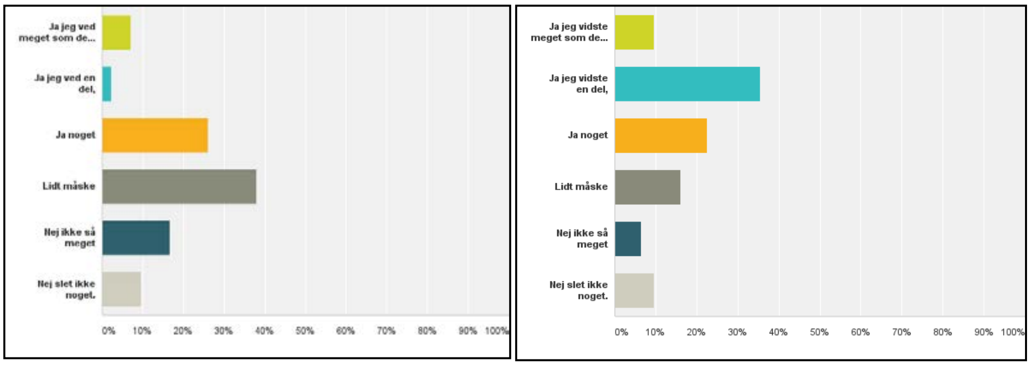

Figure 2. The bar chart on the left shows the pre-survey results and the bar chart of the right shows the post-survey results. The pre-survey question was: Do you have knowledge about Folehaven that the architects redeveloping Folehaven do not have? In the response, 7% (green) answered "Yes, I know a lot that they don't know", 2% (light blue) answered "Yes, I know a bit more", 26% (orange) answered "Yes, some", 38% (dark grey) answered "Maybe a little", 17% (dark blue) answered "No, not very much" and 10% (light grey) answered "No, not at all". Students answered a similar question in the post-survey: "Think about the City at Play course: Did you possess knowledge about Folehaven that the architects redeveloping Folehaven did not have?". A total of 10% of the students answered "Yes, I knew a lot that they didn't know", 35% answered "Yes, I knew quite a bit more", 23% answered "Yes, some", 16% answered "Maybe a little", 6% answered "No, not a lot" and 10% answered "No, none at all".

These results indicate that the students' perception of whether they have knowledge about their neighbourhood that the professional urban planners do not have changes due to their participation in City at Play. The study examined this change in their perception of their knowledge or local expertise more closely by asking students to qualitatively specify what specific knowledge they felt they had that the urban planners did not have. The qualitative part of the pre-survey conducted prior to participating in City at Play provided a picture of the specific local knowledge students believed they had. The majority of the answers to the question "What for instance do you know more about?" covered reasons why the students knew more than the urban planners, for example: "I know Folehaven very well because I grew up here, so I'm sure I can work out something with some of my friends or alone" and "I grew up in Folehaven and know almost everyone. I think my friends and I can find something good to build here in Folehaven". The student responses to two post-survey qualitative questions: "Think about the City at Play course: Did you possess knowledge about Folehaven that the architects redeveloping Folehaven did not have?" and "What for instance did you know more about?" can be grouped into four types of knowledge:

1) Physical buildings or facilities in the area
   - E.g. "I know a little about Folehaven and the buildings", "supermarkets and lighting"
2) Experiences or feelings
   - E.g. "What the atmosphere is like, what's good and what's bad, what it's like in general to be here", "I can find my way around Folehaven with my eyes closed, I'm part of it".
3) Experiences or feelings concerning locations or facilities in the neighbourhood
   - E.g. "That it's boring to be here/live here. They couldn't know that there isn't much light in the evening, which makes it scary.", "Where it's safe and unsafe", "Safe and unsafe places. What needs to be changed."

4) Social aspects of the community in the neighbourhood
   - E.g. "I know more about the things that some people need.", "I know, for instance, what it's like to live here and what most people want /don't want".

These results indicate that students became more aware of their knowledge about their neighbourhood (figure 3). The variety and diversity of the answers to the post-survey show that they also became aware of the different types of knowledge and its value in the development process. The answers concerning the first type of knowledge, "Physical buildings or facilities in the area", suggest that students developed an understanding of how one's experiences of an urban area are related to its structural elements and the urban development choice made in the area (Gehl, 2010). This understanding was further explored in the pre and post-survey, where two major issues in City at Play: 1) creating more life in Folehaven and 2) the creation of better connections between Folehaven and the rest of Copenhagen, were addressed with, for example, the questions: "Do you have any ideas about how more life can be created?" and "What ideas do you have about how better connections between Folehaven and the rest of the city can be created?" In the pre-survey 25% of the students' qualitative answers did not contain any ideas or stated that they had not considered any. In the post-survey, however, only 3% said they did not have any ideas. Responses concerning the second big issue in the pre-survey addressed more general issues with overall suggestions, such as: "No crime", "No crime, no drugs. You should be able to feel safe in Folehaven" and "Things that get people's attention". The concrete ideas that appeared in the post-survey responses indicated that students had worked intensively with ideas for creating connections and life: "Make a central hub or make streets, e.g. bike paths, that are a little more interesting so you feel like biking on them", "Build new apartments so new people move to Folehaven" and "For example, make a blue bike path that would hopefully attract people or that would break down the wall around Folehaven". In addition to suggesting specific ideas for redesigning the urban area, the students also integrated concepts introduced by the urban planners and architects, such as mixing the types of houses and apartments for new groups of people to move into, developing connections that would attract people to a central hub by building streets and paths that would give them a better experience. The discussion section will look at the knowledge types in further detail.

Discussion

This paper presented results from the project City at Play: Community Drive, where young people in deprived areas built models in Minecraft with the aim of redesigning their neighbourhood based on what they define as the potential and problems in their local area. Game-based community-driven science is a growing field (Cooper et al., 2010; Good & Su, 2011) but more attention needs to be given to understanding what knowledge and learning processes authentic problem-solving in collaboration with professional partners can lead to in a school context. The overall research aim of this paper was to understand how to integrate community-driven science and urban development in school education, and to identify what knowledge and practices emerge from this integration. Data and findings from pre and post-surveys given to the two participating 7th grade classes showed that various aspects are involved in how students perceive how the approach used in City at Play differs from their everyday school practices. The findings on learning practices showed that students experienced working with real-world problem solving more than they did compared to everyday school. Their qualitative responses clearly demonstrated that problem solving in a context outside school was a central theme, as was focusing on the community by helping people, i.e. not just doing work for their own benefit, but also being in control of their own decision making and problem solving. During our analysis of the knowledge generation part of the above described practices, it became evident that the participating students' perception of the knowledge they possessed changed significantly after the course compared to before. An assessment of the students' qualitative answers regarding what local authentic knowledge they had that the professional urban planners did not have showed that it was quite specific and covered, for example, aspects such as buildings, facilities and environments. In addition the knowledge categories our analysis identified also showed that after the course the students had a better understanding of the physical and structural elements in their local urban space and of the effect of physical elements such as buildings and lighting. They had realised that all of these various aspects affected whether they felt safe or scared, in addition to influencing the broader community in Folehaven. We also examined their responses in the post-survey concerning ideas for creating a greater connection to the city and more life in their neighbourhood. After participating in City at Play the students' ideas became more detailed with regard to the specific changes they wanted to implement in the area and incorporated technical terms related to the principles of professional urban planning. These results indicate that over the course of two weeks the students developed and changed from defining challenges in their neighbourhood in terms of larger concepts such as "crime" and "feeling unsafe" to concrete problems such as poor lightning, worn down housing, streets in need of repair and the scattered nature of community activities. These structural, well-defined problems created a framework for the student to develop redesigns of their neighbourhood, leading to suggestions and plans aimed at structural changes to meet different needs and problems of the various types of residents. The authentic framework of the models presented to and commented on by real urban planners proved to be highly motivating for both resourceful and less-resourceful students.

Overall the above results indicate that over the two-week development process the students were able to expand their knowledge using their local expertise on their area by combining it and relating their authentic knowledge about the problems and potential of their area to its physical and structural features, but also to the professional principles of developing design solutions. Helping other people in the community, solving problems in the real world and being in control of their own process and decision making proved to be important practices they experienced during the City at Play course compared to everyday schooling.

The current study examined a brief two-week period and produced promising results. This paper presents the first results, but future studies should focus on generating a deeper understanding of the mentioned practices and types of knowledge. A future research aim is also to do a similar study over an extended period to determine if the results are similar or different and to look at the long-term effects of this type of community-driven development when integrated in schools over a longer period.

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