Enhancing Understanding Through On-line Discussions

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Abstract

The use of the computer and other technologies (i.e. the internet, world-wide web, etc.) are currently being aggressively used by many educators as tools in the learning process. This paper will report on an on-going research study at American University designed to address the role of student understanding in physics using an on-line discussion group format. In terms of gauging student understanding in physics, some critical questions are raised. (1) What factors serve to motivate students to participate in on-line discussions outside of class? (2) Can student motivation and performance be linked to students' individual learning styles? (3) Can student participation in on-line discussions be linked to enhanced understanding? To address these questions, formal learning style assessment data along with results from a survey conducted in an introductory course for non-majors during the 2000 academic year will be shared.

I. Introduction

A growing number of technology-based educational tools currently exist within the domains of science, mathematics, engineering, and technology (SMET) education. In addition, the use of educational technologies is growing both in and out of the classroom and laboratory. Certainly technology has the potential to serve as a powerful tool to improve the educational process for students as well as teachers [1]. However, educational technology is only as good as the content it supports [2].

Many traditional teaching methodologies have clearly been shown to put students in the role of passive rather than active learning [3]. Traditional instructional methods have also been shown to be inadequate in terms of promoting deep learning and long-term retention of important physics concepts. The explosion in the availability of technological tools is literally forcing physics as well as other SMET educators to change the way they teach. These changes, however, must involve much more than simply implementing technology for technology's sake. The recent advances in computer-based technologies and their use in SMET education provides an opportunity for educators to take a critical look at how these tools are being integrated into the classroom and laboratory. Research has shown that these technological tools can only be effective in promoting student understanding if used in a pedagogically sound way [4]. Essential to note is the fact that the integration of computer-based technologies into the classroom and laboratory is not enough. Strategies must be employed which are designed to assess student understanding following the use of any new type of learning tool, computer-based or otherwise. Furthermore, effective strategies must be developed and implemented to assess overall student learning gains.

The use of email and Web-based discussion groups are not new to education, and have been found to be effective methods extend learning activities beyond the classroom. In fact, some research exists to show that students may be more willing to participate in class discussion and other online learning activities as compared to traditional modes of discussion [5]. The use of on-line discussion groups offers a relatively new avenue through which the learner can take an active role in the learning process. Furthermore, on-line discussion groups are one form of computer-assisted communication that can promote interactive engagement of the learner with the content being studied. On-line discussion group formats may also offer some students a more "comfortable" environment in which to interact than the traditional large lecture class. In addition, on-line discussion groups may appeal to students with diverse learning styles. The importance of adopting a learning style approach in and out of the classroom has been well documented [6 - 15].

II. Method

This study was initiated to allow an opportunity to assess the potential effectiveness of on-line discussion groups as a learning and assessment tool. Participants were students enrolled in the Spring 2000 introductory physics course at American University entitled Physics for the Modern World. Physics for the Modern World is a one-semester, algebra-based, introductory course for non-science majors at American University. Students elect to enroll in this course to satisfy a portion of the University's Natural Science Requirements toward graduation. Approximately 120 students enroll in this course each semester. Topics covered in this course typically include Kinematics, Newton's Laws, Conservation of Momentum and Energy, Rotational Motion, Fluid Mechanics, Waves, and Sound. Although traditional in its content, the course is not taught in a "traditional lecture format."

All students enrolled in the Physics for the Modern World course were automatically placed on the class listserv. The listserv was considered an additional "tool" for students to use to seek assistance when they needed help on a homework question. The following is a description of the use of the listserv from the Spring 2000 course syllabus:

As a member of this class, you will be added to a class listserv. I expect you all to regularly check your email (i.e. every day). You will receive an e-mail notification when our listserv is up and running for the semester. This notification will provide you with instructions for posting comments and questions to the listserv. The listserv will be moderated in that all postings will first be sent to me. I will then determine their appropriateness and forward them on to the listserv. You are encouraged to actively participate in any listserv discussions that may take place. I expect that all postings will be professional in nature and adhere to proper "e-mail etiquette." You may use the listserv to pose questions to your peers regarding material being discussed in class, homework questions, lab questions, etc. You may also use the listserv to pose a topic for discussion related to our in-class discussions. Feel free to discuss other items of related interest such as "physicsy" items in the news, etc. In addition, I will occasionally use the listserv to post reminders regarding due dates to assignments, give helpful hints on homework questions (where appropriate), etc. I will also use the listserv to make schedule changes and corrections, homework corrections, lab announcements, etc. as necessary. ***I do not intend to repeat announcements made via the listserv during class.*** *Thus, I do expect that each of you*

make it a point to check your e-mail often.

All listserv discussions were student-led and instructor moderated. Thus, one student could post a question to the listserv and the message would be sent to all members of the class. If another student (or often times more than one student) felt they knew the answer to the question posed, or if they simply felt they could contribute to the on-line discussion going on, they would. Most often, the students' discussions centered around questions they were working on for their homework assignments.

Keep in mind that participation in the listserv was not mandatory and in no way directly impacted a student's grade. However, some interesting results were obtained where grades were concerned. These results will be highlighted in a subsequent section of this paper.

Students were informed that although participation in the on-line discussions was not mandatory, at least some might find them to be accommodating in terms of their individual learning styles. Numerous teaching strategies have been developed which correspond to the accommodation of students' needs and diverse learning styles [16 - 20].

III. Data and Preliminary Results

In this section, some preliminary results will be presented. These results will consist of a presentation of some data tabulated for those students who actively using the listserv during the semester. In this instance, an "active" student is defined as one who posted questions and/or responses to the listserv. This table was compiled in hopes of addressing the questions guiding the study. Keep in mind that a student may "actively" have used the listserv by simply reading postings from other students. However, in terms of addressing the questions of interest in the study, only data from students who actually made postings to the listserv were included here. In addition, results consist of a summary of the highlights from a questionnaire given to students near the end of the semester will also be shared.

Course Grades

Table 1 gives a breakdown of the postings made by the 28 active participants in the on-line discussions. Interestingly, these data reveal that there did not appear to be any differences in terms of the gender of students actively using the listserv. The data show that 16 female and 12 male students were active participants in the listserv. This proportion of males and females closely parallels that of the overall composition of the class which consisted of 59 females and 63 males.

The table also gives a breakdown of the nature of the students' questions and responses. The number of questions posed by each student is given, followed by the number of responses posted. In addition, "other" postings were also tabulated. "Other" postings refer to items such as one student posting a "thank you" to another student for offering a good suggestion in terms of a potential solution to the discussion question.

In addition to a breakdown of the students' postings, the final course grades for each of the active students is given in Table 1.

Table 1. Breakdown of postings made by active students.

Student Number	Gender	Number of Questions Posted	Number of Responses Posted	Number of "Other" Postings	Total Number of Postings	Student Final Course Grade
1	F	1	0	1	2	B-
2	F	2	3	2	7	A
3	M	0	12	0	12	A
4	M	4	5	3	12	B
5	M	6	3	0	9	A
6	F	1	1	1	3	B
7	M	2	0	1	3	B+
8	M	1	0	1	2	B
9	F	5	1	1	6	B
10	F	3	1	0	4	A-
11	M	0	0	1	1	B+
12	F	0	3	0	3	A
13	F	1	3	0	4	A-
14	F	1	0	0	1	B+
15	F	0	1	1	2	B+
16	M	1	0	0	1	B
17	M	1	0	0	1	B+
18	F	1	0	0	1	B
19	M	1	0	0	1	B-
20	F	1	0	0	1	C+
21	F	2	0	0	2	A-
22	F	0	1	0	1	A
23	M	8	1	0	9	A
24	M	0	0	1	1	B+
25	M	1	0	0	1	B+
26	F	2	0	0	2	B
27	F	1	0	0	1	B-
28	F	1	0	0	1	B

An interesting issue arises upon inspection of the students' course grades. That is, all but one of the students who actively used the listserv received a grade of B- or higher. This distribution of grades is not reflective of the overall distribution of grades for the entire course (approximately 20% A's, 35% B's, 35% C's, and 10% D or lower). In addition, the overall GPA for all students

enrolled in the course was 2.74 (B-) where as the overall GPA for those students who participated in the listserv discussions was 3.31 (B+). This difference in course grades is quite distinct. Although course grades may not be the best way of assessing the effectiveness of the listserv, they certainly are a valid data point, especially in terms of providing direction for future studies. These data might lead one to question whether students who participate in the on-line discussions actually perform at a higher level than students who do not.

Questionnaire

At the end of the spring 2000 semester, all students were given a questionnaire designed to assess the effectiveness of the on-line discussions in terms of their understanding and perceptions of the course content. When asked about what factors served to motivate them to post content-related questions to the listserv typical responses were:

- "I was confused about problems in the homework and I noticed that people actually did respond and so I thought I would give it a try!"
- "I didn't have time to check some homework problems with Prof. Hein before some quizzes or exams, and that guy (Student x) seemed to be helping everyone."
- "I get stuck easily on problems, it was a nice way to get pointed in the right direction."
- "It was very helpful for homework, I only wish I knew who many of the people were that helped me so that we could have formed study groups."
- "Because I was having trouble with some problems and I wanted to see if anyone could help me with them."
- "I never had any questions I cared enough about to ask on the listserv. I generally figured them out or asked another person."
- "I thought it was a good way to get the extra help I needed and a good way to communicate."
- "I mostly used the listserv as a safety. If I could not answer a homework question, I would see if someone else had the same problem on the listserv, and usually it was there."
- "I was lost in what I was doing and no one had yet asked my questions."

When asked which factors served to motivate them to post content-related responses to the listserv, students remarked:

- "It helped me to review the material by explaining it to someone else."
- "I knew the material and felt I could help my fellow student. I got a job mid-semester and that limited my posting responses, in combination with less people using the listserv."
- "They helped me, so I wanted to help with what I knew."
- "Because I know how it feels to not have questions answered and I felt like it would be nice to help someone else out if I was confident in my answer."
- "I knew how to do the problem."
- "If I saw a question that I knew how to get that no one had responded to, I answered it. I check my email late at night, so usually they were already answered."
- "I only posted answers if I was confident enough with my own answers."
- "I had the time and understanding of the concepts to help my classmate."
- "I was unsure of what answers to give and I didn't want to be responsible for a wrong answer."

Finally, when asked about what factors motivated them to read (or not read) all or most of the postings, typical student comments were:

- "The responses helped me so much!! I always checked to make sure I was doing the right thing."
- "I read them if I was having trouble with the problems mentioned."
- "I would read the questions/answers to see if I was going in the 'right direction,' and if the answers were similar to mine."
- "To see what problems the rest of the class was having."
- "A couple of times to find answers to specific problems, but usually just to read through them. Even if I was already done with the homework, it would help me catch mistakes."
- "Again, the listserv was a good way for us to learn from each other."
- "The listserv was helpful many times on our homework so I found it in my best interest to read and participate."
- "Although I like the idea of the listserv, I still find it easier to call one of my classmates and ask."
- "I was interested to see how we shared concerns with other students and to see how we had almost the same questions."
- "I did read them because sometimes I would see from the responses that I made a mistake on something or it helped me with a problem before I could ask someone."
- "I found that many people posted questions that I was stuck on as well. I thought it was helpful."

Overall, some students appeared to find the listserv discussions useful, while others did not. One possible reason why some students find the discussions useful and others do not, may be related to students' individual learning styles. The next section provides a brief discussion of student learning styles and presents some preliminary data related to individual learning styles.

Student Learning Styles

What exactly is a learning style? Several definitions of learning style currently exist. Keefe [21] defined learning style as being characteristic of the cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. Learning style also represents both inherited characteristics and environmental influences.

Dunn [22] described learning style as "… the way each learner begins to concentrate, process, and retain new and difficult information" (p. 224). She noted that this interaction occurs differently for everyone. Dunn [23] has also suggested that the uniqueness of individual learning styles could be thought of as a fingerprint. She also noted that a person's style can change over time as a result of maturation [24].

The assessment of individual learning styles can be an important piece of the teaching/learning process. The learning style assessment instrument chosen for use in this study is the Productivity Environmental Preference Survey by Dunn, Dunn, and Price [25]. This instrument was chosen

because of its comprehensive nature, and, because of the relative ease of assessing students and interpreting the results. The Dunn and Dunn Learning Style model has had widespread use with adult learners, however, its use in physics as well as other branches of science and engineering has been quite limited. The research conducted by the author, to date, represents the only published work with the Dunn and Dunn Model that involves non-science students taking introductory college physics classes. As a result, the use of this model in physics, as well as in other branches of science and engineering education becomes even more interesting to study.

The basic tenet of the Dunns' model is that individual styles must be assessed, and, if a student is to have the best opportunity to learn, instructional techniques must be used that are congruent with each student's style. Not all theorists agree with this tenet because they feel it is extreme. Other theorists wrestle with the question of whether we should teach to an individual's strengths or try to help them develop their weaknesses. The best answer may be both. One of the best ways, especially in large classes, to teach to individual students' strengths is to use a variety of instructional styles and modes of delivery.

The PEPS assessment instrument is structured as a 100-item, self-report questionnaire rendering a mean score of 50 and a standard deviation of 10. For each of the elements, a score of one standard deviation above or below the mean indicates an element that makes a difference for that individual. The scoring of the instrument is reported in a PEPS profile having 20 items. Because three of the 20 items deal with time preference, the instrument is said to assess 18 different elements from five basic stimuli that affect each person's ability to perceive, interact with, and respond to the learning/working environment. These stimuli include: (1) Environmental, (2) Emotional, (3) Sociological, (4) Physiological, and (5) Psychological. A selected subset taken from these stimuli was used in this study. These elements are listed in the column headings of Table 2 found on the next page.

Numerous research studies [26] have documented the reliability and validity of the PEPS. Dunn and Dunn [27] posited that research on their model is more extensive and more thorough than research on many educational topics. As of 1998, research utilizing the Dunn and Dunn Model had been conducted at more than 112 institutions of higher education, at all levels K – college, and with students at most levels of academic proficiency, including gifted, average, underachieving, at-risk, dropout, special education, vocational, and industrial art populations.

Dunn, et al. [28] performed a meta-analysis of the Dunn and Dunn Model of learning style preferences, reviewing 42 experimental studies conducted between 1989 and 1990. Their results indicated that overall academic achievement of students whose learning styles have been matched can be expected to be about three-fourths of a standard deviation higher than those students whose learning styles have not been accommodated. Further, when instruction is compatible with students' learning style preferences, the overall learning process is enhanced.

Table 2 presents a summary of selected learning style data for the listserv participants. The notation used within the table is:

H = HIGH PREFERENCE **-- = MIDDLE PREFERENCE**
L = LOW PREFERENCE **A = PREFERS ALONE**

Table 2. A Summary of Selected Learning Style Data for Listserv Participants

Student Number	Motivation	Persistence	Conforming/ Nonconforming	Alone or with Peers	Authority Figures	Time of Day
1	--	--	--	--	--	--
2	H	H	--	--	--	--
3	L	--	--	--	--	PM
4	H	--	--	A	H	AM
5	--	--	--	--	--	--
6	--	--	--	A	L	--
7	--	--	--	--	--	--
8	--	--	--	A	H	PM
9	H	--	--	A	H	PM
10	--	--	--	--	--	--
11	--	--	--	--	--	PM
12	--	--	--	A	--	PM
13	--	--	H	A	--	PM
14	--	--	--	--	--	--
15	--	--	--	--	L	--
16						
17	--	--	--	--	--	PM
18	--	--	--	--	H	--
19	--	--	--	--	--	--
20	--	--	--	H	H	--
21	--	--	--	--	H	--
22	H	--	H	A	--	--
23						
24	L	--	L	A	--	PM
25	--	--	L	--	H	PM
26	--	--	--	--	--	--
27	--	--	L	--	--	PM
28	--	--	--	--	H	PM

The learning style data tend to suggest that students who participated in the listserv discussions have a tendency to prefer to work alone. Since the online discussion format is essentially an individual activity, it may be that students who prefer to work alone tend to utilize that format more than others who prefer to work with a peer or authority figure present. In addition, these data suggest that many of the participants had a preference to work and learn in the evening. Since participation in the listserv can essentially take place any time during the day or night, students who prefer to work and learn in the evening may be more likely to take advantage of this discussion format.

Presentation of learning style data for all participants and non-participants is beyond the scope of this article. Of interest to this study is a comparison of the learning style characteristics of all students (participants and non-participants) to help ascertain whether the listserv format is more beneficial to some students than other. This portion of the data analysis is currently ongoing.

IV. Observations and Conclusions

Technology, such as on-line discussions, must be carefully evaluated before being implemented into the curriculum. As with other types of technologies, from video simulations to computer-based tutorials, the instructor must be comfortable with not only the medium, but also the message sent through the medium to the students. In an on-line discussion, the instructor must carefully monitor students' statements about concepts and redirect them as necessary. Monitoring the discussions requires time and commitment on the part of the instructor, as well as a desire to assist the student to come to a deeper understanding of the concept itself. The instructor's role is often to not only provide an opportunity for in-depth investigation into a topic, but also to provide constructive feedback as necessary. In this way, the instructor can better integrate electronic discussions to help students come to a deeper and broader understanding of concepts from physics to equity in education.

Numerous studies have documented the importance and potential value of using various forms of computer-mediated communication in the classroom [29 - 35]. On-line discussions provide one such additional teaching and learning vehicle. Through this vehicle, students communicate with each other (and with the instructor) regarding various topics and principles, and, are often better able to connect these topics to their everyday lives thus facilitating the acquisition of higher-order thinking skills. In addition, one is able to see how students become more adept at transferring and applying information learned in class to novel situations. Through the use of an on-line forum, the potential exists for students to achieve greater understanding and more meaningful reflection. A study involving the role of individual learning styles in terms of students' use of and students' benefit from the use of on-line discussion forums is needed. Further research on the impact of on-line discussion forums to long-term understandings and perceptions as well as a comparison to more "traditional" methods of instruction is also warranted.

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