1.Title

Rube Goldberg and the 7th Machine: Learning through Robotics and the Design of Connected Machines

2. Proposers

1. Arnan Sipitakiat, Ph.D., Faculty of Engineering, Chiang Mai University, Thailand.
2. Paulo Blikstein, Ph.D., School of Education and (by courtesy) Computer Science Department, Stanford University, USA
3. Nalin Tutiyaphuengprasert, Darunsikkhalai School for Innovative Learning, Bangkok, Thailand

3. Abstract

This tutorial introduces a new technique of using robotics to explore ideas in physics through the construction of a Rube Goldberg machine. The concept of this learning activity is to engage learners in creating a chain-reaction machine. Groups of students collaborate by each designing one component for the overall connected chain of events. Because of the concept's appeal to children, we have spent the past two years developing techniques to amplify the learning opportunities of this activity. While topics such as the six simple machines become naturally relevant, a purely mechanical Rube Goldberg machine requires immense investment in time and effort to make sure each component works together precisely. Incorporating sensors, actuators, and programmable components into the designed structure has proven to relax the required exactness. This flexibility allows participants to focus more on their ideas and leads to more creativity. We call the digital component the "7th machine". This tutorial will provide a hands-on experience of this learning activity and provide room for discussion. Participants will understand how to incorporate sensing and control technology in learning activities involving the construction of physical mechanisms. We will highlight how we have connected learners to important ideas in physics, logical thinking, problem solving, and team building.

4. Bio of the Organizers

Arnan Sipitakiat, Ph.D.
Assistant Dean for Information Technology and Learning Innovation
Faculty of Engineering, Chiang Mai University, Thailand

Arnan received his Master's and Ph.D. from the Future of Learning Group at the MIT Media Laboratory, USA. He has spent eight years at MIT designing technologically-rich learning environments aiming to open up new ways for secondary and pre-college students to experience and learn about ideas in various domains. He has explored areas including robotics, balance control, interactive art, games, agriculture, environmental awareness, journalism, and community development. He has participated in the development of innovative schools and rural learning communities in Thailand since 1997. He is also coordinating the launch of the One Laptop per Child (OLPC) project in Thailand. Arnan is actively involved in developing learning activities for the Schlumberger Excellence in Educational Development (SEED) foundation, which organizes learning programs with schools around the world.

Paulo Blikstein, Ph.D.
School of Education and (by courtesy) Computer Science Department, Stanford University, USA

Paulo Blikstein is an assistant professor at Stanford University's School of Education and (by courtesy) Computer Science Department. His research focuses on the development of low-cost fabrication labs for education, inexpensive toolkits for constructionist learning, and the development of assessment techniques for open-ended learning using learning analytics. He holds a BS in

Metallurgical Engineering from the University of São Paulo, an MSc from the MIT Media Lab, and a PhD. in Learning Sciences from Northwestern University.

Nalin Tutiyaphuengprasert
Vice Provost - Research & Innovation Development
Darunsikkhalai School for Innovative Learning of
King Mongkut's University of Technology Thonburi, Bangkok, Thailand

Nalin holds a BA in Journalism and Mass Communication from Thammasat University and an EMBA from Sasin Graduate School of Business Administration of Chulalongkorn University. Nalin has been working with the Darunsikkhalai School for Innovative Learning (DSIL) since 2001. She has practiced and generated a learning model based on the Constructionist learning philosophy in a formal school setting. Nalin has recently been involved with Rube Goldberg Machine workshops for students at the elementary school to high school level as well as providing Rube Goldberg Machine workshop for adult learners from several schools, companies, and industries.

5. Tutorial Format

The tutorial will be a full day hands-on event. We will introduce the activity and show past examples in the first forty five minutes. Participants will then spend one hour learning how to use the GoGo Board, a low-cost and open-source robotics tool designed for children, which includes an introduction to simple sensors and actuators. This activity does not depend on the use of GoGo Boards. Participants can later implement the same idea using a robotics kit of their own choice. Before the lunch break, participants will be introduced to the six simple machines and the materials available to implement them in their design. During the afternoon, the participants will be divided into groups of two or three and start designing their section of the Rube Goldberg chain-reaction machine. After briefly presenting their ideas, participants will continue to work on their mechanism allowing time for test runs and fixes. We end the hands-on activity with a grand finale by running the fully assembled Rube Goldberg machine. We finish the tutorial with a discussion of the key learning points from the activity.

6. Example Materials


Examples of digitally augmented Rube Goldberg machines previously created
http://www.youtube.com/watch?v=XugHaR5Ryz0
http://www.youtube.com/watch?v=p1Lw6eKG23s
http://www.youtube.com/watch?v=ktG4N9GYA0E
http://www.youtube.com/watch?v=l3Q4-JUh2_8

The GoGo Board.
http://www.gogoboard.org

7. Number of Participants
We can accommodate 20 participants

8. Equipment Required

- Laptop Computers. We expect each participant to bring their own laptop computer. We need 10 computers for the final activity.
- GoGo Boards (Robotic Kits). We will supply 20 kits. Each kit includes a programmable central device, the necessary software, sensors, and actuators.
- Construction Materials used to build the Rube Goldberg Structure. We will provide these materials including card board paper, strings, Popsicle sticks, beads, elastic bands, scissors, hot glue, and tape. Most of these materials will be organized on a movable shelf.
- A Room with five tables and some space for participants to work on their mechanism.
- Support Staff. In addition to the three main coordinators, we will include three to five graduate and undergraduate students from Chiang Mai University to facilitate the activity.