Making Live Theatre with Multiple Robots as Actors

Bringing Robots to Rural Schools to Promote STEAM Education for Underserved Students

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***Abstract*—We have tried to promote STEM (Science, Technology, Engineering, and Math) education for underserved students using interactive robots. As an advanced attempt to integrate art and design into STEM education (i.e., STEAM), in the present paper we introduce our afterschool program in which elementary students create live theatre using multiple robots as actors. We hope to receive feedback and comments on our afterschool curriculum and case study, and thus, we can run better sessions at schools and make a standardized protocol regarding this robot actors approach.**

Keywords—live theatre; multiple robots; STEAM education

I. Introduction

In addition to STEM (Science, Technology, Engineering, and Math) education, the recent effort in education attempts to add art and design to the equation, which makes the STEAM (Science, Technology, Engineering, *Art*, and Math) movement [1]. Given that innovation always comes from human values, integrating art and design with STEM seems to be the right direction. Specifically, we have tried to develop and run STEAM education programs for underrepresented students in this rural area, including summer youth programs and visiting demo programs at local schools. Our target populations range from female students, students from low income families, and students with various disabilities. For example, we are developing interactive robots that can play musical games with children with autism spectrum disorders [2]. As a result of active networking and outreach, we have been developing new afterschool programs with local elementary schools. In the present paper, we introduce our first afterschool program, "Making Live Theatre with Multiple Robots as Actors".

II. Background

A. Robot Actors Project

The “Robot Actors Project” was initiated by a robotics researcher, Hiroshi Ishiguro and a drama writer, Oriza Hirata in Osaka University in 2008 [3] for humanoids or androids. These days, robots are able to dynamically interact with their environments (e.g., shaking hands, playing soccer). Based on the fact that robots can serve as actors, we can provide an impression that robots might have some free will and intentionality [3]. Through making this live theatre play, students are expected to learn and ponder about (1) technology and engineering: planning, controlling robots, and pseudo coding; (2) art and design: writing, stage designing, preparing music and sound effects; (3) collaboration: discussing, negotiating, role allocating, casting, promoting, etc.; and (4) co-existence with robots: being exposed to philosophical and ethical questions (e.g., the roles and limitations of robots).

B. Interactive Learning

In this project, we suggest that students can go beyond the limited role of passive learners and explore a more constructive and interactive role. Chi [4] recently provided a framework that offers a way to differentiate *active*, *constructive*, and *interactive* learning in terms of observable activities and underlying learning processes. Active learning is attending processes, such as looking and fixating. Constructive learning is creating processes, such as self-explaining and elaborating. Interactive learning is jointly creating processes containing partners’ contributions, such as revising errors from feedback and co-construction. Interactive activities seem to be better than constructive activities, which may be better than active activities. Based on Chi’s argument, we attempt to incorporate interactive activities in this multimodal learning environment, by allowing students to interact with multiple robots and peers, and make their own creative work (i.e., live theatre).

III. Afterschool Curriculum

After a number of summer youth programs and visiting demos, we have strong connections with local schools. We are currently developing an afterschool program about integrating art and technology in collaboration with one of the elementary schools in this area. We are supposed to run a 10 week program for one hour in each week. Here is our initial curriculum for Spring 2016. In weeks 1 and 2, we will demonstrate the robots and their functions. Each student will experience playing with each robot. In week 3, we will explore children’s preference for robots and brainstorm ideas on story and roles of the robots. From week 4, students will work in small groups to improve their story and allocate roles in a team. In the following week, students will become familiar with basic ideas of programming and the way they can control robot behavior. In weeks 6-9, students will prepare stage, music, prop, and practice the play, interacting with robots and cooperating with each other. Live performance will be in week 10 with their peers, parents, and teachers.

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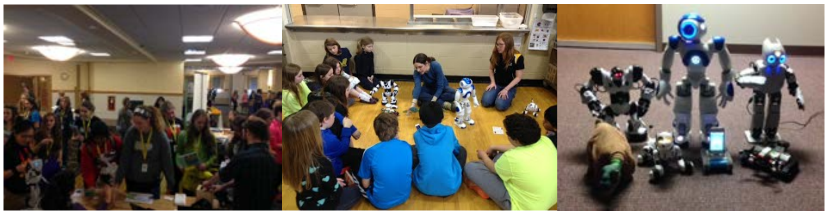

Fig. 1. Summer youth program (left), visiting demo at the local elementary school (middle), and robots used in live theatre (right).

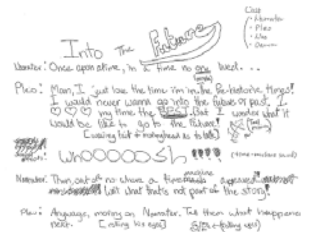

Fig. 2. A third grade female student's scenario using three different robot actors.

A. Robots Used in Live Theatre

We will use seven different robots in the afterschool program: Pleo rb, Zoomer, Romo, Mindstorm EV3 (Fig. 1. right, front: from left), Robosapien, Nao, and ROBOTIS-OP2 (back: from left). These robots have various types and different capabilities. All robots have some interactive sensors. Pleo rb, Romo, Mindstorm EV3, Nao, and DaRWIN-OP 2 are all programmable. Nao has full speech recognition capability, and Pleo rb, Zoomer, Romo, and DARWIN-OP2 are able to do, at least, partial speech communication. Mindstorm EV3 and Robosapien are operated by remote controllers.

B. How to Engage Students in Robot Programming

To provide programming experience to students, we plan to utilize the existing robot simulators and software development kits (SDK). In addition, traditional storyboarding procedures used both in script development and interface design could be iteratively refined from the broad plot level to detailed near pseudo-code instructions, i.e. "Nao and Romo meet" becomes "Nao greets Romo and Romo…" continuing to get more detailed until it is "Nao walks 0.5 m forward, says 'Hi, Romo', then waves his right hand…". While the actual coding may be performed separately by experienced programmers, rehearsals with both the programmers and students present will allow for interactive debugging of readily observable problems, potentially including deliberate bugs for this purpose. The technical limitations of some of the less sophisticated robots offer opportunities to teach problem solving.

IV. Case Study

A. Storytelling Categories and Contents

While preparing for the afterschool program, we have been creating testbed live theatre with a 3rd grade female student as a proof of concept. In the first meeting, we demonstrated each robot's capabilities and characteristics. We also discussed plausible categories and directions of a story. The student was able to choose a story among fairy tales, movies, or allowed to create an original story. She decided to write her own story line. After the first meeting, she wrote a scenario for a week (Fig. 2.). Moreover, we had a brainstorming session on how to use robots (i.e., what roles) in theatre. For example, a humanoid robot could serve as a companion; an animal robot could serve as a pet; or time period can be futuristic. Our student casted three robots out of seven (two humanoids and one dinosaur) and a human narrator. Interestingly, the story began with a dinosaur in the prehistoric times. Then, the dinosaur traveled into future using a time machine and meets two humanoids.

B. Lessons from the Case Study

Our case study confirmed some facts and provided directions. First, a 3rd grade student was able to make her own story with sufficient information. It was three pages long, which was enough to make a 3-5 minute play. She also included instructions on actors' motions and sound effects for scene transitions for live theatre. It was also humorous. Second, the story could depend on types of robots casted. The dinosaur robot was decisive in selecting the time period. To use advanced humanoids in the play, she also chose a futuristic period. Interestingly, the scenario included user interface elements (e.g., buttons and controls of the time machine) and even a bad network issue. Third, we might need more preparation time on stage and props. For example, students need to design a time machine and controls for this testbed scenario. The fidelity of the design might not matter, but it will take time for elementary students to prepare. On the other hand, it will provide students with a good opportunity of craft experience, which is a normal activity of the current afterschool programs. Finally, we came with an idea of dividing student teams in the afterschool program with a small number of robots (3-4 each). That will provide an opportunity to compare their output with peer groups' performance, which will fulfill another purpose of interactive learning.

V. Conclusion and Future Works

We believe that this afterschool activity will allow students to learn technology, art, and design in an integrated way. Our case study has helped us glean some hints about where to go in an actual program. We will seek more methods to evaluate the effectiveness of this learning activity with teachers. We hope that this attempt can stimulate diverse discussions of use of robots for STEAM education in the robotics community.

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