Con-science: parents and children exploring robotics and values

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Abstract

"Con-science" is a research program that explores how robotics can be integrated into a holistic learning experience that encourages critical inquiry about programming, mechanics and engineering as well as identity and moral issues. In this paper we present a first pilot experience conducted in a Jewish community school in Buenos Aires, Argentina, with parents and children during the Jewish High Holidays. We describe the goals of the project as well as the Lego-Logo technology and the constructionist methodology used. We also present the learning process that took place during the workshop and the final robotic projects that were produced and shared with the community as creative prayers. "Con-science" is an attempt to engage a community in building and programming artifacts to explore values and identity as a constructive and active process.

Keywords: learning, technology, constructionism, values, identity, Logo programming, Mindstorm, community work

1. Introduction

When children are young they ask all sorts of questions: "why is the sky blue?", "where does God live?," "how do cars work?," "why do people fight?." The curiosity of the child does not make a distinction between disciplines. Children are little scientists, little theologians, little engineers and little humanists at the same time. However, the curriculum does make the distinction. In traditional religious schools, morality is presented as a stand-alone subject with no connection to applied sciences. In secular schools, the focus of moral education may vary according to its emphasis on civic, cultural, moral or personal values (Bers, 1998), but it also lacks integration with scientific or technological areas.

This paper is not about religious or moral education *per se*; nor is it about robotics and programming. This research presents a design-based approach to integrate these realms of learning. It also presents an experience in which people's interest in values supports their learning about technology and vice-versa. We believe that a holistic learning experience should respect and leverage children's curiosity as well as include the possibility to pursue both the existential and the scientific questions. Growing as an integral person means having learning environments and tools to explore the whole dimension of human experience. New technologies have the potential to bridge the gap between disciplines by engaging people in design projects.

Within the philosophy of constructionism there is an extensive body of research which explore the design of learning environments and technological tools to help children become better learners (Papert, 1980). But the content that traditionally has been used in these research experiences comes from disciplines such as math and sciences. For example, the Beyond Black Boxes project (Resnick et al, 1997) aims at developing computational tools and projects that allow children to create their own scientific instruments and become engaged in scientific inquiry not only through observing and measuring but also through designing and building. In the same spirit, the "Con-science" project is an attempt to engage children in building and programming artifacts that reflect their sense of identity and the values they live by. The underlying motivation is to investigate how new technologies can be devoted to re-create traditions and to explore identity and values as a construction and as an active process and not as a passive fact within a tradition.

In this paper we describe a first pilot experience conducted in a Jewish community school in Buenos Aires, Argentina, during the Jewish High Holidays. We describe the goals of the project, the technology and methodology used, the learning process that took place during the workshop, the final projects that were produced and shared with the community as creative prayers and the future directions that we are hoping to follow within the Con-science research program.

2. The pilot experience

The first pilot project of the Con-science research program took place in the Arlene Fern Jewish Community School in Buenos Aires, Argentina. We ran a two weeks workshop during September 1998 with fourth and fifth graders and their parents, as well as some teachers. The timing of the workshop was carefully selected to overlap with the Jewish High-Holidays, a period of ten days in which the community gathers to celebrate the Jewish New Year and the Day of Atonement. In this context, children's curriculum focuses especially on the values of these festivities, the most holy in the Jewish calendar. To run a workshop during these holidays was very meaningful because of the spiritual work of reflection and forgiveness that takes place. The workshop was a first step towards forming a group of parents, children and teachers who would carry on the project by integrating its approach to values and technology inside the curriculum and extending it to other members of the educational community.

3. The site

The Arlene Fern Community School in Buenos Aires, Argentina has certain characteristics that made it a unique pilot site for starting our research program. Perhaps the most salient is that it is a value-centered learning environment which emphasizes the importance of "being" and not only of "knowing". The school's mission is to educate the family and the community. The school is based on a liberal Jewish worldview; however its approach to universal values and its search for meaning and spiritual growth, while rejecting dogmas and certainties, applies to broader religious and cultural traditions.

During the High-Holidays the school organizes activities for the whole family. For example, they engage in creative prayers by writing, dramatizing or drawing their own prayers about meaningful contemporary themes. Usually there is an open house in which

the creative prayers are shared with the community. This provided an excellent opportunity to present the process and products of the Con-science workshop to the community.

4. The methods and tools

Constructionism is the underlying philosophy, which motivates the Con-science research project. It asserts that learners are likely to construct new ideas when they are building artifacts that they can reflect upon and share with others in their learning community (Papert, 1980). Constructionism is not only a theory of learning but also a theory of education. Therefore it takes an interventionist perspective and concerns itself with the design of materials and construction toolkits that would support children to make epistemological and personal connections (Resnick et al, 1996)

One of these construction toolkits is the programmable brick (Martin, 1999). This technology is composed of a small computer that can interact with the physical world through sensors and motors. People can design all sorts of artifacts that interact with the world through sensors and motors. People can engage in building the mechanical structures as well as in programming their behaviors using the Logo programming language. During the Con-science workshop we utilized the Lego Mindstorms technology, the commercial generation of the programmable brick.

We worked with a project-based immersing methodology. By project-based learning we mean that learners were asked to choose a project that they would like to work on for the whole duration of the workshop. They would be involved in all aspects of the project: choosing the values to explore, resolving the technological challenges, creating a narrative around the project and presenting it to the other members of the community through creative prayers. By immersing learning we refer to the notion that learners would immerse themselves in the learning process by having a lot of time to play and explore their ideas in depth. For example, in this particular workshop, we worked with parents and children during five days, eight hours a day.

Different projects are carried on with the constructionist philosophy and the immersing project-base methodology (Cavallo, 1999). The uniqueness of the Con-science workshop is the challenge of utilizing this methodology and technological tools in the context of value-centered education.

5. The process

The workshop had 18 participants, half of them adults and the other half children. Children were granted special permission from the school to participate in the workshop. Parents made a big effort to attend the workshop by taking time off from work. Day by day we kept a web-based journal documenting the experience. All participants were invited to contribute to the journal. In order to convey the spirit of the workshop, this section is composed of short excerpts from the journal (http://el.www.media.mit.edu/projects/con-science/).

5.1 Day 1: Becoming familiar with the technology

Participants gathered to start the activities. Each one introduced him or her-self. We explained the workshop's goals and talked about previous experiences with this technology.

The first activity of the day was designed to help people become familiar with the Mindstorms brick, the sensors and motors and the programming language. For example, they were asked to start a motor or initiate a routine when a touch sensor was pressed. Most of the groups built vehicles that could move and respond to a sensor's stimulus. Only one of the groups used the gears to build a pulley for an elevator, and not a car.

In the afternoon the task was to build kinetic sculptures using not only Legos, but also art materials. The goal of the activity was to push their thinking in a different direction, other than building cars and trucks. It took some time, but people came up with merry-go-rounds, flowers that open up to the light, dancing dolls, cargo transporters and sweeping robots.
By the end of the day, the groups presented their projects. Some of the children appreciated the fact that there were other materials than Lego and others complained about the difficulties of plugging motors and sensors in the right places. Marcia, a nine year old girl, emphasized the fact that she was able to spend a long time without her father getting upset at her. With a big smile she said, "Parents are great when they do not get upset" and geared the conversation from technological issues to social ones.

5.2 Day 2: Starting the projects

In the morning every group presented the details of their programming. The goal was to level up all the groups while sharing with each other problems and programming tips. Since some of the youngest kids were very confused we decided to organize a theatrical improvisation to help them understand the different programming blocks and the control flow. Some kids pretended to be commands that turn motors on and off, others as sensor watchers that trigger an action and others as control structures such as "repeat forever".

After this exercise, we showed them a project that we built integrating technology with values. "The scale" is a concrete example of transforming an abstract value, such as the "balance between the good and bad actions of the previous year", into a concrete artifact that reacts to people's interaction. The scale had two buckets on each side, one for good actions and another for bad actions. Volunteers were asked to write on a piece of paper an action from that year. They hid the paper in a little wooden cube and put it in the corresponding side of the scale. Light sensors were used to detect when new actions were placed in any of the two buckets. A program detected the event and kept count of the number of actions in each side. After a participant finished putting his or her actions in the corresponding buckets, a touch sensor had to be pressed. This started a sound that qualified the balance of the year, either positive or negative. Finally, a motor-driven contraption opened a small box that offered a poetic message for reflection.

This example was a concrete introduction to our goal of integrating technology and values. Rabbi Bergman led an activity to explore the values of the Jewish High Holidays. During a long discussion, people suggested a list of relevant values such as forgiveness, friendship, celebration, memory, balance and judging. We made cards with each of the proposed values. When the groups started to select the materials to use in their projects (i.e., sensors, motors, card-board) they also chose one or more of the cards with the values that they would like to explore.

At the end of the day each group gave a progress report and expressed the goal they wanted to accomplish by the end of the week. Most of the parents found it very easy to integrate the

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chosen values into their technical design. Some of the kids complained that the activity was not as fun because they had to think hard before adding new pieces. "Yesterday every piece I found I could fit into my project. Now it is more serious, and I can't put any piece anywhere. I have to think about the overall meaning of the project", said Marco, a ten year old boy who was very excited by the engineering aspects of the activity.

5.3 Day 3: Working hard

The groups exchanged ideas and suggestions regarding their projects. Juan and Enrique, two engineer fathers, helped other groups to improve their projects by building stronger structures. The more advanced groups started to prepare for the next day open house for the school children, teachers and staff. For example, Miguel, an architect father of a nine year old boy, drew a complex model of the star of David that his son was building with Legos while Ema, a special education teacher, made a big poster with the control flow of her group's project. Rabbi Bergman brought the shofar, sheep horn blown during the High Holidays, so kids could compare its sound to the melody they were programming in the computer.

5.4 Day 4: The school open house

The school open house had two goals. First, to show to the rest of the school what the "Con-science" workshop was about. Second, to be a rehearsal for the Friday's creative prayer, in which project's demonstrations were going to be given to the community.

During the school open house most of the parents decided to pass to their kids the task of showing their projects to their peers. Juan, the father of a nine years old, was surprise to observe his daughter explain in full detail the programming aspects of their project. The open house lasted two hours during which the young visitors were asking lots of questions.

The workshop participants were very proud to show their projects to their classmates and assumed a pedagogic role while explaining how sensors, motors and Mindstorm bricks worked. Children who seemed very dependent on their parents during the workshop, were completely on their own during the open house and parents that were very involved during the workshop relaxed during the open house, and let their children take the lead.

5.5 Day 5: Evaluating and preparing for the creative prayer

During the last day of the workshop we had two tasks in front of us: to evaluate the experience with parents and children and to prepare for the creative prayer open house on Friday. The creative prayer was going to happen in the synagogue before the religious service. The solemnity of the space and the sacredness of the day, the most important Sabbath of the year, made it a very big event.

As a way to evaluate the experience we decided to write a collective prayer to thank for all the new things we learned and experimented with during the workshop. One by one every participant went to the blackboard and wrote his or her contribution. Later we transcribed it into a big poster to hang in the temple and we made photocopies to hand out to the visitors with their prayer books. The collective prayer was as follows: "We, the participants of the Lego-Logo workshop give thanks because: we had the possibility to experiment, to work

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and to share new materials with classmates, people who we didn't know before and our parents. We were creative and we could build projects that express what we believe, feel and live by. We played with materials that opened up many new possibilities. We shared in community and we were able to create while playing."

Besides the collective prayer, every group prepared a blessing or good wish card to emphasize the value worked on their projects. The idea was to hand them out to the visitors. For example, the group who chose the value "give and receive" wrote: "We wish that in this New Year you have many opportunities to give good moments and receive lots of love." Many groups accompanied the text with drawings made in the computer.

5.6 Day 6: The creative prayer open house

The open house for the community was held in the synagogue as a creative prayer. We installed the computers, the projects and the posters in one of the corners in the synagogue. An hour before the religious service we invited the community members to walk around, ask questions, play with the projects and talk with the presenters. The blessings or good wish cards were very successful and were distributed non-stop. A group of parents that started to work with Logo MicroWorlds a year before also showed their projects. Even though the number of visitors kept growing, the open house ended with Rabbi Bergman inviting everyone to sit down to continue with the traditional religious service.

6. The projects

In this section we describe some of the projects built by parents and children. We group the projects into three different categories according to the way in which the technology was used to explore values: 1) technology to **represent symbols**, 2) technology to **represent values** and 3) technology to **evoke reflection and conversation**. The first category, technology to re-create symbols treats values in a shallow way. People created artifacts that resembled the Jewish symbols without deeper exploration of the nature of the values represented by these symbols. At the opposite side of the spectrum, the third category, technology to evoke reflection and conversation, treats values in a more elaborated way. People created projects to engage participants in experiencing the complexity of values. This intense experience evoked thoughtful discussion. In the same spirit as other constructionist activities, the Con-science program allowed people to build their own knowledge by creating external artifacts that reflect personal learning styles.

6.1 Technology to represent symbols

Every tradition has symbols that reinforce a sense of group identity. The Jewish tradition is particularly rich in these symbols which are usually associated with a festivity or a ritual. To recognize and distinguish the symbols of a tradition is one of the first steps towards building knowledge about the tradition and eventually identifying with it. Often times, symbols are used by educators as a way to give concrete shape to abstract values. However, a rich educational experience can't be limited to learning about symbols. Symbols are a gateway to deeper explorations of the values and socio-cultural practices of a tradition.

During the workshops several groups used the technology to create symbols. For example, Michael, a ten year old boy said: "We built a "Maguen David", Star of David, as a symbol

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of our Jewish people and we programmed it to turn forever like the wheel of life and have flashing lights resembling candles welcoming the New Year. We also reproduced the sound of the shofar. It has three different tones that are supposed to awake us for reflection and atonement." Michael's group chose the value "awakening" or "call for reflection." They designed their project by anchoring it to traditional symbols. The construction of the star was done in a very careful way out of Lego pieces, and flashing lights. The center of the star was connected to a platform that moved with a motor. They used a touch sensor to launch and stop their program, which had three basic jobs: turn the motor on, turn the lights on and off, and play the sound of the shofar.

A second project on this category was built by Paul and Ariel, father and nine year old son, who chose the apples and honey that symbolize the wish to start a sweet New Year. In every Jewish home, during the first dinner of the New Year, there is a plate with apples to dip in honey. When talking about his project Paul said, "we built a crane that transports apples from one place to the other in order to prepare them to celebrate Rosh Hashanah (New Year)." Paul and Ariel were very intrigued by the idea of building a complex car-like artifact. When showing their project to others they would explain the details of its mechanics and program and would very often forget to make the connection with the chosen value "sweetness". The crane car was built with the Mindstorm Brick as a remote control, connected with touch sensors. They used three touch sensors. The first sensor moved the crane, so when the sensor was pressed, the program start the motor to make it moves forward, and if pressed again, it changed the direction to make it move forward. The second and third sensors were used to control the palettes. When the crane reached the platform of apples, one of the sensors had to be pressed in order to open the palettes, then the other sensor to close the palettes and pick an apple in order to transport it to the honey plate.

The examples presented above show how certain groups used the technology to create projects that represent Jewish symbols. Although they started to connect these symbols with their meanings, they did not explore in depth the relationship between the values and the symbols.

6.2 Technology to represent values

Some people created projects that used the technology to represent values not only as a symbol, but also as the theme. For example, a group chose the value "friendship" and created a puppet theater. The theater had a curtain that opened to show the performance of two Lego dolls hugging after a fight. "This project tells the story of two girls that after a fight give each other a hug and become best friends", explains nine years old Marcia, "This project talks about the "Teshuva" that allows us to repair our mistakes. The friends did "Teshuva" and became friends again with a big hug." Marcia created a story about the girl's situation and the connection with some of the values of the high holidays, such as "Teshuva". Marcia built the dolls with Legos, attached colorful strings as hair and placed motors in the arms to swing back and forth simulating a hug.

The "friendship" project used technology as well as storytelling. Since the chosen value was the main element of this project, the group seemed to have the need to tell a story to reinforce the interpretation of the value. Telling a coherent story around the robotic creation was as important as getting the mechanics and the programming right. They used

technology to represent a value as a powerful idea that needs to be supported by both a behaving artifact and a compelling story.

6.3 Technology to evoke reflection and conversation

Some groups used the technology to design an engaging activity for others to experience their own interpretation of the chosen value. For example, one group chose the value "giving and receiving". Juan, one of the fathers in the group said: "we talked a lot about giving and we found out that giving is, at the same time, receiving. So through our project we wanted to show that when we give something we do not exactly know what we are receiving but we always receive something back." Pattie, Juan's eight years old daughter, explains: "we made a doll with two yellow hands and every time you give her a present in her hand, she turns around and gives you something back with her other hand. But you don't know what she is giving you. There are smiles, flowers and hugs in her second hand and you can receive anything." The first component of the "giving and receiving" project was the head of the doll, built out of materials they glued and colored in an artistic way. The body consisted of gears, which provided strong motion to the rest of the doll, and a motor attached to a rotation sensor to keep track of the turns. Every hand had a light sensor and a light source. They used the source to make the light more constant, so the small changes in the light reading were easy to detect. They wrote a program that detected a new object in the receiving hand, made the doll turn to offer a gift with the giving hand, and waited to turn back after it detected the taking of a gift. This was a very complex project both in terms of technology and mechanics as well as in the conceptualization of the value they chose. The group spent a long time conceiving a design that would actually represent the notion of giving and receiving. They found the doll and her two hands a very appealing one.

Another example of the creation of projects that evoked reflection and conversation is the case of Paula and her ten years old son Matias. With the help of two other moms, they created a conveyor belt contraption that transports the actions of the previous year. Paula explained how they came up with the idea: "during the High Holidays we think about the actions in our everyday life. It is the time to think, reflect and become conscious about our past deeds, so we can choose to continue with the good deeds or to rectify the actions that we believed were wrong". This idea gave birth to the conveyor belt. The machine was designed to carry actions until a reflection point, where the users could spend the needed time to decide about their positive or negative significance. An action considered good was transferred to a good container and an action considered bad, was taken back, meaning that people had to amend it. The mechanics consisted of a structure to hold the belt, which was made out of rubber bands, a motor located in the starting point of the contraption to move the belt, and two touch sensors to select between good and bad actions. Actions were foam rubber cubes wrapped in color papers and labeled with a name. A program was created to start the motor for a given number of seconds, and wait for the sensor input to take the actions to the next stage. If the sensor for good actions is pressed, the program starts the motor in the same direction to go forward. If the sensor for bad actions is pressed, the program makes the motor move in the opposite direction taking back the action to the staring point.

For the two groups presented above it was very important to have users of their projects not only learn the value of reflection, but also experience it by reflecting about their own

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actions. During the open houses they were very careful to explain the complex mechanical structure as well as the state of mind in which they wanted the users to be drawn into.

7. Technology and Values

Learners have different interests and strengths . Some are naturally inclined towards the humanities, while others prefer the technology. However, both domains are needed in order to grow up as an integral human being. In the "Con-science" research project we integrate both technology and values to support learners with different interests and strengths. On one hand, people interested in values, but not in technology, ended up mastering the technology due to their motivation to build an artifact that expressed their values. On the other hand, people who wanted to work with the technology also ended up exploring values by the need to choose a project theme. Our goal was to provide an experience in which participants could create meaningful projects not only to show to others in the community but also to reflect about the most cherished values.

7.1 Interest in values supports learning about technology

Let's go back to Marcia's project on friendship. She had a hard time building the mechanics for the movement of the arms, as well as writing the program to control the hug. Her dolls looked as if they were hitting each other instead of hugging. When showing the project to the young visitors, one of the youngest ones complained, "This is not about friendship! The dolls are not hugging but slapping each other." The young boy was referring to the fact that both arms wouldn't move up at the same speed and wouldn't reach the same altitude. Marcia tried to convince him that he was wrong and created a very complicated story about a new type of hug. But the young boy wouldn't give up and invited his friends to give their opinion. After engaging in a long discussion about what friendship is, everyone agreed that the project wasn't about friendship but about fighting. Marcia wasn't happy. Next day she talked with the other group members and they all agreed that there were two possible solutions. To either change the story and the value conveyed by the project or to work harder on the programming. Despite the fact that Marcia said that she hated programming, she chose to do it because friendship was a very important value for her. She debugged her program and played with the mechanics until she came up with a movement that looked very much like a hug.

Marcia's story is about how the technology was used to engage a child in a high intensity intellectual effort. On one hand, Marcia's friendship theater, and the fact that it wasn't working as expected, generated an in-depth discussion about value issues such as what friendship means. In a normal class situation this philosophical discussion would have happened under the teacher's initiative (i.e. the teacher telling a story about friendship and asking kids to comment on it) or at a very high personal cost (i.e. if there was a fight in the classroom and the conflict needed to be resolved). On the other hand, the personal attachment that Marcia had to the value she chose motivated her to work harder to debug her program. Given Marcia's preferences, it would have been easier for her to change the theme around her project, than to fix the programming.

7.2 Interest in technology supports learning about values

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During the open house for the community, Matias was presenting the conveyor belt that transports actions to one of the adult visitors. When playing with the contraption, the visitor decided that his action was good. He observed that the action moved forward very slowly. He commented: " I see, the good actions take more time. Since they are good, they should last longer." Although this deep reflection about values was triggered by the performance of the technology, this wasn't the original reason why Matias' contraption performed in that way. The belt structure was divided in two parts because the rubber bands were not long enough to cover the whole area. They were slightly different in length, which affected the speed in which the actions traveled on the belt. Matias, who before the visitor's comment seemed to only explained the difference in speed in technical terms, became interested in this new way of explaining why good actions travel slower than bad actions.

This incident shows an example of ways in which the richness of the learning environment encourages people to explore other interests and learning styles. The comment made by the visitor raised for Matias the issue of how actions happen in real life. During the workshop Matias showed more interest in the technology than in the values aspect of his project. However, the fact of building a tangible artifact to share with others, helped him to reflect about the experience in a different way. During the creative prayer, in the last open house, Matias demonstrated his project by explaining how the technology worked, but also how the value he had chosen with his group was conveyed and implemented in the project.

8. Future Work

We hope that this first pilot project of the "Con-science" research program can serve as a seed that will give birth to other projects with similar goals. Hopefully we will be able to work with different secular and religious groups concerned with bringing technology and values together.

9. Acknowledgements

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