Facing Coaching Challenges in Long Term Inquiry Projects: Examples from Electromagnetic Systems

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Abstract. During the 3 year Inquiry Physics program, students progress towards their final project, scaffolded by continuous mentoring. Coaching challenges are met by a supportive framework covering physics knowledge and inquiry know-how. Six final projects in our current class deal with electromagnetic systems - motors, generators, wireless power transmission and related motion. Text-books and scientific papers are provided for advanced topics. Socratic questioning and just-in-time teaching help connect observed phenomena and theory. Inquiry is supported by identifying variables and manipulating them, digital measurement instruments (e.g. USB based oscilloscope), demonstration of procedures and facilitation of continuous documentation in a designated digital environment.

1 The Inquiry Physics Program

The notion of involving physics learners in first hand investigation of physical phenomena has permeated physics education philosophy for over a century [1]. Science education policy-makers have long realized that the rapidly developing science and technology based economy requires training young people to go beyond the traditional, lecture-based instructional model towards becoming researchers and designers of systems and processes.

The Inquiry Physics program [2] is an elective major intended for students in grades 10-12, who take it in parallel to the traditional advanced level physics course. During the program students acquire inquiry knowledge and skills and complete a serious physics inquiry project under the guidance of specially trained Inquiry Physics mentors.

2 Facing Coaching Challenges

Lack of a solid knowledge-base and insufficient inquiry training are the two main impediments to success for students undertaking advanced inquiry projects. Many of the required topics are absent from the school physics curriculum or are not covered in time. Required inquiry aspects are almost absent from school physics culture, and they are gradually developed within the Inquiry Physics program. However, our experience has shown that when the students are faced with unstructured inquiry contexts and new measurement challanges, they require additonal guidance. Mentors coaching inquiry teams should be aware of these deficiencies and design ways to mediate the content and skills in an effective and digestible manner. The content and inquiry support components should be interleaved, as the inquiry project progresses from initial confusion towards organized conclusion.

Following is a short description of the coaching support that was provided to a team of two girls inquiring into "Wireless Power Transfer". In our conference paper we will extend the description to several inquiry projects of electromagnetic systems.

Team 15 decided to explore electromagnetic induction phenomena, in the contemporary exciting context of remote charging of mobile phones. They started with the simple set up of two parallel coils, and progressed to resonant RCL circuits after reading about WiTricity. The physics content support included scientific papers on wireless power transfer [3]; a text book on "Alternating Current Circuits", and an instructional text about combining oscillations and related Lissajous figures. These resources were provided over a period of several months, following friendly questioning about ongoing experiments which revealed knowledge gaps. Direct instruction was provided, explaining text book narratives and demonstrating the derivation of various relationships. When needed, the instructor accessed relevant web resources to demonstrate a system or procedure. During the explanations the students took notes, asked questions, performed calculations, manipulated the experimental system and often photographed a relevant page of the text book and the instructor's notes.

Team 15's inquiry project required insulated copper wire of various thicknesses for preparing coils with desired specifications, and materials for supporting the coils, a signal generator and a selection of electrical components (e.g. capacitors and wires). The experimental set-up required Resistance, Capacitance and Inductance meters, and a digital measurement system with voltage, current and magnetic field sensors. Since the calculated resonance frequencies were in the order of magnitude of several kHz, a usb-connected digital oscilloscope was added to accurately measure voltages and phase differences (Fig. 1). Initial set up and operation of the signal generator and oscilloscopes were explained and supervised by the technical staff.

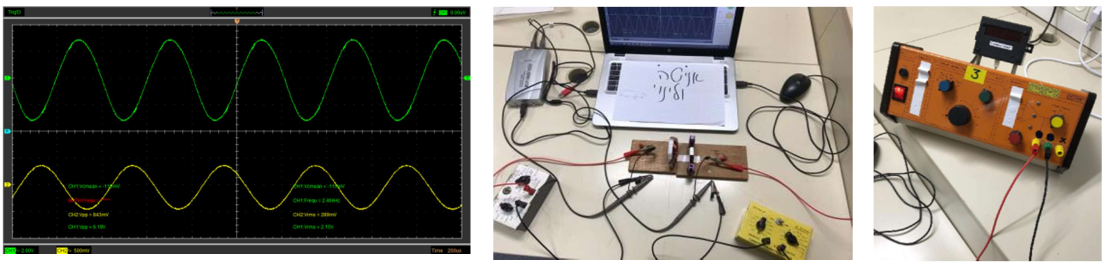

Fig. 1 Experimental set up for "wireless power transfer" inquiry

Systematic documentation of relevant information was supported by Moodle sites created by the program leader for each inquiry project, with a structure modeling the components of the final report. Team activity has been monitored using Moodle generated reports, providing evidence that team 15 has been quite diligent in uploading experiment plans and outcomes, photographs, and other materials, and confirming that they have benefitted from the provided coaching

3 Conclusion

Guiding high school physics students through the process of carrying out a long-term advanced inquiry project involves facing challenges on several fronts, in particular regarding physics content knowledge and inquiry know-how. Students in their final year of the Inquiry Physics program can benefit from the supportive framework that allows them considerable independence and space for unstructured exploration, along with technical support, responsive monitoring and mentorship.

References

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