Sparking Creativity in Computer Science for Interdisciplinary Students

Renita Murimi
Paul Dickinson College of Business
Oklahoma Baptist University
Shawnee, OK
renita.murimi@okbu.edu

Abstract— A class on Technologies for Creative Learning was designed to investigate the answers to a well-researched question: "What learning mechanisms spark creativity?" The class was offered for the first time at Oklahoma Baptist University during the Winter 2013 semester, and was structured to introduce computer science concepts to an interdisciplinary group of students. A key enabler of most learning mechanisms today is technology, and this class explored the use of various platforms in the design and functionality of learning through technology, using computer science as the learning objective. This work addresses the implications of programming and robotics to foster creativity in computer science and discusses the outcomes of the class.

Keywords—computer science; interdisciplinary; robots.

I. INTRODUCTION

"What learning mechanisms spark creativity?' was the question we sought to answer as we designed a new course in Computer Science at Oklahoma Baptist University (OBU). OBU is a liberal arts school, and students majoring in a wide spectrum of disciplines could be sought to understand the learning mechanisms that encouraged creativity. We designed a class on Technologies for Creative Learning to encourage creativity in Computer Science through the design platform of robots. We were inspired by similar classes at Massachusetts Institute of Technology [1] and at University of California, Berkeley [2] and at, where the classes were designed to study the impact of educational technologies. Our class, however, was designed to introduce computer science to interdisciplinary students through robotics [3]. To accomplish this, students were first introduced to various learning theories and programming environments [4]. These lessons were then applied to design creative projects using robots to form a culmination of computer science, creativity and learning by discovery in student-created projects.

II. CURRICULUM DESIGN

The curriculum was divided into three modules: Introduction to the Theory of Learning, Learning Computer Science Concepts and Creativity and Collaboration. Each module comprised of a learning phase and a testing phase. Information about each of these modules and associated activities are as follows.

A. Introduction to the Theory of Learning

The first week of class introduced students to the theories of learning [5] and innovation [6]. Students were encouraged to approach the class with the mindset of a kindergarten student whose learning mechanism can be represented by a spiral [5]. Since learning is a lifelong activity, it was chosen to be the key element of investigation and it was explored through the medium of computer science. As part of the design phase of this module, students were introduced to Scratch [7] through a two-fold assignment where they were asked to familiarize themselves with Scratch and build a simple project to introduce themselves to the class through a Scratch project. In the second part, students built a gallery of projects around a theme. For both of these assignments, students noted that while Scratch was intuitive to learn, the most challenging part of the assignments was figuring out the theme of the individual project and the gallery of projects. This simple experiment demonstrated the utility of programming platforms that could be explored by students of various backgrounds. Through Scratch, students were introduced to computer science concepts such as decision structures, loops, I/O, synchronization, functions, algorithms and OOP.

The second half of the design phase introduced students to multi-agent modeling using Netlogo[8]. Students were encouraged to explore the library of models available in Netlogo and modify the simulation parameters of the models and observe the varying outcomes. Through this assignment, the class was introduced to concepts in randomness, swarm intelligence and simulation mechanisms. Scratch and Netlogo formed the cornerstones of learning about computer science in this class.

B. Learning Computer Science Concepts

The second module on Learning CS concepts expanded on the knowledge of Scratch that the students gained in the first modules. Using the software environment supported by Alice [9], students used the design platform of the Finch robot [8]. This module focused on learning by discovery, where they explored Alice based on their knowledge of Scratch and programmed a Finch robot. Robotics was chosen as the design platform in the design phase, since robotics is an important tool in cultivating an interest in computer science. Since robots are a cultural construct in our world, robotics can inspire cross-

disciplinary interest in students and foster creativity and collaboration. The individual projects were judged by a panel of judges for their novelty and execution. The projects that were built consisted of robots that danced, moved around a maze, a robot that hid from light, a robot that avoided obstacles and a name-tracing robot. The programming of these robots required students to understand the functionality of the various sensors in the robot, and use their knowledge of programming concepts introduced in the first module.

C. *Creativity and Collaboration*

This final module on Creativity and Collaboration was designed to tie in computer science concepts, learning theories, collaboration and creativity. The final module was a group project whose theme was 'The Social Life of Robots'. The interpretation and implementation of this theme was left open to students. The students decided to program the robots around a pursuit-evasion game called Zombie tag. The rules of the game were designed as follows:

1. The game starts with one robot being the Zombie, and the rest of the robots are Humans. Zombies move slower, and only in straight lines, while Humans (who can launch into panic at the sight of a zombie) can move around in any direction and faster than Zombies. A Zombie's LED (the beak of the Finch robot) is green, and that of the Human is purple.
2. The Zombie's aim is to tag (pursue) a Human, while the Human seeks to evade the Zombie(s). The tag is accomplished by touch between the robots. As soon as a Zombie tags a Human, the Human Finch's beak turns green to signal that it is now turned into a Zombie and adopts all the characteristics of a Zombie. The game continues with two Zombies pursuing to tag the remaining Humans. This process continues till there is one Human left, who now becomes the initial Zombie for the next round of Zombie tag.

The design of this game is interesting for two reasons: first, a group of interdisciplinary students designed a game around a classic game-theory concept, and second, it involved distributed programming. The Zombie that started the game could be any robot, and all the robots seamlessly switched from Human mode to Zombie mode upon being tagged. The initial computer science concepts and multi-agent modeling were implemented through robots at the interface of computer science and game theory. Considering that there was no requirement for previous programming experience, in the true spirit of interdisciplinary learning, this class touched on educational research in the areas of cognition, psychology, education, computer science and programming.

III. Class Outcomes

Surveys were conducted to assess the outcomes [11] of this pilot offering. At the start of the first module, students were asked to note their most challenging experience out of the following three choices: learning to program, learning to share and learning to ride a bike. This question was adopted from [5], and the responses were typical. The non-computer science majors unanimously chose 'learning to program'. At the end of this class, this response changed, with 75% of the non-computer science students choosing an option different from 'learning to program'. Additional questions on the survey asked students to reflect on the kindergarten model of learning: (Imagine, Create, Play, Reflect, Imagine) and to note their most interesting and challenging parts of this spiral in learning about computer science. 'Imagine' and 'Create' emerged as the top two answers for the entire class. The entire class picked 'Programming the Finch' as the most fun task out of a list of options that included reading assignments, maintaining a blog, programming in Scratch and exploring Netlogo. However, the cost of the robots was a limiting factor in the breadth of robotics assignments that could be made possible for the design of this curriculum, and was stated by students as an element that needed to be addressed for future versions of this class.

IV. Results and Future Work

The pilot offering of this class generated a huge amount of interest on and off campus. We are planning to offer this class every Winter term, and expand the offerings available to students in terms of robotics projects that students can work on. Plans are underway to establish a robotics lab, and we are investigating various modes of curriculum design to continue sparking creativity in computer science in a liberal arts environment.

References

[1] Resnick, Mitchel, and Karen Brennan. *MAS.714J Technologies for Creative Learning,Fall 2009*. (Massachusetts Institute of Technology: MIT OpenCourseWare),http://ocw.mit.edu (Accessed 25 Mar, 2013). License: Creative Commons BY-NC-SA

[2] Technologies for Creativity and Learning. http://www.ischool.berkeley.edu/courses/i290-TfCL

[3] D. Blank, "Robots Make Computer Science Personal", in Coomunications of the ACM, vol. 49, No. 12, pp. 25-27, 2006.

[4] A. Goncher, A. Johri, S. Kothaneth and V.K.Lohani, "Exploration and Exploitation in Engineering Design: Exploiting the Effects of Prior Knowledge on Creativity and Ideation," 39th IEEE Frontiers in Education Conference, pp. 1-7, 2009.

[5] R.K. Sawyer, "Education for Innovation," Thinking Skills and Creativity, vol. 1, Issue 1, pp. 41-48, 2006.

[6] M. Resnick, "All I Really Wanted to Know (About Creative Thinking) I Learned (By Studying How Childern Learn) in Kindergarten, ACM Creativity and Cognition Conference, pp. 1- 6, 2007.

[7] Scratch. http://scratch.mit.edu/.

[8] Netlogo, http://www.ccl.northwestern.edu/netlogo

[9] Alice, http://www.alice.org.

[10] The Finch, http://www.finchrobot.com/

[11] R. Frutcher and K. Emery, "Cross-Disciplinary Learning Metrics and Assessment Methods," ASCE ICCCBE-VIII Conference, 2000.