# Laughter over Dread: Early Collaborative Problem Solving through an Extended Induction using Robots

Mark Zarb
School of Computing Science and Digital Media
Robert Gordon University
Aberdeen, United Kingdom
m.zarb@rgu.ac.uk

Michael James Scott
Games Academy
Falmouth University
Cornwall, United Kingdom
michael.scott@falmouth.ac.uk

## ABSTRACT

Software development companies want new hires with strong interpersonal and problem solving skills. To ensure the development of such skills, they must be embedded throughout the curriculum. However, many students struggle to collaborate with peers and in self-regulated practice during the early stages of their course. Explicit scaffolding can, however, motivate such engagement. This tips and techniques session shows how an ice-breaker using LEGO EV3 robots at two UK institutions enhanced peer interaction and increased self-regulated practice over the first four weeks of 2016-17 and 2017-18.

## Categories and Subject Descriptors

K.3.2 [**Computer and Information Science Education**]: Curriculum

## Keywords

Interpersonal Skills, Teamwork, Problem Solving, Induction, Communities of Practice, Robots

## 1. INTRODUCTION

The development of human capital in order to drive economic well-being has become a prominent focus of higher education. In recent years this has led to employability skills becoming central to definitions of student success. Employers in the technology sector often raise concerns about graduate employability, highlighting needs for interpersonal and problem solving skills [5]. The Shadbolt Review [9] echoes these concerns, illustrating that computing graduates have lower rates of employment compared to other STEM disciplines. This is despite reports of skills gaps and huge growth in the sector [11]. Furthermore, some computing graduates cite their university experience "could have better prepared them for '*the world of work*' in terms of developing their employability skills and knowledge" [3, p. 11].


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According to Ericsson's theory of deliberate practice, such skills require significant dedication and a sound strategy to develop [2]. Therefore, encouraging students to practice their interpersonal and problem solving skills early in the curriculum, such as the CS1 context, would afford greater time for students to develop them. Especially if it encourages subsequent self-regulated learning that is constructively aligned with employers' expectations.

However, challenges do arise. Firstly, establishing a context which inspires self-regulated practice. First-year students struggle to sustain their engagement without ongoing encouragement [4]. There is, therefore, a need to frame problem solving activities using approaches that encourage self-regulation (e.g.[14]). Secondly, when navigating the transition into higher education, many struggle to form a community of practice and engage with their peers [10, 13]. Thus, they tend not to practice their interpersonal skills in a problem-centric manner early enough in their course.

Falmouth University and Robert Gordon University, together, have been exploring solutions to these challenges. While conducting previous research [7, 12, 8], the authors observed that students seemed to engage in peer support more readily, and were less intimidated by logic errors, when programming robots. Such activity seemed to evoke a sense of mastery, belonging, and agency, in line with building motivation according to self-determination theory [1]. To this end, the authors put together a series of induction activities centered upon notions of collaboratively building and programming robots.

## 2. INDUCTION DESIGN

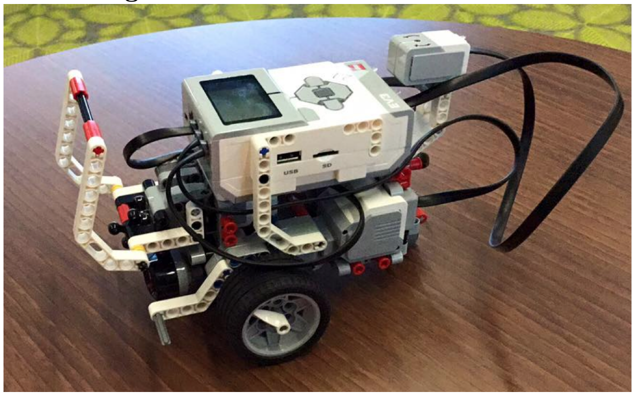
The LEGO Space Challenge using Mindstorms EV3 robots forms the thrust of the induction:

**Materials and Supplies.** Each team needs to have enough components to be able to build a basic Mindstorms robot (Figure 1), although this activity could be tweaked depending on available materials.

**Introduction.** A general introduction is given to the class, where students are divided into teams. Each team is handed a box containing all the components required to build a basic Mindstorms robot, a step-by-step handbook for construction, and an introduction to the coding interface.

**Challenges.** Once all teams have built the basic robot (or after a set time period), a document containing all the challenge briefs are handed to the teams. This can be supplemented with videos showcasing each challenge, to give teams a general consideration of the solution.

**Figure 1: LEGO Mindstorms Robot**



**Development Time.** Teams then being to solve the given challenges. The challenges themselves are set out so that teams can test their robot, so they can devise solutions using an iterative approach.

**Competitive Play.** At the end of the timescale, teams are asked to participate in the challenge event, where they are required to solve all challenges within a set time period. Each team's time taken can be used to populate a leaderboard and announce the winning team.

The instruction given to students is fairly minimal: students are placed into teams, asked to build a basic robot from a number of parts as a common starting point, and then given a set time period to build and program the robot to solve a number of predetermined challenges. This forces them to work in multidisciplinary teams from the start, and learn to approach problem solving in an explicitly collaborative context.

## 3. FINDINGS

Variations of these sessions have been run annually since 2015 at Robert Gordon University, and since 2016 at Falmouth University. Extending already known benefits of educational robots in the programming context [6], qualitative data from observations and an end-of-task survey at both sites support hypotheses of improved collaboration and problem solving. Notably, students reported that it was fun to solve problems with the robots and that it was a great ice-breaker to make them interact with each other to build them. Further to this, many students successfully completed the space challenge, demonstrating key computational thinking skills.

This approach allows students to start working with each other without the expectation and pressure of grades, reaping the benefits of an informal experience. It was observed that students were successful in learning the foundations of computational thinking using LEGO robots, and that feedback from these challenges often resulted in "laughter rather than dread", encouraging the students to continue problem solving. This was deemed an excellent ice-breaker that opened up dialogue between newly-met peers. Furthermore, staff reported that these sessions allowed students to form small communities of practice early in the academic year, and that students tended to refer to these communities for support throughout the semester, even after the induction had ended.

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