

Work in Progress: Outreach Assessment: Measuring Engagement

An Integrated Approach for Learning

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Abstract— The Learn By Doing Lab (LBDL) at Cal Poly, San Luis Obispo is an on-campus laboratory where 5th through 8th grade students are taught by undergraduates who may be planning a careers in teaching. The two populations - elementary students and undergraduates - are equally important in the process. Since 2008, the lab has seen over 4000 elementary and junior high students and over 100 undergrads have participated. In most outreach assessment the number of individuals participating is an important metric, but this last Spring we experimented with a more in depth measure of effectiveness. As in any learning experience engagement in the process is an essential ingredient. Although there are several methods of measuring engagement, we chose to observe the activity of the participants as a proxy for engagement. Two industrial engineering (IE) undergraduates who themselves have been exposed to the topics of work sampling and observation studies had an opportunity to improve professional skills through this application. This involvement of undergraduates is consistent with the LBDL and Cal Poly's motto of "learn by doing." These two students, who are also co-authors, spent multiple hours coding and randomly sampling the of the elementary and junior high students as well as the undergraduate teacher's activities. Not only did the IE students discover important insights for the LBDL they also learned how to apply work sampling in a research setting. This paper discusses the integrated learning environment and the next steps involved in these undertakings.

K12 outreach; observational studies; integrated leaning

I. INTRODUCTION

A quandary in K12 outreach activities is the effectiveness of the events. Whether it is a hands-on laboratory like we have at Cal Poly or informal science activities, the effectiveness is often measured by the number of individuals participating [1,2]. Sometimes there is a self-report survey given, but the reliability and validity of such instruments is hard to determine. We tried an observational method that has been used successfully in other educational settings [3].

Initially we wanted to explore the observational method to see if any insights could be gained regarding student learning or the design of the activities. We also thought this could be used in other educational settings. As we explored this method it seemed similar to "work sampling" [4], a method of determining time standards in the Industrial Engineering (IE) practice. Students in our IE program are exposed to this technique but the chance to practice this method is limited. Given this, we recruited two students (co-

authors on the paper) to help develop the assessment method as a work sampling task.

There are two groups of interest in the LBDL. The first is the K12 students (we refer to these as "K12 students") who visit the lab and the second group is the college students (we refer to this group as "TA's") who take the class to explore the possibility of a career in teaching. Both of these groups were observed.

As we progressed we saw that there were actually three goals of this study. As we initially desired, the first goal was to measure engagement in the outreach activity for both the K12 students and the TA's. The second was to practice this method of assessment so we could use it in other settings. The third goal was to provide an opportunity for IE undergraduates to hone their skills in a technique used in their field. This paper starts with a brief description of the LBDL activities and then discusses the three goals. We also will touch on the unique integrated nature of this study.

II. DESCRIPTION OF THE LBDL ACTIVITIES

The LBDL is an on-campus laboratory where 5th through 8th grade students are taught by undergraduates who may be planning careers in teaching. Since 2008, the lab has seen over 4000 elementary and junior high students and over 100 undergrads have participated. The activity in this specific study involves the building and testing of a wind turbine. TA's begin the one hours session with a short discussion about engineering practice. The TA's then work with small groups of K12 students to develop an efficient wind turbine. The turbines are tested using a fan to determine the blade configuration (i.e., size, shape, and pitch) that generates the maximum voltage. Students are encouraged to test and adjust. The activities are repeated twice a day with a different group of K12 students. A successful activity has students talking and testing in a fun active environment.

III. WORK SAMPLING AND OBSERVATION STUDIES

Work sampling is a technique used by IE professionals to determine work content. The study is designed using random samples and statistical analysis to determine the approximate rate of occurrence of the activities. The output from the technique is a statistically confident definition of proportion of occurrences. This is very similar to the engagement observation studies described in the literature.

A. Reflection by the IE Students

“Learning the concepts of work sampling within lecture was quite different from applying it to the Learn by Doing Lab. The objective and procedure to obtain results were given to us in our courses, but in the LBDL there weren’t predefined procedures for work sampling. As a team of two, we discussed the best ways to record data, observe the subjects, and analyze the information. This freedom worked positively in allowing us to fortify our previous knowledge of work sampling and statistical analysis. The research was truly a “Learn by doing” example as it allowed us to test our proposed research methods and learn what worked and what did not. Seeing the material in lecture is one thing, but being responsible for the research and observation was truly beneficial for me. Before, my knowledge was adequate, but now I feel much more comfortable in applying my skills to real world situations. I can see that work sampling cannot only be applied in factories, but really in any situation.”

B. Next steps

The transfer of knowledge from lecture to research activity, in this case the LBDL, was a valuable experience. We plan on having undergraduate students to participate in this type of research activity in the future. There are many areas of observations that are of interest and knowing how this helped the students more thoroughly understand work sampling technique encourages us to use it in the future.

IV. OBSERVATION TO MEASUREING ENGAGEMENT

To define the observational categories we spent time watching activities. This lead to five different categories for the TA’s: Working, listening, interacting, traveling and idle. For the K12 students three categories were used: Working, focused watching, and idle. We set up a schedule of random observations for a total of between 15 and 20 observations during the two hours of activities each week. There were between 12 and 16 TA’s each day and between 30 and 40 K12 students. It was important to take the observations in a random fashion to maximize statistical validity. The data was collected and analyzed for insight into the activities.

A. Reflection

Several insights came from the studies. First the process of observing is not straightforward. We had to make adjustments in the process after the first week. The categories were initially not defined with enough detail. In addition tracking all subjects was difficult. In hindsight having two observers scoring and tracking, would have helped the validity of the study. We considered video taping the labs for both a visual record and for validation of observational judgments.

B. Next steps

As we continue to develop these studies we will have two individuals observe and score the subjects. Although it might be ideal to videotape and watch the videos to develop scores, it would make this tedious activity even more so and we feel the interest level for the researcher would fall.

We are using these observational techniques for other studies on engagement, including a random study of classroom activities across campus and in studies that contrast innovative teaching to traditional lecture.

V. EFFECTIVENESS OF THE LBDL ACTIVITES

The observational studies themselves lead to several insights into the outreach activities. In order to statistically test the comparisons we ran Chi-Square goodness of fit tests. All reported differences had a $p=.001$ of lower, but we would feel more comfortable if we had had multiple observers to validate the observations.

A. Reflection

- The younger K12 students spent more time watching while the older students spent more time working
- The second group of K12 students each day had higher proportions of working. This may have been due to a kind warm-up or practice for both K12 students and TA’s.
- The lower ratio of K12 student to TA’s the higher the proportion of working time.
- When there were more females in a group the group spent more time working.
- The TA’s were noticeably more active in the activity when the children were younger probably because more explaining was necessary.

B. Next Steps

As we refine our ability to observe the insights gained will help to develop more effective outreach activities.

VI. CONCLUSIONS

The LBDL provided an exceptional place for us to practice aspects of integration. We integrated the IE student’s curriculum into an observational study on engagement in order to develop insights into activities that help engage K12 student interest in STEM activities. As we progress in our practice in these areas we believe we will be able to develop effective measure of engagement while encouraging technique development through educational research.

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