Relationship of Demonstration Construction Quality on Pedagogic Effectiveness

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Abstract - **Scientific studies have established the importance of engineering demonstrations, yet comparatively little is known about what makes some demonstrations more effective than others. In this study we investigate the pedagogic effect of demonstration construction quality. This study considers two build qualities: "raw" and "polished". Raw demonstrations use prototype-quality construction techniques such as exposed solderless breadboards, and polished demonstrations use production-quality construction techniques designed to emulate typical consumer electronics. The impact of the demonstrations on student interest were assessed by constructing paired sets of demonstrations of raw and polished quality. These were used in lectures to 119 students and student interest and comprehension were assessed by post-lecture surveys. Initial data using only a single demonstration in both raw and polished versions show students in both technical and nontechnical majors score higher in objective testing and report higher interest in the material using raw construction techniques (two-tailed p=0.051 and <0.01 respectively). Further data using other demonstrations will be obtained in 2009 to determine if these findings can be generalized.**

Index Terms - Demonstrations, Demonstration construction, Lecture aids).

INTRODUCTION

It is widely accepted that demonstrations improve pedagogic efficiency in general [1]-[3] and motivation in particular [4]. Many studies describe positive effects of particular demonstrations on student learning, for example [4]-[7], yet little research has been done to determine what fundamental aspects of demonstrations make them most pedagogically useful. We sought to characterize demonstrations based on their construction finish quality, and determine the effect of this metric on pedagogic utility.

Specifically, this study separates demonstration build quality into one of two categories: "raw" and "polished". Raw demonstrations use prototype-quality construction techniques such as exposed solderless breadboards and knobs attached to angle-brackets, leaving wiring and through-hole components visible. Polished demonstrations use production-quality construction techniques such as CNC-machined front panels, with circuit boards hidden behind a lacquer-finished exterior. Based on anecdotal evidence, we hypothesize that technical majors such engineering and physics students prefer demonstrations that use raw construction methods, perhaps because it appeals to their sense that they could build the device themselves, and that liberal arts students prefer polished construction techniques, perhaps because they look similar to commercial consumer electronics products they use.

METHODS

The hypothesis that the construction finish of a classroom demonstration affects its pedagogic value will be assessed by constructing two different demonstrations: a remote controlled vehicle and a laser-based audio communication device. This works-in-progress paper reports the experimental findings of the remote controlled car only. The car was used with a ten-minute lecture describing the coil and damper in suspension systems. It was used in one of two configurations to demonstrate the raw and polished construction techniques by either leaving the top chassis exposed or covering it with an injection-molded painted monster-truck body. The cover did not obscure the coil/damper struts so the car's potential efficiency as a demonstration for the lecture topic was unchanged.

Pedagogic efficiency was assessed with a five minute post-lecture questionnaire. The questionnaire recorded basic demographic information (academic major, class year), and asked several questions of progressive difficulty about the lecture material to objectively assess student comprehension. It also asked the students to self-rate the demonstration's impact on their understanding of the material and separately on their desire to learn more about the subject. Thus, three different metrics of the pedagogic efficiency of the demonstration were obtained: an objective comprehension score, the students' self-assessed subjective comprehension, and the students' subjective assessment of their enjoyment. All scores were normalized on a 0-1 range to simplify comparisons. Two-tailed Student T tests were used to determine whether construction quality affected the above three chosen metrics of pedagogic efficiency. Error bars in results refer to the experimental standard error of the mean.

PRELIMINARY RESULTS

The raw data is shown in Figure 1. The type of construction exhibited a strong trend toward statistically significant impact upon objective comprehension scores with a two-tailed p of 0.053, and clearly influenced student enjoyment with a $p < 0.01$. Interestingly, by both measures the "raw" demonstrations were more effective than their "polished" counterpart. Demonstration quality did not appear to influence the students' self-assessment of their comprehension ($p>0.20$).

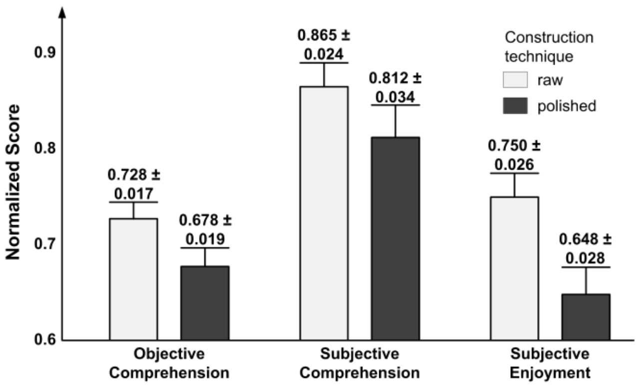

FIGURE 1
STUDENT RESPONSES TO DIFFERENT TYPES OF CONSTRUCTION TECHNIQUES.

Results grouped by major revealed grossly similar findings. Grouping did not alter trends, although smaller experimental subgroupings removed statistical significance from all measurements except non-technical majors ratings of enjoyment (Figure 2). These showed they overwhelmingly preferred the "raw" demonstration quality ($p<0.01$). The fact that high statistical significance was achieved indicates that, at least for this particular demonstration, it is unlikely caused by the relatively small sample of N=24 and 33 for the polished and raw trials of non-technical majors, respectively. Further experimentation with different demonstrations is planned to determine if this conclusion can be generalized regarding demonstration construction technique.

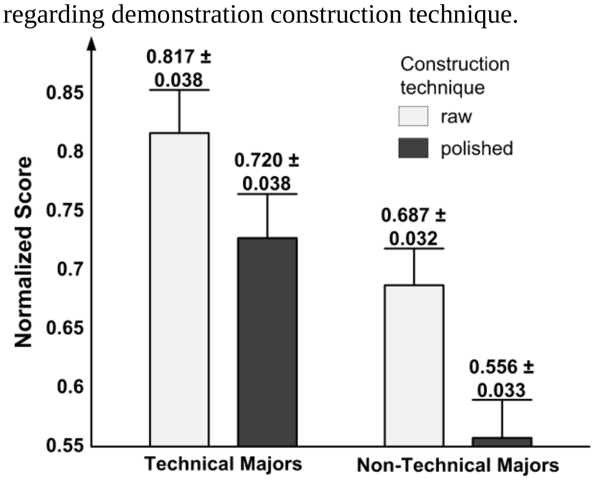

FIGURE 2
GROUPING SUBJECTIVE ENJOYMENT SCORES OF FIGURE 1 BY MAJOR.

Conclusion

These preliminary results show the particular engineering-style demonstration used in this study is more effective, both as an instructional and motivational tool, when using prototype-quality construction techniques than when using commercial-quality polished construction techniques. These results hold regardless of student major. By collecting additional data using other demonstration models we hope to determine if this finding can be generalized, and thus serve as guidance that when creating any engineering pedagogical demonstration, we should keep them looking like the prototypes they are.

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