

THE EFFECTIVENESS OF DISCUSSION BOARDS IN TEACHING BIOLOGY

by

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ABSTRACT

This study was designed to determine the effectiveness of using on-line discussions in a biology classroom. Students participated in a series of discussion board topics. Data were collected by analyzing scores on pre and post assessments, surveys, interviews, and discussion board data such as number of posts. In addition to the effectiveness of these discussions, the study aimed to determine how involved the instructor should be in the discussions. As the instructor, I varied my level of participation throughout the study. The use of discussion boards showed little impact on learning the content. Students preferred and discussions were more in-depth when the teacher was an active participant in the discussions

INTRODUCTION

Dallastown Area High School services students between grades 9-12 within the Dallastown Area School District (DASD). DASD covers the town of Dallastown and several other small towns. The school district is located in York County in the south-central region of Pennsylvania. DASD is a large suburban school district with approximately 5,800 students. The enrollment in the high school is approximately 1,800 students. The school district is well known in the area for high academic achievement, and the *Pittsburgh Business Times* ranked the district in the top 20% of all Pennsylvania School Districts based on state examination scores.

In recent years, the school district has placed heavy emphasis on technology in the classroom. Many new technology initiatives have been started and much of the professional development activities are designed around technology integration. The district has also opened its Cyber Academy. This will serve as the school district's own cyber school run by full-time teachers within our school district. In addition to my regular classroom teaching, I have signed on to teach the Cyber Biology course. Because of this new teaching assignment and my general interest in incorporating technology into the classroom, I have decided to complete an action research study on integrating a specific technology aspect into my classroom. I have chosen to include discussion boards in both my typical classrooms as well as my cyber course. The purpose of this study is to determine the effectiveness of discussion boards in enhancing learning. As a secondary question, I am also interested in seeing what role the instructor should serve during the use of discussion boards.

CONCEPTUAL FRAMEWORK

As technology advances, many educational institutions are incorporating on-line courses into their programs. Many graduate programs are completed solely on-line or predominantly on-line. Even at the high school level, cyber schools are gaining popularity. Despite the advances in technology, many people still doubt the efficacy of on-line learning. One option that has arisen is a blended model. Blended learning is a model that combines two different modes of instructional delivery. One such model is blended e-learning that combines face-to-face learning in addition to learning through a computer based website (Wu, Tennyson, & Hsia, 2010).

Using the blended e-learning teaching model, the teacher and students are able to reap the benefits of face-to-face learning and e-learning. Traditional face-to-face learning has the advantage of being very familiar to the students, while e-learning provides flexibility and 24/7 access (Wu et al., 2010). Several systems exist to run the e-learning portion of a blended course, Moodle is one such system. Moodle stands for Modular Object-Oriented Dynamic Learning Environment. Moodle is known as a course management system (CMS), a program that teachers can use to host their website. The advantage to a course management system is the ease of use and the ability to incorporate web-based tools like forums, grading, chats and document uploading. Another advantage of using Moodle is that it is an open source software meaning that it can be used freely. Using Moodle has the benefit of a uniform set-up and an easy to follow format (Perkins, 2006). Research has shown that students benefit most from an e-learning environment when they feel comfortable using a computer, when the course provides a variety of

resources, and when it incorporates interactions between students and their peers (Wu, Tennyson, & Hsia, 2010).

Activities within a blended e-learning environment can be separated into two categories. Synchronous activities are those that are completed in real-time which include chats and webinars. Asynchronous activities are those that are not completed in real-time. Asynchronous activities include e-mails and discussion forums (Chandra, 2009). The benefit of these activities is their ability to foster discussion among peers.

One benefit of blended e-learning is the increased opportunity for collaboration (Wu, Tennyson, and Hsia, 2010). Collaboration is a term used to describe learning that involves a group of students working together to perform a learning task (Gros, 2001). While collaborating, students must restructure their own knowledge in order to communicate with others (Lazonder, 2003). Because students are working with each other to develop and share their knowledge, collaborative learning is a commonly used learning strategy.

An approach frequently designed to incorporate collaboration within the e-learning environment is the use of discussion forums. Discussion forums allow students to discuss course related content in a structured and assessable manner. A key aspect of using discussion forums is determining their set-up. If discussion forums are not properly designed, lack of participation and procrastination can limit their effectiveness. Although the goals for each discussion should be based on the learning objectives, it's important to have clear expectations for how posts and responses should be made (Hew & Cheung, 2008). In a study completed by Strijbos (2005), it was found that although structure is important, too much structure can be prohibitive to a natural discussion amongst the

students. It was also found that learning tasks that include multiple parts encourage more interaction than simple tasks. The teacher must take these factors into account when designing and implementing discussion forums within a course.

The instructor's role can be an essential factor in the effectiveness of a discussion forum. There are a variety of roles the instructor could play, ranging from being a constant participant who asks and answers questions to being completely absent and everything in between. Research shows that when an instructor is actively involved the length of a discussion forum is often shorter than when the instructor has little involvement. Also, students reported that they appreciate the peer to peer interaction more than peer to instructor interactions. Students can become overly dependent on instructors to answer questions and make comments instead of creating their own comments and answering their peers' questions. Based on this research, it is suggested that an instructor needs to play a part in the discussion forum but must be limited in their participation. Using this strategy, allows students to develop a positive learning community with their peers while the instructor can serve as a guide to ensure that discussions are productive. Despite limited involvement in the discussion, instructors still play a vital role in the health of the discussion. It was found that instructors and students who followed up a question with another question led to more in depth discussion. The use of this strategy would allow the instructor to chime in without squashing the discussion. By examining the research, it is evident that the instructor must decide what role and how involved they will be in the discussion forums. The instructor's role is an important factor in the effectiveness and the development of a discussion forum (Mazzolini, 2002 & 2007).

A blended e-learning environment can have many benefits especially when collaboration is built into the e-learning portion. Although there are many advantages to this system, the instructor thoroughly investigate how activities such as discussion forums will be designed and determine what the role of the instructor will be within those forums. If designed and used appropriately, discussion forums could provide an excellent outlet for students to create and share their knowledge.

METHODOLOGY

This study was conducted within three honors biology courses and took place from November 2012 to March 2013. The students in the honors biology class were all sophomores and were high achieving and highly motivated ($N = 64$). All students within the three honors biology classes choose to participate in the study. The students participating in study were comprised of 35 males and 29 females. The majority of the students were Caucasian in addition to 4 Asian-American students, 3 Hispanic students, and 2 African-American students. The purpose of this study was to determine the impact of using discussion boards on the learning of biology related content. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained.

Several discussion boards were used throughout the semester using the course's Moodle page. Three different units were used for this study: photosynthesis and cellular respiration, DNA, and evolution. Each unit lasted approximately two to four weeks. The students were given a weekly topic to discuss in small groups of four to five using the discussion board feature on the class Moodle site throughout the duration of each of these

units. Students were expected to respond three times throughout the discussion. Students were required to make an initial post followed by two responses to their peers over the span of a week. Students were expected to synthesize material learned in class with additional research completed outside of class. While two classes served as the treatment, the third class served as the non-treatment. Each class served as a treatment group twice and as the non-treatment group once (Table 1). Another aspect of discussion boards that was explored during the course of this study was the role of the instructor in these discussions. As the instructor, I varied my involvement in the discussions. During some discussions, I was heavily involved by making several posts and answering questions. During treatments with teacher involvement, I responded at least twice to every thread. This involved posting follow-up questions, points of emphasis, and clarification of students' posts. In other discussions, I was not involved in the discussions and made no posts.

Table 1
Summary of Treatment and Non-Treatment Groups

Class	Photosynthesis and Cellular Respiration Unit	DNA Unit	Evolution Unit
<i>Period 3</i>	Treatment without Teacher Involvement	Non-Treatment	Treatment with Teacher Involvement
<i>Period 5</i>	Treatment with Teacher Involvement	Treatment without Teacher Involvement	Non-Treatment
<i>Period 8</i>	Non-Treatment	Treatment with Teacher Involvement	Treatment without Teacher Involvement

At the conclusion of each unit, the students were graded using the Discussion Board Expectations and Rubric that has four levels of achievement based on the depth of

their posts (Appendix A). The rubric was designed to show the students' quality of posts and also to give students' feedback on their discussion posts.

Student learning outcomes were measured using pre- and post-assessment scores for each unit. The Photosynthesis and Respiration Pre and Post Assessment included three essay questions that addressed explanations of photosynthesis, cellular respiration and fermentation. The results were scored on a 0-4 scale where 0 = no knowledge, 1 = below basic knowledge, 2 = basic knowledge, 3 = proficient and 4 = advanced. Student responses were compared pre to post and changes were reported (Appendix B).

Student learning outcomes for the DNA unit were measured using pre- and post-assessment scores from the DNA Pre and Post Assessment. The DNA Pre and Post Assessment included six multiple choice questions. A percent correct score was given for both pre- and post- assessments and the percent improvement was reported (Appendix C).

During the Evolution unit, student learning outcomes were measured using pre- and post- assessment scores from the Evolution Pre and Post Assessment. The Evolution Pre and Post Assessment included 14 true-false questions. A percent correct score was given for both pre- and post- assessments and the percent improvement was reported (Appendix D). Once the percent improvement was calculated for each unit, a one way ANOVA was used to determine if there was a significant difference between the mean percent improvement of the treatment, treatment with teacher, and control groups.

Thread length, the number of posts created under each student created topic, and total number of posts were also recorded for each unit. These data were taken to determine how the role of the instructor affects posting by students. Students completed

the Discussion Board Student Attitude Survey before and after the treatment (Appendix E). This was used to determine the students' opinions on the use of discussion boards within the different units and how those opinions changed after using discussion boards.

After students had completed all of the treatment units, a random sample of students were interviewed about their experiences, suggestions, and attitudes surrounding the use of discussion boards. Five students were randomly selected from each class period. I met with each student individually, and I used the Interview Starter Questions as a basis for the interviews. Follow-up questions were used to delve deeper into students' thoughts and opinions (Appendix F) (Table 2).

Table 2
Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i> What is the impact of the use of discussion boards on learning?	Pre-assessment and Post-assessments	Discussion Board Student Attitude Survey	Student Interviews
<i>Secondary Question:</i> What should be the role of the instructor in discussion boards?	Discussion Board Student Attitude Survey	Discussion Board Data (Number of Posts, Thread Length)	Student interviews

DATA AND ANALYSIS

Data collected via the Discussion Board Student Attitude Survey showed that students generally did not find the use of discussion boards enjoyable ($N = 64$). Prior to

the treatment, 67% of the students who were undecided as to whether they enjoyed using discussion boards. After the treatment, 23% did not feel that discussion boards were enjoyable. Another 34% of students felt strongly that discussion boards were not enjoyable. The number of students who found that they enjoyed discussion boards changed very little from before treatment. Student interviews echoed those results. One student stated that “I would rather just discuss in class.” Several other students had similar responses (Figure 1).

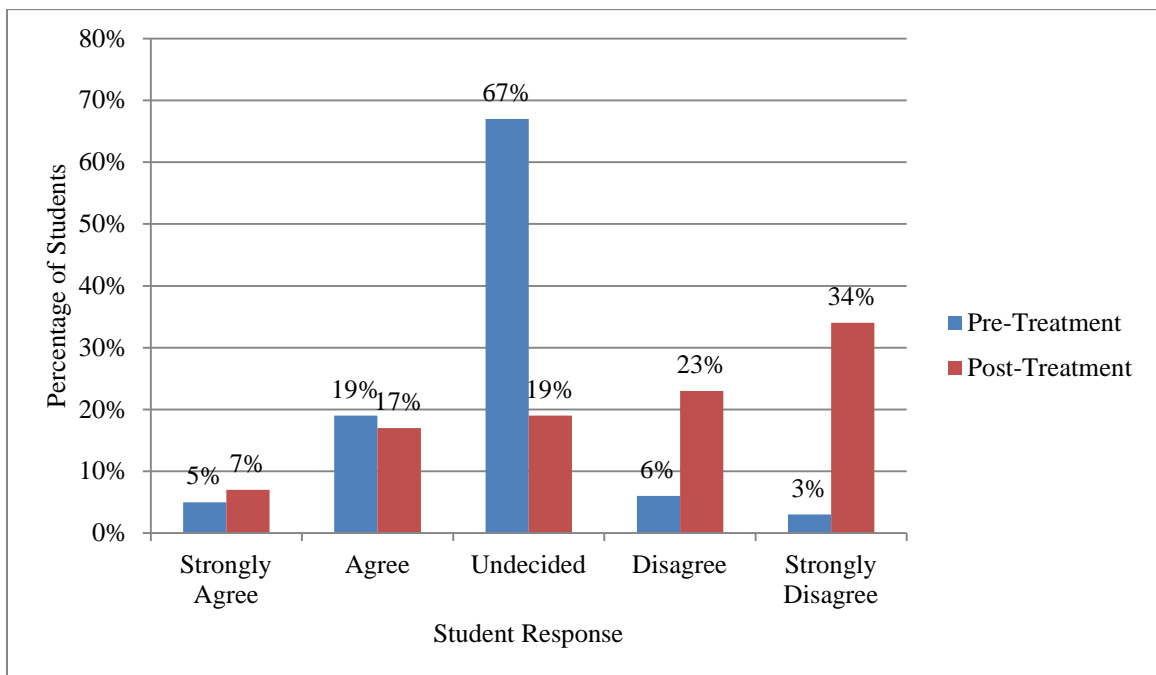


Figure 1. Student responses to the statement: *I enjoy participating in on-line discussions*, ($N = 64$).

The data also suggested that the use of discussion boards had little impact on student achievement and learning. A comparison of pre-test and post-test results of treatment and non-treatment groups showed little difference in scores. During the Photosynthesis and Respiration unit, the non-treatment group showed 61% improvement, while the two treatment groups improved by 50% and 47%. In the DNA unit, the non-

treatment group improved their scores by 22%. This was very close to the treatment groups with teacher involvement that improved by 23%. The treatment group without teacher involvement showed a large increase improvement, 45%. This appears to be an outlier. In the Evolution unit, all of the scores were within a 4% range. The two treatment groups improved by 25% and 28% respectively while the non-treatment unit improved by 28%. There were no statistically significant differences between group means as determined by one-way ANOVA ($F(2,6) = 0.237, p = .80$) (Figure 2).

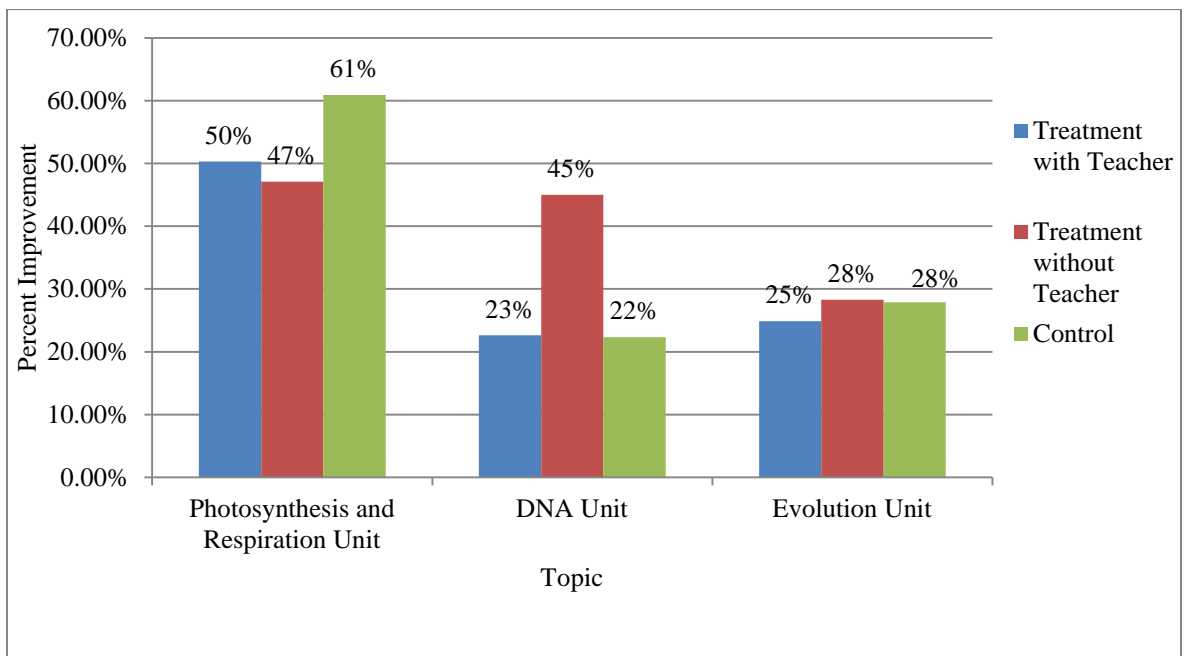


Figure 2. Student percent improvement between pre-test and post-test, ($N = 64$).

In addition to the pre-test and post-test results, the Discussion Board Student Attitude Survey asked students to share their attitudes on whether discussion boards helped students learn the topic. After completing the treatment units, 16% of students selected that they *disagree strongly* and 22% selected that they *disagree* with the statement that the discussion boards helped them understand the topic. This is a large increase from the pre-treatment survey in which none of the students responded that they

strongly disagreed with the statement and only 6% said they *disagreed* (Figure 3). A student explained this in their interview by stating that “they didn’t help me learn anything.” The same student stated that the topics “were interesting but were not things that would help us for the test.”

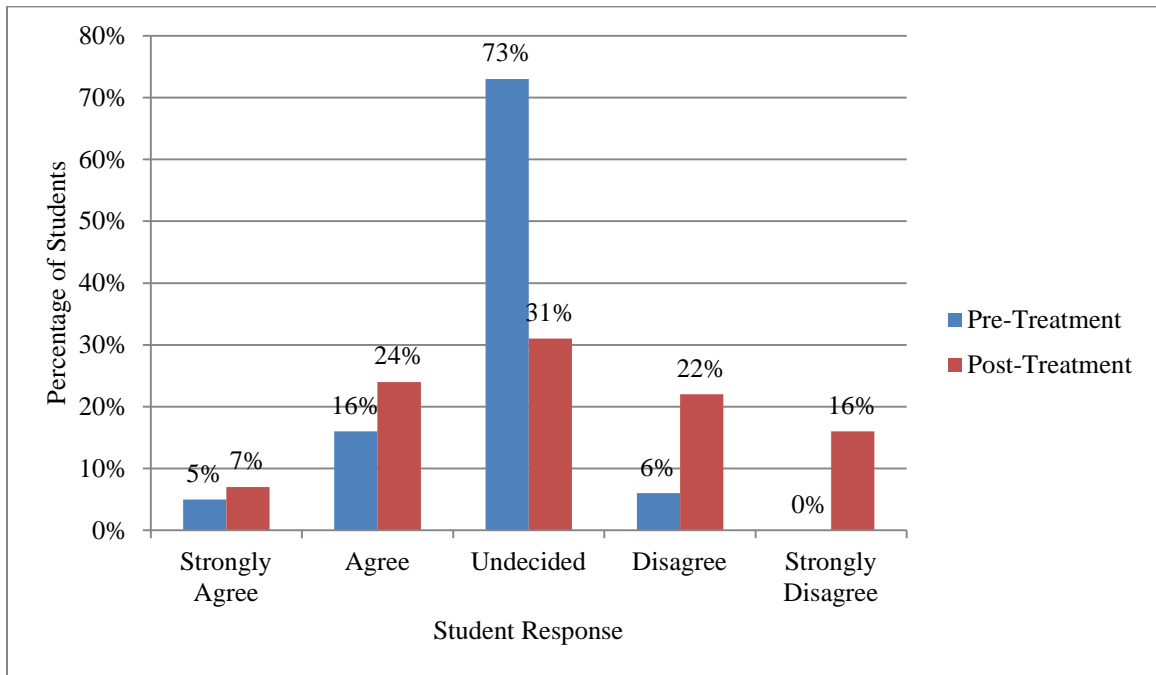


Figure 3. Student responses to the statement: *Participating in the on-line discussions helped me understand the topic*, ($N = 64$).

The Discussion Board Student Attitude Survey results show that many students did not find it helpful to share their ideas or respond to others’ ideas. There was an increase in the percentage of students who *disagreed* or *strongly disagreed* when asked if it was helpful to share their ideas. The percentage of students who *disagreed* or *strongly disagreed* was 18% and 13% after completing the treatment. Only 8% of students during the pre-treatment stated that they *disagreed* with the statement (Figure 4). During student interviews, one student stated that “student responses did not help because it was all pretty much the same responses.”

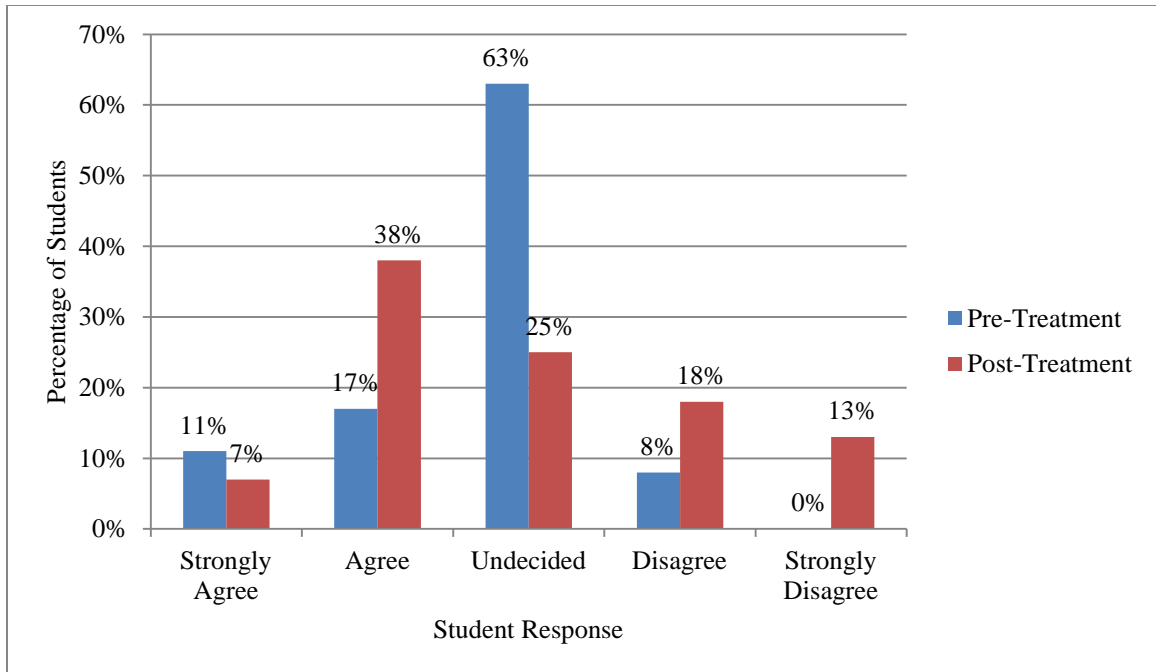


Figure 4. Student responses to the statement: *I find it helpful to share my ideas and respond to other students' ideas*, ($N = 64$).

Another aspect being examined was the impact of teacher participation in the discussion boards. The number of posts made to each discussion board was counted to determine if teacher involvement affected the number of posts made by the students. The Photosynthesis and Respiration unit and the Evolution unit both showed an increase in the number of posts made by students when the teacher was involved. The increase was most pronounced in the Evolution unit where the number of posts increased by a total of 56 posts. During the DNA unit, the number of posts was higher in the discussion boards that lacked teacher involvement. There were 116 posts in the boards where the teacher was involved and 131 posts in the boards where the teacher was not involved. As with any discussion or discussion board, some topics may appeal to some groups of students more than others and lead to more questions and comments (Figure 5).

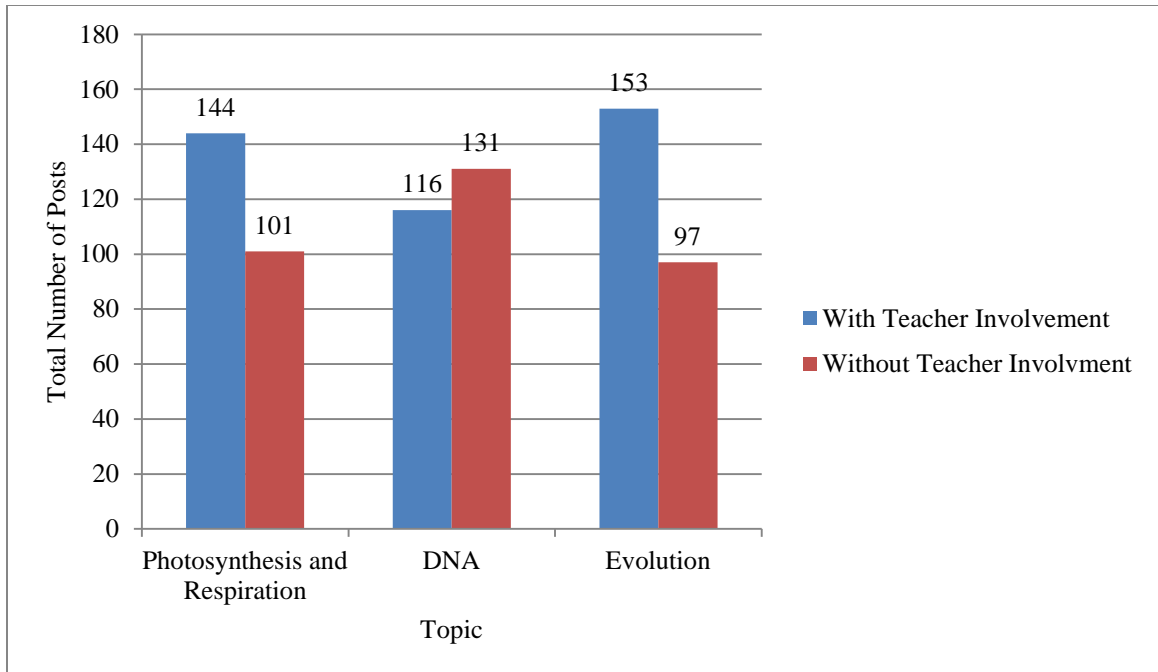


Figure 5. Total number of posts made, ($N = 64$).

In addition to monitoring the number of posts made, the thread length was tracked. These numbers represent the length of the conversations. During each treatment unit, there was an increase in the average length of the discussion threads. The Evolution unit showed the largest increase in thread length. Without the teacher being involved, the average thread length was 2.18 posts. With teacher involvement, the average thread length increased to 4.66 posts. The Photosynthesis and Respiration unit showed the lowest increase in thread length. The average thread length without teacher involvement was 3.32 posts. This number increased to 5.09 posts when the teacher was involved in the discussion board (Figure 6).

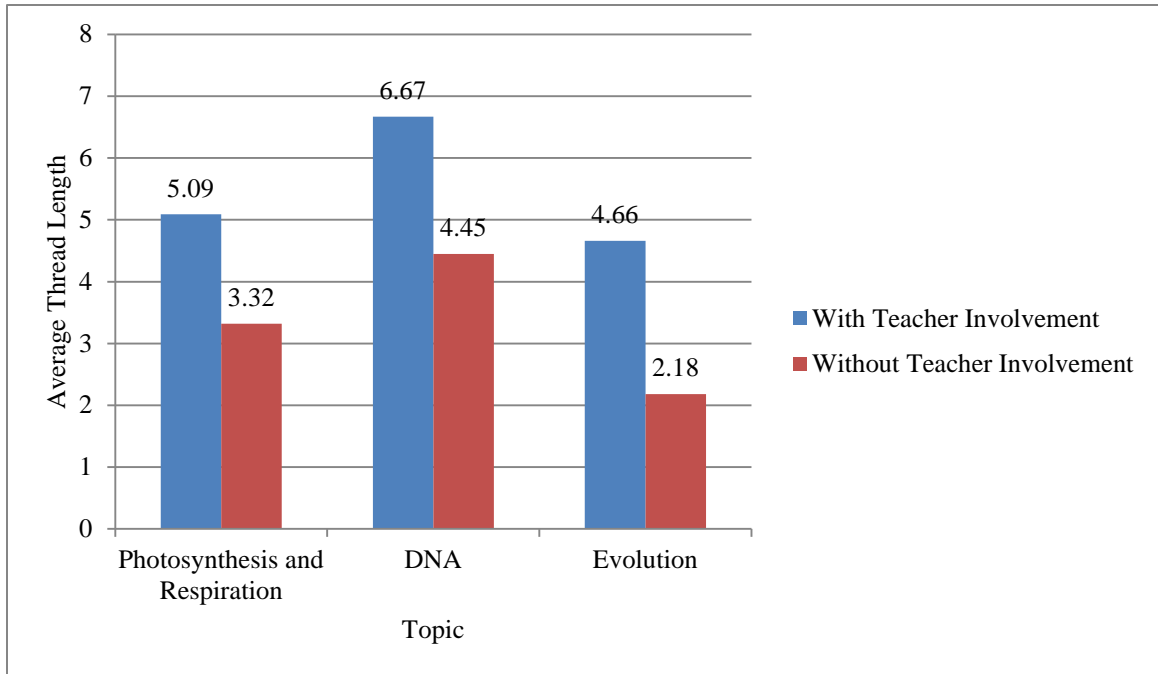


Figure 6. Average thread length in number of posts, ($N = 64$).

Students were asked to respond to the statement *Posts made by my teacher are informative and meaningful*. A majority of students, 80%, either *strongly agreed* or *agreed* with this statement on the post-treatment Discussion Board Student Attitude Survey. This is an increase from the pre-treatment survey when only 30% of students felt the teacher's posts were informative and meaningful (Figure 7).

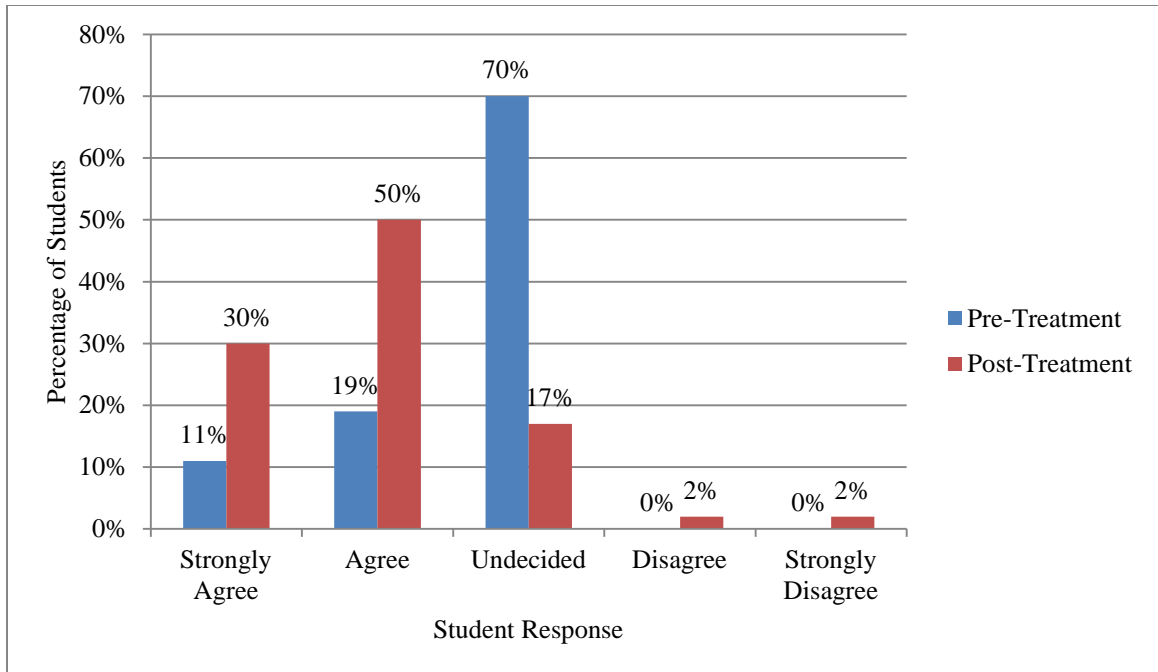


Figure 7. Student responses to the statement: *Posts made by my teacher are informative and meaningful*, ($N = 64$).

Students also responded to the statement *on-line discussions are more meaningful when the teacher is highly involved*. The post-treatment Discussion Board Student Attitude Survey showed the percentages of students who *strongly agreed* with this statement increased from 5% before the treatment to 19% after the treatment. A similar increase could be found in the number of students who *agreed* with this statement. The number of students who *agreed* increased from 13% to 34% (Figure 8). During student interviews, one student stated that discussion boards “weren’t any help to learning unless the teacher is really involved.”

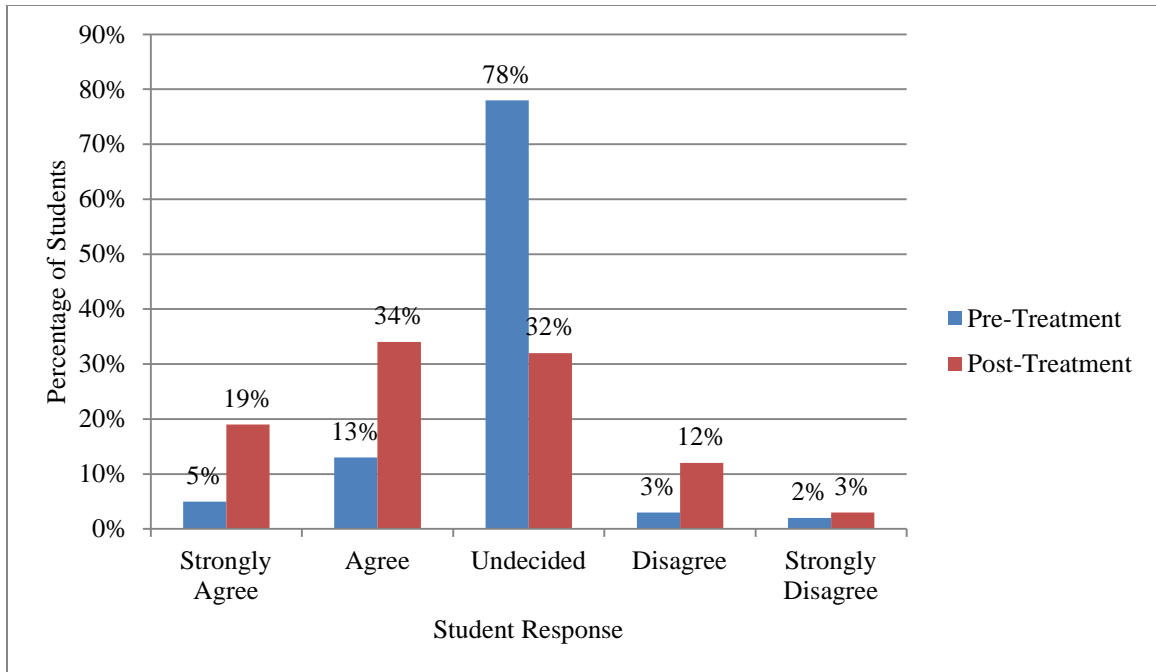


Figure 8. Student responses to the statement: *On-line discussions are more meaningful when the teacher is highly involved*, ($N = 64$).

INTERPRETATIONS AND CONCLUSIONS

The results of this study suggested that the use of on-line discussion boards did not have a positive or negative effect on student learning. A comparison of pre-assessments and post-assessments show no correlation between using discussion boards and a change in student grades (Figure 2). There was no significant difference in the means between groups that experienced either of the treatments when compared to the control. The Discussion Board Student Attitude Survey and student interviews also suggest that students did not find the discussion boards to be a strong learning aid. This could be due in part to the difficulty of designing and implementing an on-line discussion. The literature suggests that careful planning and clear expectations must be put into place to ensure that discussions are meaningful and informative. Although a valiant attempt was made to create discussion topics that required higher order thinking

skills, this is easier said than done. Many students had difficulty constructing posts and making meaningful responses to others' posts. In fact, one common complaint amongst students during the interviews was that students did not find their peers' posts meaningful because they would often repeat information that was already posted. Other students expressed difficulty in constructing meaningful posts to the discussion board topics. Much of the research on discussion boards were completed with undergraduate students and even graduate students in some cases. I felt as though high school students had a much more difficult time contributing to a meaningful on-line discussion.

The results also suggest that students did not find the discussion boards enjoyable. This is an important aspect to measure because part of my job is to help inspire and motivate my students to become interested in biology. An extension activity, such as these discussion boards, should be enjoyable in order to help pique student interest in the topics discussed in class. Although high school students can often be cynical about new learning experiences, I attribute this to their perception and the reality that participation in the discussion boards did not enhance their achievement on the tests. Many of the topics were designed to encourage further discussion on the topics taught in class. It was an opportunity to discuss subjects or applications of material that we may not have time to in class. I feel that students did not see a strong enough connection between the discussion topics and testable material. Because of this, students were less likely to put in the necessary effort to contribute to the conversations. Lack of meaningful contributions by some students and the difficulty of seeing the correlation between the discussion topics and test material most likely led to an unfavorable view on discussion boards.

I feel that the strongest conclusion of this study can be made about the role the teacher should play in the discussion boards. The results show an increase in the average thread length and the number of posts made when the teacher was involved in the discussion boards. Students were more actively engaged and the conversations were more in depth. In the Discussion Board Student Attitude Survey and student interviews, students expressed that the teacher's posts were meaningful and helpful. Many of the students suggested in the interviews that the teacher should be a more regular part of the conversation. One student commented that the "teacher's comments were informative and more teacher posts should be made." Being that this is the first time that many of these students have ever used discussion boards in an educational setting, I feel as though the teacher needs to have more pronounced role. It helps the students feel more comfortable and steers them in the correct direction. This opposes the findings of several studies completed at the college level, where teacher involvement often squelches student conversation. This may be due to the different levels of confidence and experience that exists between high school students and college level students. High school students struggle more with independent learning activities such as this.

VALUE

This study was valuable to me as a teacher because I was able to evaluate and determine best practices for a teaching tool I had been planning to use for several years. Instead of simply using the technique and making a judgment call at the end of its use, an organized action research study allowed me to analyze the data and see how I can maximize the use of this tool. In the future, I plan to continue the use of discussion

boards in my classroom but with several modifications. This study suggests that participation in discussion boards did not affect student achievement on tests, but I feel it was still a valuable learning experience. Students became accustomed to using this tool, one that they will inevitably use in their future academics. Also, it allowed me to engage students in a discussion about current events and unique scientific topics related to what we learned in class. Students seemed to enjoy the opportunity to take what we learned in class to the next level in some of the discussion boards.

It was easier in some units to create discussion board topics than it was in other units. With this knowledge and experience, I plan to use discussion boards more sparingly. I will use them only when I have an intriguing discussion question or interesting current event that students will enjoy discussing. During this study, some of the topics seemed forced, and it was difficult for the students to buy-in to the discussions. I believe that when used sparingly and with the right questions students will feel better about using this tool. Many students expressed that they enjoyed certain topics more than others. Despite negative comments on the Discussion Board Student Attitude Survey, many students still suggested during the interviews that discussion boards should be used again next year.

When I use discussion boards in the future, I will be involved in all of the discussions. Many of my students at the high school level lack the skills necessary to sustain a meaningful dialogue on a science topic via an on-line discussion. I must be involved in the discussion so that I can help students ask the right questions and encourage them to discuss the topics on a deeper level. It's possible that after several uses

I could be less involved in the discussions over time and allow students to take more ownership of the discussions.

This action research study has been a great benefit to me as a professional. It required me to take an in-depth look at my teaching practices. During my previous years of teaching, I have reflected on my teaching but never felt I had the time for deeper reflection or the time to develop an action plan. I have always enjoyed trying new strategies or tools but I tend to either scrap them or use them after I try them. Action research has shown me that by looking at data there may be more options than simply scrapping or continuing my usage of the new tool or strategy. There are adjustments that I can make, pieces of strategies that I can keep, or modifications that can be added to help maximize the effectiveness of that tool or strategy. For example, I probably would have just scrapped the discussion boards after one use. Through action research, I have seen that if used correctly and with some modifications discussion boards can serve a purpose in my classroom. Most importantly, I have learned the value of getting student feedback. I received a lot of great suggestions and opinions from students when I took the time to ask them. It's a pleasant surprise to see how willing they are to provide meaningful feedback.

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APPENDICES

APPENDIX A

DISCUSSION BOARD EXPECTATIONS AND RUBRIC

1. Initial postings are completed by Monday.
2. Follow up post is made by Wednesday. A third post must be made by Friday.
3. Content is complete, on-point, thoughtful, and offers new ideas. Supporting detail is abundant and appropriate (ie, references from the pieces read and/or other sources).
4. Content often encourages further discussion on the topic or follows up on others' thoughts.
5. Postings are characterized by originality and are relevant to the topic
6. Postings demonstrate an understanding of the material assigned.

You will be graded based on the following rubric:

4 Points - The posting(s) integrates multiple viewpoints and weaves both class readings and other participants' postings into their discussion of the subject. All posting requirements have been followed.

3 Points - The posting(s) builds upon the ideas of another participant or two, and digs deeper into the question(s) posed by the instructor.

2 Points - A single posting that does not interact with or incorporate the ideas of other participants' comments.

1 Point - A simple "me too" comment that neither expands the conversation nor demonstrates any degree of reflection by the student.

0 Points - No comment

APPENDIX B

PHOTOSYNTHESIS AND CELLULAR RESPIRATION PRE AND POST
ASSESSMENT

1. Explain the process of aerobic respiration. How is the process important to living things?
2. Explain the process of fermentation. How is the process important to living things?
3. Explain the process of photosynthesis. How is the process important to living things?

APPENDIX C

DNA PRE AND POST ASSESSMENT

- ___ 1. Which of the following is NOT a component of DNA?
- Phosphate groups
 - Nitrogenous bases
 - Lipids
 - Five carbon sugar
- ___ 2. What is the basic unit of DNA?
- Nucleotide
 - Nucline
 - Nitrogenous Base
 - Megatron
- ___ 3. What is the name of the five carbon sugar found in DNA?
- Glucose
 - Deoxyribose
 - Ribose
 - Lactose
- ___ 4. In his work with pneumonia-causing bacteria and mice, Griffith found that
- The protein coat from pathogenic cells was able to transform nonpathogenic cells
 - Heat killed pathogenic cells cause pneumonia
 - Some substance from pathogenic cells was transferred to nonpathogenic cells, making them pathogenic
 - The polysaccharide coat of bacteria caused pneumonia
 - Bacteriophages injected DNA into bacteria
- ___ 5. For double-stranded DNA, consider the following base ratios:
- A/G
 - C/T
 - C/G
 - $(A+C)/(G+T)$
 - $(A+G)/(C+T)$
 - $(A+T)/(G+C)$
- Which of those ratios always equals 1?
- 1 and 2
 - 4 and 6
 - 3, 4, and 5
 - 1, 4, and 5
 - 3 and 6
- ___ 6. Which scientist(s) provided the best evidence that DNA has a double helix structure?
- Hershey and Chase
 - Avery and Griffith
 - Erwin Chargaff
 - Rosalind Franklin

APPENDIX D

EVOLUTION PRE AND POST ASSESSMENT

- _____ 1. The theory of evolution explains how life originated on Earth.
- _____ 2. Evolution states that people evolved from chimpanzees.
- _____ 3. Evolution explains historical events and isn't currently happening.
- _____ 4. Evolution and religion are incompatible.
- _____ 5. The theory of evolution states that species change over time.
- _____ 6. A theory is a broad explanation of natural phenomena and is supported by multiple lines of evidence.
- _____ 7. Science only deals with testable ideas.
- _____ 8. Only populations can evolve; not individuals.
- _____ 9. In the scientific community, scientists argue about whether evolution happened.
- _____ 10. Evolution leads to progress. Organisms get better through evolution.
- _____ 11. Humans can influence evolution.
- _____ 12. Evolution can also be described as survival of the fittest.
- _____ 13. Not every trait of organism is an adaptation.
- _____ 14. Whales have hind limb bones.

APPENDIX E

DISCUSSION BOARD STUDENT ATTITUDE SURVEY

Please respond to the following items by drawing a circle around the response that most closely reflects your opinion: strongly agree (SA), agree (A), undecided (U), disagree (D), or strongly disagree (SD).

1. I feel that I learned a lot through my on-line discussions with classmates.

SA A U D SD

2. I enjoy participating in on-line discussions.

SA A U D SD

3. Posts made by my classmates are informative and meaningful.

SA A U D SD

4. Posts made by my teacher are informative and meaningful.

SA A U D SD

5. I find it helpful to share my ideas and respond to other students' ideas.

SA A U D SD

6. Participation in the on-line discussions helped me understand the topic.

SA A U D SD

7. On-line discussions are more meaningful when the teacher is highly involved.

SA A U D SD

APPENDIX F

INTERVIEW STARTER QUESTIONS

1. Did you find the topics/questions to be interesting? Did they help you learn the topic?
2. What could be done to make the discussion boards more interesting and engaging?
3. Did you find reading others postings to be informative?
4. Did you find reading the teacher's posting to be informative?
5. Would you recommend using discussion boards in honors biology next year? Why or why not?
6. If they were implemented, what changes/improvements would you recommend be made?
7. Any questions/comments/suggestions you have about the use of discussion boards.