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Physical Learning through Technology: Cyberhoodies

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Physical Learning through Technology: Cyberhoodies

A Major Qualifying Project
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
In partial fulfillment of the requirements for the
Degree of Bachelor of Science

By:

_____
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Date:

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Report Submitted to: Professor Ivon Arroyo

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Abstract

The goal of this project is to create alternative educational activities in the form of outdoor games, teaching early mathematics skills in a healthier and potentially more efficient method. Utilizing technologies such as the Arduino Lilypad on clothing such as sweatshirts supplemented by OLED displays, this MQP intends to create a valid alternative to indoor education in the form of a "CyberHoodie". In the process, two studies are carried out to analyze the benefit of such learning technologies and of the games themselves on student motivation towards mathematics and on actual student learning of mathematics.

Experiential and Outdoor Education

In recent years, traditional classroom education has been the subject of much scrutiny. From the difficulty of managing restless students to the arguably poor results achieved by modern public schools, the past few decades of educational research have been a constant struggle to find better, cost-effective ways to teach our children and understand how students learn (Donovan and Bransford, 2005). The advent of the Internet Generation, defined as children born after 1982, greatly changed the way students learn; however, there has been little change in educators' teaching strategies, and a variety of opportunities of learning technologies have not yet been approached (Woolf, 2010).

The Net Generation "are native speakers of technology, fluent in the digital language of computers, video games, and the Internet" (Prensky, 2007). These children have grown up with computers, video games, cell phones, and other technologies, and are thus able to effortlessly navigate and intuitively utilize new information technology as it is released. Net Generation students can easily become bored with traditional learning methods, and, "need self-directed learning opportunities, interactive environments, multiple forms of feedback, and assignment choices that use different resources to create personally meaningful learning experiences" (Glenn 2000). These children are "oriented toward inductive discovery or making observations, formulating hypotheses, and figuring out the rules. They crave interactivity." (Oblinger & Oblinger, 2005). The Net Generation wants exciting, fast paced, challenging activities, and, thanks to their technological expertise, "they have the tools to go further in their learning than ever before – far beyond their teachers' ability and knowledge, and far beyond what even adults could have done in the past" (Prensky 2004).

While the educational progressivism movement has not made a cultural impact in much of the first world, there is much to be learned from the research and theories presented by progressives. One such example would be experiential education, a method of teaching with a focus on experiences, such as direct student-to-teacher interaction or forging knowledge tangentially through experiences such as outdoor play. Experiential education can be very beneficial to students from the Net Generation. For instance, the Next Generation Learning Challenges (NGLC), supported by the Bill & Melinda Gates Foundation, believe strongly in educators blending personalized learning technologies with hands-on and experiential learning, and have put forward millions of dollars in support of this effort. Also, as Oblinger and Oblinger suggest: "Digital resources enable experiential learning—something in tune with Net Gen preferences" (Oblinger & Oblinger, 2005).

Outdoor education is a type of experiential education that has seen its fair share of media buzz recently. Historical accounts of the practice, which has existed as an alternative to classroom teaching since the early 1900s, have been published in both New Zealand and the U.K. It has also been the subject of much research, much of which showed outdoor learning to contrast favorably with traditional classroom instruction, especially in the case of children with learning difficulties in traditional environments (Neill, 2008).

Outdoor education utilizes hands-on learning and a cognitive constructivist learning environment, with active inquiry by students relating prior knowledge to the problem at hand. This method of teaching and learning was favored by John Dewey, perhaps the most famous educational theorist of the 20th century, in his writings on education. Dewey believed strongly in experiential education, and spoke often of the importance of the utilization of interactive and collective experiences in effective education (Dewey, 1938).

Tactile, hands on learning, especially with math problems, also allows the student to see the concrete example of how a problem can be solved instead of being given an abstract formula (Alibali and Nathan, 2012). For example, children trying to find the perimeter of a section of a park may first measure each side, giving them a thorough knowledge of what a perimeter is, and from there can begin to use the more abstract formula to determine the result. Understanding how and why something "works" is instrumental in long term retention. Jean Piaget, in his Theory of Intellectual Development, places the concrete operational stage before the formal operational stage (the development of abstract reasoning), and states that the concrete stage could not be skipped if the child was to have the ability to move on to the next stage (Ginsburg and Opper, 1987) .

I believe there are many educational benefits associated with the use of a game involving CyberHoodies technology. These include: a) having students learn outside the classroom in a form of outdoor education, b) letting learning take place with a tactile or kinesthetic style where the student uses hands on movement and gesturing to solve problems (Alibali and Nathan, 2012), c) utilizing technology in teaching, d) having students work together in a cooperative, collaborative environment, and e) integrating games into an educational environment.

While the educational progressivism movement has not made a cultural impact in much of the first world, there is much to be learned from the research and theories presented by progressives. One such example would be experiential education; a method of teaching with a focus on experiences, such as direct student-to-teacher interaction or forging knowledge tangentially through experiences such as outdoor play. Experiential education is very beneficial to students from the Net Generation. The Next Generation Learning Challenges (NGLC), supported by the Bill & Melinda Gates Foundation, believe strongly in educators blending

personalized learning technologies with hands-on and experiential learning. Also, Oblinger and Oblinger found, "Digital resources enable experiential learning—something in tune with Net Gen preferences."

Outdoor education, also called Learning Outside the Classroom (LOtC), a type of experiential education, has seen its fair share of media buzz recently. Historical accounts of the practice, which has existed as an alternative to classroom teaching since the early 1900s, have been published in both New Zealand and the U.K. It has also been the subject of much research, almost all of which showed outdoor learning to contrast favorably with traditional classroom instruction, especially in the case of children with learning difficulties in traditional environments.

In his 2007 book, *Schoolyard-enhanced Learning: Using the Outdoors as an Instructional Tool,* Howard Broda (2007) said, "Outdoor education includes everything from camping to environmental problem solving to writing a poem under a tree on the playground! Outdoor learning is not a technical term but a concept – the idea of using the outdoors as a tool for learning." Broda continued, "Confining learning exclusively to the four walls of a classroom just doesn't make sense. Increased academic achievement and heightened enthusiasm for learning, coupled with decreased discipline problems, all have been associated with learning that happens beyond the school walls. The concepts of learning style and multiple intelligences are also very compatible with outdoor learning activities. Frankly, outdoor learning would be a logical to our instructional repertoire simply because it adds interest and variety to our teaching – a change of pace and place."

A 2008 U.K Office for Standards in Education, Children's Services and Skills study found that "…when planned and implemented well, Learning Outside the Classroom contributed significantly to raising standards and improving pupils' personal, social an emotional development… (Oliver, 2008)" The study further noted, "…The first-hand experiences of learning outside the classroom can help to make subjects more vivid and interesting for pupils and enhance their understanding. It can also contribute significantly to pupils' personal, social and emotional development…" and "…learning outside the classroom can also help to combat under-achievement." They found significant benefits to the Every Child Matters outcomes, as well, "In each of the schools and colleges visited in this survey, learning outside the classroom improved young people's development in all five of the Every Child Matters outcomes, especially in two areas: enjoying and achieving, and achieving economic well-being." Finally, the responses from the students were overwhelmingly positive. Learners of all ages involved in the survey said that they enjoyed working away from the classroom. They found it 'exciting', 'practical', 'motivating', 'refreshing' and 'fun'. They made such comments as: 'You see rather than listen'; 'We learn in a fun way'; 'We like learning by doing' (Oliver, 2008.)

Outdoor education utilizes hands on learning and a cognitive constructivist learning environment with active inquiry by students relating prior knowledge to the problem at hand. This method of teaching and learning was favored by John Dewey, perhaps the most famous educational theorist of the 20th century. In his writings on education. Dewey believed strongly in experiential education, and spoke often of the importance of the utilization of interactive and collective experiences in effective education (Dewey, 1938.)

Tactile, kinesthetic, or hands on learning, especially with math problems, also allows the student to see the concrete example of how a problem can be solved instead of being given an

abstract formula. For example, children trying to find the perimeter of a section of a park may first measure each side, giving them a thorough knowledge of what a perimeter is, and from there can begin to use the more abstract formula to determine the result. Understanding how and why something "works" is instrumental in long term retention. Jean Piaget, in his Theory of Intellectual Development, places the concrete operational stage before the formal operational stage (the development of abstract reasoning), and states that the concrete stage could not be skipped if the child was to have the ability to move on to the next stage (Dewey, 1938.) The potential benefits of learning outside the classroom are clear, and utilizing the CyberHoodie as a teaching tool is an easy, feasible and effective way to allow teachers to get their students learning outside the classroom.

CyberHoodie use can also employ a cooperative, collaborative learning style, as students compete in teams to solve the assigned problems. Collaborative learning offers both academic and social benefits to the students. In a 1984 study, R.E. Slavin (1984) found cooperative learning produces "greater student achievement than traditional learning methodologies. Slavin found that 63% of the cooperative learning groups analyzed had an increase in achievement." Working in heterogeneous groups also forces the children to learn to understand and accept diversity in other students in order to accomplish their assigned task, as they work with children from different cultures, with different learning skills, and personalities. The development of social skills is also a huge benefit to cooperative learning, as students learn to accept opinions other than their own, are forced to take risks, and receive and give praise for their contributions.

The technological aspect incumbent in the CyberHoodie program is particularly attractive to today's Net Generation. The use of technology in teaching allows instructors to reach students of all learning styles and cultures, it attracts students with their technological shrewdness and

understanding, and it helps prepare students for a future when technology will play an even bigger role than it does today. Ellen R. Bialo and Jay Sivin-Kachala, (1996) in their study for the American Association of School Librarians, reports that technology can lead to improvement in performance most notably in math, science, social studies, and language arts. When using technology in the classroom, "at risk" students demonstrated improved attitude, confidence, writing skills when using technology in the classroom.

The benefits of the use of technology in education are clear; technology can help all students, including ESL students and students with disabilities, master basic skills. Technology gives teachers immediate assessment feedback, providing easy and organized student progress information. Perhaps most importantly, technology makes students appreciate learning and can aid in their self-confidence and self-esteem given appropriate features such as pedagogical agents that are affective and motivational (Arroyo et al, 2013).

Finally, the game aspect of the CyberHoodie program also has potentially significant educational benefits for students. In a 2002 study, Salies found the use of games as a classroom tool increased memory, class performance, social benefits, and improved the transfer of learning (Sailes, 2002.) Games have also been shown to improve academic performance in students. An analysis of students in fourteen K-12 school districts by Haystead and Marzano (2009) found the use of academic games led to an increase of 20% in student achievement scores.

The games students will play with the CyberHoodie are a form of stealth learning, where teachers will be able to introduce new topics and review and practice learned material is a fun and interesting way without the students realizing they are learning. Prensky stated games were engaging and provided structure, motivation, enjoyment, gratification, pleasure, intensity,

learning, creativity, and social opportunities (Prensky, 2007.) Children play and enjoy games naturally; incorporating them through the CyberHoodie into a curriculum will pay huge dividends.

It is our contention that the use of Cyber Hoodies in education will foster both experiential and outdoor education in a hands-on cognitive constructivist learning environment which will be an effective teaching and learning tool for the current Net Generation of students. Our goal is to create an educational setting where the student will learn through discovery instead of instruction, where the lesson will shift from teacher to student based, and where the student will go from merely memorizing to synthesizing the material. We want the entire range of students, from special education to gifted, to be able to not just understand, but evaluate and analze the material being taught. We feel that by utilizing technology and games in a learning outside the classroom environment with cooperative learning and kinesthetic, hands on activities, the CyberHoodie will meet our goals and become an effective, enjoyable, alternative to traditional teaching and learning.

Background Research in Games for Learning

Some research has been carried out in relation of using Lilypad/Arduino technology for learning. In one particular paper, Zualkernan (2010) discusses the viability of a wearable 'tag' game as a potential solution to a number of child health and education concerns. First is the fact that children's activity levels in many developed countries are at an all-time low, which causes a number of issues with mental and physical development. Second, the internet has acted as a replacement for much social interaction and face-to-face education, which in turn causes today's youth to stay indoors more often.

A proposed solution is offered in the form of technological education – that is, a wearable game which will hopefully appeal to kids' desire for new tech while still being an educational tool which forces physical interaction.

After establishing the myriad issues plaguing youths today, many of them stemming from decreased physical play, Zualkernan discusses previous implementations of similar technology. Targeted at groups ranging from early youth to the elderly, many have had successful test runs but none have been implemented in formal educational settings. The proposed project attempts to take the lessons learned from these previous attempts, and takes hints from the more successful implementations.

He then recalls some basic tenants of game theory in order to provide background for his experimentation. He establishes the three basic levels of rules – Operational, Constitutive, and Implicit – and discusses the many types of games. By providing background and theory behind games from flight simulators to "Who Wants to be A Millionaire", he shows some of the ways in which gaming experiences can inspire learning.

After discussing the game itself – a basic implementation of tag utilizing true or false questions pertinent to a student's topic of interest -- the researchers discuss their proposed implementation. Similarly to our CyberHoodie project, Zualkernan's wearable tag game consists of a LilyPad Arduino setup sewn onto a shirt. Unlike our current implementation, however, he used a number of LED arrows to make the quiz questions more visually stimulating and obvious to the students. His questions were also hand-typed on paper and inserted into the shirt, as opposed to having information on a digital display. This was likely a necessary compromise due to budgetary and time constraints, as fairly massive screens would be required to display the questions in a satisfactory manner, not to mention the added weight of such accessories.

Finally, learning design is discussed, discussing the varied types of motivation by dividing them into *internal motivation* – challenges to the self, stemming from the participant's creativity and curiosity – and *external motivation*, which consists of competitive and cooperative challenges. After establishing the challenge criteria by listing desired motivations for the students (goals, uncertain outcomes, performance feedback, and self-esteem), the idea of allowing students to establish their own goals is presented.

Zualkernan discusses his progress with the project at the time, and discusses a group tag game played in much of south-east Asia. This provides more incentive for a reader to believe the project to be viable in the sense that children will enjoy it, as a streamlined variant involving no technology already exists.

Goals

The long term vision was to create a fully functional "Cyber Hoodie." This hoodie is to be powered by the Arduino Lilypad, a single-board microcontroller designed for textiles, and must be capable of the following:

-Sending and receiving data to and from a local sever using the http protocol

-Displaying information (player score, questions, etc) on an LCD/OLED.

-Functioning while the hoodies are being worn and students are running around in them. Components must not dislodge during normal use.

With said functionality in place, the proposed CyberHoodie will act as a universal yet simplistic gaming engine, capable of multiple types of gameplay. For example, here is a rough workflow of what a hide-and-seek style game may look like using the CyberHoodie platform.

1: Server is set to 'hide and seek' mode.

2: Players turn on their CyberHoodie devices

3: WiFly device, connected to the LilyPad, receives clue data and its associated hiding spot. Assigns a random student to be the "seeker", displays this information on their OLED, and assigns other students to hide.

4: The LilyPad of the hiding student is given a location to quietly travel to, countdown begins on the "seekers'" devices.

5: After the countdown ends, the hiding spot specific clue is displayed, and seeker(s) begin looking for the hiding students, following mathematical clues on

their LCDs. For example, the hoodie may prompt a student to hide behind a

rectangle, giving the student the dimensions of said object.

This is a very flexible system, designed to be easy to modify and expand upon. A

"scavenger hunt" game could easily be implemented as a modification of the hide and seek

game, by replacing the 'hider' with a stationary object, perhaps with an RFID reader[1] that is

placed on the locations to search. When the 'seekers' scan their hoodie's RFID chips with a

simple swipe of the arm, this reader could confirm that the object has been found, triggering the

server to give the students the next objective. Even more complex, a 'tag' game could be

implemented with the addition of location services and Near-Field Communication technologies

– the OLED would be used to keep score and map the location of the student who is 'it', the

location services would teachers if a student is out-of-bounds, the server would keep track of

which student is 'it' and where they're located, etc. All of this could be achieved without

removing existing functionality or adding bloat to the software – the CyberHoodie technology is

built to be expanded upon.

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[1] http://www.parallax.com/product/28140

Methodology for Design/Development of Hoodies

The project is currently utilizing the Apache Tomcat web service engine and the IntelliJ Java Programming Environment in order to create a Java servlet that responds to http calls. Said servlet will receive calls from the CyberHoodies, and respond based on the current "game mode". Figure 1 shows how I have designed hoodies to make http requests of questions and clues, and how the Java Servlet interacts with a MySQL database to store information about students, and their status in the game. While this design has reached the development stage, it was not used in the studies reported with actual students. However, this was a large part of my own contribution to this project.
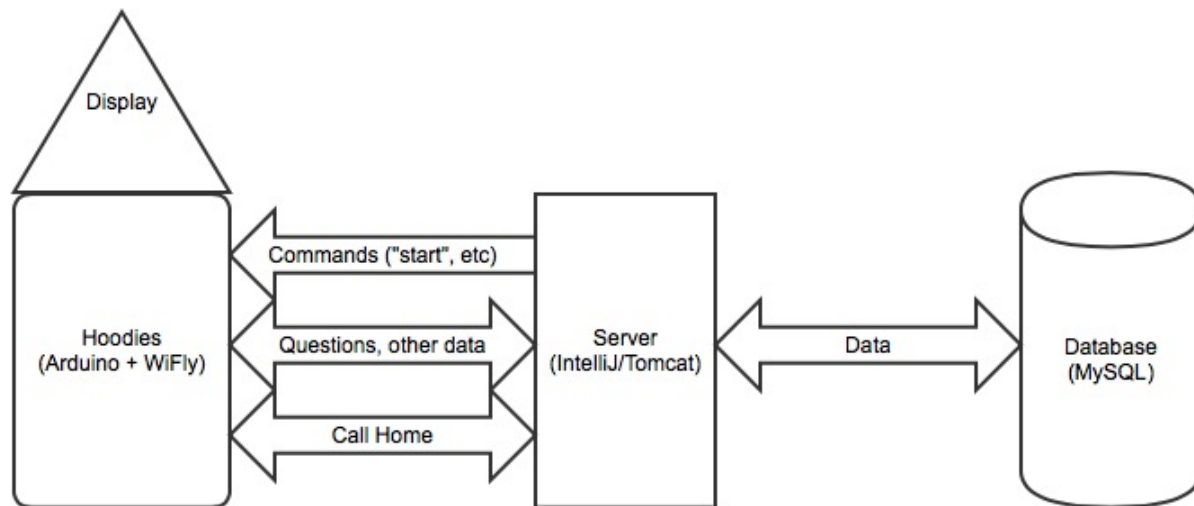

Figure 1. Architecture of the CyberHoodies.

Game Modes

The games we have researched consist of:

    "CyberHoodie Hide and Seek". One or more players will be selected to hide, and one or more players will be selected to seek. Once the students are randomly assigned as hiders and seekers, the hiding players will be given instruction on where to go. Seeking players, after a short countdown to allow hiding players to find their hiding spots, will be given geometrical or mathematical clues. All information can be sent via the java servlet.

    "Cyberhoodie Scavenger Hunt." When the game is set to this mode in the database, players are marked as 'seekers' by the servlet, and are immediately given geometrical or mathematical clues on where to find certain objects (hidden in the area by a teacher, marked with RFID chips.). Clues can also accumulate, creating hints to find a final item – this encourages students to work together.

Usability Study

The first study that was carried out as part of this project was a usability study, in which two games were deployed with three elementary school students in a Worcester playground: a mathematics scavenger hunt and hide and seek. As the hoodies weren't ready yet, we made analog versions of the math games using index cards and stickers, with the final purpose of understanding the nature of the games themselves, how students would respond to them, and other issues we might have not originally envisioned. This would allow to understand their feasibility, and what the place for technology would be.

Method. We evaluated two possible games, a game of scavenger hunt and another one of hide and seek. For scavenger hunt, clues were kept on notecards, and sheets of stickers represented objectives. For hide and seek, hiders and seekers were given identical hints on where to hide. Hiders would hide following mathematical clues such as "hide behind a cylinder of 5 feet high", and the seeker would follow the same clue to find this hiding person. Once the seeker found a hider, they would both run back to home base – the first person there would get a point. Points would also be given to the hider for finding the right child (did their clues match or not?). Students were given a survey at the end of each game and participated in general qualitative interviews (See Table 1.)

Results. Results to the survey of this exploratory study are in Table 1, and showed that students disliked some aspects of outdoor education, such as running being too tiring or outdoors being too cold. For the most part, however, Table 1 shows that they enjoyed the experience in general – the students who took the survey answered an average of 4/5 when questioned on whether they'd like to learn math while moving and running around. One potential issue is that

the students did not seem to think they were learning, according to their answers to the surveys and informal interviews. Although they were all using mathematical skills, some even solving problems without calculators or paper, the students only gave the scavenger hunt a 3/5 on a survey question asking "Do you think you learned math by playing this game?" The results were even worse when discussing the Hide and Seek game, with an average of 1.66/5. See Table 1 for more info.

Discussion. The usability study established that students are willing to do math outdoors, although they didn't feel like they learned from the activity. There were also some issues with the clue stickers; students could match up the numbers from the stickers to their clue cards, defeating the purpose of the entire scavenger hunt, and allowing the students to complete the study without doing any actual math. The participants also had too much to carry, as the clue books are fairly large, and the measurement tools are bulky. Finally, the participants occasionally took too many stickers, which impacted the game negatively for others; with no stickers present, it is impossible to solve a clue. These issues created the need for a technology-enhanced pilot study, where presenting and solving clues could be entirely digitized.

Technology-Enhanced Pilot Study

The technology-enhanced pilot study, which took place at a Western Massachusetts middle school, was the first real-world use of the CyberHoodies. The hoodies did not have any WiFi, Bluetooth, or RFID capability, and functioned as a handsfree way to read clues and hints (See Fig 1.3.) As such we still needed physical clues, so easter eggs took the place of the stickers from the previous study.

Method. Two groups of two students were given hoodies and measurement tools in an indoor gym, and played the Scavenger Hunt game with clues generated to match objects in the gym. Participants only had fifteen minutes to complete the Scavenger Hunt, and each group had a different set of hints and clues. Due to time constraints and survey results, the Hide & Seek game was not deployed, but only the scavengers hunt game. The main difference between this study and the previous one was the addition of the CyberHoodies, which the students read hints and clues from.

Results. Students seemed to be more motivated than in the previous study, and much more excited about the trial. The mere addition of technology seemed to hold the participants' attention. Unfortunately, the issues with physical clues returned, as one group took an easter egg associated with the other group's clues. This made it impossible for the other group to complete said clue. Regardless of this, the study was still a success, with participants doing an impressive amount of math. Table 2 shows that surveyed students enjoyed the game more than the previous study (mean = 4.75), and felt as if they used their math skills more (mean = 4.75) They did not feel as if they learned math (mean = 3.5), but all students surveyed would play the game again (mean = 5) (See Table 2.)

Discussion. The biggest obstacle in the technology-enhanced trial was time. The students were very excited to use the cyberhoodies, used their math skills quite a bit, and were all willing to do the experiment again. While we had some more issues with physical objects associated with clues, these will be managed once RFID technology is added to the hoodies.

Next Steps

Both the usability and pilot studies ran into similar issues with physical scavenger hunt objects. As RFID and WiFly were never implemented, we never determined if they were acceptable solutions to these issues.

RFID Solutions. RFID (Radio-Frequency Identification) is a technology that uses electromagnetic fields to transfer data. RFID tags are very small, but they can store a reasonable amount of information; this is perfect for our scavenger hunt objects. Unfortunately, although the tags themselves are small, RFID readers can be quite bulky. We purchased a few RFID readers early on, but they could not be incorporated into the CyberHoodies, as they were not compatible with the LilyPad Arduino. RFID readers are also fairly expensive. This led to us researching other solutions for a digital scavenger hunt.

Alternative RFID Solutions – Skylanders. In 2011, Activision launched the Skylander's franchise, a video game featuring RFID 'portals'. These 'portals' read data from Skylanders-branded figurines, determine which character is featured from the figurine's RFID tag, read their score, gold, and, level from a save file, and cause the character featured on the figurine to appear in-game.

As of April 2014, it costs approximately $40 to buy a small RFID reader from a local DIY supply store. These RFID readers require USB power to function and require a wire to transmit data. Wired Skylanders portals can be obtained for less than seven dollars online, and wireless ones can be had for less than twenty. The wireless Skylanders portals use Bluetooth technology, which means we would be able to connect them to a unified server, and give one to

each participating student. They could even possibly be connected to the hoodies, although they would not be able to transmit data directly. The wireless portals can read normal RFID tags in addition to skylanders-branded figurines, so this seems like the cheapest method of adding RFID functionality to the CyberHoodie.

There have already been multiple projects that use the RFID technology in Skylanders portals. One project that could be useful to the next group is SkyReader, by author SiliconTrip. SkyReader allows a host computer to connect to a Skylanders portal, and read the data from whatever figurine is present on the portal (silicontrip, 2013). With a few small changes to the software, SkyReader could be used to associate certain clues with certain figurines. The kid-friendly and intuitive appearance of the Skylanders hardware would make the Cyberhoodie a more familiar experience for students.

Wireless Communication (Wi-Fly/Bluetooth). While we never figured out how to make the Wi-Fly attachment work with the Lilypad, there are other solutions available that would allow the Lilypad to communicate with a server. The Bluetooth Mate Gold (WRL-12580) and Bluetooth Mate Silver (WRL-12576) are both documented as being compatible with the Lilypad Arduino, and, as such, would be perfect for this purpose (RS, 2013). The blog "Carmen Arduino", avaialable at http://carmenarduino.blogspot.com/2013/06/connecting-bluetooth-mate-to-lilypad.html, features instructions on how to attach these accessories to the Arduino.

Final Thoughts

The Cyberhoodies project expanded my knowledge of alternative education, and writing code for the Lilipad Arduino gave me some wonderful real-world programming experience. As much as I learned from the experience, I feel as if students could learn much more from Cyberhoodie technology. During the pilot study, participants didn't need more than thirty seconds of explanation before they understood how to use the Cyberhoodies; the technology was intuitive to them, as they had likely grown up using devices with similar interfaces. There are many potential benefits to technologically-assisted learning in schools, but familiarity is the most pressing.

Unfortunately, not all of our learning theories could be tested in a satisfactory manner. While we did encourage collaborative learning by having participants work together, many of them seemed to have unequal roles. In the pilot study, for example, we noticed that in both groups, one student did most of the math, as the other kept track of the clues and hints. We also cannot state if our research on tactile & outdoor learning environments bodes true, as we never got far enough with the study to have statistics to compare. In order to effectively test our theories on outdoor and collaborative learning, we would need to have controlled trials with far more participants. Unfortunately, such a thing was not possible while still developing the hoodies.

I do not feel as if we accomplished everything we set out for with the Cyberhoodie project, but we did create an excellent platform to build from. The Arduino Lilypad has proven itself to be a capable device for this project, and with the addition of a WiFi or Bluetooth attachment, its capabilities for game modes and statistics tracking will be endless. It is very

upsetting that we could not get far enough to properly test the educational theories that led to the creation of the CyberHoodie. It is also very exciting to have assisted in creating a device with such potential. I believe that, with further development, the CyberHoodie could help revolutionize the way students learn.

Tables

Table 1. Results of Usability Study

	Scavengers Hunt	Hide and Seek
How much did you enjoy this game?	4 (1)	4 (1)
Did you use your math by playing this game?	3.33 (.58)	4 (1)
Do you think you learned math by playing this game?	3 (1.73)	2.67 (1.15)
Would you play it again?	3.67 (1.53)	4 (1)
How Challenging was this game?	3 (.82)	1.67 (1.15)
How much do you like learning math sitting in the classroom?	2.33 (.94)	2.33 (1.15)
Would you like to learn math by moving and running like this?	3(1.73)	4 (1)

Table 2. Results of Cyberhoodies Scavengers Hunt Pilot Study

	Scavengers Hunt
How much did you enjoy this game?	4.75 (0.47)
Did you use your math by playing this game?	4.75 (0.47)
Do you think you learned math by playing this game?	3.5 (0.48)
Would you play it again?	5 (1.53)
How Challenging was this game?	3.5 (0.25)

Figures

Figure 1.1 – Early hoodie design

Figure 1.2: Early hoodie design, display attached.

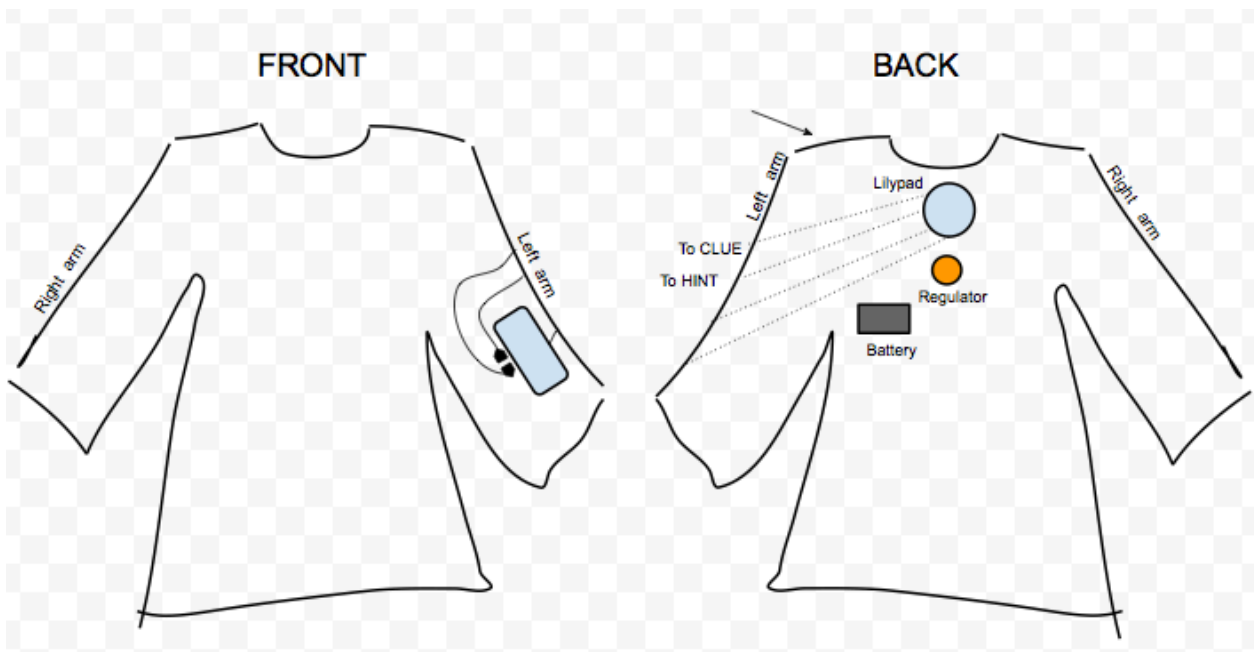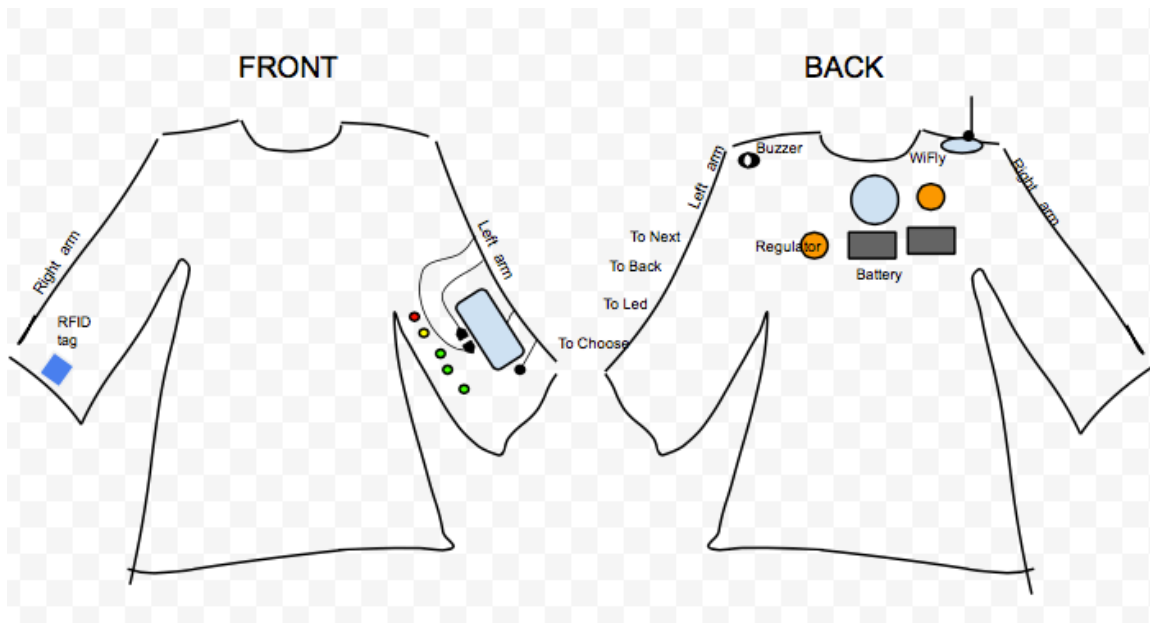Figure 1.3: Hoodie schematic, as used in technology-enhanced trial

Fig 1.4: Hardware vision of hoodies

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