# Transforming Pervasive into Collaborative: Engaging Youth as Leaders with GIS through a Framework that Integrates Technologies, Storytelling, and Action

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**Abstract.** This paper presents the methods and preliminary results gained in geographic information systems (GIS)-based participatory activities designed to engage youth in urban planning. We describe our engagement framework that integrates such pervasive IT tools as GIS, online serious games, agent-based modeling, and mobile participatory GIS into engagement strategies that tap into what we see as the storytelling capabilities of these tools. We show how these methods help citizens, in our case youth, assume leadership roles and take positive, tangible actions in their communities. This paper summarizes the elements of our framework and the initial results of a program called "Community Growers" that we created between our Iowa State University research team and a chapter of the Boys & Girls Club of Central Iowa. Participants included middle school-age youth from three resource-vulnerable neighborhoods in Des Moines, the capital city of Iowa, USA. We conclude the paper with a discussion and further research directions.

**Keywords:** participatory GIS, interactive online maps, engaging under-represented youth, online storytelling, action projects and youth leadership

## 1 Introduction

Current procedures and activities in urban planning and community action almost completely neglect youth involvement and leadership. Our research aims to develop and explore novel methods and methodologies that can be used to empower youth in co-creating and taking action with community leaders to foster more vibrant communities. We present the conceptual framework for engaging the youth was created as a result of our previous research and experience in numerous projects [1-11]. The framework suggests an integration of technologies such as geographic information systems (GIS), Volunteered Geographic Information (VGI), online serious games, and agent-based modeling (ABM) and link them with action projects.

These technologies can be used in combination to support plan and document local action, placing the work of youth or other stakeholder groups within the widening circles of community development. This may lead to positive impacts on supporting community assets and alleviating deficits.

This paper concentrates specifically on the use of GIS as storytelling mechanisms that support youth in creating action projects and taking on leadership roles in their communities. We tested this framework for engaging youth with the youth that attend the Boys & Girls Club in some of the lowest-income neighborhoods in Des Moines, Iowa. We have created an 8-week program, called "Community Growers," for middle school-age youth. We involved them in learning a specific GIS software and exploring places in their neighborhood with the help of this software. By working with these youth on visible community projects, we not only aimed to foster their "community agency" but also, through their use of GIS technologies, enhance their potential to conduct and lead local change [12]. Our project partners include the City of Des Moines, the Viva East Bank! coalition, and the Baker chapter of the Boys & Girls Club of Central Iowa, which has its facility in the Hiatt Middle School.

The main contributions of this article are in a. introducing an engagement framework consisting of participatory technologies combined with action projects and b. to demonstrate the approach to capitalize the storytelling and collaborative capabilities of GIS. The research presented here taps into an under-examined research area related to the use of GIS-based technologies by the youth, especially in an urban planning participatory process. Our work with GIS aims to expand the social and collaborative implications by capitalizing on the widespread use of this technology in community leadership, thus incorporating maps generated by community partners as shared spaces that facilitate knowledge exchange and discovery of aligned goals. We summarize the main research concepts and results from the experiments enabled by online interactive maps based on GIS technology and conclude with a discussion of the results.

## 2 Methods and Pervasive Technologies for Civic Engagement in Urban Planning

### 2.1 Engaging Under-Represented Youth

Involving youth into urban planning processes, and particularly those from low-income populations, has long been a challenge. Due to such factors as their families' school-life stresses and language barriers, these populations are the most difficult to engage in thinking about their neighborhood, changes that are needed from their perspective and therefore often remain absent from municipal and community decision-making [13]. When researchers seek to engage these populations, the typical strategy is to begin with local power-brokers such as landlords, business owners, public officials, and developers [3]. This approach affirms hierarchical relationships that privilege leaders and public officials more than residents, and especially the youth.

Conversely, some researchers take a less-travelled path and place youth at the center of community engagement; however, much work is still done *for* youth, rather than *with* youth [14]. Youth are rarely included in decision-making at either the city or neighborhood level: "Youth's voices are often absent from community-building processes, deepening the gaps of miscommunication and contributing to community exclusion" [15-17]. Our work seeks not only to integrate the voices of youth into city and neighborhood decision-making but also to empower these participants as community leaders who are learning to use technologies as collaborative tools that can help them work with community partners and take action. Developing these skills, we believe, will benefit them in becoming the next generation of city decision-makers.

### 2.2 Socio-Technical Storytelling to Support Action and Leadership

To empower the youth to share their ideas and experiences, we incorporated the use of technologies through a lens of storytelling. Storytelling, long associated with the humanities, has become a cornerstone of community engagement practices to authorize under-represented populations and non-credentialed stakeholders as co-producers of new policies and practices [18-22]. Recent advancement in GIS-based storytelling focuses on the creation of map-based stories, which include multi-media such as a combination of pictures and videos that are geo-located and presented on the map, offered online to anyone with internet access. GIS may be used with communities to map their stories, primarily to capture their lived experience [23, 24].

Shenk et al. [2, 3, 8] are developing a methodology of socio-technical storytelling that uses the narrative and collaborative capabilities of such technologies as GIS, Volunteered Geographic Information (VGI), and agent-based modeling (ABM). The focus is not only on capturing individual stories but rather on creating a group's community story that leads to action. Each technology, with its distinct capabilities for visualizing and presenting data, may assists stakeholders in telling and uncovering community stories differently. The spatial components of GIS provide the ability to visualize data on multiple layers, demonstrate spatial relationships, and include the emotional components of places. These features allow stakeholders to see gaps and clusters of both community assets and needs and then connect these with the emotional experience of place. This telescoping between systems and the personal/social may motivate stakeholders to take ownership through action and to see why this action can have positive impacts for the larger community.

This approach differs from traditional approaches to storytelling not only in that it requires the use of technologies but it also moves away from an emphasis on individual stories. Rather, socio-technical storytelling uses technologies as catalysts for sharing and uncovering of facets of a community's story to foster collaborative actions. Such an action-based approach may support a community's ability to come together within individual groups (bonding social capital) and connect with external partners and resources (bridging capital)—a fostering of community capacity building that is key to supporting resource-vulnerable populations to become more resilient and hopeful [25-28]. We are developing socio-technical storytelling as an approach that uses technologies as catalysts that can inspire the social processes and positivity

useful in empowering groups not accustomed to assuming leadership, such as youth and, in a larger sense, groups experiencing stressors in a community that benefit from a greater sense of hope and positive momentum.

### 2.3 Public Participatory GIS (PPGIS), mobile PPGIS and Volunteered Geographic Information (VGI)

Public Participatory GIS (PPGIS) as a research area was established and discussed in the mid-1990s by Schroeder [29]. At that time, it mostly concentrated on the desktop GIS applications and further development of GIS platforms by adding participatory functions and operations for example in the works by Kingston et al. (1999) and Sieber (2003, 2006) [30-32]. These features were first implemented and tested for their technical capabilities [33] and also for their newly included participatory functions [34]. Later, many researchers stressed the importance of the user interface and usability of PPGIS [35-37] for non-GIS experts and technicians.

Development of new pervasive technologies and especially mobile devices led to novel ways of collecting geographic data on a volunteered basis; in such situations, citizens act as sensors [38-40] contributing data to the GIS-based systems that are often freely available online and/or on a variety of mobile devices [41]. Goodchild [38-40] coined such (mobile PPGIS) spatial volunteered applications Volunteered Geographic Information (VGI). In a VGI environment, anyone with a mobile device can contribute data and/or information about the surrounding even while walking and observing the environment. Through a user-friendly user interface, one can enter geographically-located data/information/knowledge into the pervasive system which stores the data in a geographic database. VGI uses the same structure of storing objects that a GIS does and is able to relate graphical data about the objects (houses, streets, lakes, …) with the attribute data describing the characteristics of these objects. It is designed mainly as a data collection method offered on personal computers and such pervasive technologies as smart phones and tablets. An example of a VGI used in our research is Maptionnaire (maptionnaire.com) which combines online maps with an online spatially-related questions. The users can choose a geographic area or a geographic object and respond to the questions related to the selected geographic object. The users' responses are then stored in a geographic database and can be visualize on a map. Maptionnaire is an example of an online GIS-based participatory platform that also enables crowd-sourcing and citizens' engagement into discussions based on map representations of the area under discussion.

### 2.4 Favorite Places and Power Places

How do people perceive and experience places in their neighborhood? Especially, how do youth experience and use these places? What is important to them in respect to their selected places? Knowing more about the places and people's perception of these places may enable urban planners to design more sustainable, functional, and enjoyable areas. We build on the previous work by Korpela and Hartig on favorite places [42-46] and Poplin [7, 47] on power places.

Korpela and Hartig [42-46] defined favorite places as places that afford restorative experiences and may aid emotional and self-regulation processes. They worked with young people, especially adolescents, asking them to write an essay describing their favorite places. The adolescents reported going to their favorite places to relax, calm down, and clear their minds. They also described the experience of beauty, freedom, and escape from social pressures. Their favorite places were described as aesthetically pleasing and engaging. Natural settings such as parks, proximity to water, and green areas were over-represented among favorite places. The adolescent participants reported the reduction of anxiety, fears, and social pressures while being at their favorite places. The research conducted by Korpela and Hartig [42-46] indicates a link between favorite places and restorative experiences.

Poplin et al. [8, 46] conducted research on power places, which are defined as places where people can recharge, relax, and find inner balance. She used paper and online GIS-based maps to gather data from her focus group of college students. The experiments were conducted in Hamburg, Germany [47] and Ames, Iowa [7]. All 191 captured the power places in Hamburg were located in open spaces, primarily in parks or in close proximity to water. In contrast, the Iowa experience was different; one third of the captured power places (36 all together) was located inside, in the buildings of the university campus in Ames. Only two parks – Ada Hayden and Brookside Park – were indicated as power places. There are more than 55 parks in Ames, but it seems that only two are often used by the students. Additional experiments need to be conducted in order to better understand how different cultures influence the choices of power and favorite places.

## 3 Conceptual Framework for Using Pervasive Technologies to Engage Youth in Co-Creating Their Neighborhood

Engaging the youth in participatory processes presents a challenge for city planners, urban designers, architects, and governmental institutions. What could be a modern approach to inspiring youth to contribute to the co-creation of their neighborhood communities? The more professional technologies may be used to expand the youth's typical use of technology for entertainment and individual aspects such as facebook, snapchat, Instagram, etc. Today, the majority of the youth own cell phones, which are often used for a personal communication and/or entertainment. Youth are used to texting, using Instagram, taking pictures—often selfies, and using snapchat with friends and family members. We build our conceptual framework on this experience assuming that the majority of the youth may be familiar with online maps, they may have an experience with different software tools, and they may have some experience in how to use pervasive technologies such as smart phones and tablets.

Our framework for engaging youth into urban planning processes suggests using a variety of different technology-based methodologies combined with action projects. It interlinks the use of technology with the implementation in the practice. The implementation in the practice comes in the form of action projects. The conceptual framework aims to illustrate the link between the use of novel technologies in the process of co-creation combined with the implementation of the ideas through action projects (Fig. 1). It was developed as a result of several brainstorming sessions within

the project team and previous research accomplished by the project members [1-11]. The framework itself is not limited to the youth; it can be used and implemented for adult stakeholders. The conceptual framework for engaging youth and adult stakeholders may involve different technology-based methodologies, but it is not limited to these technologies.

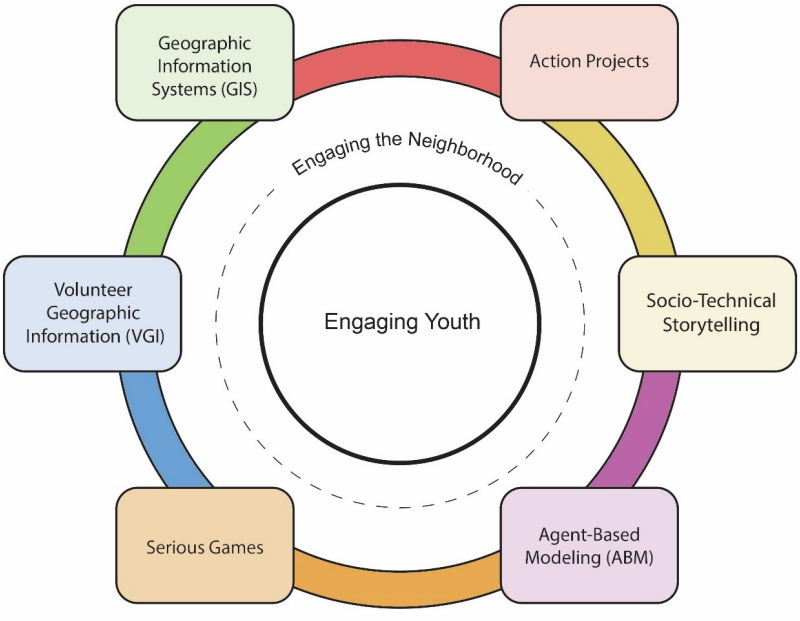


**Fig. 1** The framework for using technology-based methodologies and action projects to engage youth in co-creation of their neighborhood.

The fundamental components of the framework for engaging youth into the co-creation of their neighborhood with the help of novel technologies – proposed by our research team - are the following:

**Online Geographic Information Systems (GIS)**. The younger generation is usually technically savvy and/or interested in trying new approaches. Online GIS adds the spatial component and represents the environment on a digital, online, interactive map. The citizens/the youth can learn about the locations of resources (such as food supply, libraries, schools), experiment with the distances to these places, explore their neighborhood from a spatial perspective, and interact with the maps. Online GIS can be used 24/7 by anyone with an Internet connection, smart phone, tablet, or other mobile device.

**Volunteered Geographic Information (VGI)** systems, often implemented online, represent technologies that can be used on mobile devices such as smart phones or

tablets. The youth can even use VGI outdoors while walking around the neighborhood or at the location of a discussion. They can insert data about the neighborhood, thus becoming citizen scientists who contribute their specific knowledge to the VGI system.

**Agent-Based Modeling (ABM)** is a computational simulation model that allows researchers and stakeholders to explore how the individual micro-decisions of agents can lead to macro-level changes (new policies, new approaches) in complex adaptive systems. ABMs let researchers create different agents and then run "what if" scenarios to examine the consequences of the simulated human decision-making.

**Serious Games for Civic Engagement.** Online serious games represent a novel method for engaging citizens into urban planning processes [5, 48, 49]. Such games can be educational, fun, and can enable to engage youth in exploring alternatives, submitting their vote for their preferred spatial solution, and learning and questioning current and proposed solutions for their neighborhood. They can represent space in a virtual reality application, as a 3D or 2D space or even as an online interactive map. A variety of different concepts, game stories, environments, and the art of experimentations within the online game environment are all possible.

**Action projects** add a very important component to the framework. Their main goal is to enable the link to the reality, to the real-world where discussed issues can be improved, solved, corrected or something new can be created in order to improve/change the neighborhood. Too often, the discussed issues seem to be very theoretical; they may happen in an online interactive environment, in a public discussion, or on a paper presented as a future plan of the neighborhood. The citizens are often not involved into creating a change. Action project aim to do exactly this; they aim to enable the citizens to create and implement the changes they want to see in their neighborhood.

In this article we present how the framework was tested to engage youth into collective reflections and co-creation in the selected neighborhoods in Des Moines, Iowa. We focus on the question on how GIS and GIS-based storytelling can be implemented to engage youth into urban planning processes and how they can initiate action projects.

## 4 Case Study: Engaging Youth from the Under-Represented East Bank Neighborhoods in Des Moines, Iowa

### 4.1 Des Moines Neighborhood and its Population

Our study area is located in Des Moines, the capital of Iowa, USA, with a population of 203,433 as of 2010 census data. The main focus are the following three neighborhoods (Fig. 2): Capitol East, Capitol Park, and MLK Jr. Park. They were selected because they have among the highest levels of resource-vulnerable and young populations in the city. In these neighborhoods, the total population is 8,673 with significant populations of Black and African American residents: 22.7% averaged across the three neighborhoods and Hispanic or Latino/a residents: 33.3%

averaged across the three neighborhoods. These neighborhoods have a larger percentage of residents whose first language is not English. The median income in these communities is about $23,000. Over 34% of the population is under 18 years of age. About 30% of adults do not have a high school diploma or other higher education. Nearly 30% of the population is living below the poverty line (for example, $16,240 for a family of two or $24,600 for a family of four). In addition, these neighborhoods have high populations of young people ages 5-17.

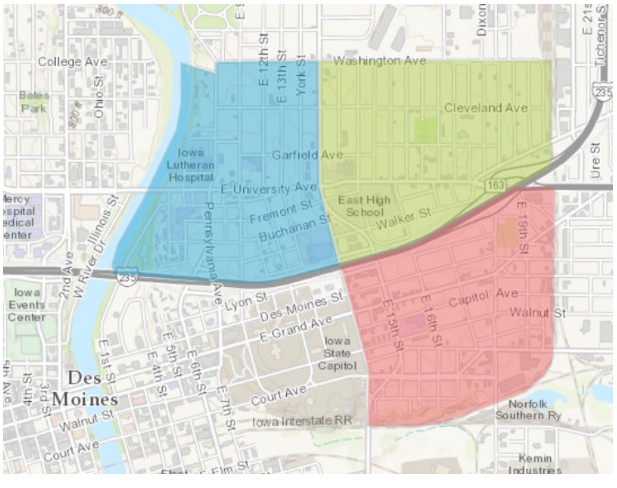


**Fig. 2.** East Bank neighborhoods in Des Moines, Iowa

### 4.2 Participants: the Youth from three East Bank Neighborhoods

The students participating in our study were in 6th, 7th, or 8th grade. They were between 11 and 13 years-old. We conducted two-parts of the study; the first one in the spring and the second one in the summer. Table 1 summarizes the number of participants and received assent forms. Participants were not asked to identify their racial backgrounds; however, the group was ethnically diverse, which is in keeping with the racial demographics of these neighborhoods.

**Table 1.** The number of participants and received assent forms

| Spring 2017 session | | | | |
|---|---|---|---|---|
| No. of students | Girls | Boys | Assent forms in English | Assent forms in Spanish |
| 8 - 22 | 16 | 1 | 11 | 6 |
| Summer 2017 session | | | | |
| 4 - 10 | 6 | 2 | 6 | 2 |

### 4.3 Methods for Data Collection

The data about the participants, their preferences, and skills were collected with the help of several brainstorming sessions and activity packets.

**Brainstorming sessions.** Throughout the program, researchers structured each session around small- and large-group prompts for brainstorming, sharing personal experiences/interests, and working with the technologies, such as GIS. The youth used their answers in the group-work to generate PowerPoint presentations for community partner meetings. The summer group additionally created a social media post and worked on their PowerPoint journal.

**Activity packets** contained qualitative questions about their interest in joining the program, their self-image as leaders, the importance of the community garden, and their goals for the garden. The activity packets concluded with five quantitative questions regarding their use of data technologies, involvement with community or city leaders, and experience in gardening. Quantitative data for the youth's use of GIS and involvement with city leaders are the following data (n=19, both sessions combined filling out the initial activity packet):

- On the question asking if a participant had ever created a map on the computer, 16 circled the answer for "not yet," and 3 answered "once or twice."
- For the question asking if a participant had shared ideas with city or community leaders, 17 answered "not yet" and 2 answered "once or twice."

All of these materials and questions had IRB approval, and all data was aggregated or identified, depending on the data, to protect the youths' privacy.

### 4.3. Creating the "Community Growers" Program for Youth

To engage the youth into the project, several steps were needed. First, we established a relationship with staff at the Baker chapter of the Boys & Girls Club of Central Iowa. Our focus on technologies, leadership, and action projects was of interest to the Club because these elements aligned with their goal to develop partnerships that would not only support the youth's 21$^{st}$-century skills (collaboration, communication, creativity, critical thinking) but also, through these partnerships, create projects that have significant impact. Of interest both to the researchers and the Club was conducting action projects in the large community garden connected with the youth's middle school and our program's focus on community leadership.

Working in partnership with staff of this after-school program, we established "Community Growers," program. The program focused on several key aspects: the youth's own leadership skills, the use of technologies, and the school's community garden that would form the center of the action projects. Twenty-two boys and girls signed up to be part of the spring 2017 8-week program, and 10 signed up for the summer program (also approximately 8 weeks). Only one student from the spring group was able to attend the summer session. Our research team met with the youth twice a week with sessions each lasting 50 minutes. The youth experimented with GIS, imagined the next chapter of the garden's story, devised action projects, and conducted community partner meetings with other (adult) community leaders.

### 4.2. Research Focus on Testing the Conceptual Framework for Engaging Youth and Utilizing Online GIS for Socio-Technical Storytelling

There were two main goals of our focus on underrepresented youth in Des Moines were a) to test the conceptual framework for engaging youth into urban planning and especially into the co-creation of their neighborhoods and b) to demonstrate the use of online geographic information systems in the process of socio-technical storytelling and to test its collaborative capabilities. Our research aims to connect the main idea in the framework which suggests to link the use of novel technologies with the implementation of the ideas in practice, in community visible projects. The research methodology is designed to a. teach the youth how to use online GIS in a playful way, b. to share and tell stories while using online GIS and the collected data, c. collect data about favorite and power places, d. help to understand the role of the community garden and e. enable the youth to take leadership over the garden as an example of an action project. The results of our research are summarized in the following section.

## 5 Spatial and Personal Mapping for Socio-Technical Storytelling

### 5.1. Learning the Basics of GIS Map-Making

The research process included mapping experiments with youth experimenting with the paper map, learning how to use the online interactive map in a playful process, and the sharing of "stories" about favorite and power places. The youth were introduced to the online interactive GIS that can be implemented on computers, smart phones, tablets, or other pervasive technology. We utilized ArcGIS Online, an online GIS software created by Environmental Systems Research Institute (esri.com), from Redlands, California, as a learning GIS tool teaching youth how to create maps and also as an implementation tool that enabled mapping of the collected data about places.

**The "big paper map" experiment**. Mapping favorite places started with a discussion based on a big paper map. The youth interacted with this map, searched for places in their neighborhood, became acquainted with the representation of places and placed names on the map and their neighborhood and its surroundings visualized on a map. This "big map" experiment started as a discussion, a group collaboration, and an introduction to the world of maps. The initial paper map did not include street names and other points of interest and it was not particularly effective in communicating the spatial situation in the neighborhood. On the positive side, it initiated discussions about the locations of the main buildings, helped the youth to find their home place on a map and increased the curiosity about the use of maps in general.

**The online map experiment**. The online map experiment was designed as a game-based learning experience with game challenges included at the end of the experiment. The youth first learned how to log-in to ArcGIS Online. We guided them through the online user interface explaining the basic functionalities. The experiment included learning about zoom-in and –out functions, importing base maps, selecting a variety of different base map representations, using search function, and searching for

places in general and places with known addresses, creating map notes in order to add additional point features on the online interactive map, renaming the created map notes, and entering points of interest with the help of map notes (Fig. 3).

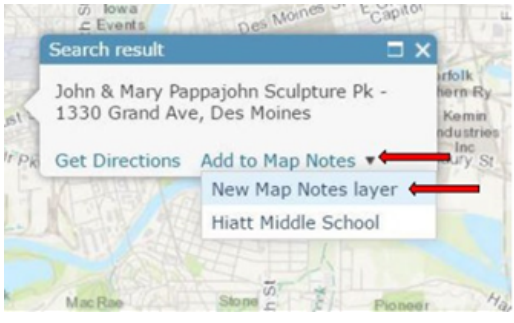


**Fig. 3.** Creating point features with the help of map notes in ArcGIS Online

In the second part of the online map experiment, the youth learned how to calculate the distance between their school and the point created with map notes (Fig. 3). This part included analytical tools in the online GIS and enabled the youth to select whether they wanted to see a walking or driving distance. We asked them to figure out a walking time from the Hiatt Middle School to Papa John Sculpture Park as part of the game-based competition toward the end of the experiment (Fig. 4). The challenges at the end of this exploration included the following tasks:

- In the search bar, search for a restaurant and add it to the Map Notes
- Rename it
- With the tools available to you in ArcGIS Online, measure how far it is from the school.
- How long does it take to walk there?

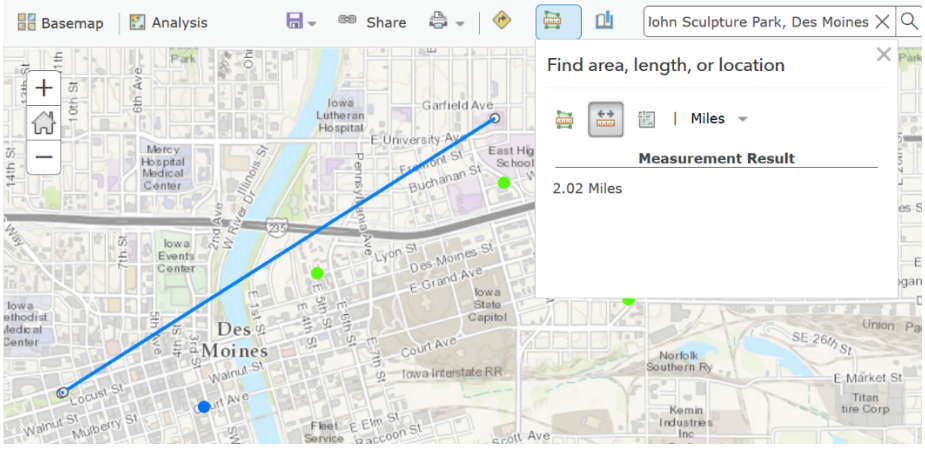


**Fig. 4.** The youth used the measurement tool to measure distances

The interaction with the youth was intentionally playful; we introduced the challenges and the awards for those who can accomplish the challenges quickly. The playfulness was used as a stimulation for the youth to participate in the activities, and also to encourage them to listen to the described tasks, feel motivated to learn about them and encouraged the ambition to perform better/faster on the tasks. We brought some candies in order to encourage competition, we measured time they spent on a certain task, and awarded the fastest with the candies. The youth competed in accomplishing the challenges, and there was a lot of excitement about the tasks in the computer room. We aimed at creating a relaxing, enjoyable, and playful atmosphere. At the end, all youth got candies as a reward of participating in the challenge.

### 5.2 Socio-Technical Storytelling: Using GIS to Share Stories about Places

Our approach to introducing youth to GIS mapping is to use this map as a catalyst for socio-technical storytelling, using the technology to support the sharing and uncovering of facets of the youth's, and ultimately their community's, stories that can lead to collaborative, positive action. Additional data was collected in personal story-sharing activities in which the youth described and located on a map their favorite- and power places (Fig. 5). Favorite places were defined as places they like the most. Power places were defined as places where they can recharge, relax, and find peace and inner balance.

The data collection about their places was completed in several complementary ways. The youth were able to use the paper map to indicate their favorite- and power places and could map them, with the help of our research team, into the online GIS application. We developed a questionnaire for the power places that enabled the youth to sketch their power places, describe their characteristics with three words, and tell how they feel at these places. These activities encouraged the youth to describe their power places with words, often with an emphasis on why the places mattered to them, what they did in those places and/or how they felt emotionally when in those places. They used these personal stories as a layer of personal data and connection in the map; the maps integrated personal and community assets and needs that expose the possibilities for adding to that story through action projects.

**Fig. 5.** Mapping favorite and power places on paper maps and online interactive maps

The research team then inserted the data gathered with the youth into a group online, interactive, GIS-based map. Using the integrated capacity of an online GIS, we created different data layers and narrative expressed through image and text. With the focus on places, we stored their favorite places on one layer and power places on the second layer. Figure 6 shows the final version of the map with blue dots indicating their favorite places in purple dots their power places.

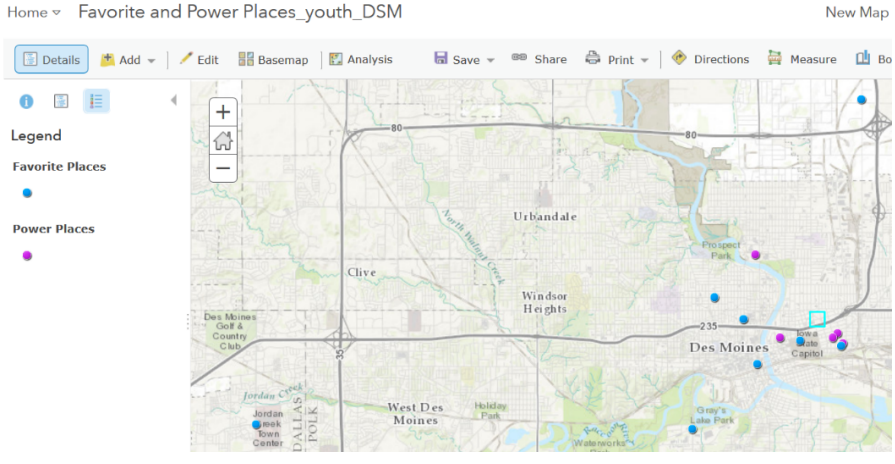


**Fig. 6.** Mapping favorite and power places

Table 2 shows an example of the attribute table stored in ArcGIS Online. The words for the descriptions of the power places include joyful, quiet, rainbow, relaxing, safe, calm, sunny, warm. These descriptions sometimes also include descriptions of emotional states such as happy and touched. The emotions include words such as joy, happy, excite, playful, lonely, quiet.

**Table 2.** Attribute table showing the descriptions of power places and emotions felt at these places

| Power Places (Features: 6, Selected: 0) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Name | Address | Describing 1 | Describing 2 | Describing 3 | Emotion 1 | Emotion 2 | Emotion 3 |
| 10 | Redhead Park | 1700 Dean Ave, Des Moines, IA 50316 | Relaxing | Joyful | Quiet | Joy | Happy | Listened to |
| 18 | Whitmer Park | 518 Lyon Street, Des Moines, IA, 50309 | Sky | Rainbow | Sun | Happy | Sleepy | Excited |
| 22 | Birdland Pool | 300 Holcomb Ave, Des Moines, IA 50313 | Open | Safe | Touched | Calm | Revived | Radiant |
| 4 | Boys and Girls Clubs of Central Iowa | 1421 Walker St, Des Moines, IA 50316 | Happy | Tired | Sleepy | Relaxing | Calming | Fun |
| 35 | Des Moines Neighborhood | Capitol Ave, Des Moines, IA, 50316 | Flower | Sunny | Warm | Calm | Quiet | Lonely |
| 14 | Capitol View Elementary School | 320 E 16th St, Des Moines, IA 50316 | Funny | Happy | Loud | Happy | Excited | Playful |

A more extensive data collection including more young people is needed in order to get enough quantitative results about these places and emotions felt by the youth at these places. Additional data may help to improve the understanding about the use of open, public spaces and the preferred locations for the youth. In the next steps of the project we intend to involve the adults into the survey about the places and compare the youth-view with the adult-view of places and spaces in the neighborhood.

The research team then added the following layers of points of interest to the common map: public service buildings, restaurants, grocery stores, entertainment locations, parks, and recreation facilities. This interactive online map (Fig. 7) combines the infrastructure with the personal experience of places described by the youth. It enabled them to better understand the places and how the infrastructure might impact the personal perception of these places.

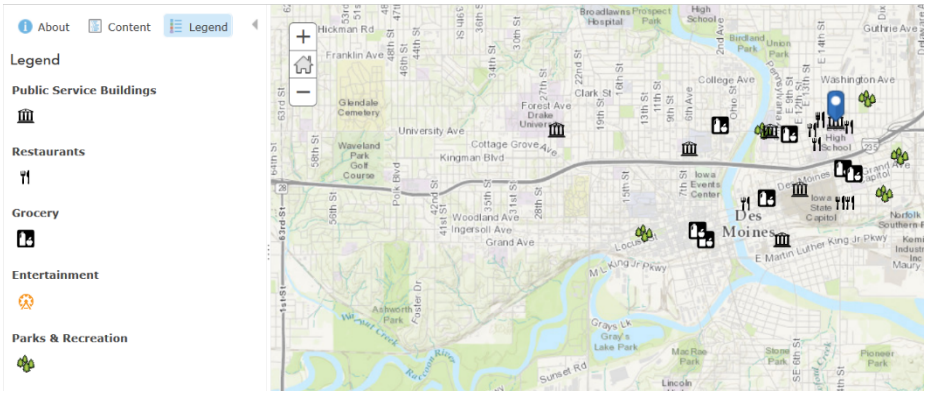


**Fig. 7.** Mapping favorite and power places

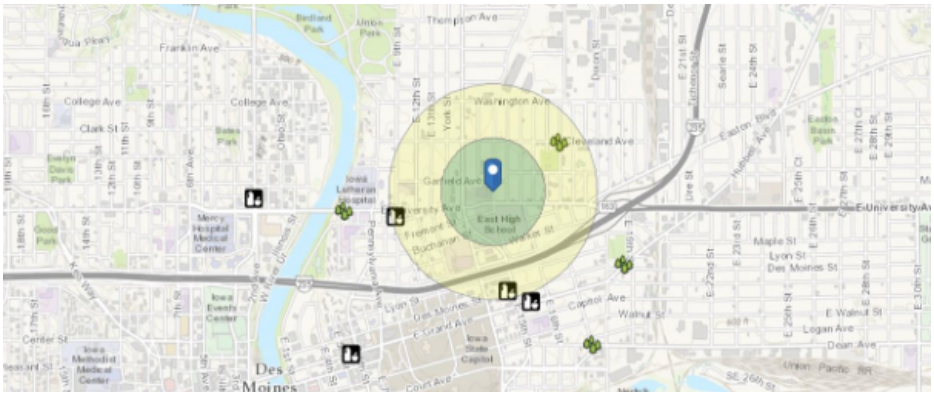


**Fig. 8.** Creating buffers around the school

After the team generated the map with these layers, we created 0.25 and 0.5 mile buffers around the youth's school (Fig 8). The youth noticed that only three grocery stores were within a 0.5-mile radius of their school and not all those stores had much fresh produce. The group then began to talk about where they and their friends shopped and discovered that quite a few of the participants shopped at a medium-sized Mexican grocery store nearby. Nearly all of the families shop at a large, mainstream grocery store, which is over 2.5 miles away. The youth began to think about the importance of food access, and some realized how, for older people and those without cars, the distance made it even harder to get healthful food. These moments involved the shift in socio-technical storytelling of moving from personal data to the larger stories that emerged from viewing information within larger systems-views.

The summer group made use of the spring group's map with its multiple layers. One of their activities was to look at the grocery stores layer and examine what the distance of the stores/restaurants from the middle school suggested. In looking at the maps, the youth discovered that there are "more restaurants than grocery stores," and they noticed that the nature of the grocery stores and restaurants revealed "there are a lot of different cultures" in their neighborhood. The spatial components of GIS allowed them to see gaps and clusters of both community assets and needs, as they began to share their stories of when/how their families gets groceries. This process of sharing encouraged them to begin to imagine the stories of those residents who were older and/or who did not have a car who would have trouble getting to stores. They realized how hard it may be for many in their neighborhood to get fresh produce, which prompted an appreciation for weeding and tending the garden. The maps served as a catalyst for storytelling and emotional connection, which in turn, motivated the youth to take ownership through action projects.

The youth became quite passionate about growing food. The youth began to see the garden as able to reflect the cultural diversity of their neighborhood—an idea that also inspired their "Remember your roots" sign (Fig. 9) as well as their choice to select music representing many cultures for the garden party they were planning. Taking pride in the cultural diversity of their community, they, in turn, wanted to add to this community story of celebrating diversity. Through the GIS work and the stories of family and pleasure, the youth viewed the garden from a more personal perspective. began to imagine how it could be a favorite and power place for the community. Such interest in play and community also formed the core of their action project to build some items as a playscape in the garden so that kids could play and interact with natural materials, and parents could have more freedom to pick produce and to visit with others.

### 5.4 Action and Leadership Through the Work with GIS Technologies

The map generated from the stories and ideas of favorite places and power places became the impetus for action projects that integrated the emotional components that support community interaction with the sustainable components of food access. This combination empowered them as fosterers of community resilience as they not only came together as a group to take action (bonding social capital) but then, in turn,

began to connect with community partners as collaborators (bridging social capital). The pervasive nature of GIS-generated maps in urban planning and communicating with the public helped the youth weave themselves into a larger story of action and collaborative leadership. Using the maps generated by other community groups with their own, they could see how stories interest to facilitate partnership.

**Planning their group's action:** The youth's story became one of wanting the garden to be a place that not only provides healthful food but also: "that is beautiful"; where "people can come to relax" and "feel welcome"; and that provides "a safe and fun place for kids and adults." This group then incorporated ideas from their favorite and power places into the atmosphere in the garden, devising the following plans for action:

- Have more places to sit and have conversations in the garden
- Build in the garden a few items that could be a playscape (a children's play area made out of natural materials).
- Spend time tending the garden—helping to grow the produce and weeding
- Make signs to encourage people to come in and feel welcome


**Fig. 9.** The community garden

Because the weather in Iowa in the spring is too cold for work in the garden, the spring group focused on plans for the seating and playscape as well as making some of the signs. Their work with the favorite and power places played a significant role in their choices. Most notably, one of their favorite places was the Iowa State Fair, and, from that favorite place, they got the idea to build a play tunnel with vines growing over it for the playscape. Several of them remembered playing in those tunnels themselves. In turn, their work with the aspects of a welcoming atmosphere and happiness prompted these messages on their signs: "Growing healthy food and happy smiles"; Growing happiness"; "Welcome, kids. Play, kids, enjoy!" The realization that many of the grocery stores in the neighborhood had ethnic connections prompted the sign "Remember your roots."

**Leadership with external partners:** In the summer, the youth worked on the GIS map the spring participants had helped generate alongside an interactive, GIS-based map about community gardens in Des Moines and the larger metro area that had been generated by the non-profit group Eat Greater Des Moines. EGDM would become one of their community partners. After working with EGDM's map, on the GIS map

of community gardens that the organization Eat Greater Des Moines has on its website. After using Eat Greater Des Moines' GIS map of local community gardens, the group began to see not only how their garden fits into the story of other gardens but also how they could add to their garden's story and assets through their projects. The summer group shared the following in their PowerPoint journal: "By using the GIS map about other community gardens, we learned that there are four community gardens in our area. Ours is special because it is one large plot that is open to everyone and is free for everyone. Ours will also have a play place for little kids, which is different, but we noticed that other gardens have educational programs for kids (like the Capitol View school garden)! We want a place where kids can PLAY, too, so adults can be able to do things in the garden like weed and get food."

The group then used these ideas and their experience with EGDM's map when they met with the Executive Director of this group a few weeks later. In this community partner meeting, the youth referenced EGDM's map and what they had learned from it; they shared their map and what this information showed about their community; and then together, the youth and EGDM planned to co-host a garden party at the youth's community garden that fulfilled the mission and interests of both groups. Thus, GIS maps became a shared language between groups as a space to share stories and interests. For the youth in particular, it also gave them a shared currency, of sorts, that emphasized how they, who also used GIS and online maps, became part of a circle of community leaders—leaders who used maps to share, or, in the youth's case, create their story of impact.

**Impact:** This project has had substantial impact in three key areas: 1) gathering this community around the Hiatt Garden, 2) raising local leaders' recognition of the youth as co-creators in healthy, sustainable city-making, 3) empowering the youth as future leaders through technology. Regarding participants increased involvement in community leadership, this group (the youth) had never been so involved with community partners. Eat Greater Des Moines had never worked with this youth or co-hosted an event with any other youth group; Viva East Bank! had been doing work in these neighborhoods to support youth but had not worked with this group as fellow leaders. A few months after the programs had ended, a representative of the Community Growers group presented on the group's leadership and partnership at the City of Des Moines's Council meeting.

The youth themselves also recognized their increased interaction with community leaders. In the quantitative data section of their final activity packets (n=12, both sessions combined), 10 participants answered that they had shared their ideas with city or community leaders once or twice, 1 answered "not yet," and one answered "all the time." These responses represent a dramatic shift: at the beginning of the sessions only 12% answered they had shared their ideas with city or community leaders once or twice and now 91% answered this way. Also, on their "Community Growers" t-shirts (n=22, both sessions combined), 8 indicated that knowing GIS and using GIS maps were part of what makes them a Community Grower.

In addition, city officials, their community partners, and the Boys & Girls Club staff noted their leadership and the importance of their action projects. One of the Senior Planners for the City of Des Moines and the Project Manager of the Viva East Bank! coalition attended the garden party and had this to say: "As a city planner for Des Moines, I have been working in the neighborhood where the garden is located for

over five years. I have seen this space change from just bare ground into a garden that has so much potential to be a learning lab for Hiatt kids and a place for the community. The best part about the garden party for me was seeing how proud the kids were to show off what they've learned and created to their families, and the idea they've had that this can and should be a place to bring people together. Getting neighbors to know and trust one another creates the foundation for healthy neighborhoods and communities. While this plot of land is one small piece of the city, it can be the starting point for so many things!"

The Executive Director of EGDM wrote about the partnership with the garden party: "I recognize the challenge it has been to help the neighbors, parents, and students know the garden is 'theirs' to enjoy. Providing the garden signage was one solution but creating space to invite people in was another. It was great to hear from parents they have always wanted to check out the garden.... It was great to see the kids taking the lead on the organizing and planning. They did a wonderful job!"

The program specialist at the Boys & Girls Club who helped facilitate both sessions of the program commented on the dramatic change she had seen in the youth over the course of the program: "It was an awesome transition to reflect upon. By the end of the summer, the kids were coming up and telling me all of these things about the garden, their project, different ideas, what they were planning on doing next. They had truly taken OWNERSHIP of this experience and were excited about the impact they could make. … I could see a difference from beginning to end with the group. Their mindset didn't just stop at this program either, I saw how overall they took their newfound role as a "LEADER" and used it throughout Club and school."

## 6 Advantages and Disadvantages of the Proposed Framework and the Use of Pervasive Technologies by the Youth

The framework for engaging youth into co-creation of their neighborhoods includes more than just the use of GIS and GIS based storytelling. It suggest to use a combination of technology-based methodologies and link them with action projects that enable to make real-world changes based on the discussions enabled with different technologies. Throughout the execution of the test study in Des Moines we concluded that GIS offered socially focused, collaborative potential to connect stakeholders within groups and with external partners to co-create collaborative action for more sustainable, resilient neighborhoods. The real value of the framework is not in suggesting to use technology for involving the youth, but rather connect the process of using technology, generating results, initiating discussions with the help of technologies, but in the linking this process with action projects. This became very obvious and visible in our project in which creating the maps and share the stories, empowered the youth in understanding the food issues in the neighborhood which lead to the idea of the community garden and its value. It interlinked the exploration, learning and storytelling with the activity that is visible in the neighborhood which consequently empowered the youth and connected the youth with the neighborhood leasers. It represents our first successful example where the link between the use of technologies and action projects successfully empowered the youth in the

neighborhood.

The potential advantages of the pervasive technologies in engaging youth into the co-creation of their neighborhoods can be summarized as follows:

a. **Novel devices and accessibility**. GIS are increasingly available on a variety of devices such as smart phones, tablets, or even on a bigger touchable screen that can be installed in a public space in a city, neighborhood or village. This widespread availability thus becomes a strength for our youth from resource-vulnerable neighborhoods because they have access to this technology. The novel technologies are moving to the cloud-based principles according to which the map becomes a web-map available in the cloud and the GIS software can be used as a service and does not need to be installed directly on the device in order for the user to be able to use its main functionalities. Increasing number of applications are designed to be used on smart phones, tablets and/or on the big screens. The ArcGIS Online software we used in our experiments with maps can already be used on any of these devices.
b. **Communication and connection**. These online maps enable novel ways of communication, sharing stories with the help of online maps and can even lead to empathy. They can be combined with pictures and can enable the youth to communicate in a novel way. They also enable them to express their environmental and neighborhood concerns and communicate with other neighborhood leaders and activists.
c. **Combining GIS with other technologies.** A possible market opportunity emerges from the possibilities to combine these technologies with other applications such as social media, facebook, snapchat, twitter, or online games. Such combinations have the potential to reach more young people online and offer the possibilities to engage them into serious discussions about the issues that may concern this young generation of citizens.

The potential disadvantages of the pervasive technologies in engaging youth into the co-creation of their neighborhoods can be summarized as follows:

a. **Addiction**. A possible disadvantage may be the increased use of the mobile devices and the applications installed on these devices. The youth can possibly become addicted and less interested in face-to-face communication or even meeting in person with friends. The increased use of mobile devices and other pervasive technologies may seem so attractive to the youth that they would tend to spend even too much time using these devices. Our aim, however, is that our socially focused and action-oriented approach to technology helps reimagine technology for users as a single-user oriented experience to one that remains community and face-to-face interaction supporting.
b. **Usability**. The usability of online applications is always a concern for those that develop GIS-based online applications. GIS applications that are difficult to use or need a substantial time invested into learning may not be well adopted by the youth. A profound understanding of the communication with online maps and their use by the young generation may increase the development of online mapping applications for the youth.
c. **Working with maps**. Working with maps has to be well prepared in

advance. In our case, the youth had difficulties using the paper map and getting oriented with the help of this map. Partially this was caused by the fact that the map did not include labels or points of interest and it was difficult for the youth to get oriented and understand spatial relationships and representations on the paper map. This was improved by the use of a digital version that included the main points of interest, buildings and also the names of the streets, parks and city districts. In this sense, the use of the digital interactive online map served better for the main spatial orientation on the map.

## 7 Conclusions

Working with youth from Des Moines was inspiring. We were teaching the youth about the novel technologies such as online GIS and online interactive maps and let them – in a game-based environment – playfully explore the capabilities of online interactive mapping. Using the maps, they began to see their garden and their community from different perspectives- their own, individual perspective (my favorite and/or power places) and the neighborhood's perspective (we, our garden, our community), a broader perspective that embeds their personal perspectives into a vision for the community. Thus, GIS and socio-technical storytelling enabled the youth to design and implement action projects to build their sense of themselves as leaders as well their community's cohesion and sustainability. The community garden became a successful example of this engagement and expressed youth leadership.

Our next work is to integrate this use of GIS with other parts of our engagement framework to see how certain combinations of technologies can strengthen each other if used in clusters. For example, we used an agent-based model [9] later in the garden project process, which dramatically strengthened the social dynamics of the GIS maps, and we will also be implementing and testing an online game which will enable the youth to explore energy and energy efficiency of residential buildings. We plan on testing these newly developed models with the youth in Des Moines and other stake-holders and decision-makers.

Using GIS technologies with youth opened new horizons in the possibilities which may not only attract youth to participate. Learning about the new technologies stimulated their engagement and brought to the process both problem-solving and a crucial sense of play within a space that encouraged them to create through exploration and, crucially, to create collaboratively. Such an approach releases the capacity of pervasive technologies to support a truly socio-technical future that integrates the social with the digital. By bringing together the narrative capabilities of data science through GIS and other pervasive IT–such as online serious games and ABM–with community engagement with youth, we aim to empower youth to connect personal experience to action and decision-making that move from the personal to neighborhood to city scales.

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