

Investigating Physics: An Intimate Look at an Online Inquiry-based Graduate Science Course

Andee Rubin, Sue Doubler

TERC

Cambridge, MA

Andee_Rubin@TERC.edu

ABSTRACT

In this paper, we describe a new online course, Investigating Physics, which is part of an online master's degree in science education. The course is firmly rooted in the pursuit of scientific inquiry as a pedagogical model and we discuss here what design issues and solutions arise from this commitment to inquiry and in what ways the course supports the creation of a learning community that supports and extends students' growth in scientific thinking.

Keywords

Online master's degree, scientific inquiry, investigating physics, learning community

Introduction

Everywhere where we look, there are new online courses, from high school through graduate school. Serious conversation about important design aspects has proliferated more slowly, however, and the definition of a set of perspectives from which to analyze online courses has barely begun. This is a difficult task, since educators rarely agree on ways to analyze face-to-face learning interactions either.

Therefore, it is important that the conversations we have about online courses include pedagogical decisions as well as decisions about the online structure of the course. We describe here a course whose designers constantly returned to the pursuit of inquiry as a pedagogical model and, we believe, arrived at some interesting and new ways to think about the issues that arise when inquiry is the guiding principle of course construction.

Investigating Physics

Investigating Physics is the third in a series of six online courses that make up a fully online master's program for elementary and middle school teachers in Science Education, developed collaboratively by TERC and Lesley University. The program seeks to "re-open the door to science" by providing teachers with a safe environment where they can think hard, work collaboratively, and extend their science understandings. Totalling 33 credit hours, the program helps teachers increase their knowledge of physics, biology, earth science, engineering and ecology, while exploring new ways to support their students' science learning. As they develop their own expertise with computer-based technologies, they learn ways to enhance their students' learning with technology as well.

Creating a course that takes serious a commitment to learning science through inquiry presents many design challenges. In the Investigating Physics course, as well as the other courses in the program, we have successfully used the following design features.

The courses are designed to be solid science courses, but written for an audience that has often had negative school experiences with science. In the case of physics, people's memories were especially painful and some began the courses quite tentatively. The Investigating Physics course is on forces and motion—especially Newton's Laws. The aim of the course is for participants to see Newton's Laws in their own everyday actions by taking the perspective of a physicist. To guide the students' in their scientific thinking, one of the two instructors for the class is a scientist.

Each course is designed with an explicit focus on inquiry as a tool for learning – and teaching. This is not a simple task; it is easy to give lip service to inquiry, but more difficult to ensure that understanding develops through inquiry - especially online. This is where the learning community fostered by the course is most important. As explained in more detail below, participants' interactions with one another, which are carefully supported by the course structure, are the major place that understanding unfolds from the investigations carried out by each course participant.

A key aspect of inquiry fostered by the course is first-hand experimentation carried out in course participants' homes. In Investigating Physics, a kit of materials is mailed to participants before the course begins - it contains a low-friction cart, several balls, some spring scales - simple materials that cost little and could be used in a classroom as well. Each course session begins with, first-hand experimentation that demands close observation; participants record their results in their journals, which then form the basis for their online conversation during the week.

In each course in the program, there is a dual emphasis: on science and on pedagogy. In the Investigating Physics course, the pedagogical emphasis is learning how to conduct interviews with children to understand their scientific ideas.

During the course, each student conducts interviews with several children on the same topics they are studying themselves, and transcribes and analyzes portions of each interview to share with other participants. In order to support this aspect of the course, there is a second instructor, who is a science educator. Both instructors interact with the students in the various forums described below.

Video is used in two different and, we have found, highly effective ways. In a more common use, there are video segments of interviews of the kind they are learning to conduct. These were designed and produced especially for the course. The other use of video is more unusual. We include short video clips of motions that take place over too short a time to be analyzable in normal time. Participants can view these videos in slow motion and can analyze them frame by frame. Most of the videos in the course are less than one second long. Participants follow the path of objects they are studying by putting an overhead transparency over the screen and marking the series of positions the object is in as the frames advance. This creates a trace of the motion of the object and is the basis for many of the participants' discussions

An important part of students' learning is the study of different mathematical representations for motion, some conventional, others tailor-made for the medium in which they are working. In many online courses, the only thing participants can share is text. We explicitly gave students the ability to share graphs and other sketches with one another, using Powerpoint. This turned out to be an important part of the course, as sometimes the only way students could communicate their analysis of a motion scenario was through a diagram

Of course, all this takes place in a learning community which is the result of several features of the course. Early in the course, students are divided into several teams of five or six people. This is their "study group," the students with whom they will explore the science, share their interviews and offer personal support. Students communicate with one another in three separate forums. In the Physics Forum, students discuss the data they have collected, their analysis of it and further questions it evokes. This is where students also share graphs and sketches to illustrate their analysis. In the Learning Forum, the conversations center on interviews with children, including bits of transcript and analysis. Because all participants ask similar questions in their interviews, they are able to compare both their interviewing techniques and what they discovered about the child they interviewed. We added a third forum after the course began: the Motions in your Life Forum, in which participants describe places in their lives where they find the kind of motions and forces they are studying. There is also a place to share more personal trials and tribulations and to ask for support: Charlie's Café, named after a "real" café at Lesley.

We've learned a great deal about designing such a course, and in the process we have generated enough data (i.e. the online conversations) to keep many Ph.D. Candidates busy for years. We hope this is indeed what happens, since the analysis of these data can reveal much more about how online courses work.