

THE EFFECTS OF STUDENT CHOICE ON ACHIEVEMENT
IN THE HIGH SCHOOL SCIENCE CLASSROOM

by

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ABSTRACT

Education has changed from a one-size-fits-all approach to learning to an approach that caters to the individual student. Teachers regularly employ strategies in their classroom to ensure students are exposed to the content on a variety of platforms. The purpose of this study was to explore how students' achievement in science class was affected when given a choice of classroom activities to complete based off their interests. Secondary questions included how student attitudes towards learning science changed when given choice and how teaching practices changed as a result of implementation of student choice activities. The research was accomplished using a student choice-board, a matrix of activities from which students chose based on personal interests. After completion of a prescribed number of activities, student achievement was measured using pre- and post-test data. Qualitative data were acquired through student interviews, observations, Likert-style surveys, and journaling. The results of the study indicated that there was no appreciable difference in achievement when students learned by choosing their activities and when traditional teaching methods were employed. Student attitudes towards learning science showed either an increase in positive attitude or were neutral. The most definitive result of the study was how teaching style changed.

INTRODUCTION AND BACKGROUND

I teach in a rural public school district in northwest Ohio with a district-wide enrollment of approximately 1,400 students. I teach life science courses at the district's high school which has an approximate enrollment of 435 students. For the 2017-18 school year, according to the Ohio Department of Education, 91% of the student body was identified as white, non-Hispanic, 7% was identified as Hispanic, and 2% was identified as other. Of the total enrollment, 25% of students were identified as economically disadvantaged and 8% of all students had an identified disability for which an individualized education plan was on file with the district (2018).

Over the course of my teaching career, I have explored ways to try and make science content relevant, engaging, and fun for my students. Through observation and anecdotal evidence, I saw that students enjoyed learning when there was a personal interest in what they were being taught. Through storytelling, sharing pictures, and using place-based activities, in conjunction with traditional teaching methods, I was able to get most students engaged with the content. Then, my district implemented a technology plan that significantly increased the number of devices for students to use. This new access to technology further helped to motivate and engage students in the content. However, even equipped with these tools, there was still extreme apathy and ambivalence to the content.

During one of our professional development days, I was introduced to the concept of student choice for assessments as a method of differentiating instruction. This strategy works by presenting students with a few activities, from which they choose one, as a way to demonstrate content mastery outside of the typical quiz or test format. The strategy

encourages students to pick an assessment method in which they show interest rather than choosing an assessment method based upon a prescribed learning style of visual, auditory or kinesthetic. If students are being assessed in ways that interest them, I thought the same concept could be applied to content delivery.

With this in mind, I created a student choice-board as my instructional tool and subsequent research instrument. A choice-board is a matrix with a variety of content activities for students to choose from, similar to a tic-tac-toe board. The activities on the choice-board were selected or created without respect to specific learning styles. Rather, they were selected and created to give students a wide range of traditional, modern, and digital platforms from which to choose based on personal interest. My hope for the students was that they would show increased engagement with the content which would translate into better grades. I also wanted to provide an atmosphere where the students felt more self-efficacious in their ability to learn science and where science was not deemed boring.

The creation of the student choice-board led me to draft my research focus: How does student choice affect student achievement in science class? I also identified a few secondary questions related to the research focus:

1. How do student attitudes towards learning science change when given choice?
2. How does providing students with choice affect my own teaching?

CONCEPTUAL FRAMEWORK

Research has been done that shows the merits of incorporating more choice into classroom instruction. Using differentiated instruction as the basis of student choice,

teachers are able to increase content achievement without the hassle of determining student learning styles. In addition, students who are autonomous with their learning show increased positive behaviors related to preparedness for class and homework completion.

Providing students with choices in their learning is a form of differentiated instruction. However, for the purpose of this study, there needs to be a discussion which sets these two concepts apart. First, “differentiated instruction is a set of strategies that will help teachers meet each child where they are when they enter class and move them forward as far as possible on their educational path” (Levy, 2008, p. 161). Differentiated instruction can take the form of audio, visual, or hands-on activities in the normal course of instructional delivery. Differentiated assessment allows for students to show their content mastery in ways other than a typical quiz or test. Both differentiated instruction and assessment are techniques that educators regularly employ in their arsenal of teaching methods. This is in contrast to student choice or autonomous learning. Differentiated instruction does not necessarily have to provide students with a choice. In the normal course of instruction, I can have students read from a text, watch a video online, and complete a laboratory exercise. I have effectively differentiated my instruction, but I did not provide students with a choice in which activities they could complete. The understanding of this difference is crucial to my action research project.

Autonomous learning, and the underlying motivation, is central to the self-determination theory of learning. According to Gagné and Deci’s theory, autonomous learning is the highest form of reflection, driven by intrinsic motivation, and doing an

activity that is completely voluntary because it is perceived as fun (2005). The underlying intrinsic motivation to complete tasks out of sheer enjoyment sets a tone for the classroom that caters to individual students' desires and wants. Brooks and Young say, "offering students choices in a classroom may enhance their feelings of self-determination and intrinsic motivation to participate in class activities" (2011, p. 51). To this end, it becomes imperative that teachers provide students with a variety of activities to choose from that sound enjoyable. In doing so, students draw upon their own internal motivation to complete a task rather than feeling forced to do something by the teacher. The emphasis is on what the student is interested in, not on how a student might learn based on a prescribed learning style.

By offering students choice in their learning, one might suppose that the teacher is differentiating instruction to meet all students' learning styles. While generally agreed upon that there are three main modalities, auditory, visual, and kinesthetic, Pashler, McDaniel, Rohrer, and Bjork claim the "sheer number of different schemes or models of learning styles that have been proposed over the years" should give us pause to consider why a definitive approach to learning style doesn't exist" (2008, p. 105). The inability to come to consensus on learning styles negates the concept that students have one method of learning that fits them best. It also eliminates from consideration that students are choosing to learn based on what interests them.

Riener and Willingham contend that students do in fact have preferences in how they learn, but these preferences are situational (2010). For example, when learning to play dodgeball, one student may want to see how the game is played, but when learning

math, the same student may want to be told how to do a problem. Rather than assign this student a style label of “visual” or “auditory,” one must consider that the student simply chose how to learn based on his or her interest in the subject matter at that given time.

Further, the evidence that students have mastered content by using a particular learning style is limited at best. Riener and Willingham go on to say that the “failure to find any experimental support for matching the mode of instruction to a preferred learning style” does not by definition increase student achievement with the content (2010, p. 34). This viewpoint is supported by the Pashler, et. al. study findings that say, “there is no adequate evidence base to justify incorporating learning-styles assessments into general educational practice” (2008, p. 105). In addition, Chen, Jones, and Xu (2018) completed a study that surveyed accounting students’ preferences for learning to find that students prefer a balanced approach to learning. In fact, 66% and 63% of students found a balance between reflective-active and global-sequential styles, respectively, to be more beneficial than one or the other (2018). This illustrates that one style is no more important than another when determining how a student learns best. It is then the responsibility of the educator to provide several options for students to choose from based on their interests.

In providing students with autonomous learning opportunities, whether as a classroom activity, homework or assessment, many researchers have found positive outcomes in student achievement and motivation. For example, researchers Smith and Geil (2016) looked at how student choice affected engagement in language arts class. During Phase I of their research, the teachers assigned the books to read. During Phase II

of the research, student groups were allowed to nominate and then vote on books to read. Using mostly student interviews, the findings suggested that “more students were engaged in reading and made sure to be prepared for the discussions” when allowed to choose the material to be read in class (2016, p. 7).

In another study, Patall, Cooper and Wynn (2010) set out to see how student choice on homework assignments changed student outcomes in class. The authors used several questionnaires, including student background, school experiences, learning climate, and an intrinsic motivation inventory. Homework was designed to assess the same content, but was delivered in two ways, of which students could choose one. Unit test scores were also assessed to help triangulate the data collected. The researchers found that students were more interested in their homework, completed more of that homework, and scored higher on the unit test when they were provided with choices (2010).

Finally, Pretorius, van Mourik, and Barratt (2017) examined how student choice in assessment of learning improved outcomes. The study was designed to give accounting students two compulsory assessments and two optional assessments. The assessments were weighted differently depending on if the compulsory assessments were completed alone or in conjunction with the optional assessments. Further, surveys that measured student understanding of the flexible nature of the assessments were administered. The collection of quantitative and qualitative data provided a solid backing to the study findings. In short, the optional assessments in conjunction with the compulsory assessments were the preferred track of a majority of students (66.4%). A significant majority of students (89%) were aware of the flexible nature of the assessments, and, of

those completing the optional assessment track, the overall score average was 12 percentage points higher than those who took only the two compulsory assessments (2017). All three examples are consistent with self-determination theory and autonomous learning. One can conclude that, students, when presented with a choice, show greater achievement on class preparedness, homework completion, and summative test scores.

What was not mentioned, however, is the role of the teacher beyond procurement of student activities. Without organization and support, student choice in and of itself might not provide the level of achievement indicated above. Stefanou, Perencevich, DiCintio, and Turner, (2004) discuss the types of autonomy support offered by teachers to students. Support types include organizational/procedural and cognitive. The researchers found that when both low organizational/procedural and cognitive supports are offered, students are in a rote mindset. When high organizational/procedural and low cognitive supports were offered, the semblance of student choice was seen. Students were able to do what they wanted, but the results were uniform to the teacher example. When low organizational/procedural and high cognitive supports were offered, the students developed deep engagement with the task assigned by the teacher. Finally, when both high organizational/procedural and cognitive supports are offered, students show complete engagement, creativity, and self-reliance with the content (2004). In this way, the teacher is still critical to the success of the student, offering all levels of support to guide the students towards understanding independent of how the student arrives there.

Current trends in education advocate for more student choice, or autonomy, in learning. Traditional teaching strategies using differentiated instruction and learning

styles are being replaced with activities that promote student choice based on interest and background. These activities draw upon students' intrinsic motivation and desires which has subsequent effects on achievement. Upon closer examination, autonomous learning shows a correlation between student choice and greater achievement of content learning. The role of the teacher changes to one of support rather than direct instruction. In this way, students are fully supported in their desire to learn.

METHODOLOGY

This project's main goal was to see how achievement changed when using more autonomous learning activities in the science classroom, how students' attitudes towards science was affected, and how my own teaching changed as a result.

I conducted my study with a sophomore Honors Biology course. In Ohio, biology is a state-mandated tested subject for all sophomores. Total enrollment in this class was 26 students of which 16 self-identified as female and 10 self-identified as male. No students were identified as having a learning disability, one student was identified as Hispanic, and one student was identified as being economically disadvantaged. Two female students were identified as being gifted in English language arts, and three male students were identified as being gifted in math. One of the female students in this class was a freshman who was new to the district this year and was placed in this level science class. With her as the only exception, all students in this class had me as their 8th grade science teacher. Being that this was the only section of Honors Biology for the whole high school, and that I wasn't teaching a general Biology course, I opted not to use

another group as a comparison. The research methodology received an exemption from Montana State University's Institutional Review Board (Appendix A).

The project consisted of a two-cycle treatment of alternating units, one unit delivered by traditional teaching strategies, the other unit delivered using a choice-board. Each unit in the cycle had an approximate duration of two weeks. All units began with a pre-test of students' prior knowledge, giving the baseline data from which to measure student achievement after instruction was complete. At the conclusion of the unit, students were given a post-test identical to the pre-test so that an accurate comparison of growth could be made. Each test consisted of 25 multiple choice questions taken from the textbook publisher's resource guide to allow for standardization. The test itself was constructed in Google Forms and delivered electronically to the students.

During the traditional teaching unit, I utilized a variety of activities that are in my current teaching repertoire. This was the way I would normally teach a class if I had not been conducting the study. Items I used included reading activities from the text book, interactive notes, lecture, internet video, graphic organizers and traditional lab activities. I used formative assessments to manage student learning throughout instruction. At the conclusion of the unit, the post-test was given.

During the independent learning unit, I created a choice-board of carefully selected activities for students to complete (Appendix B). The choice-board was a spreadsheet table with each column correlated to a section of the unit the students were learning. Each row held a different activity which then had a point value assigned to it. The point value was based on the complexity of the task the student needed to complete.

For example, if a student chose to watch an instructional video and answer questions about the content, that was assigned a lower point value since it is not a complex task. However, if a student chose to complete a lab, that was assigned a higher point value as it was more complex. Students were asked to reach a specific total of points for each column. They were able to choose whatever activities they wanted to complete so long as they reached the point goal. Once they accomplished this, students took two formative assessments for that section. Upon completion of all formative assessments, students were given the post-test for the unit.

To answer my research questions, I used a variety of quantitative and qualitative methodologies. The methodologies are outlined in the matrix found in Table 1. This triangulation also helped to ensure that my research instrumentation was reliable.

Table 1
Data Triangulation Matrix

Research Questions	Methodology						
	Formative Assessment	Interview	Likert Survey	Pre-Test	Post-Test (Summative Assessment)	Journaling	Observation
How does student choice affect student achievement in science class?	X			X	X		
How do student attitudes towards learning science change when given choice?		X	X			X	X
How does providing students with choice affect my own teaching?	X					X	X

Quantitative data was collected by way of student scores on their pre-tests and post-tests. Qualitative data was collected by way of formative assessments, Likert-style surveys, interviews, journaling, and observations. The formative assessments varied in type, but the data was used to inform me about student content understanding. The Likert-style survey (Appendix C) was used to gauge student attitudes towards learning science. Using one-sentence statements, students were asked to rank the degree in which they agreed or disagreed with the statement. The survey was given anonymously after each treatment cycle was over. The anonymous nature was intentional so that students would not be afraid to express their true thoughts and feelings to me. Further, I wanted to remain as objective as possible when reading their responses. The survey was created and delivered using Google Forms, and students were given class time to complete it.

After each treatment cycle, I also held focus-group interviews with approximately four or five students. These students were selected by assigning them a number and using a random number generator. Student participation was voluntary. A copy of the interview questions can be found in Appendix D. The focus-group interviews were conducted during homeroom time during the school day. An occasional one-on-one interview was conducted with a few select students with whom I have good rapport and trust their perceptions of class. I used the same general framework of the focus-group interview, but I was able to ask more specific, probing questions to these students.

To help generate data on the effects on my own teaching, I asked a colleague to observe me on four separate occasions: twice during non-treatment units and twice during treatment units. The observations were unstructured, and my colleague was asked to free

write anything she deemed necessary or relevant during the observation time. The observations lasted the entire 45-minute class period.

Finally, I kept a journal to record personal observations, thoughts, and feelings that came to me during the course of my instruction. My planning period was immediately after the subject class, so I devoted five minutes each day to reflecting on how I thought class went, positive comments that were made, and struggles I encountered.

To establish validity and reliability of instrumentation, several checks by a variety of sources were made. The validity of instrumentation was ensured by using standardized testing materials released by the publisher of the textbook used in class and by using released test materials from the State of Ohio's Biology End of Course Examination. My science colleague, a veteran biology teacher, reviewed the instruments and cross-checked those to the textbook, state test, and Ohio's Biology Standards. Reliability, or consistency of data, was ensured through use of data triangulation as mentioned previously.

DATA AND ANALYSIS

Student pre- and post-test scores were downloaded to a spreadsheet for sorting and analysis. Achievement gains were calculated as the difference between pre-test and post-test scores. Those results were then normalized. Student achievement was inconsistent between treatment cycles. Figure 1 shows the distribution of normalized gains for each unit.

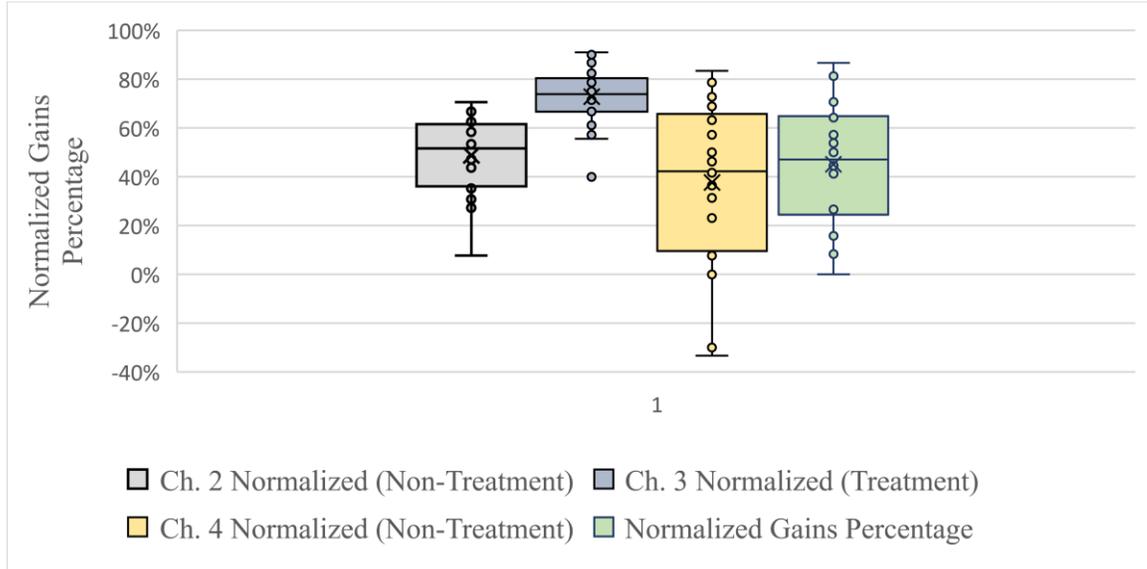


Figure 1. Normalized gains of administered tests, ($N=26$).

The distribution of normalized gain scores was approximately normal and showed that students generally had higher achievement gains after treatment compared to the non-treatment unit immediately preceding. For Cycle 1, students' average achievement gains were 49% during non-treatment and 77% during treatment ($N=26$). For Cycle 2, students' average achievement gains were 38% during non-treatment and 45% during treatment. On the surface these numbers seem positive. Also of note is the fact that during treatment, the range in which scores fell was smaller. This would suggest that the gains in achievement for treatment units were more valid and reliable than for non-treatment units.

It should be noted that there are outliers from Cycle 2 that do affect the overall achievement gains average. The Chapter 4 unit saw two students fare worse on the post-test than on the pre-test which gave them negative achievement gains. When asked about this, the students said they were overwhelmed with the content and second-guessed a lot of their answers. When these two scores are excluded from the calculations, the average

increases five percentage points to 43%. This is almost equal to the gains experienced during the corresponding treatment unit (45%).

Further statistical analysis was done with these data to ensure the significance of the achievement gains. The Wilcoxon Rank Sum Test was performed since the t-Test requirements were not satisfied. Table 2 shows a summary of the significance of gains between units.

Table 2
Wilcoxon Rank Sum Test Results Matrix

	Ch. 2 – Non-Treatment	Ch. 4 – Non-Treatment
Ch. 3 Treatment	p-value = 0.0000001 Significance: Yes	p-value = 0.00001 Significance: Yes
Ch. 5 Treatment	p-value = 0.6926 Significance: No	p-value = 0.2321 Significance: No

The Wilcoxon Test confirms that the achievement gains for Cycle 1 between Chapter 2 and Chapter 3 are significantly different ($p\text{-value} < 0.0001$), however the achievement gains for Cycle 2 between Chapter 4 and Chapter 5 are not significantly different ($p\text{-value} > 0.05$). Interestingly, the comparison of achievement significance for opposite cycles showed the same results. Chapter 3 had significant gains compared to Chapter 4, and Chapter 5 showed no significant gains compared to Chapter 2. Based on these results, I would argue that the treatment played a significant role in achievement gain during the first cycle but was not significant during the second cycle.

To gain some insight as to why Cycle 2 did not show significant gains compared to Cycle 1, student input was valuable. One student responded to an interview question by saying, “I really tried during the first part, but then didn’t care so much the second time.” When asked to elaborate, the student said he usually stops trying so hard after the

first few months of school. Another student attributed her lack of performance on the fact that she did not use class time wisely. She said, “I knew I was wasting my time in class, and that time adds up.” Four out of six focus-group students mentioned time management as a factor in poorer performance during Cycle 2.

Aside from achievement in science class, my research looked at how student attitudes towards science class were affected. When asked about their feelings of traditional learning versus more independent methods of instruction, students found having more choice was beneficial for them even though the quantitative results don't consistently show this. For example, one student commented that “I can take more time on things that I get confused about and speed through things I understand.” Another student commented that he or she likes “independent learning because we can go at our own pace with things, and if I have questions, you are there to answer them.” Conversely, some students find independent learning daunting. One student said, “When I do the independent learning unit, I don't know what is important and what isn't. With traditional learning, Mr. Larsen teaches us the important stuff in the unit.” It would seem that even if students are not experiencing greater achievement in science class, their perception of independent learning is still positive.

Analysis of Likert data further confirms this finding. Figure 2 shows the degree to which students prefer traditional teaching. While most students are ambivalent to traditional methods, only four students had an absolute preference for traditional learning. Statements about independent learning were more telling.

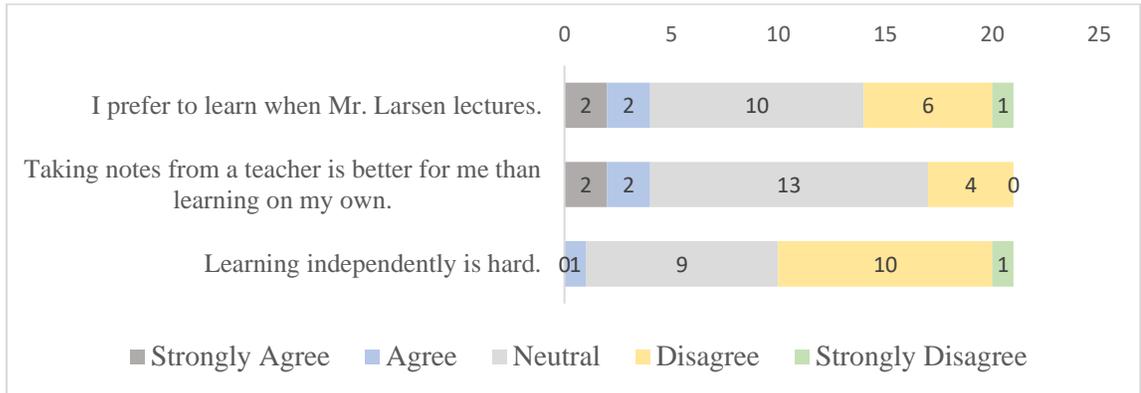


Figure 2. Student response type to questions asked about traditional learning methods, (N=21).

Figure 3 shows the degree to which students prefer having a choice in their learning. With a few exceptions, most students were neutral or had positive responses to statements about independent learning.

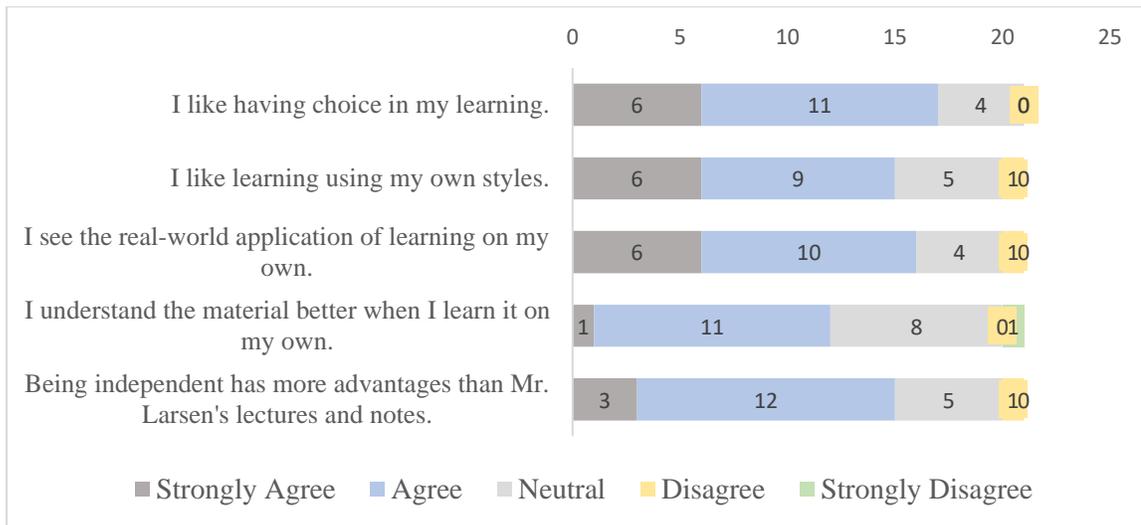


Figure 3. Student response type to questions asked about independent learning strategies, (N=21).

From interview data, one student had an exceptional take on independent learning. This student said, “I like that we have the opportunity to learn individually. I feel like I can learn the information at my own pace and I always have access to the book when I need it. I feel like I can take notes on what I think I need to remember, and I can

go back as much as I need to fully understand the information.” Another student remarked, “I like how the way of independent learning prepares me for college and other life events where I need to learn things on my own.” These students recognize the value in being able to learn independently.

Students also overwhelmingly had positive attitudes towards science class. Figure 4 shows the degree to which students agreed or disagreed with statements about science class. These statements related to positive attitudes, and with one exception, students were either neutral or felt positive about class. In a focus-group interview, one student remarked, “I look forward to coming to class. I like what we are doing.” Another student said, “I am more comfortable asking questions to you since I had you as a teacher before.” The one exception answered, “Science class is boring because we only take notes.” Because the student answered with how the content is being delivered versus about his or her ability to learn in the classroom environment that has been created, I do not take the response to be indicative of the group as a whole.

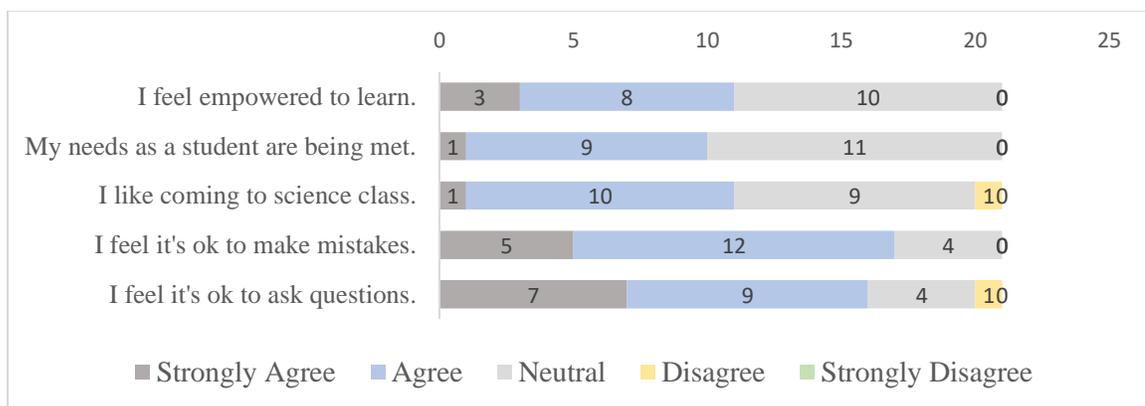


Figure 4. Student response type to questions presenting positive attitudes towards science, (N=21).

When presented with statements that correspond to negative attitudes about science class, students still overwhelmingly presented a positive view of class. Figure 5 shows that only three students felt negative towards class. Most students were indifferent or responded in a positive way. One student commented in an interview that “the content still has to be interesting, so more options of things to do would be good.” This response typifies feelings of indifference with a positive spin.

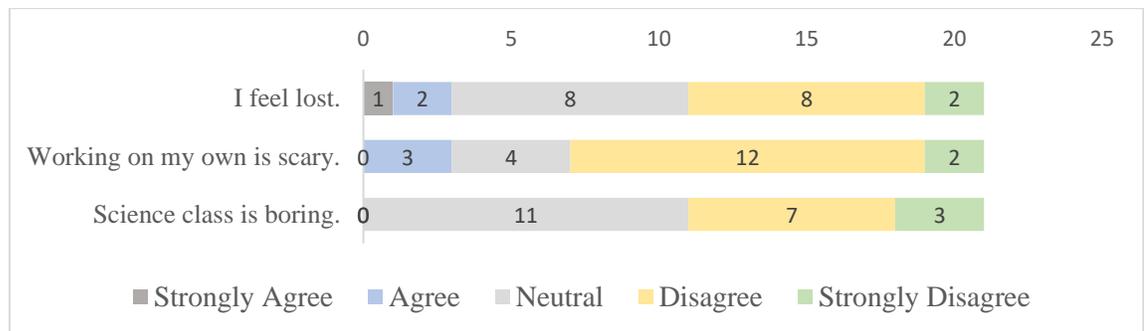


Figure 5. Student response type to questions presenting negative attitudes towards science, ($N=21$).

Finally, my own teaching was significantly impacted during the course of my research. Several themes presented themselves after examination of my personal journal. First, more time was devoted to students in meaningful ways. During both treatment cycles, when students were learning independently, I was able to have 27 one-on-one conferences with students about content they were struggling with. Each conference averaged 4 minutes in length. When a colleague observed me, she noticed too that I was “in a facilitator role, answering questions as needed.” She noted that I would “debrief with students after certain tasks are completed.” This type of formative assessment was used to monitor the progress of the class. I also noted that I enjoyed talking to students individually rather than as an entire class.

Second, many students struggled when given choice. During the second day of Cycle 1's treatment unit, two students withdrew from the course and another three students approached the guidance counselor about doing the same. Ultimately, those three remained in the course. Over the duration of the study, I met with two parents who had concerns about their child's learning. One student survey response was, "I get lost very easily in this class. I do not learn well like this and my grades are reflecting on that. I dislike teaching myself and am lost." One telling observation that I made was that students are not comfortable with being wrong. Being independent with the content is foreign to them and a different mentality.

Lastly, an extreme amount of planning was required to do this well. My colleague noticed that "the prep-work to prepare the choice-board was very heavy to front load, but extremely effective once in place and flowing." Time spent preparing the choice board took me 10 total hours compared to four hours of time developing traditional lessons, according to my journal. However, once this initial work was completed, only modifications would be necessary in subsequent years.

The choice-board unit was delivered over a two-week time period whereas the traditional unit took slightly longer at two-and-a-half to three-week period. I attribute this difference to students asking questions. During the choice unit, students asked questions of me in a more one-on-one setting. This allowed other students to progress at their own pace. During the traditional unit, class time would have to be used to answer questions, and the group as a whole progressed at the same pace.

I also noticed that within the first three days of using the choice-board, I had typos, not enough activities, and directions that were not exactly clear. Other observations were that students moved slower through the activities, and that they chose to do all activities rather than the ones that they had interest in for fear of missing something.

INTERPRETATION AND CONCLUSION

The study's purpose was to see how offering students a choice in their learning affected their achievement in science class. I also wanted to see how a change in teaching methods affected students' attitudes towards science class. Finally, I was concerned with how my teaching would change as a result of students learning more independently. Ultimately, I found that of my three research goals, the way I teach was the most impacted facet.

In analyzing the pre- and post-test scores of students, I was initially optimistic that independent learning would be a boon to increasing achievement in science class. However, the reality was that giving students a choice in their learning did not really affect their achievement that much. The Chapter 3 unit was not only the first-time students used a choice-board but was the unit in which they showed the most achievement gains. This was compelling for me to see because this is what I had hoped for. However, I was disappointed that I was met with resistance from students and parents alike. Having a few students withdraw from my class and then having even more approach our guidance office about withdrawing was extremely disheartening. Being that this course was an honors course, I expected students to want to learn the content in

deeper ways. Instead, students and parents were more concerned with the grades received rather than the knowledge to be gained. When the results of the treatment came back that students had significant gains, I was elated. After the end of Cycle 2, however, I saw that student achievement gains were not significant for the second choice-board they completed.

This problem is in-line with the research done by Stefano, Perencevich, DiCintio, and Turner on organizational/procedural and cognitive supports. Given this particular group of students, I recognize that they are used to having high levels of organizational/procedural supports and low levels of cognitive supports. According to Stefano, et. al., this type of classroom mimics student choice by allowing students to do what they want but produces a uniform result at the end (2004). My choice-board provided both high levels of organizational/procedural support and cognitive support, and because of this, students struggled. Going forward, teachers need to ensure that all levels of support are being used so that students have greater adaptability from classroom to classroom and subject to subject.

Regardless, offering students a choice in their learning did prove beneficial when looking at Likert survey data and from student interviews. Students viewed having more choice as a positive quality, and their attitudes towards science class were reflective of that. Students prefer different ways to access the information and to show their mastery of the content. The research of Chen, Jones, and Xu showed student preference for a balanced approach to learning (2018). I believe that this is the case after now that my research is complete. A blended environment where all strategies are employed is the best

for students. Differentiating instruction is the key to helping keep the narrative of the content moving along but also providing students with the opportunity to have their individual needs met.

Considering the results of the survey, interviews, journaling and observation, I realize that the way the content is delivered has less to do with their attitudes towards class than how they feel while they are in class. When asked about their attitudes in class, students responded to statements that describe things that are within my control as a teacher. I can either empower or enable the student. I can either create an environment where students feel safe or one that is hostile. This is independent of whether I am teaching using traditional methods or if students are learning on their own. In reading through my journal, I often noted that the ability to work one-on-one with students during the independent learning phase was the highlight of my day. I attribute this to knowing that I positively impacted that student. Often when using lecture and note-taking, one does not get to interact with students in a personal way. When students had questions, they were able to come to me for direct help. In this way, I was able to truly help that student with the material that he or she may not have had the courage to ask about in front of the whole class.

I get the sense that students find the monotony and routine of school to be very boring which leads them to disengage from school. By creating an environment that taps into their intrinsic motivation, students generally have a greater outlook on coming to class. As Gagné and Deci describe in their research, if a student perceives an activity as

fun, they'll do it of their own accord (2005). This is something that all educators should consider when thinking about how their own classroom environment is structured.

VALUE

This research project has been beneficial to my own professional growth in numerous ways. From planning and instruction to building relationships with students, there has been a profound impact on my role in my own classroom. Creation of the choice-board was an extremely tedious task. Finding the perfect resource to include on the board that matched the standards, my teaching style, and the message I wanted the students to receive was difficult. Many hours were spent collecting these resources, and this was a big difference than how I would normally go about planning. Finding several really great resources rather than just one really great resource seemed impossible. As the choice-board came together, though, I also recognized where I was lacking. I had a significant amount of technology and traditional textbook-style resources but not as many hands-on laboratories or other experiments. For the future, I will need to add more labs or other hands-on type activities that the students might find more interesting.

Differentiation of instruction is an ongoing process that cannot be fully realized the first time it's implemented.

I would love to be able to implement a choice-board with a group of students from a variety of backgrounds and abilities to see how their achievement is affected. Having a relatively small group of top-performing students was not ideal, but it was necessary given my teaching situation. I am curious to see how a student with an individualized education plan (IEP) would succeed when given choice. I am curious to

see how a student of average ability would succeed when given a choice of how to learn. A more accurate idea of how student choice affects achievement could be gained by seeing how each sub-group respond to the treatment. Looking ahead, a general biology class might be a good group to use for comparison purposes.

The role that assessment takes in my classroom would also be different. For this research project it was necessary to have a semi-standardized way of measuring achievement gains so that I could normalize those results. Multiple choice and other standardized tests, to me, are not an accurate measure of a student's content knowledge. These types of tests have specific strategy and do not account for guessing. A standards-based assessment system seems like a better way to assess student content mastery. Differentiation of the assessment is another way to provide students with choice in showing how much they know. Upon reflection, I wonder if students would have had greater achievement gains in the second cycle if they had been able to show me their learning in a different way. This will remain to be seen as I move to add more differentiated assessments in the future.

This project helped me to build better relationships with my students by allowing me more one-on-one interactions with them. I believe the most profound effect that this project had on my teaching was having more time to meet the individual needs of the students. In a classroom of 26, it is almost impossible to have a meaningful interaction with every student, every day. Through independent learning methods, I was able to have important conversations and interactions with students that were more productive than if I had been lecturing to the class as a whole. Students who needed assistance or who would

have otherwise been afraid to ask a question during class were able to meet with me and get the help they needed. Students did well at self-regulating their behaviors during class time, and because I did not have to manage behaviors, there seemed to be less resentment harbored towards me.

Looking to the future, I know that individualized education is where the system is headed. I understand that the one-size-fits-all approach is dying, and educators will be expected to meet the needs of each individual student. My role in the district is changing next year, and I will not be in the science classroom any longer. I will still be working with students but in a career development capacity. I am unsure at this time how providing opportunities for choice will fit into what I will be doing with my students. However, I will not forget the lessons learned from this research project, and I hope to incorporate them into my work in the future. Ensuring that my students are able to capitalize on their abilities is the best way to make them future ready.

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APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD EXEMPTION CERTIFICATE



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

950 Technology Blvd, Room 127
 c/o Microbiology & Immunology
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MEMORANDUM

TO: Andrew Larson and Walter Woolhaugh
FROM: Mark Quinn *Mark Quinn, Ch*
 Chair, Institutional Review Board for the Protection of Human Subjects
DATE: October 4, 2018
RE: "The Effects of Student Choice on Achievement in the High School Science Classroom" (AL 100418-LX)

The above research, described in your submission of October 2, 2018, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B
STUDENT CHOICE BOARD

Cell Structure & Function Make 100 Points 20 Points per Column Must do Bright Yellow Ask Questions				
Cell Theory	Cell Organelles	Cell Membrane	Diffusion & Osmosis	Active Transport, Endo- & Exocytosis
Create an Interactive Notebook layout for each section we are learning. (25)				
Read pg. 69-72 and answer questions on pg. 72. (5)	Read pg. 73-79 and answer questions on pg. 79. (5)	Read pg. 81-84 and answer questions on pg. 84. (5)	Read pg. 85-87 and answer questions on pg. 87. (5)	Read pg. 89-91 and answer questions on pg. 91. (5)
Watch this video and write a summary. (5)	Watch this video and this video and write a summary. (5)	Watch this video and write a summary. (5)	Watch this video and write a summary. (5)	Watch this video and write a summary. (5)
	Draw a labeled diagram of an animal and a plant cell. (5)	Draw a labeled diagram of an animal cell membrane. (5)	Draw a labeled diagram of diffusion and osmosis. (5)	Draw a process diagram of active transport. (5)
	Create a labeled model of an animal and a plant cell. (10)	Create a labeled model of an animal cell membrane. (10)		
	Do this Gizmo. Log on to Explore Learning and launch Cell Structure. Be sure to answer the assessment questions. (10)		Do this Gizmo, this Gizmo, and this Gizmo. Log on to Explore Learning and launch Paramecium Homeostasis, Diffusion, & Osmosis. Be sure to answer the assessment	Watch this animation, answer the questions and email the results to Mr. Larsen. (5)

			questions. (15)	
	Create an analogy for the cellular organelles, and write a story using the analogy. (5)		Do the egg diffusion lab. *Must tell Mr. Larsen you are doing this by 9/20/18 *Lab to be performed on 9/25/18 (10)	Read about the Sodium Potassium Pump here. (5)
	Do this HyperDoc. (10)			
Do this HyperDoc. (10) GROUP of 3 ACTIVITY		Play this game. Do all 5 challenges. Screenshot the score sheet when finished. (15)		
FA#1 - Structure and Function assessment probe	FA#3 - Venn diagram animal cell vs. plant cell	FA#5 - Tell me about selective permeability, ligands, and receptors.	FA#7 - Venn diagram osmosis vs. diffusion	FA#9 - Venn diagram active vs. passive transport.
FA#2 - T-Chart Prokaryotic vs. Eukaryotic	FA#4 - Label an Animal Cell diagram and a Plant Cell diagram	FA#6 - Label a plasma membrane diagram	FA#8 - Tonicity Problems	FA#10 - Explain how Na/K pump works (active movement)

APPENDIX C
STUDENT ATTITUDES SURVEY

Honors Biology Survey

Participation in this research is voluntary, and your participation or non-participation will not affect your grade or class standing in any way.

Please mark each answer honestly and to the best of your ability. Your answers are completely anonymous.

* Required

1. Read each statement and select the answer that describes how you feel about science content in general. *

Mark only one oval per row.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I can apply this content to real life.	<input type="radio"/>				
What we are learning is appropriate for an honors level course.	<input type="radio"/>				
I like what we are learning.	<input type="radio"/>				
I see the value in what we are learning.	<input type="radio"/>				
Science is easy for me.	<input type="radio"/>				

2. Why did you answer the way you did about science content? *

10/10/2018

Honors Biology Survey

3. Read each statement and select the answer that describes how you feel when comparing independent learning to traditional teaching.*

Mark only one oval per row.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I like that Mr. Larsen is trying to do different things.	<input type="radio"/>				
I like having choice in my learning.	<input type="radio"/>				
Being independent has more advantages than Mr. Larsen's lectures and notes.	<input type="radio"/>				
Taking notes from a teacher is better for me than on my own.	<input type="radio"/>				
I prefer to learn when Mr. Larsen lectures.	<input type="radio"/>				
I understand the material better when I learn it on my own.	<input type="radio"/>				
Learning independently is hard.	<input type="radio"/>				
I like learning using my own styles.	<input type="radio"/>				
I see the real-world application of learning on my own.	<input type="radio"/>				
I wish Mr. Larsen would just teach normally.	<input type="radio"/>				

4. Why did you answer the way you did about independent versus traditional learning? *

5. Read each statement and select the answer that describes how you feel about science class when you are learning independently.*

Mark only one oval per row.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I feel empowered to learn.	<input type="radio"/>				
I feel lost.	<input type="radio"/>				
I feel it's ok to ask questions.	<input type="radio"/>				
I like coming to science class.	<input type="radio"/>				
Working on my own is scary.	<input type="radio"/>				
My needs as a student are being met.	<input type="radio"/>				
Science class is more fun than other science classes I've had.	<input type="radio"/>				
I feel it's ok to make mistakes.	<input type="radio"/>				
Science class is easier than other science classes I've taken.	<input type="radio"/>				
Science class is boring.	<input type="radio"/>				

10/10/2018

Honors Biology Survey

6. Why did you answer the way you did about how you feel about learning independently? *

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 Google Forms

APPENDIX D
STUDENT INTERVIEW QUESTIONS

Small Group Interview Questions –

1. How is science class going for you?
 - a. How would you describe science class?
 - i. PROBE: Why do you say that?
 - b. To you, what makes an honors class an honors class?
 - i. PROBE: What do you see as advantages/disadvantages to an honors class?
 - c. How is the work we are doing honors level?
 - i. PROBE: In what ways is it different than a traditional class?
2. How has your attitude towards science class changed since doing more self-directed work?
 - a. How do you feel about coming to science class?
 - i. PROBE: Can you explain why you feel this way?
 - b. How empowered do you feel in class to make appropriate decisions?
 - i. PROBE: Can you give me an example?
 - c. How do you think this class is preparing you for your future?
 - i. PROBE: Can you explain why you think this way?
3. How has your attitude toward science content changed since doing more self-directed work?
 - a. PROBE: Can you give me an example?
4. How has the ease of learning changed for you?
 - a. PROBE: Can you give me an example?

5. How has your interest in the content changed for you?
 - a. PROBE: Can you give me an example?
6. How has the relevancy of the content changed for you?
 - a. PROBE: Can you give me an example?
7. How has your understanding of the content changed for you?
 - a. PROBE: Can you give me an example?
8. Do you think the amount of work you had to do was acceptable? Why or why not?
9. What are the biggest struggles you have with doing more self-directed work?
 - a. How could I improve that?
10. What do you like best about doing more self-directed work?
11. What would you like to change about doing self-directed work?