[O21] Distance education in elementary physics without face-to-face sessions: the design of problem-solving and laboratory content for a web-based course

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There is a strong prejudice among physicists, and specialists in other mathematically intensive disciplines, that effective distance education is not feasible in their subject because of the impossibility of teaching 'problem-solving' without strong one-to-one interaction and because of the necessity to conduct meaningful laboratories which require expensive apparatus. For these reasons, it is widely held that some face-to-face sessions are essential. Where students in a course can be truly remote, and travel to a central site is difficult and expensive, issues of fairness arise when some local students have access to instructors and remote students do not. The advent of the versatile and interactive Internet provides a means of addressing these issues. The ubiquity of the personal computer and a fresh approach to simplifying the laboratory exercises addresses the problem of experimental work.

1. A suite of interactive lessons (applets) is being developed at the Universities of Calgary and Alberta (in western Canada) with careful pedagogical design to address basic concepts in Elementary Physics. These highly interactive tutorials mimic a private seminar experience, combining student exploration of a physical principle with instructor 'explanation at the blackboard'.[1]

[1] The pedagogical approach might fairly be compared to the activity oriented style of SToMP without the latter's continuous narrative linking one activity with the next.

2. At the University of Guelph we have emphasized the development of teaching tools to assist students in their problem-solving skills. The 'Socratic Problem Solution' (SPS) supports students in individual problem-solving by stepping them through typical multi-path problems. By working through more complex problems that are broken down into small steps, students are helped through the solution process bit by bit. They receive enriched feedback about correct – and incorrect – interim choices to ensure that they are applying the correct principle and accurately solving each step of the larger problem. SPS on-line tutorials have been created for every major concept which is emphasized in this course. The SPS problems are taken from the student's textbook, and keyed to the exact place in the Study Unit where it is relevant. It is important that the developing solution be an example of a students own notebook with an accumulating solution on every 'page'.

3. While some lab experiments, e.g., electricity, have proven intractable without specialist apparatus, several meaningful, quantitative experiments have been designed in mechanics and optics using mostly items found in the normal household. Since the course cannot be taken without a computer connected to the internet, it is included in the list of 'household' items. These 'do-it-yourself labs' contrast with the high-tech use of the computer simulated experiments. Physical

principles that students find difficult to conceptualize are demonstrated using common objects, turning 'esoteric science' into something they encounter in everyday life.

4. To provide the on-line equivalent of unstructured help sessions, two 'Supported Learning Group' (SLG) sessions are held each week. In these, a student who has successfully taken the course in the previous year convenes and moderates a 'chat-room' group. The student is not expected to be a tutor; he functions as a leader of the group to find their own way through problems which they bring to the session by collectively contributing to the discussion. To help in the visualization of the problem the student facilitator has been supplied with a shared graphical palette.

The clientele of this course is as difficult as any group can be since it is for those entering the University without high school Physics. This lack can be for various reasons but the most common is that the students avoided Physics as being too difficult. On entering university they are confronted with the fact that all students in any science must take Physics so the course is offered in a face-to-face version to about 200 students each Autumn (Sept – Dec) semester. It is only offered as a distance education course in the Winter (Jan – April) semester, so that students who fail in the Autumn, and are granted permission to repeat, also are part of the clientele – about 50%.

Utilizing these four sets of tools and strategies, an award-winning [2] course, offered entirely at a distance, has been constructed which has had considerable success compared with previous 'paper and videotape' versions and whose results in both student persistence and performance rival those of the traditional residential course offerings.

[2] The OPAS (Office for Partnerships and Advanced Skills) Excellence for Teaching with Technology Award (2004).