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An Innovative Approach to Teaching Robotics

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Abstract

Problem Solving Using LEGOS is a 3-credit hour course offered to any student at Pace University of Pleasantville, New York. The class uses a project-based learning environment, which consists of four design projects. This paper discusses the pedagogical advantages of teaching robotics in a mixed-reality environment with a virtual instructor as opposed to teaching robotics in a traditional laboratory setting.

1. Introduction

Problem Solving Using LEGO Robotics is a 3-credit hour course offered at Pace University of Pleasantville, New York and New York City. The class uses a project-based learning environment, and teaches robotics, computer programming concepts and problem solving skills to Pace students of all majors. Students work in teams toward the common goal of developing logical and creative solutions to problems using LEGO robotics technology known as Mindstorms. They perform service learning by going out to area middle schools, teaching students and their teachers and coaches about the LEGO robotics technology, exciting the middle school students with a fun yet valuable experience in science and technology.

2. Robotics

Robotics provides students with the opportunity to test the results of abstract design concepts through concrete, hands-on robotic manipulation [5]. Using robotics requires a conceptual shift away from learning from technology toward learning with the technology that is consistent with the "Mindtools" approach to problem-solving advocated by Jonassesn [6]. In this learning environment, students often discover they need to learn new knowledge and continuously revise existing knowledge before they can begin solving problems.

One of the biggest challenges faced by most computer science educators is assessing whether a student comprehends programming and robotic design concepts. Even though learners may have all the material from which to learn, they may still need guidance on how to use the material to crystallize ambiguous concepts and for out-of-classroom practice.

3. Virtual Instructors

We are exploring new technologies for learning in the form of LEGO robotics and obtaining problem solving skills. Students use the LEGO (Mindstorms for Schools) Team Challenge kit #9790 in conjunction with a programming environment called ROBOLAB. The Virtual Instructor is a paradigm that addresses these constituents and could thereby reduce the learning curve as well as enhance the robotic curriculum.

Virtual instructors are intelligent pedagogical agents with the option of being displayed as embodied characters or conversational interfaces [3] that use the best instructional method for providing personalized instruction.

In our research, we investigated how virtual instructors apply empirically tested pedagogical techniques of scaffolding. Scaffolding is an instructional technique formulated by Lev Vygotsky's socio-cultural theory in which a teacher breaks a complex tasks into smaller component tasks, models the task, and create links to students' existing knowledge. Scaffolding supports students in their learning until they are ready to pursue a task independently [1]. The virtual instructor guides

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students in a combination of virtual reality and augmented reality environments providing a multi-modal learning environment to support the visual, auditory, kinesthetic, and tactile learner understand complex and ambiguous robotic conceptual and construction tasks (i.e., psychomotor tasks).

During robotic conceptual learning, a student may interact with a virtual instructor, which has a pedagogical purpose to provide effective instruction to increase conceptual learning and increase robotic construction accuracy and assembly task repeatability. The virtual instructor uses its virtual reality environment to simulate fundamental components used to build mobile robots. The components in virtual reality environments are computer simulated three-dimensional models and animations that include, but are not limited to gears, gear combinations, motors, sensors, and sensor rotation. In the virtual reality environment, the virtual instructor applies the pedagogical technique of scaffolding to step a new learner through the process of robotic component assembly and gradually decreases the instruction as it assesses that learning progress is being made. Collaborative learning through multi-user virtual environments may be accomplished in this e-learning environment.

To create the bridge between applying concepts learned in the virtual reality environment to hands-on exercises in the real world, we applied preliminary research on how wearable mobile augmented reality systems may provide both decision support and hands-on assembly assistance [3][4]. To enhance learning performance and robotic assembly accuracy, students could wear intelligent lab goggles equipped with speech recognition, object recognition, and instructional services. While wearing these intelligent augmented reality goggles, students could be provided guidance from the same virtual instructor on the step-by-step process to assemble gears, motors, and sensors during robotic construction tasks as defined by the LEGO exercises. To assist the student, the augmented reality goggles could serve as an intelligent human computer interface by annotating robotic components with graphical guides to illustrate the connectivity and rotation paths for assembly. Because robotic assembly requires two hands, the goggles could provide a hands-free computer interface by supporting speech interactivity with the virtual instructor guide.

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