

Using Electronic Interviews to Explore Student Understanding

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Abstract. This paper reports on methods used to probe student understandings of optical fibers and total internal reflection (TIR). The study was conducted as part of the expansion and improvement of web-based materials for an innovative introductory physics course. Initially, we conducted face-to-face Piaget-style interviews with a convenience sample. Our next step was to interview students taking the course at Rensselaer. Physical limitations necessitated that this be done from a distance, so we conducted “e-interviews” using a Chat Room. In this paper we focus on the e-interview experience, discussing similarities to and differences from the traditional face-to-face approach. In the process, we address how each method informs us about students’ activation of prior experiences in making sense of unfamiliar phenomena (*e.g.*, “transfer of learning”).

INTRODUCTION

Since 1999, Rensselaer has offered The Science of Information Technology (ScIT) to a total of 158 academically diverse students [1]. This innovative course teaches the scientific principles behind the operation of computing systems. For example, in ScIT we apply total internal reflection (TIR), a phenomenon commonly covered in traditional physics courses, to optical fibers, a technology eminently relevant to the students [2].

Part of our ongoing curriculum development process is to assess student preconceptions and construct a diagnostic test that distinguishes between preconceptions associated with different levels of comprehension. The Physics Education Research (PER) literature abounds with studies of preconceptions [3], but few (an exception is ref. [4]) have examined how students approach topics addressed in ScIT: *e.g.*, TIR, propagation of signals, and semiconductors. We chose to study how students describe refraction and optical fibers.

Piaget [5] developed the method of critical exploration to see what thoughts lay behind a child’s initial answer to a question. Such clinical interviews have been widely accepted as an effective means of eliciting

learners’ reasoning and conceptual frameworks [5-7]. The PER community has its own strong history [8-10] of using such interviews to effectively probe student comprehension about a physics-related concept.

We initially conducted face-to-face interviews with a convenience sample of 12 volunteers with diverse physics experience. When such face-to-face interviews with ScIT students were not possible, we conducted “e-interviews.” (The use of e-interviews to guide the development of web-based curricular materials seemed particularly apt.) In this paper we discuss our experience with both interview formats.

METHODOLOGY

Interviews have traditionally been conducted using face-to-face (f2f) dialogue. The interaction is recorded and later transcribed. In the summer of 2002, we used this format to interview a convenience sample of 12 volunteers (Group A, Subjects A1 to A12). The interviewees included five in-service teachers who had formerly taken introductory physics, five physics REU participants, and two physics faculty. These interviews

provided a “broad picture” of how individuals from a variety of backgrounds think about optical fibers.

Our next step was to interview members of our target audience: students enrolled in ScIT (Group B, Subjects B1 to B22). All interviewees had taken high school physics; many had also taken college physics courses, as summarized in Table 1.

TABLE 1. Physics Background of Interviewees.

Highest Completed Physics Course	Grp A	Grp B
High School Physics	1	9
College Physics I	0	8
College Physics II	4	3
Upper-Level Coll. Phys.	5	1
Physics Faculty	2	0

Face-to-face interviews with students enrolled in ScIT were not possible, since the interviewer and students were in different regions of the country. Additionally, Rensselaer’s tradition of innovative use of technology in and out of the classroom, along with the amount of time spent by college students in Chat Rooms and using Instant Messaging (IM) [11], suggested that ScIT students would be fairly comfortable using electronic communication. We therefore conducted “e-interviews”, using the Chat Room tool of WebCT. All 22 ScIT students were interviewed in this manner before instruction; post-instruction e-interviews were conducted with 8 of those 22.

ScIT students signed up for interview times in one of WebCT’s four chat rooms. At the appointed time, the interviewer and the interviewee “met” by logging into the chosen Room. Like their f2f counterparts, our e-interviews started with participant identification and verification of informed consent. Initial questions about students’ backgrounds helped build rapport and establish comfort with the environment before turning to the content-laden questions.

Both sets of interviews were conducted by the same interviewer (a physicist); a cognitive psychologist “observed” many interviews to gauge their efficacy. The content portion of all interviews began with the question “What does an optical fiber do?” Subsequent questions included, “How might the fiber keep the light from escaping out the sides?” “What can you tell me about refraction?” and “How does TIR occur?” In the tradition of Piaget, our interviews were dynamic and driven by the participants’ responses, so the exact set of questions depended on those responses.

Consecutive interviews were scheduled in different Chat Rooms. Each Chat Room opens up in its own browser window, creating individual “examining rooms.” For example, the interviewer could wrap up

an interview with one student in Room 1 while starting the preliminaries with the next student in Room 3. The separate browser windows, along with the scroll bars and automatic transcription of the conversation, assisted the interviewer in keeping track of the “tone,” as well as the specific content, of each interview.

FINDINGS

Our purpose in this paper is to report on our experiences using the two interview formats and offer some observations for those who might consider the e-interview approach. We are not attempting to show either the superiority of one method or the equivalence of the two; indeed, such direct comparison of these two disparate formats is akin to the proverbial comparison of apples and oranges. We have grouped our observations around three aspects of the interview experience: descriptions of targeted physics topics, how the different modes of communication affected the social interaction, and practical considerations.

Targeted Physics Topics

We found that the physics descriptions gleaned from the e-interviews were consistent with those observed in the f2f interviews. Analysis of those descriptions is reported elsewhere [12]. Here we present specific examples of descriptions found in the two formats.

Consider the following excerpts from e-interviewee B11 and f2f-interviewee A8.

B11: “Light [in an optical fiber] is prevented from escaping too early, by using mirrors to make sure the light bounces through the cable and doesn't escape. ... [the mirrors] are made of glass and located throughout the cable.”

A8: “if uh, you want the light to go in different directions inside of the tube you would ... Somehow screw, uh, put mirrors on the sides of the tube at a certain angle so when the light goes, uh, enters from this side ... it would be reflected here (points at diagram).”

In both formats subjects successfully conveyed an image of mirrors embedded at points within a fiber

F2f-interviewee A5 and e-interviewee B10 each drew upon past experiences to *reject* a mirrored-surface model of fibers. A5 recalled “those things you get at like Disney World ... there's like a light that you see at the end of the strings, but the strings themselves don't look lit up.” B10 also recounted his experience

with character wands which “looked similar to a flashlight with a battery inside ... when you turned them on, there were all of these wires coming out of the top of the wand, and the ends would glow different colors.” Although A5 expressed her experiences vocally while B10 typed his, both were able to effectively communicate the memories they activated.

Social Interaction

Social interaction in face-to-face interviews utilizes multiple communication channels. The f2f subject uses not only words, but also tone of voice and gestures to convey meaning. Additional communication may occur through drawing or interaction with demonstration equipment [8]. For example, we provided a scratch pad in the f2f interviews; it was used in all but one of those interviews. Furthermore, the f2f-interviewer may discern the subject’s emotions and motivational state by reading facial expressions and postures. These visible channels of communication are simply not an option in e-interviews; their absence changes the nature of the social interaction, as described below. In our specific experience, this change did not lead to a substantive difference in descriptions of the targeted concepts provided by interviewees.

Consider the descriptions of Disney World wands provided by subjects A5 and B10. A5, in her f2f interview, used gestures to illustrate how the fibers sprouted out of the character’s head and wiggled. B10’s description required a few more words but conveyed a similar description of his past experience with optical fibers. Similarly, B11 and A8 were both able to convey a model of fibers with mirrors embedded in them, even though e-interviewee B11 did not have the scratch pad provided in A8’s f2f interview.

Participants in the e-interviews created work-arounds to constraints they experienced. Subject B18 “drew” with keyboard symbols: “I think it would bend toward that wall -- so it enters like ‘\’, then inside is more towards ‘---’ (but not, necessarily), and then when it leaves, it’s back to ‘\’.” Subject B21 drew off-line: “[light bends] towards the normal -- Changed my mind, away from the normal -- I drew a picture.” The interviewer commented on the lack of a scratch pad in 6 of the 30 e-interviews when visualizing what students described was particularly difficult. Some success was achieved through questions such as “Can you describe what you’re visualizing?” (One student replied, “I’m visualizing the beam that goes through the boundary to bend closer to parallel [sic] with the boundary.”) Still, the absence of a scratch pad in e-interviews did sometimes limit the extent of probing.

The Chat Room interviewer can glean some insight from the language and format used. Lack of uppercase letters, the inclusion of IM jargon [13] such as “lol” or “iirc”, and the use of emoticons such as :) and :-& can indicate how comfortable the participant is or qualify a statement. Twelve of the 22 ScIT students e-interviewed used IM jargon, and the interviewer used jargon or emoticons in almost every e-interview, to put the subjects at ease. Subjects frequently chose to type out their qualifications and hesitations – phrases such as “i don’t know the specifics, but ...,” “umm -- i could make a stab in the complete dark,” and “I think I am confused -- Let me re-phrase my answer” were common throughout the e-interviews. Also common was the use of question marks at the end of statements to indicate hesitancy. The interviewer suggested the use of a symbol (#) to signify the completion of a turn, since pauses were easily misinterpreted.

Gestures, facial expressions, and tone of voice may be misinterpreted or get lost in a transcription of an f2f-interview. E-interview participants cannot use anything except their words and are therefore likely to describe their thoughts more explicitly. And the e-interviewer does not have to worry about her unconscious reactions influencing an interviewee’s responses. We harbor no illusions, however, that the text of a Chat Room transcript can provide the same detailed information as can a video of a f2f interview. Emotions/reactions in an e-interview arise from the interviewee’s conscious effort; unconscious (or unacknowledged) reactions are not easily identifiable in an electronic conversation. Additionally, the e-interview is not a “controlled” environment; *e.g.*, the subject’s doorbell could give rise to a pause that the interviewer interprets as the subject thinking hard about a question. The importance of these constraints will, obviously, depend upon the information sought in the study.

Practical Considerations

Researchers conduct interviews to collect information, but the information collected is not the only factor one must consider. Time and resource constraints, along with the willingness of subjects to participate, play a crucial role in the success of a study.

E-interviews are convenient. They can involve participants from across the country – even from around the world. Times can be arranged without regard to building access or office hours. (Ours were often held between 9 PM and midnight, a convenient time for the participants to be on-line.) When necessary, the interviewer can overlap interviews by using multiple Chat Rooms, decreasing the necessity of quickly

wrapping up an interesting interview because the next interviewee showed up.

While the “contact” time of e-interviews is indeed longer than that required by f2f interviews, it may be offset by the increased convenience, negligible transcription time for the interviewer, elimination of travel time for the interviewee, and the potential to make constructive use of the time waiting for the other participant to type a response. Our e-interviews had a median time of around 38 minutes, roughly six times that of our f2f interviews, although this is a tentative comparison because of the difference in samples. Only one e-interviewee truncated the interview because of time constraints; others seemed not to mind. One subject replied, “I’m not going anywhere,” when the interviewer apologized for the interview length; another commented, “this is very convenient for me.”

SUMMARY

We conducted interviews primarily to gain insight into how students conceptualize a very specific set of topics, to drive curriculum and assessment tool development. We believe both types of interview experience contributed significantly to this goal. Even with the limitations of e-interviews, students were able to dialogue comfortably with the interviewer about their understanding of these concepts. Interviewees in both formats provided comparable explanations of the physics topics. And subjects in both types of interview conveyed how they were using past experiences to make sense of optical fibers.

For the purposes of our interviews, the lack of a scratch pad posed the greatest hurdle. Some options for future e-interviews are to post a set of drawings on the web that can be accessed and used for reference by both parties, or to use WebCT’s Whiteboard Tool. (The Whiteboard allows electronic images to be created and viewed in real time by all participants.) We anticipate that the advent of Tablet PCs will allow interviewers and subjects to share images drawn with an electronic pen, but it will be a while before that promising technology becomes ubiquitous.

The e-interview experience provided us with access to students not otherwise available. Was the information we gathered the same as the information that could have been gathered in a face-to-face interview? Of course not. But the content-specific information in which we were most interested appears consistent with that gathered in face-to-face interviews driven by the same set of questions. Other interviewers should use

their time and resource constraints, awareness of their participants’ familiarity with technology, along with consideration of the information they are seeking, when deciding whether to conduct e-interviews.

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REFERENCES

1. 35% of Rensselaer’s ScIT students have been Information Technology majors, 20% were Computer Science majors, 17% were graphic arts majors, 10% were Engineering or Physics majors, 8 % were in other sciences, and 8% were studying Architecture or Management.
2. All materials are web-based, and many can be found at the ScIT website: <http://www.rpi.edu/dept/phys/ScIT>.
3. See, for example, E. F. Redish and L. C. McDermott, “Resource Letter PER-1: Physics Education Research,” *Am. J. Phys.* **67** (9), 755-767 (1999).
4. M. C. Wittmann, R. N. Steinberg, and E. F. Redish, “Investigating student understanding of quantum mechanics: Spontaneous models of conductivity,” *Am. J. Phys* **70** (3), 218–226 (2002).
5. J. Piaget, *The child’s conception of the world*, trans. by J. & A. Tomlinson (Totowa, NJ: Littlefield, Adams, & Co. 1926/1972).
6. E. Hunt and J. Minstrell, “A Cognitive Approach to the Teaching of Physics,” in *Classroom Lessons Integrating Cognitive Theory and Classroom Practice*, edited by K. McGilly (Cambridge, MA: MIT Press, 1994).
7. H. Ginsburg, *Entering the child’s mind* (New York: Cambridge University Press, 1997).
8. L.C. McDermott, “Research on conceptual understanding in mechanics,” *Physics Today*, **37** (7), 24-32 (1984).
9. I. A. Halloun and D. Hestenes, “Common sense concepts about motion,” *Am. J. Phys.* **53** (11), 1056-1065 (1985).
10. E. F. Redish and R. N. Steinberg, “Teaching Physics: Figuring Out What Works,” *Phys. Today* **52** (1), 24-30 (1999).
11. See, for example, “The Internet Goes to College,” by the Pew Internet and American Life Project, found at www.pewinternet.org/pdfs/PIP_College_Report.pdf
12. F. Mateycik, D. Wagner, J. Rivera, and S. Jennings, “Student Descriptions of Refraction and Optical Fibers,” submitted to 2004 PERC Proceedings.
13. “lol”= “laugh out loud,” and “iirc” = “if I remember correctly.” Emoticons are faces on their sides: “:)” is a smile and “:-&” means the typist is “tongue-tied.” See <http://www.netlingo.com/> for more.