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A Teachable Unit on Soft Corals with Instructional Method Variances

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Abstract

The soft coral *Sinularia flexibilis* contains an aqueous alcohol extract that has shown antineoplastic activity against lymphocytic leukemia (Weinheimer and Matson, 1977). It also has other biological properties that work as antimicrobials, anti-inflammatory agents, and cytotoxicity activities (Kamel and Slattery, 2005). There is much research on the effects of flow rate on growth and morphology (Khalesi, Beeftink, & Wijffels, 2007) and the effects of light-dependency on growth rate (Khalesi, Beeftink, & Wijffels, 2009). The purpose of this student project was to further research on *S. flexibilis*, as well as incorporate that research into evaluating the effects of lecture-based teaching methods versus 5E-based teaching methods. The results showed nearly a two-point difference in the averages of the quizzes given in the two lectures, with the lecture-based lecture having the higher average. The qualitative feedback from the students attending both lessons also showed a significant preference for the lecture over the 5E lesson.

A Teachable Unit on Soft Corals with Instructional Method Variances

The Great barrier reef is the largest coral reef in the world. It's located off of the north coast of Australia, and is dominated by the upright branching (alcyonarian) soft coral, *Sinularia flexibilis* (Quoy and Gaimard, 1833)(Khalesi, Beeftink, & Wijffels, 2007). Studies on this specific soft coral have proven to be very useful in the biomedical field. Aqueous alcohol extracts act as anticancer agents in lymphocytic leukemia (Weinheimer and Matson, 1977), and its secondary metabolites perform biological activities that work as antimicrobial, anti-inflammatory, and cytotoxic activities (Kamel and Slattery, 2005).

Lectures have long since been the preferred method for teaching the youth of society. However, several new modes of teaching have surfaced. One of the most popular ones is the 5E model, which stands for engagement, exploration, explanation, elaboration, and evaluation (Bybee et al., 2006). Each "E" of the model utilizes different methods of teaching and student interaction to create a more engaged learning environment. One study by Anil and Batdi even concluded that the 5E instructional model has a positive effect on academic achievement, retention and attitude scores (2015). While the jury is still out on the various types of teaching methods, there seems to be an interest in studying the 5E model specifically.

Research on *S. flexibilis* covers a broad range of variables that influence morphology and growth rate. Specifically, Khalesi, Beeftink, and Wijffels performed two experiments: the effect of light-dependency on growth rates (2009) and the effect of flow rate on growth and morphology (2007). Research on the effects of lecture-based teaching as well as 5E model-based teaching also covers a variety of subjects from teaching the English language (Zahan and Begum, 2016), overall student achievement (Ward and Lee, 2004), biology (Sickel and

Friedrichsen, 2015), and meteorology (Finley, 2018). The purpose of this student project was to further research on *S. flexibilis* and then incorporate that research into a study that examines the effectiveness of lecture-based teaching methods and 5E-based teaching methods.

Materials and Methods

The corals and aquaria

The *Sinularia flexibilis* used in this experiment were collected from the on-site Marine Biology lab at Bowling Green State University, in which polyp-bearing colonies of 5cm-6m were cut from the parent coral and attached to aragonite coral plugs within two weeks. Each of these soft corals was genetically identical, as they all were originally from one parent. The corals' original tanks were modified to accommodate the needs of the experiment. Their home was located in reef aquaria at $34\text{‰}\pm 0.5$ salinity, where the saltwater is made using Instant Ocean in water filtered by reverse osmosis, and at temperatures of 26 ± 0.2 °C. To keep the input of light consistent, the tank was equipped with three 175 watt 10,000K Metal Halide bulbs that accounted for a day/night cycle by providing 12 hours of light and 12 hours of dark.

Experimental design

One tank was utilized to house two coral trees, each fitted with seven polyp-bearing colonies. A single feeding tube was fashioned out of plastic sheets of Sibe Polymer fashioned and Marineland Aquarium Sealant. One of the trees with seven colonies of corals was placed into the tube. This tube received two to five squirts from a small pipette of the Coralific Delite Coral food, which was a powder that was mixed with water from the tank to create a liquid, and the other coral tree that was not fitted with a tube and was not fed served as the control group of

corals. To ensure consistency, the light intensity was measured in each tube using a LUX meter. The growth rate was measured once a week after the fed-group of corals was fed and given 10 minutes in the tube to absorb the food, and then 30 minutes after the coral tube was removed to re-acclimate to the tank environment.

Once the results from the coral tests were analyzed and recorded, they were used to conduct two separate lessons about corals. One of them was completely lecture-based, and the other was based on a 5E model of teaching. They were conducted two separate days, Thursday, November 9th, 2017 and Thursday, November 16th, 2017, with approximately 30 different students in attendance for each lecture. After each lecture, a quiz was given to test retention of the information. This was the quantitative data analysis. A qualitative data analysis was also performed by asking two opinion-based questions after each quiz was given on how much the students preferred the specific style of teaching that they were exposed to and how much material they felt they retained from the lesson. The quiz, as well as the more qualitative questions, were kept the same for both lectures in order to keep consistency.

Growth rate and analyses

Growth measurements were performed weekly for 10 weeks. Biomass of both coral trees was measured separately using a water displacement method utilizing disposable Staccup beakers at 120cc, and then recorded. For the statistical analyses, a one-way analysis of variance (ANOVA) was used.

To analyze the quantitative data from the quizzes, the scores from the quizzes were compiled and averaged from the individual lectures to compare the scores in order to see the retention rates when the same material is taught two different ways. To analyze the qualitative

data from the preferential analysis, the answers were compiled from the individual lectures and read thoroughly to gain an idea on which teaching style the students preferred and why.

Results

Corals

The weekly average weights for the fed corals (Group 1) and the non-fed corals (Group 2) showed a variation in the growth over six weeks (Figure 1). This figure includes their initial weights under Week 1. Group 1 began with an average weight of 16.48 grams and dropped to an average weight of 16.17 grams after the seven-week period. Group 2 began with an average weight of 14.95 grams and rose to an average weight of 18.31 grams after a seven-week period.

The individual weights of the corals from Groups 1 and 2 varied in a similar fashion (Figures 2 and 3). The individual weights of the seven corals in Group 1 showed three corals that had gained weight over six weeks, and the other four corals lost weight. The individual weights of the seven corals in Group 2 showed growth in all corals except one.

The ANOVA ran on this data (Figure 4) showed a slight mean growth difference, just over one, between the fed corals (Group 1) and the non-fed corals (Group 2).

Lecture: Quantitative

After the lecture was given, a 10-question, 14-point quiz was given. Out of 23 students who took the quiz, the minimum score was 9 points (Figure 5), the maximum score was 14 points (Figure 5), and the average score was 12.11 points (Figure 7).

Lecture: Qualitative

Of the 23 students to take the quiz, only 17 of them responded to the qualitative questions: “On a scale of 1-5, (1 being the lowest, 5 being the highest) how did you like this method of teaching? Why?” and “In your honest opinion, how much information do you feel you retained from this style of teaching? Feel free to elaborate on the “why” aspect (why do you feel you retained this much? Are you a type of learner that does not benefit from this style of teaching? Etc., etc....).” The answers were as follows (answers with an × indicate that no rating was given):

1. On a scale of 1-5, (1 being the lowest, 5 being the highest) how did you like this method of teaching? Why?
 - a. 5. It was interactive and interesting. It kept the students engaged.
 - b. 5. I work well with interactive teaching styles.
 - c. ×. I thought this method was very beneficial because of the way you incorporated a Kahoot with it.
 - d. 4. Engaging, provided a video and audience engagement but graded quiz made me sad.
 - e. 5. It was interactive and fun as well as interesting with course-related content.
 - f. 4. I’m not someone who really enjoys interactive learning in classrooms, but I really loved the subject material! Go coral!
 - g. 5. Good enough. I’m pretty sure I got 100 on the quiz so that must mean it’s good.
 - h. 5. It was active and fun.
 - i. 5.

- j. 5. I feel like it would be better if people interacted more.
 - k. 5. Because I actually learned from it and took a Kahoot quiz that repeated the information to help me learn.
 - l. 5. It was very interactive.
 - m. 4. I like this method of teaching, especially with Kahoot because it forces us to actively pay attention and to cooperate.
 - n. 5. I love a good old-fashioned way of teaching, way better than book/computer learning.
 - o. 4. I like how it is interactive.
 - p. 5. Your presentation was interesting and interactive. You are also a good presenter.
 - q. 4. Because the presenter made the slides clear. And she spoke as though she knew her information.
2. In your honest opinion, how much information do you feel you retained from this style of teaching? Feel free to elaborate on the “why” aspect (why do you feel you retained this much? Are you a type of learner that does not benefit from this style of teaching? Etc., etc....).
- a. I feel that I learned a lot of information, mainly because the quiz motivated me to take notes and pay attention.
 - b. I feel that the quizzing and “games” helped me retain more information than I would have otherwise. This was engaging and I enjoyed it.
 - c. I feel as though I retained a lot more information than a normal presentation given in this class every week and I feel like incorporating the Kahoot really helped.

- d. I feel like I retained all of it because it was a mix of what I already know and interesting new facts. The presentation was well done and informative.
- e. I don't know how much information I retained. I'll let you know in a week, but I feel like I will remember most of what I learned. The subject matter interested me and the class was different than the normal lectures.
- f. I already knew most of it, but I recognize there was a lot of interesting methods and repetition so I'm sure it was useful to many.
- g. I retained more because I needed to focus, even though I knew most of it, tough names such as the coral you worked with stuck with me so that's good.
- h. The majority of the information I retained because you repeated it multiple times.
- i. I will retain most of this information because it interests me, but also because Emily was engaging with the class.
- j. I feel like I retained a lot of this information, I liked the fast-paced and interaction aspect of it.
- k. A lot – for the reasons above (see K above).
- l. I retained almost all of it because it was so interactive and very lively.
- m. I feel like I retained a lot of the information that was just presented to me, but that could also be due to the fact that it was just said to me.
- n. I retained a lot of this information mainly because I was pretty familiar with it and because it was interesting to learn about these topics.
- o. All of it, since I already knew everything.

- p. I will retain most of this information because it interests me. Maybe not so much because of the presentation but most likely because I find this stuff to be interesting.
- q. Also, the interactive learning activity was fun and interesting. I do benefit from this method of teaching because I am a visual learner.

5E: Quantitative

After the 5E lesson was given, the same 10-question, 14-point quiz was given. Out of 32 students who took the quiz, the minimum score was 5 points (Figure 6), the maximum score was 13.5 points (Figure 6), and the average score was 10.41 points (Figure 7).

5E: Qualitative

Of the 32 students to take the quiz, 30 of them responded to the qualitative questions: “On a scale of 1-5, (1 being the lowest, 5 being the highest) how did you like this method of teaching? Why?” and “In your honest opinion, how much information do you feel you retained from this style of teaching? Feel free to elaborate on the “why” aspect (why do you feel you retained this much? Are you a type of learner that does not benefit from this style of teaching? Etc., etc....).”

The answers were as follows (answers with an × indicate that no rating was given):

1. On a scale of 1-5, (1 being the lowest, 5 being the highest) how did you like this method of teaching? Why?
 - a. 2. I hate group work.
 - b. 5. Very interactive and visual.
 - c. 5. Because it was more hands-on and interesting.

- d. 3. Because the feeling that the slideshow went by very quickly and much of the information was spoken, and I wasn't sure what was truly important. It is engaging though which can be good.
- e. 4. Because the information was nicely given.
- f. 4. It was very informative and I liked the presentation. I would appreciate it if you would speak a little louder.
- g. 4. Because I enjoy doing hands-on activities because it helps me retain the knowledge better when I can physically do something to understand it. I also enjoy the PowerPoint and how it gives good notes to focus on to help organize my own thoughts and notes. The only complaint is that the lecture was given too quickly to be able to take detailed notes.
- h. 5. I liked this method of teaching because it was interactive and Mily made it interesting. Doing the activity in the beginning helped me understand the fragility of corals.
- i. 5.
- j. 5. This is because it was considered fun learning while still keeping the system organized.
- k. 5. I enjoyed the activity in the beginning. The presentation was both informal and fun.
- l. ×
- m. 4. The material was interesting. I enjoyed learning about it. The quiz made me make sure that I was paying attention.

- n. 4. I like how students were able to engage by being hands-on and participate throughout the presentation.
- o. 3. Because I feel like you talked too fast.
- p. 4. I thought this presentation was interesting but too broad of information, could be more specific.
- q. ×. I liked it because you actually explained things thoroughly and it was easy to understand and I like how you quizzed us to show how much attention we paid.
- r. ×. I didn't notice too much of a difference than current methods. But I liked how you tried to make it more hands-on.
- s. 4. Very effective and kept my interest.
- t. 3.5. It was unique, however, I did not understand the point of taking the notes if we were not going to have any time to look them over.
- u. 3. I did not like the activity part, I felt that it was not overall beneficial and wasted time. I did, however, like being quizzed on the information we were tested over, as it helped me to pay attention to what was being taught and to retain the information.
- v. 4.5. I say this because watching the video presentation first and then hearing the way Emily presented her material was helpful to my learning style and for me retaining information as a student.
- w. 4. It included hands-on tasks as well as listening to the lecture and taking notes which were followed by a quiz forcing you to pay attention.

- x. 3. Because hands-on teaching is a good process but it was confusing because we didn't really understand what we were doing it for. The presentation was really fast too.
 - y. 5. Because it was interactional hands-on and right after we learned the topics we quizzed our memory of them which I feel helps a person retain the information.
 - z. ×. I very much liked this type of teaching. It allows the students to interact with the teacher and in my opinion, they take much more away from it.
 - aa. 4. I liked the PowerPoint, very well done.
 - bb. 3. Good presentation, but could have engaged us a little more.
 - cc. 3. I liked the presentation portion but the first bit involving the coral really dragged out and the point wasn't worth the buildup. Other than that you did really good.
 - dd. 5. Because the activity got me thinking and then the lecture was also interesting to me. In your honest opinion, how much information do you feel you retained from this style of teaching? Feel free to elaborate on the "why" aspect (why do you feel you retained this much? Are you a type of learner that does not benefit from this style of teaching? Etc., etc....).
2. In your honest opinion, how much information do you feel you retained from this style of teaching? Feel free to elaborate on the "why" aspect (why do you feel you retained this much? Are you a type of learner that does not benefit from this style of teaching? Etc., etc....).
- a. I felt I remembered the information better.

- b. I knew much of the information said but liked the new information I did not know. I liked the plastic demonstration. I like visual and hands-on, so this was good.
- c. I learned about hard and soft corals and how 25% are controlled by coral. I do benefit from this kind of learning.
- d. I probably retained most of the information, but because I took notes. Without writing things down I wouldn't be able to keep it. I am a very visual learner so examples and people with more information to write down rather than an audio presentation alone work better for me.
- e. I retained a very large amount of the information given.
- f. I feel like I retained a good amount considering I was able to answer the questions easily. Although, it would be helpful if you increased your volume in the case that I missed questions.
- g. I feel as if I retained the majority of the information taught with this style of teaching. I feel that I retained a lot because the PowerPoint gave me something to look off of to understand more of what was being talked about. I learn more from hands-on experience, so I feel that the coral activity at the beginning was the most effective in retaining the knowledge.
- h. I feel like I retained most information that was taught. I am more of a hands-on learner so I feel that activity in the beginning helped connect everything for me.
- i. I thought I learned a lot from this teaching and had very useful information.
- j. I retained a decent amount of information from this style of teaching. I retained so much because she put the info on a power point then had us take notes. Not only

that but she had a quilt set up as a study tool so we could perform well on the quiz.

- k. I retained a lot from this style of teaching since it combined both a hands-on activity and a lecture. I benefit from both of those types of learning because they make me think and stay focused.
- l. I personally do not retain information well just by listening to a presentation and not taking notes that I can look over after hand and study. I benefit from being able to take notes that I can have on hand at all times that would be available to me look over. I need time to process information because I can't do it right away like others might be able to.
- m. I honestly feel like I retained a lot of information. I got all of the multiple choice questions correct and I feel semi-confident in the extended response. I always learn more when I am interested in the topic.
- n. I retained the majority of the information because it was a concise presentation and it didn't have a lot of extra information to remember.
- o. I retained a little bit of information but not as much I would have liked because you talked a bit fast and didn't elaborate on things. Also putting the definitions on the board along with the words would help.
- p. I already knew half of the information being presented so I retained quite a lot of it.
- q. I feel like I retained a lot of information, it was easy to grasp. I benefit from this type of teaching because I am a visual learner. Thank you for taking time out of your life to teach us about coral.

- r. I am a type of learner who benefits from more of a hands-on style but the majority of the lesson was given through talking. I feel I still retained most of the information.
- s. I feel like I retained a good amount. It was explained well and put into words that were easily understandable.
- t. I feel as though I retained quite a bit of information about coral and possible causes of bleaching.
- u. I feel I retained more information from the style of teaching because I had more motivation to pay attention to what we were learning instead of zoning out.
- v. I say this because watching the video presentation first and then hearing the way Emily presented her material was helpful to my learning style and for me retaining information as a student.
- w. I knew the majority of this information already but I feel like it is still a very useful form of teaching for other people to learn. I enjoy hands-on learning more than lectures so it made the experience better having the interactive portion in the beginning.
- x. I feel like I didn't learn a ton just because she went so fast and did not elaborate on certain things. I am normally a student who does better with hands-on learning but this didn't really help a whole lot.
- y. I feel like I retained almost everything discussed in this lesson because we were quizzed right after we learned the material.
- z. I will retain pretty much everything that we discussed this evening, simply because this is my interaction is my preferred way of learning. I like hands on!

aa. I will most likely retain most of the info taught, I'm a visual and hands-on learner.

I enjoyed the short video.

bb. Almost all of it, I have weirdly good short-term memory, doesn't really matter.

cc. I feel like I retained quite a bit, I'm more of an auditory learner rather than visual so that is probably why I liked the lecture better but who knows.

dd. A fair amount because knowing I had a quiz it made me memorize the things being lectured on.

Discussion

Corals

Research on *S. flexibilis* indeed covers a broad range of variables that influence morphology and growth rate. Khalesi, Beeftink, and Wijffels performed two experiments: the effect of light-dependency on growth rates (2009) and the effect of flow rate on growth and morphology (2007). However, a study on the effects of coral food on the growth rate of corals was not analyzed until now. The results showed that the average coral growth for those corals in Group 1, or the fed corals, showed a fluctuation in growth that was not seen in Group 2, or the non-fed corals. Since the coral food used in the study, Coralific Delite, was a powder-based food, it could have acted as a coral stressor. Sediment being dropped onto corals can stress the corals, and even cause them to bleach, or eject the algae that live on the surface of the corals and provides them with the majority of nutrients and materials they need to survive (Verseveldt, 1980). The coral food could have acted much like the sediment and stressed the corals to a point where their growth was not only inconsistent, but in most cases, decreased as opposed to increased. Further research should be performed in order to confirm or deny this hypothesis.

Lecture versus 5E-Based Lesson

Research by Anil and Batdi provides a compelling argument that the 5E instructional model has a positive effect on academic achievement, retention and attitude scores (2015), which inspired this model to compare the 5E model with traditional lecturing methods. The hypothesis that arose from this analysis, and an analysis of all of the research on the effects of lecture-based teaching as well as 5E model-based teaching that included a variety of subjects, such as teaching the English language (Zahan and Begum, 2016), overall student achievement (Ward and Lee, 2004), biology (Sickel and Friedrichsen, 2015), and meteorology (Finley, 2018), was that the 5E model would provide higher quiz scores and more positive feedback. However, it seemed to be just the opposite. The quiz scores from the 5E lesson showed a greater variance, ranging from a low score of 5 and a high score of 13.5, with an average of 10.41 points. This average was nearly two points lower than the average for the lecture. The lecture also had a low score of 9, which was four points higher than the low score of the 5E lesson.

The qualitative feedback from the students also showed a similar trend to the scores. The lecture, overall, had more positive feedback and the students admitted to feeling as though they were able to retain a majority of the information. The students that attended the 5E lesson were less positive. The main complaints of the lesson were that they did not feel the hands-on portion was beneficial and that the lecture was too short and went by too fast. This, in turn, affected their feelings about their retention and, as seen with the quiz scores, their retention overall.

In terms of a single class period, a lecture works best because it is easiest to get across all information. A 5E lesson does not work so well because so much time must be dedicated to the other aspects of the 5E model (engagement, exploration, explanation, elaboration, and evaluation

(Bybee et al., 2006)). Spread out over multiple class periods, the 5E model may prove more successful. It may also be best to gauge the type of lesson and information that needs to be given beforehand. This may also be a key element in determining whether using the 5E model versus a traditional lecture is truly beneficial for that particular lesson.

Tables and Figures

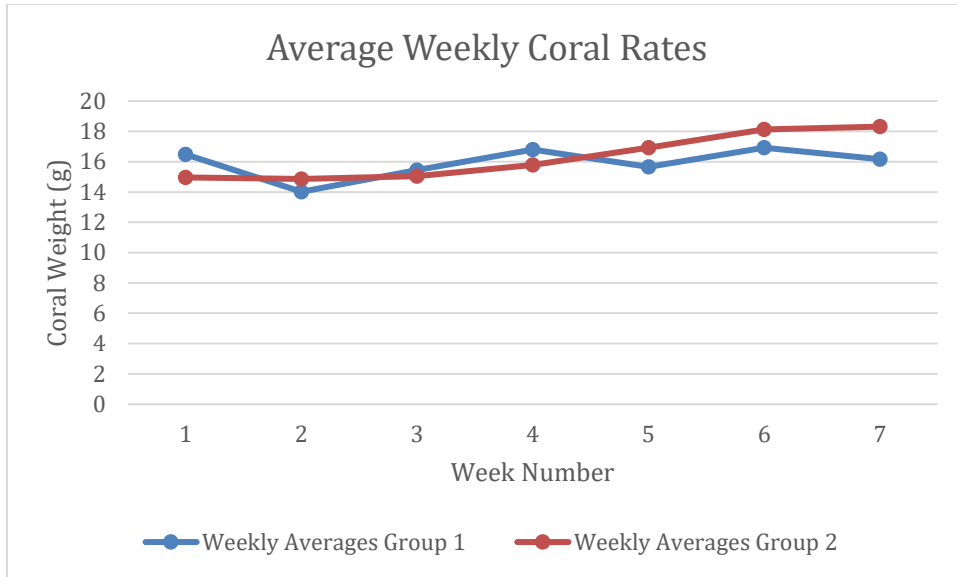


Figure 1

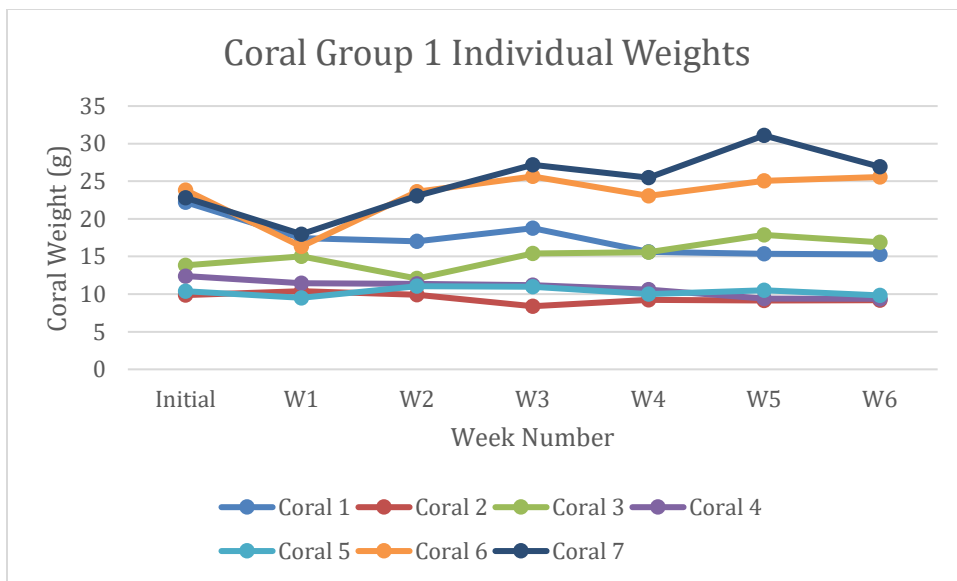


Figure 2

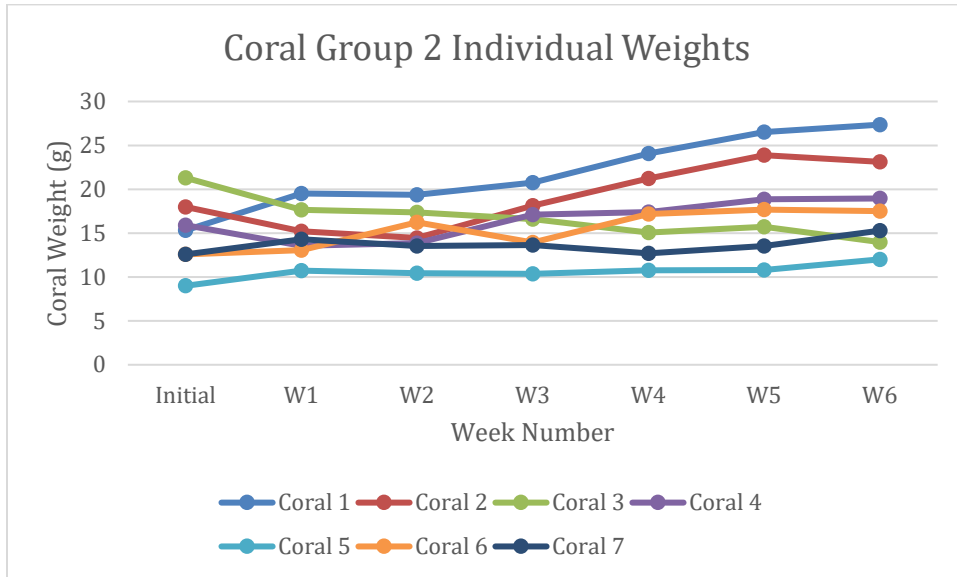


Figure 3

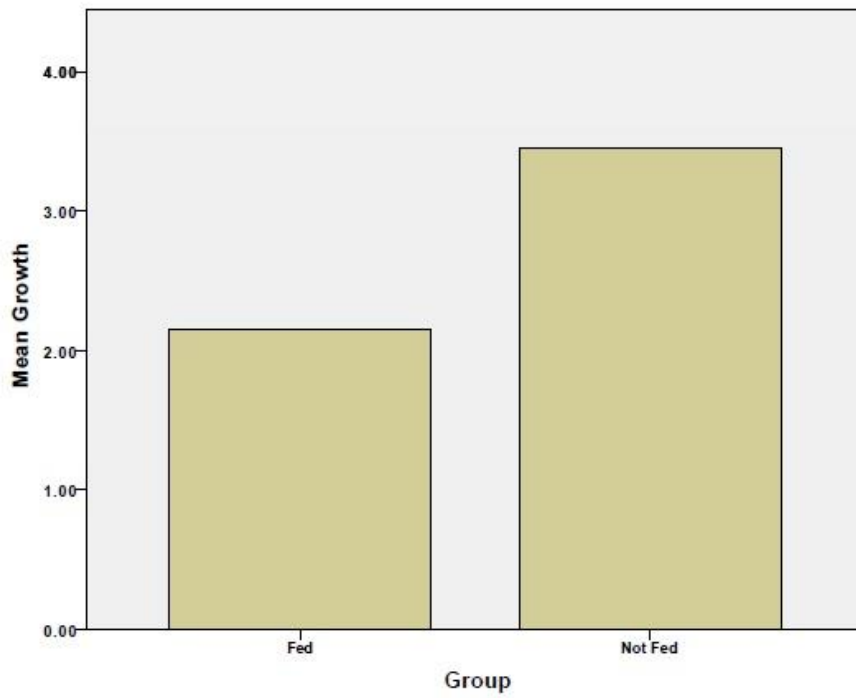


Figure 4

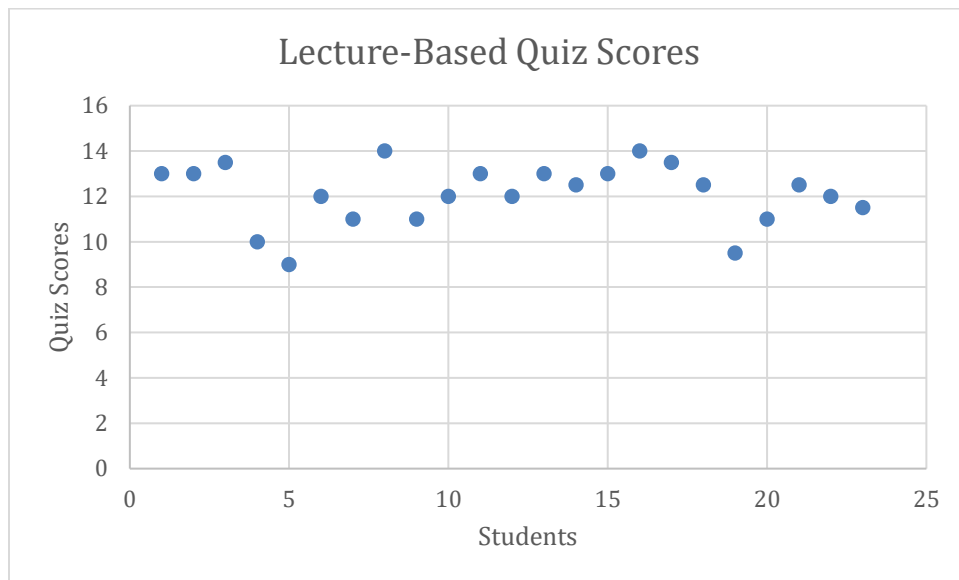


Figure 5

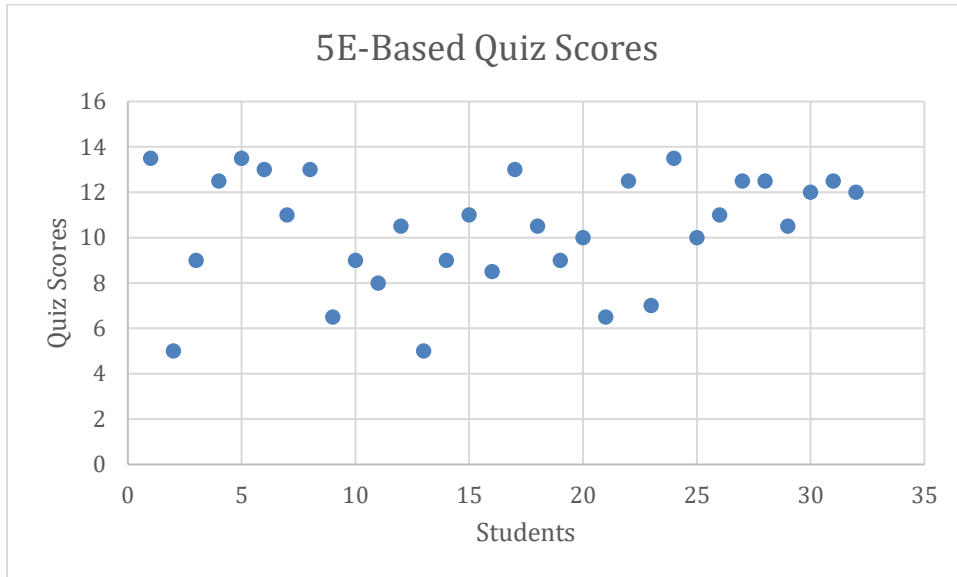


Figure 6

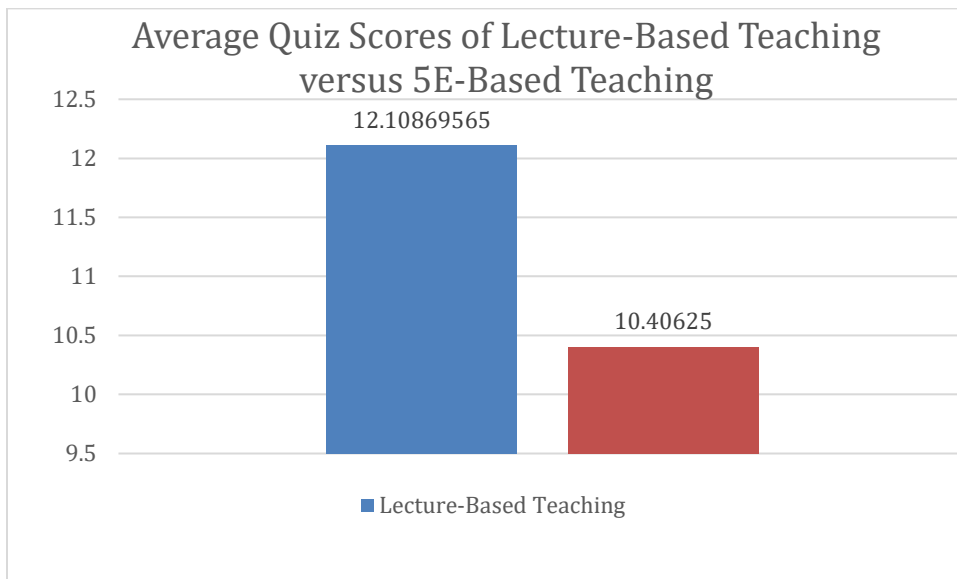


Figure 7

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