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Title: Development of a Classroom Radio Receiver Engineering Activity

Midterm Progress Report

Arizona State University Space Grant Consortium

My space grant project focuses on developing a lesson plan for middle school aged students to build and understand an AM radio receiver system. Special emphasis is placed on teaching the students both engineering and science concepts. In order to test the effectiveness of the lesson plan, I will be giving the lesson at several middle schools on two separate Native American reservations, one high school and one elementary school on the same reservation. I am also giving the lesson at a retirement home in Tempe, AZ, in order to include this largely ignored outreach demographic. The effectiveness of the lesson is directly measured with the use of a modified Fryer chart, where students answer 4 key concept questions before and after the lesson, in separate colored pencils. The overall grades can be calculated before and after the lesson, to determine (on a number scale) how much better or worse the students do after the lesson.

The timetable submitted during the proposal process is shown in Table 1. So far, I am on schedule to meet these goals by the end of the semester. I the lesson plan has been developed, which includes sections for: Background Information, Lesson Outline, Detailed Instructions, and Curriculum Alignment. The main science and engineering narrative is given in the background information section. This is the material the teacher is asked to draw upon in the brief, approximately 15 minute lectures that come before and after the radio receivers are being constructed by the students. There is another brief lecture period that comes before the students attach their receivers to the antenna to listen to the incoming radio signals. The lesson outline tells the teachers when to draw on this material, and the corresponding step number is clearly indicated on the background information section. The content that is presented in the lectures is then reinforced during the steps of the construction process.

Week	Goal
1-5	Initial Lesson Development
6-9	Classroom and Public Demonstrations
10-12	Evaluation and Refinements
13-15	Teacher Development Workshop and Final Evaluation

Table 1. Proposed schedule of progress

There is a small, pre and post-lesson activity that the teachers must do on their own, which is to have the participants fill out the Fryer charts. I have made this decision to not include it during the lesson itself, since I think the time to do the activity will fill the entire time slot. I have done a practice run (detailed below) and think that it will take a minimum of 2 hours to complete the activity. Since I will be giving the lesson personally during this trial period, I want to make every effort possible to fit into a 2 hour time window. However, if the lesson plan is distributed at the end of this semester, the teacher could easily decide to split the lesson up into two, one hour long class periods. This will make the activity easier for teachers to fit into their existing class structures.

While I have yet to perform the lesson at a primary education school, I have done one lesson at a collegiate level. This was not written into the original proposal, but was easy to implement and helped me

better develop the lesson plan. I have given the activity to a group of 32 freshmen undergrads during Camp SESE, a weekend retreat that happens within one month of the student's arrival to ASU. Therefore, the students have only a high-school level of understanding of the concepts being taught, and so was a great preparation asset. The structure of the lesson had not been worked out yet, and so the students worked in small groups and were more self-guided than I had planned on providing. I did give a short, approximately 5 minute presentation on what the activity was about, and what the groups were supposed to do. Then, the students broke up into groups of 3-4, and I walked around and helped the groups as they moved on to the next step. The different groups progressed at different times since the materials were limited. I had several copies of the steps that were distributed among the groups, as well as two circuit diagrams. I also had a completed device that the students could look at as reference.

There were several lessons learned from this experience. First of all, the circuit diagram was pretty unhelpful to all but one student who had experience working with electronics before. Therefore, passing out a diagram to the students to use as a guide will be useless, since they will have to be taught how to use it before they will understand it. I will assess whether there is enough time to include this in the lesson activity or not, but it is currently not a teaching point. Also, it took the group of well-focused college students the full 2 hours to complete the activity, with letting them just follow written instructions and going around to help them as needed. Part of this was due to the fact that I only had 4 rolls of magnet wire, which bottlenecked the whole process since rolling the inductor is one of the first steps and takes the longest amount of time. So, for the middle school students, my lesson will be structured as a 'guided tour', where I demonstrate each step briefly before letting the groups do it on their own, and then repeating this process for each design step. In order to do this, each group will need to have their own kit that includes all the tools and components necessary to build the receiver. I have purchased this material, which sets a limit on the number of groups to 10. This should cover a typical classroom of 30 students. I will try the original, more self-guided structure on the retirement home community, to see if it works better on that age group. Some of the steps will take a considerable amount of time, which will alternatively give me a moment to reinforce the lesson concepts or to walk around to individual groups and help as needed. Also, I identified several directions listed in the written steps that needed to be much clearer. This is especially important for the younger groups who have the least experience with electrical components. One of the things I will need to pay attention to and optimize is the length versus the clarity of the instructions. If the steps are not clear enough, then the devices may fail due to faulty construction, and the lesson will be extremely ineffective. However, if the directions are too lengthy per step, some of the details may get glossed over or lost in the shuffle, and the same issues could arise. Lastly, the camp where this activity was held had poor radio reception, and so none of the students devices were able to work (neither did my ready-made device, which was tested and worked in the city of Tempe). Since some of the more remote reservations may have the same problem, we have purchased an AM radio transmitter, which can be used as a back-up source if necessary.

So far, I am satisfied with the progress made up to this point and I am excited to begin its implementation. I feel fortunate to have had the opportunity to test the lesson plan early and work out some major issues before taking the activity to different schools.