# Training Volunteers with a Robot Assembly Simulator (RAS) App

## Design Recommendations

**Dlab 4**: STEM Outreach

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## Problem Statement

Engage: University Outreach is a not-for-profit organization that, among other things, run a number of workshops across Australia. The aim of these workshops is to provide information about university to young people who would not normally be exposed to it, such as those living in regional areas. In doing this, they aim to break down stigma, inspire a sense of wonderment, and ultimately move towards equal access.

Engage often works in partnership with other organizations like Robogals, Lenzitech, and Engineers Without Borders to cater to different demographics and fields in STEM, and introduce hands-on activities into workshops. In our case, we consider a Robogals workshop, in which participants are taught how to assemble and control a Lego Mindstorms NXT robot.

Due to the number of these workshops, and the intrinsic distance between them, they're run by volunteers. The problem, as it relates to this proposal, is that it is hard to train these volunteers to be both technically proficient in operating and troubleshooting the robots, as well as inspiring proponents of the Engage philosophy, in the 2-hour timeframe of their standard training session.

## Background

**Developing an Approach using Qualitative Research Data (R01 and R03)**

The question at the heart of this proposal is what the most efficient and effective means of teaching is. We aimed to refine and focus this by drawing parallels between our problem and a case study; the modern paradigm of university education. Given that we were predominantly concerned with phenomenological trends, we used a qualitative research methodology. This process is visually represented in figure 1.

We first considered what kind of teaching mediums would appeal to volunteers. In universities, conflicting lecture time slots are often combatted by providing supplementary notes and exercises students can access on the web (Nast et al. 2009). Nowadays, some courses are based entirely online. Bassili and

Joordens suggest that approaches like this are successful because they allow students to work at their own pace and go back over content they may not have understood (2008).

Shifting our topic, we then assessed whether providing a supplementary online resource would have the same effect on the volunteering cohort, using the following qualitative points; volunteers are predominantly driven by their own interests, rather than to achieve a certain grade or qualification, suggesting that they'd perform better with additional resources. However, from our introduction to the problem, it was established that volunteers were not expected to commit time outside of the workshop to their training, unlike university students, so they'd have to be able to process everything in a short period of time benefit.

At this point, we realized that the technology was already in place for workshop participants to operate their robots using a phone or computer app (Lego 2016). The next logical step was to determine whether volunteers would benefit from the introduction of an app to help construct and troubleshoot the robot, as well. Szpunar et al. argues that one of the disadvantages of online learning material is that it's very easy to get distracted, and that one way to combat this is to intersperse the material with interactive elements (2013). The aforementioned app would accomplish this by its very nature. It would allow volunteers to absorb information quickly, while remaining a constant source of interaction.

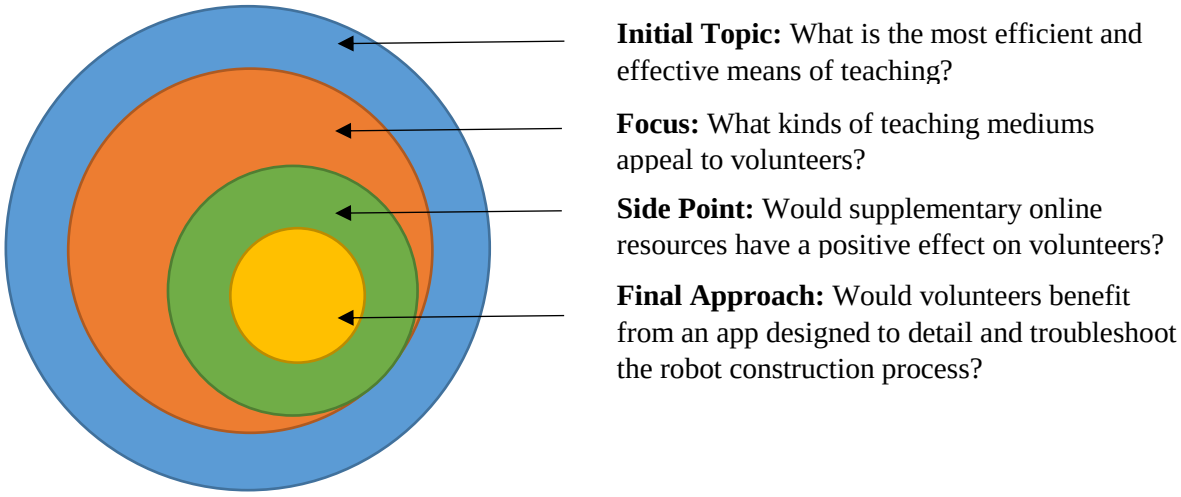


**Figure 1 –** The process by which our final approach was developed

**Interview with Robotics Tutor (R02)**

An interview was conducted with an engineering student at the Australian National University engaged in teaching robotics to young children, but not affiliated with Robogals (personal communication, 21/09/2016). As someone with experience in a technical teaching environment, she provided final insight into some of the forthcomings of our approach. We thought that an interview was appropriate because we were largely interested in understanding her opinions and how they related to this proposal. Several of these opinions are discussed below.

When asked how she learned to teach robotics, she responded by claiming that she learned on the job, and that this was important because technology changes rapidly. This was something we had not considered in the implementation of the app. However, we theorized that regularly updating such an app was actually a means of future-proofing volunteers. The steps to construct the robots might change as they get updated, but the process of following instructions on the app would remain the same.

When asked how she felt about a supplementary online component and similar tools overall, she said that she doubted that they would be effective because such a large part of being a successful tutor had to do with leaving a positive impression on the workshop participants, which couldn't be taught online. We acknowledge this in the *Design* section below.

## Design

After conducting research, our proposed solution to the problem is to redistribute the training content for the workshops to incorporate a Robot Assembly Simulator (RAS) app for computers and phones. This app would be a complete, step-by-step, visual resource for volunteers and workshop participants on how to assemble template robots as seen in figure 2, as well as a troubleshooting guide for problem components.

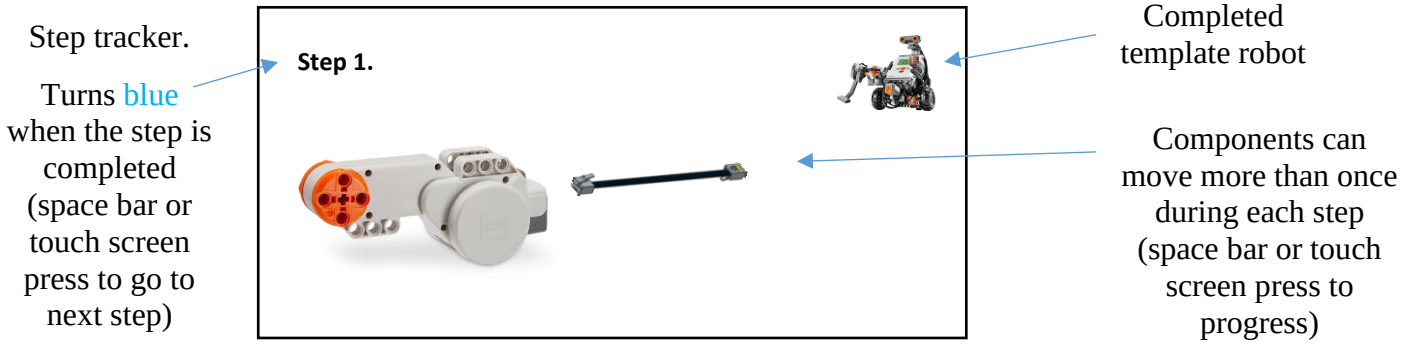


**Figure 2** – Labelled step-by-step assembly guide

In doing this, volunteers would be able to familiarize themselves with the same tools workshop participants would use. Moreover, it would drastically reduce the training time needed to cover troubleshooting, because volunteers and workshop participants would be able to consult the app on a case-by-case basis, as can be seen in figure 3.

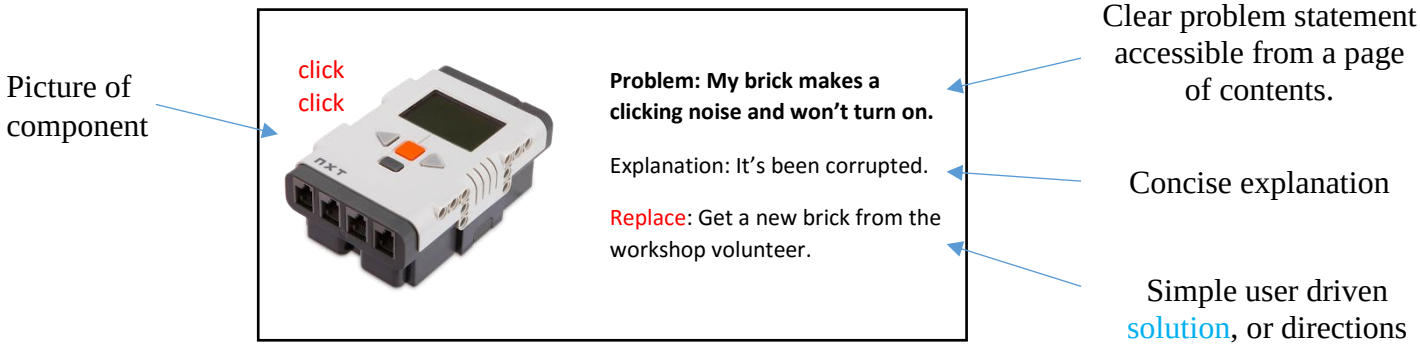


**Figure 3** – Labelled troubleshooting example

Based on feedback from interviews, a secondary aim of this approach is to put more emphasis on developing organizational skills and confidence in the training sessions; to better allow volunteers to convey *why* rather than *how* workshops are to be conducted, and ultimately leave a longer lasting impression on workshop participants.

# Analysis and Applicability

### Planned Schedule (S04)

See figure 4 and 5 for Gantt charts detailing two revised hour-long training sessions.

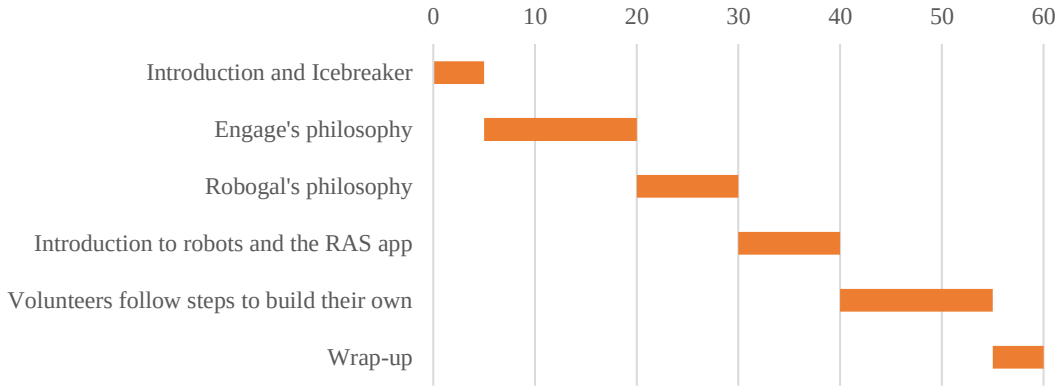


**Figure 4** – First scheduled training session

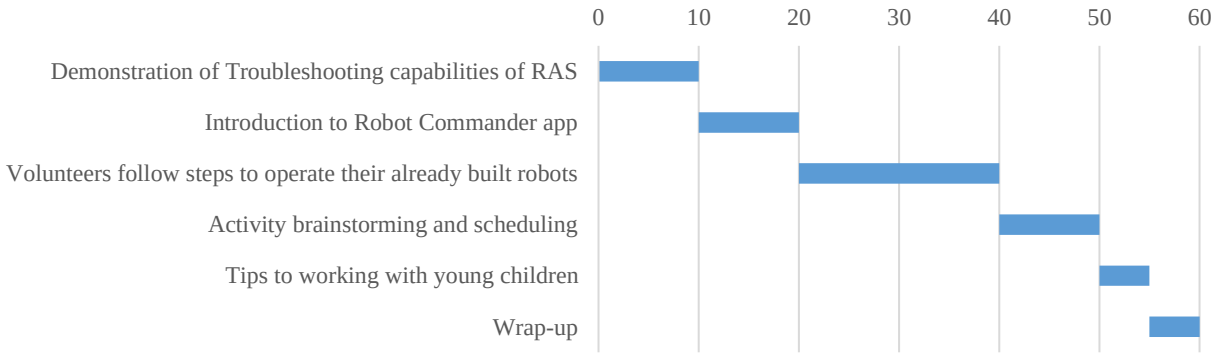


**Figure 5** – Second scheduled training session

There are a number of strengths to this schedule, namely that half of the first session is dedicated to strengthening volunteer's understanding of the outreach principles of Robogals and Engage, as opposed to a 'briefly explaining [their] aims' in the original schedule. Moreover, volunteers are guided through the entire construction, troubleshooting, and operation of the robots in the two-hour timeslot, instead of requiring additional (notably optional) training.

There are also a number of things that could be improved upon. Firstly, there is very little room for delay in the scheduling, and none of the activities are longer than 20 minutes. In addition to this, the volunteers all follow the same schedule, and aren't given the option to specialize. An alternate proposal might involve

splitting the volunteers into small groups to complete more intricate, complicated tasks (such as calibrating sensors, or designing custom robots for their best performance) but we felt that this would ultimately detract from the quality of the average workshop because, by Engage specifications, volunteers sometimes have to work alone or in very small groups. Following this alternate proposal, there might be inconsistent gaps in the teaching ability of volunteer's, going against the underlying Engage principle of equal access.

**Life-cycle costing for the RAS (S11)**

The most pertinent difficulty in regards to this proposal has to do with the cost of developing and maintaining the RAS app. Given that it will largely be comprised of images and text, with few simple animations, we can draw upon market research to estimate that an hour-long workshop's length of electronic training will cost between $5,850 and $15,600 USD to produce (Cobb 2015). Given that it will also include multiple robot templates of instruction, and a detailed troubleshooting section, we expect the final figure to be roughly $40,000 AUD.

If we suppose that some fraction of this needs to be updated every year, and additional work dedicated to debugging and adapting the app for different operating systems, we expect that maintenance costs will be somewhere in the range of $6,000 – $8,000 AUD per annum in the decade preceding the RAS app's release (Chomko 2012). This comes to complete life-cycle investment of $100,000 in addition to all other costs of the standard training sessions.

We acknowledge that this is a very large financial investment, and one that does not directly further the Engage or Robogal agenda. If this proposal were to be realized, it would only make sense to work in partnership with Lego and the producers of the robot commander app to add this (seemingly basic) functionality to their pre-existing framework, to minimize costs.

**Assessing Inclusiveness (S01)**

It's also important to acknowledge the social and cultural consequences of this proposal, as it deals primarily with people disadvantaged for university entrance by their location and/or background. We note that the RAS app would be primarily based on visual instruction, and the text in it could easily be translated. As such, it would be perfectly catered to non-English speakers, which may become increasingly relevant as Australia's migrant population continues to grow (Australian Bureau of Statistics 2016).

However, we also note that there is an innate exclusivity to constructing workshops under the assumption that participants will have access to smartphones or other devices. In particularly isolated or poor regions, young people may not so commonly be afforded this luxury. This could be addressed in future by having volunteers install the app on a laptop they bring with them (to present with) that they can share with workshop participants.

# References

Australian Bureau of Statistics 2016, *Media Release: Overseas born Aussies highest in over a century*, last accessed 22/09/2016, <http://www.abs.gov.au/ausstats/abs@.nsf/lookup/3412.0Media%20Release12014-15>.

Bassili, J. N. and Joordens, S. 2008, 'Media Player Tool Use, Satisfaction with Online Lectures and Examination Performance', *International Journal of E-Learning and Distance Education*, 22(**2**): 93-108.

Chomko, R. 2012, 'Maintaining an app is critical to its overall success', *Fierce Wireless*, last accessed 22/09/2016, <http://www.fiercewireless.com/developer/maintaining-app-critical-to-its-overall-success>.

Cobb, J. 2015, 'How much does it cost to create e-learning?', *Tagoras*, last accessed 22/09/2016, <http://www.tagoras.com/cost-to-create-e-learning/>.

Lego 2016, *Robot Commander App*, last accessed 22/09/2016, <http://www.lego.com/en-us/mindstorms/downloads/robot-commander-app>.

Nast, A. et al. 2009, 'Online lectures for students in dermatology: a replacement for traditional teaching or a valuable addition?', *J. Eur Acad Dermatol Venereol*, 23(**9**): 1039-43.

Szpunar, K.K. et al. 2013, 'Interpolated memory tests reduce mind wandering and improve learning of online lectures', *Proceedings of the National Academy of Sciences of the United States of America*, 110(**16**):6313-6317.