EXPERIENTIAL LEARNING TO IMPROVE SECONDARY BIOLOGY COMPREHENSION AND RETENTION

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INTRODUCTION

Do you remember being in school and being assigned to read your textbook in class, finishing only to realize you do not remember a word you just read? The boredom overcame you while you read and the daydreams started pouring in, or your eyelids just started to get heavy and you did not read at all.

On the other side of that boredom, do you remember those lessons where you actually got to do something, rather than just read about it? You were able to pick up the scalpel and dissect a frog, noticing the amazing intricacies inside. You finally realized how everything fit together inside that tiny body, and it was no longer a flat sheet of paper to help you understand what you were looking at, but the real thing!

This is the concept of experiential learning, and it has been proven time and again that students learn and retain more by doing, rather than just reading and regurgitating. It is said that we remember 20% of what we hear, 30% of what we see, and 90% of what we do (Gregory, 2006, p. 118). Confucius has also said "I hear and I forget, I see and I remember, I do and I understand" (Tangen-Foster & Tangen-Foster, 1998).

With a direct instruction classroom, it becomes hard for students to pay attention, with potentially pertinent information being overlooked. When ideas build on each other, this can become a problem if an initial concept is missed completely. On the other hand, when a student is actually involved in the learning and is instructed to think more about why than what or how, the ideas are much more concrete with greater retention.

For a student to sit in their seat and be told to quiet down and listen, we as teachers are going against the very nature of human beings. We are meant to move around and explore- this is how inquiry and progress has come about. If the first scientist did not think "Why is this happening?" we would never have gained as much technological and scientific progress as we have now.

Life is about learning, and humans are naturals when it comes to inquiry and discovery. What better way to discover than by getting up and touching, seeing, smelling, hearing and tasting the things around us? Our senses are there to help us explore. When we use them correctly, we can learn more about life and the world than we ever thought possible. The fundamental nature of the subject of Science is to perform constant experimental testing and hypothesizing what might happen. As teachers, it is not only our responsibility to help students learn, but to get them excited about learning as well. Experiential learning has the potential to be a great method for achieving that excitement. This paper will focus on experiential learning and its effect on grades and test scores for student learning and retention as well as student interest in the material. I will continue by presenting research outlining issues in education, as well as the risks and benefits of experiential learning.

LITERATURE REVIEW

Biology Education: Past, Present and Future

A substantial amount of research has been conducted on the issues of Biology education as well as how our education system needs to evolve. Science is always changing, and teachers have a duty to keep up with that research to be sure they are giving their students the most accurate information out there. On top of this, teachers should also be attempting to help their students learn in the most effective way possible. If the information is just going in one ear and out the other, the student is not really learning. One method to get students more involved is by using experiential education. This is when the student becomes an active participant in what he/she is learning, thereby making the concepts more concrete and memorable. Multiple authors below have outlined the effectiveness of this method of teaching, as well as where the future of biology education lies.

Regarding the history of Biology education, Robert Yager explains that there is a divide between the education students are getting in the classroom and the education they are expected to know in the scientific industry (Yager, 1982). In his article The Crisis in Biology Education Yager states that there is a "mismatch between the science being taught and the science being needed" for students in the education system (1982, p. 329).

In 1957, when Sputnik was launched by the Soviets, Americans felt that they were behind in their technological progress, and demanded changes be made in the school system to better prepare their children for the future and advance the field of science and technology. At this point, millions of dollars were poured into education and curriculum design, encouraging teachers and students to use this new curriculum and prepare students in the science field more efficiently (Yager, 1982, p. 329).

Analysis of how this new system was working was conducted and it was found that fewer than half of all high school graduates had an interest in science. Not only that, but fewer than 10% of secondary students were considered "attentive" in science. Finally, there is little data to support the idea that students are prepared for life by their education in science (Yager, 1982, p. 330).

Many researchers and educators were out to find solutions to this problem of unprepared, apathetic students. They seem to agree that the education system we have now and the education system we need is not the same. One way or another, critics agree there needs to be a change in how teachers operate and how curriculum is defined. Yager says it best when he states "Science education, like science, must be ever-changing" (Yager, 1982, p. 336).

Another individual who believes a change is necessary is the author of Philosophy of Education for Biology Teachers (1939). K. A. Sarafian is getting back to the roots of biology as well as some problems within the teaching of the subject. Sarafian contends that Biology is the science of life. It should help individuals to understand life, as well as gain an appreciation of life and functions of organisms, including plant, animal and human life. "It should make one conscious of the interrelationship and unity of life" (Sarafian, 1939, p. 97). If the author was an educator, he states "I would make my chief textbook the trees, the flowers, the plants, the animals, the races of men which may be found in their environment" (Sarafian, 1939, p. 97). For a student to really understand the material they are learning, they need to explore it hands-on.

Sarafian states that the education students are getting today is one that is based on memorization of textbooks with day-by-day assignments. Not only that, but he states that textbook knowledge is "baffling, confusing and deadening in interest" (Sarafian, 1939, p. 97). Many teachers do not realize that using a student's interest level as a motivator for learning can be a very useful tool (Sarafian, 1939, p. 98). Some may think that laboratory learning is enough hands-on technique, and is expanding out of boring textbook learning, but Sarafian believes that this, too, has become a place for "blind following of routine manipulation of scientific instruments, outlines, manuals and tools." The "genuine spirit of research and investigation" has been lost to following directions and doing the assignment correctly for a grade, rather than to learn the result and reasoning of the experiment (Sarafian, 1939, p. 99).

Another article raising awareness of the problems in Biology education is High School Biology (1956). The author is unknown, but the article is published by the National Association of Biology Teachers, and the issues addressed are incredibly common amongst the literature. Not only are textbooks overwhelming our education system, but students in a classroom are being taught the same exact lesson. Initially, this seems like a good thing, but gifted students are left under-stimulated, and their powers of analysis and synthesis ignored (1956, p. 48). This article points out that teachers should recognize individual differences among their students, including ability, background and preparation. A variety of materials and assignments should be made available to recognize and tailor to these individual differences as well as similarities (1956, p. 49).

Not only do students vary within a school, but they also vary within a state. Another issue raised by this article involves urbanization. Urbanization has created a problem as well as an opportunity for teachers. Students who grow up in urban environments students are less exposed to the flora and fauna of the countryside, and teachers are faced with the difficulty of bringing these elements to the city. Ways of doing this include "living exhibits, including domestic species, museums, zoos and botanical gardens, as well as through field trips making effective use of parks, vacant lots, lawns and gardens, streams and lakes" (1956, p. 52). All of these elements involve hands-on learning, which has proven to be an incredibly effective technique. A great point raised by this article is the fact that the "success of any method is directly dependent upon the teacher and the total environment of the learner" (1956, p. 52).

Cognition and Student Learning

This "total environment of the learner" (1956, p. 52) is directly influenced by how the mind works during learning. In Psychology of Learning (1945), William Clark Trow addresses the motivation of students and how this may affect their learning. In this study, the mental effects of monotonous tasks were measured. Results showed that students lost focus quickly, and found ways to entertain themselves, including whistling, fantasizing and talking (Trow, 1945, p. 228). Not only this, but knowledge retention was measured based on that same motivation and student attitude. They found that in the processes of remembering and forgetting, emotions and student frame-of-mind were incredibly important (Trow, 1945, p. 230).

Further study reported that the more concrete an explanation was, the easier it was to understand. If the explanation was abstract in thought, students were more confused and had a harder time recognizing what they were learning (Trow, 1945, p. 234). This is directly related to experiential learning in the way that hands-on learning is a way of making these ideas more concrete in the minds of students.

More on the way we learn is directly outlined in Designing Brain-Compatible Learning by Gayle H. Gregory and Terence Parry. In this book, the authors state that people learn "10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they both see and hear, 70% of what they say as they talk, and 90% of what they physically do" (Gregory, 2006, p. 118). A study by William Glasser adds that people retain 95% of what they teach to someone else (Gregory, 2006, p. 118). The way this works is directly related to our experiences and emotions. When emotions are engaged, the brain sends multiple chemical messengers that mark the event and tell the brain that this is something important. This directly results in more focus from the individual and facilitates learning.

Semantic learning relates to textbook learning. This type of learning is the recollection of dates, names, places and other random facts. This system of learning is the least efficient and requires a lot of motivation to make it work. Despite this fact, it is still a very common method of instruction in our school system today (Gregory, 2006, p. 20). Another type of memory is procedural memory, also referred to as muscle memory. This is more directly related to the way we learn when we're actively learning or performing an activity. Procedural memory involves basal ganglia as well as part of the cerebellum, and although it may take more time and effort for these memories to form, once they are formed they are incredibly hard to lose. Active learning is remembered more easily as well as more fondly by students, resulting in a large amount of information retention. Although this has been proven effective as a method for teaching, it is regarded as "frivolous" and a "waste of time unsuited for academic learning" (Gregory, 2006, p. 21).

When we learn by doing, there are many things going on in our brains to remember that moment. Electrochemical processes release enzymes that form synaptic connections between our neurons. This eventually forms a network of neurons, which, once initially set-up are ready for the next time that specific task needs to be completed. In the future, the synapse formation is already done, resulting in a faster reaction time to the familiar task at hand (Gregory, 2006, p. 27). Experiential learning is a great way for students to experience and develop these synapse formations.

Another large component of student work is their motivation. This can be a key asset for any teacher to hone in on to push their students to get involved in their own learning. In David Johnson's book, Motivation Counts: Teaching Techniques That Work, he points out that a day-to-day grind is not the best way to engage your students. He states, in fact, that there are multiple methods of motivating students, including good questioning techniques (Johnson, 1994, p. 19), helping students understand the abstract (Johnson, 1994, p. 55), and through problem solving experiences (Johnson, 1994, p. 67). These can all be useful tools for getting students involved. One of the points Johnson makes is that you can push student involvement if you just relate the material to something they understand and know already (Johnson, 1994, p. 67). The biggest idea to take from this author is that motivation matters amongst all curriculums. It is not just about Science, but you can motivate students in Math, English, and Social Studies. Students are very malleable individuals, and all it takes is a little something to pique their interest, and you can have them ready to learn in no time.

Teaching Style Comparisons

In a study meant to see the most effective lesson styles that kick-start our brains, Montague Oliver summarized three different types of lessons that were given to different classes. His article, The Efficiency of Three Methods of Teaching Biology, investigated lecture-discussion v. lecture-discussion/demonstration v. lecture-discussion/demonstration/laboratory exercises. These methods were used to test how well a student learns with variable amounts of involvement and example (Oliver, 1965, p. 289). The study found that students did not acquire any more knowledge by having the laboratory exercises added to the instruction plan. There was a higher acquisition level for high achievers than low achievers, but the method of instruction had no effect on the results. In fact, this study concluded that a teacher is better off using simple direct-instruction alone rather than adding demonstration and laboratory tasks. Their idea is minimal effort to get the job done (Oliver, 1965, p. 294).

Student Perceptions of Science

In order to develop effective learning experiences, we need to first address the idea of motivation in the classroom. Jack Hassard, author of Science Experiences: Cooperative Learning and the Teaching of Science (1990) says that student attitudes towards science are less than enthusiastic. By the end of 3rd grade, half of students would not want to take another science class. Also, 4 out of 5 eighth graders had the same opinion (Hassard, 1990). The perception by students of who scientists are and what they do is a prime example of the perceptions and misconceptions of science. Students were told to draw what they thought was a scientist and where he works. This task was performed hundreds of times, and the results were often very similar. The scientist was usually male, Caucasian, had bald or crazy hair, wore glasses, worked alone in a laboratory, and shown mixing chemicals (Hassard, 1990). Stereotypes of science often overwhelm our ability to think critically of how science might be useful. The author states that we should show students that science can be fun, and getting them up and experiencing it is a very effective way (Hassard, 1990).

Experiential Learning: Pros and Cons

Much research has shown that our cognitive development can be best utilized by performing and actively participating in what we are learning. As I stated earlier, we have the potential to learn up to 80% more when we are actually doing, rather than passively learning (Tangen-Foster & Tangen-Foster, 1998) (Gregory, 2006). When students are able to leave the confines of a tradition classroom, they tend to be more enthusiastic participants. The Tangen-Fosters state that experiential learning is typically comprised of "action events which change the way people think, feel or behave" (Tangen-Foster & Tangen-Foster, 1998, p. 3). A good education is crucial for youth today in order to have a positive effect tomorrow. In The Caring Capacity: A Case for Multi-age Experiential Learning, the authors reflect on villages of Masai. The elders have a greeting that translates to "How are the children?" which suggests that "with the welfare of the children go the welfare of the entire community" (Tangen-Foster & Tangen-

Foster, 1998, p. 3). This is the exact reason our education system needs to rethink its methods to give our students the most effective learning experiences possible.

A teacher's perspective on experiential learning can be a valuable tool as well. In Tom Herbert's article Experiential Learning: a Teacher's Perspective (1995), he explains experiential learning as more of a continuum of participation. On one side of the scale are passive learners who are receiving knowledge, and on the other side are students actively involved in learning from the experiences they are having (Herbert, 1995, p. 20). On the passive end, students are receiving the information according to the teacher's perspective, rather than interpreting on their own what they are seeing or hearing. Effective experiential learning is when students are able to make meaningful interpretations of information by making more decisions about the situation at hand (Herbert, 1995, p. 21). There is a personal investment in the material, therefore helping to student to put more value on the information. In true experiential situations, students are making decisions that affect their learning, and a teacher must be willing to accept the consequences of their decision making (Herbert, 1995, p. 24). The best way for the student to learn is to make the mistakes and grow from them. Most importantly, the student is the one to decide what he/she learned from the lesson and by their investment, feels like the information they learned is the most important material to them (Herbert, 1995, p. 25).

Robert Arthur Dow, author of Learning Through Encounter, writes about experiential education in a church setting. Although this is not applicable for what I am doing, the same ideas hold true for experiential education as a whole. Robert states that the "principal argument for experiential education is that learning is only learning when new behavior results from the process" (Dow, 1971, p. 28). Not only that, but he stresses that learning must give us essential information, not the "excess baggage" that is often crammed into our curriculum. Programs are "ready-made" and meant to deliver information. Unfortunately, a large portion of this information is useless, yet still taught in schools. The up-front information is what we need in order to approach a situation and know how to handle it.

The truth is, people learn from experience. Living-learning situations help ideas to become more concrete: we have done it before, and can do it again. In order for experiential learning to work, according to Dow, one cannot just go through life and perform an activity, they need to make a conscious effort to reflect and appreciate the situation (Dow, 1971, p. 30). This reflection causes the message to be remembered easier and more efficiently. With experiential learning, we can adapt what we know and be able to relate it to other situations, therefore developing better problem-solving skills to use in any situation we may experience.

Dow explains a situation where a student may be experiencing something, while his/her peers are merely observing. The individual experiencing is much more likely to connect-the-dots and realize things about the situation than the individuals watching. They learner is put in a situation where he/she can actually see and feel what may happen or how the situation is actually occurring. The observers may only notice a couple details about the situation, while the one experiencing the situation would notice much more about it, reflecting and relating his/her observations to other encounters.

Another point made by Dow is that experiential learning does not always leave the students as the ones being educated. The experiential environment can, in fact, result in a student becoming a leader and a teacher, and by his/her observations, teach the rest of the class (including the teacher) about what they notice. We always hear students say "when am I ever going to use this?" Experiential learning gives students a real-world example of how it relates to their lives and how it applies to the everyday (Dow, 1971, p. 37).

When dealing with good and bad aspects of experiential learning, different students have different reactions. In Leslie K. Hickcox's Personalizing Teaching through Experiential Learning, she explores three different programs at the university level for student-teacher interactions while utilizing experiential learning. In her opinion, experiential learning creates new opportunities for engagement between faculty and students (Hickcox, 2002, p. 123). Her findings indicate that students leave these programs with a new outlook on how learning can work for them. Many have had so much success with experiential learning that it makes them realize that there are other ways to teach than just lecture-based.

With this success, many students also develop more of a relationship with their professor, helping them to cope with any issues that may come up during the course of the year. Professors are more open to a one-on-one discussion with their students and students are more comfortable with their learning environment, therefore also becoming more open to discussion with their professors (Hickcox, 2002, p. 123).

At Portland State University, some faculty members had more trouble than others in their willingness to implement experiential strategies. Some thought the curriculum did not deliver enough information to the students, while others said the curriculum was being "dumbed-down" (Hickcox, 2002, p. 124). Another issue raised by faculty was whether there was enough time to convey the appropriate information in the amount of time they had to teach (Hickcox, 2002, p. 124). What many of these individuals did not realize was that it does not matter how much content you give your students, but that they understand the big picture and can find some sort of personal relationship with the information. One student of the program stated that the program is "less about churning out brains with legs, and more about churning out citizens" (Hickcox, 2002, p. 125)

Another study done at Marylhurst University documented individual experiences. One student, at 49 years old, was a CEO of a health diagnostics program and felt that Marylhurst's experiential program had positives and negatives. Positives included "learning life-planning strategies, improved writing skills, learning group processes and how to work in small groups, and learning effective communication skills." Negative aspects were all personal and issues that most college students deal with, regardless of the educational program of the institution (Hickcox, 2002, p. 126).

Finally, at Northeastern Illinois University, educators saw experiential learning as a way for individuals to "build a model for all to see" (Hickcox, 2002, p. 126). This University found that students exposed to experiential learning were more prepared for the work force, ignoring the usual sink-or-swim mentality once out on their own. Students were left with alternative ways of thinking and learning, and approached problems from a different point of view. Most lessons utilizing experiential learning were for faculty workshops helping their skills of conflict resolution and ease of tension. This proved effective for faculty relations as well as their approach to teaching.

The results from these three universities included good and bad aspects. Faculty had to come to terms with not being able to deliver the large amount of content they usually did. Also, many students entering the universities from a more traditional education background found assimilation less than easy. Because they had not experienced life in general like many older students had, they did not yet have the tools to succeed in an experiential learning classroom. On the positive side, as long as teachers slowly introduced this new concept to their students, they were fine with acquisition and adjustment. It was also found that those who thrive most in these environments are actually from middle to upper class backgrounds. Although there was a socioeconomic difference between students, those who understood the material were easily able to help their peers and bring them up to speed with everyone else.

Another book, Performance Based Learning written by Sally Berman, explains experiential learning the same way. In this book, experiential learning is referred to as performance learning, defined by students as being "immersed in learning facts, skills and concepts by doing tasks or performances" (Berman, 2008, p. 1). Berman states that it is not about performing the specific task of that moment, but it is about being able to perform that task in any situation it is necessary, as well as knowing that this is the right task to perform. The author relates experiential learning to playing an instrument, rather than going to a concert to watch someone else play an instrument. One cannot learn to play the guitar by merely watching someone, they have to know how the strings feel, how hard to strum them, and if the sound coming out is the one that is supposed to be (Berman, 2008, p. 1).

Another key point made by multiple authors has been that the amount the learner gets out of experiential learning is directly related to their commitment to the task at hand. This again relates to the musician- a guitarist is going to have to work hard to learn all the chords and finger-holds to play his guitar, and in order to do this, must be committed. He cannot just pick up the guitar and play; he needs to practice- a lot! Experiential learning is meant to put students in a situation they remember fondly. By performing a task and remembering it, they will be able to repeat it with minimal effort (Berman, 2008, p. 3). By these tasks being a pleasurable experience, the memories are more solidified and therefore more easily retrieved when a situation calls for it, such as playing the guitar. Performance learning is "brain-friendly learning that creates a positive emotional climate and enhances students' ability to remember ideas and concepts as the students perform tasks and learn skills" (Berman, 2008, p. 8). Students feel challenged, but also feel like the task is interesting, and worth investing time into. Experience with performance learning can lead to students becoming more "flexible, persistent and creative thinkers and doers" who also have the confidence that they can perform in any given situation (Berman, 2008, p. 8).

The first sentence in the book <u>All Together Now!</u> reads "We do; therefore we learn" (Ukens, 1999, p. 3). Lorraine Ukens writes that people remember when they experience things in an "unforgettable way." She defines experiential learning as involving active participation in a structured setting, an "analysis of the experience" and the "application of the experience to work and life situations" (Ukens, 1999, p. 3). Experiential learning is meant to put individuals in situations where they do not feel like they are learning, but by this feeling, actually learn more material in an unintentional way. The training in tasks is only useful if the learner can later apply what he/she learned to another situation when the need arises. During the training, the learner makes a "cognitive link" which can later be retrieved and put to use.

Ukens states that experiential learning can actually be most effective with adults, since they have already established their values and routines. When utilizing experiential learning, the adult learner does not feel like he/she is being forced into learning which may change their habits and values. In fact, the experiential learner is not aware that they are learning at all. They just think they are performing a task, not realizing that they are developing valuable insight in this new situation.

Most importantly, experiential learning can be done at the learner's own pace, resulting in students feeling more comfortable in the situation, and less rushed. Not only this, but students understand the big picture, rather than just learning facts and details. Overall, this becomes an enjoyable and useful method of learning (Ukens, 1999, p. 4).

From Robert Yager's take on the history of Biology education to exploring the "total environment of the learner" (1956, p. 52), one thing is certain. Biology education has already and must continue to evolve. Science is ever-changing, therefore, the curriculum must also be ever-changing to adapt to the needs of our students. Experiential education is one method that has been proven effective in a Biology classroom by getting students out of their seats and into a frame of mind where learning can take place. Experiences have been shown to improve cognition as well as emotions of students, resulting in higher knowledge retention. It is because of these reasons that I have continued to explore experiential education and its benefits in my own classroom.

RESEARCH QUESTION

With all of this research in support of as well as against experiential learning, I have applied it to a high school biology classroom to see if the data holds true. I believe that students are meant to inquire and want to learn more about what they are doing, and experiential learning is an amazing tool for this. As a teacher, it is my responsibility to execute this method properly to bring my students into a more learning-conducive environment. Motivation is low in science, and students need a reason to get excited. By bringing the concepts full-circle to relate to students' own lives and what they know, I hope that I have and will continue to spark the passion for science that I have. With the use of experiential learning, I predicted I would be able to help students gain and retain knowledge in science in a more effective way than if they were taught by direct instruction and textbook reading. The question I want to answer is: Does experiential learning help students to comprehend more effectively? More importantly, do students feel like experiential learning can be beneficial to their own learning. As a long-term goal, I intended to introduce them to a side of science they were unfamiliar with, sparking an even greater interest.

METHODOLOGY

Method and Rationale

When exploring experiential education, I used a quantitative research approach. Quantitative research allows outcomes to be measured and quantified. There are multiple variables (independent variables), all of which are controlled. These variables include the students, the classroom, the subject as well as the summative assessment. One variable that can be changed, the dependent variable, is manipulated to attempt to see if a certain outcome can be reached, or the normal outcome changes. A quantitative study is perfect for this implementation because I measured student improvement by percentage.

In addition to the quantification aspect, there is a small amount of qualitative data. Results will be based on student responses and opinions. The way I have avoided any biases is by quantifying these student responses, so although responses are opinion, I have measured the number of student responses in different categories, thereby making it more quantitative and able to be measured.

Sample

During student teaching, my classes included High School Pre-AP Biology students with subjects covering Invertebrates and Vertebrates. Although I taught other Science and Biology classes, I have only utilized my Pre-AP Biology students, therefore limiting my sample size to two classrooms. All students have taken a test after the Pre-Lab portion of instruction to measure their recollection of what they read and summarized. After the laboratory portion of the class has finished, the students completed another test, measuring how well they did when they were actually able to explore the concepts hands-on. I tested these variables from April to May, so my time frame was a limiting factor for my data collection.

I was also limited in some of the variables that affect every class there is. In each class, there are students who will answer the questions correctly regardless of their method of learning, because they are just that smart. Along with these are students who will answer questions wrong regardless of their instruction, because they do not care enough to pay attention and put the effort and thought in. In an honors Biology class, there is still a full spectrum of students who have elected to be there, but might not have expected the rigor and have essentially "shut down" and stopped putting forth the effort. In order to deal with this variable, I took the average percent of improvement, which will be averaged with other students to get a final sample average. Another variable was the amount of information contained in the Pre-Lab. Although the format for each lab was generally the same, some contained more background information than others. I have tried to deal with this variability by limiting where I take my questions from. I have made sure that all of my questions were in the Pre-Lab and students were familiar with the concepts if they completed their Pre-Labs.

Instrumentation

I did not change any aspect of student instruction. I utilized the lab activities my mentor teacher already had outlined for students, so my tests were merely over content they should know. The pre and post tests students took were only a few questions, and generally simple if they did their work and prepared properly. This measurement was purely summative, with a right or wrong answer. There is no variability in quantification due to the nature of the questions, which are fill-in-the-blank.

I compared these pre-test scores and post-test scores to see if the research has proven true. The variability amongst students was also not a factor, because the comparison was made from one student's pre-test to that same student's post-test. I averaged each person's improvement percentage to end up with an average improvement amongst students. By using the pre-lab information as my control, I was able to see how groups of students typically do on tests after further exploration. This gave me a base value for the data I collected from the experimental test. Student data was collected and compiled, with no personal data included in the summary.

In addition to these tests, I also had students gage how well they thought the lab helped them to retain information. This survey was also quantitative, in that most responses were similar and able to be grouped together. Students were made aware that I would not be showing their answers to my cooperating teacher, so answers were to be completely open and honest.

Analysis/Validity

The data collected was compiled and quantified using graphs and charts to summarize the number of students within a specific score range. These were compared, using statistical analysis, to the average grades they typically earn. Data from each member of both classes was compiled and quantified, leaving little room for biases on my part. As I stated earlier, every answer was either correct or incorrect, and every response to the subjective question fell into the categories of "yes", "no" or "undecided." My N-value was 46 for total participation, giving me fairly consistent data, at least for this school. There were about five students who did not participate in my research project for various reasons including not getting their form in on time as well as just not wanting to participate. Students were made aware that their participation was merely appreciated, and not required.

Personal Background and Bias

I have always loved Science, and I hoped to see a spark for some of my students by seeing them experience it hands-on rather than just reading it in a textbook. The lessons I remember the most are the ones where I was actually able to cut open a pig's heart, or blow air into a pig's lungs to see how the tissues work. I don't remember anything I read about in textbooks, which is why I am trying to show my students how useful the alternative is. I have been a scientific researcher for the last 3 years, and have found out over and over again that I learn more effectively by doing, rather than watching.

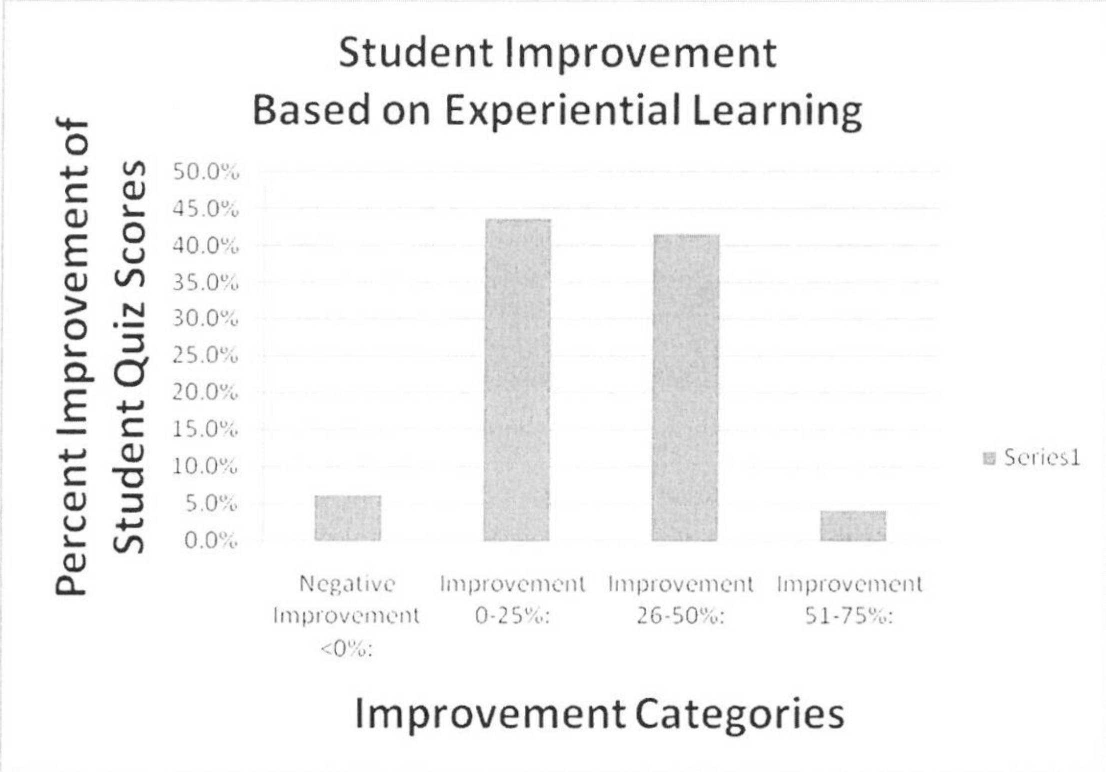
As a scientific researcher, there will always be some form of bias in the data I collect. In order to avoid as much bias as possible in this experiment, I looked only at scores and the survey question. This data was black and white, and students were graded on right or wrong answers to questions as well as their yes or no responses for lab effectiveness. The grading I did had no formative component where I had the potential to favor any students. All will be on an even level and either have the correct answer or not.

When it came to the survey question, students were to respond if the lab helped them to learn or not. I asked them to explain why or why not, but this is more for their reflection and for my personal growth as an educator than for my data collection. The data I used was their first response of yes, no or undecided. These answers were collected and compiled to show the percentage of students and their opinion of the material.

DATA

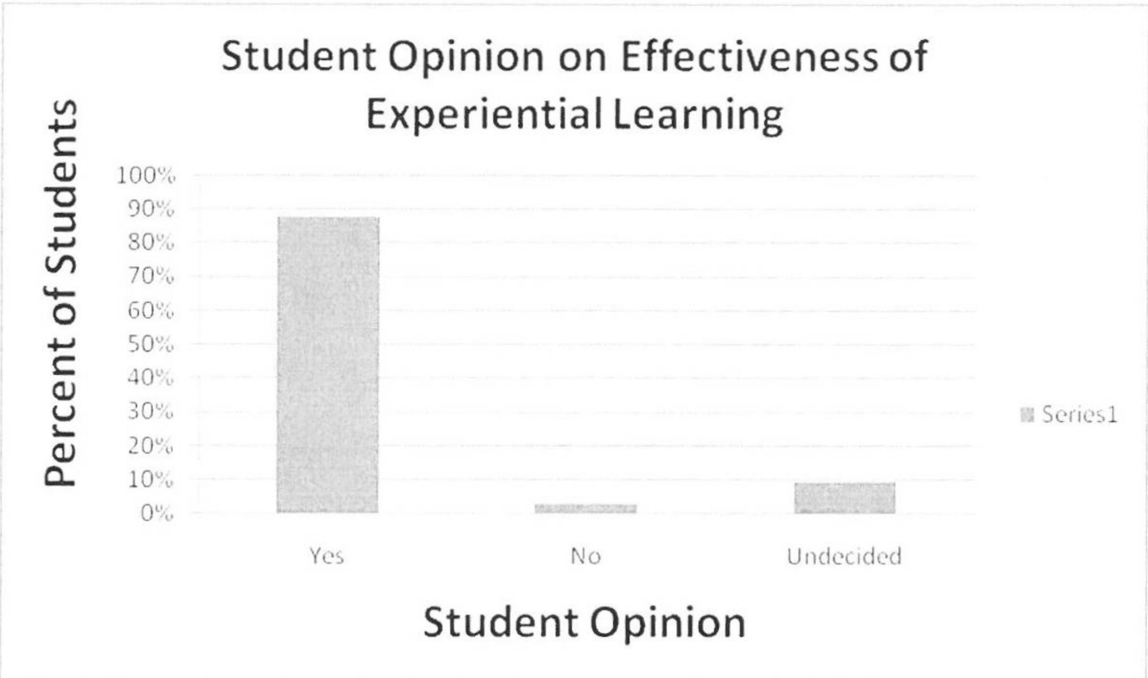
The raw data collected from student quizzes is compiled below. Students were quizzed on general content contained within the Pre-lab instructions, which they would later experience during the actual lab activity. Students were asked six questions, all relating to anatomy of the animal they were about to dissect, including locations and functions. Of those students who participated, 6% of them had a negative improvement from the Pre-test to the Post-test.

Graph 1. Table compiles student quiz score data, quantifying improvement percentage based on pre and post-test results. N-Value: 46 students



After students completed their content quizzes over lab material, they were also asked if they thought experiential learning was helpful for their own learning. They were asked to respond to this question without knowing how they did on the content section, so student answers were based purely on student self-perception, and not on raw scores. The graph below shows student opinion on effectiveness of Experiential Learning.

Graph 2. Table compiles student opinion on Effectiveness of Experiential Learning. Data is based on student opinion without knowledge of content progress. N-Value: 64 responses



While student responses were largely in the category of agreeing that Experiential Learning was a helpful tool for them, others were not convinced. Approximately 88% of students thought Experiential Learning was useful while only 3% did not. There were still 9% of students who were undecided and unsure of whether or not Experiential Learning was effective for them.

ANALYSIS/VALIDITY

Those students who had negative score improvement were largely students who completed the pre-lab and took my quiz immediately after. The answers were fresh in their minds and they were able to regurgitate the answers right onto the paper. By the time the post-test came around, though, the information was not as fresh and students were less able to recall it efficiently. Some of the other students who had a negative score improvement were students who were absent for part of the activity and were unable to take the post-test until days after experiment completion. In these cases, the answers were long forgotten and students had too much trouble recalling the information correctly.

When analyzing students who had a 0-25% improvement average, this was the largest majority of students. Over 40% of students had a minimal average improvement utilizing Experiential Learning. There were a few students who did not care during the pre-lab or the lab itself, and therefore did not get anything out of the activity, resulting in 0% improvement.

The rest of the students who actually had a small amount of improvement ranged all the way from getting one answer correct in the pre-test and two answers correct in the post-test to getting five answers correct on the pre-test and six answers correct on the post-test. This does not distinguish between lower level students and higher level students. Unfortunately, this lumps them together into one group.

In the next group with student improvement ranging from 25-50%, student variability was even greater. Student improvement ranged from 0-78%, but when a student had a lower and a higher score and I averaged the two, they ended up with a middle score and therefore may not accurately reflect their abilities. In order to stay consistent, I still felt this was the best way to quantify the data. Either way, student scores improved utilizing Experiential Learning, which is the result I expected.

The questions I asked of my students were all ideas taken directly from their pre-labs. If students did the work and read the pre-lab like they were supposed to, they would be able to answer every question correctly. After seeing student responses and the incredible amount of questions they answered incorrectly (after completing the pre-lab), it did not change my opinion of the effectiveness of Experiential Learning. More than anything, it gave me a clearer picture of teacher expectations of students in relation to student effort.

What was obvious to me when a student was unable to answer most of the questions correctly was that they did not put in the time and effort necessary to succeed. There were a large number of students who obviously did not read the pre-lab discussion and understand the expectations in front of them. If I learn nothing more from this experiment, it is that the range of student work ethic and drive is vast, with a large majority of students being placed on the lazier end of the spectrum.

I know my students well enough personally to know that they are intelligent and can remember something they just read. I also know them well enough to know when they do and do not complete their work. When there is no accountability for completion of their work, there is really no reason for students to do it. This has given me completely new insight into the minds of students and what I need to do to keep them motivated and interested.

While looking at the data included in the second table, responses are clearly skewed towards students feeling like Experiential Learning is helpful for them. The large majority of students agreed that Experiential Learning enhanced their acquisition of knowledge, and these were largely the students who actually had some percentage of improvement during the experiment. Those students who did not improve or had a negative improvement were the students who were either unsure of Experiential Learning's effectiveness or did not think it was an effective method at all.

Unfortunately, those very same students who did not think Experiential Learning was effective did not read the pre-lab ahead of time, or pay very good attention during the activity itself. Their scores were a direct reflection of their effort, rather than a reflection of the effectiveness of the method being tested.

There are a few factors affecting the validity of these numbers, including student participation. Although most students participated, there were a few that chose not to. Among those who did participate, there were also some who only had time enough to take one group of tests. When attempting to average percent improvement, taking only one result into consideration is not an average, but a raw score. This data seems to be enough to skew my end results. The other problem I had when administering these pre and post-tests was the timing. Although most students completed the pre-tests at the same time, there were some who were either absent, or completed them before finishing the Pre-lab. I tried to make it clear to students that they needed to read the Pre-lab information before taking the test, but many were not willing to put the effort in or just wanted to get the test over with. As a facilitator, it was difficult for me to keep track of who had done what, so results are skewed as a result.

Along with the issues on the Pre-test, there were also issues with the Post-test. Different students work at different paces, therefore administering the post-test was a little more difficult. If the bell rang before they could take the test, I was not able to give it to them until the next day. This may have affected the amount of information that was "fresh" in their minds following dissection versus the information that was lost after a day away from the material. There were even some students who were unable to take the Post-test for multiple days following the activity, either due to absences or merely my forgetting to have them complete it. After a few days, students were even forgetting things they had gotten correct on the Pre-test, accounting for the negative percentage of improvement. Taking the average of all scores should be able to even out the differences and anomalies, but could still have potentially skewed the data.

When it came to student surveys over their own perceptions of Experiential Learning, the responses were relative to the types of students involved. The students who agreed Experiential Learning was helpful were typically either higher scoring students or students who did not care enough to take the survey seriously. Higher scoring students tend to assume every method is helpful because all methods work for them. On the other end of the spectrum are students who were completely apathetic and did not take the surveys seriously. They just answered with what they thought I would want to hear. Some students do what they think they need to please the teacher, rather than genuinely reflecting inward and answering what works for them.

IMPLICATIONS

Throughout this study, I have been able to understand how student learning as well as student perception of learning can be guided and improved for some students. I do not consider Experiential Learning to be a "fix-all" for student education, but through my data, it was more beneficial than not to a variety of students. When students can apply real-world situations to a concept and dive in deeper than just reading in a textbook, it opens the possibilities for a deeper understanding, rather than just superficial "learn it and forget it" knowledge. In order to reach more students to help them understand concepts more thoroughly, Experiential Learning can easily be implemented and student success heightened. Through this study, I have shown that a large majority of students have success as well as feel like they have success using Experiential Learning.

CONCLUSION

As I said before, I have personally learned more effectively by my hands-on experience in the science classroom. I want to be able to give my students this opportunity to develop a passion for science as I have, and will do so by getting them up and out of their seats. It has been shown in the literature that experiential learning can be an effective tool for helping students gain and retain more knowledge. It has also been said that it must be done correctly to work well, which is where my testing of the method comes in. Many authors say there needs to be an evolution of science curriculum in high schools today, and one way to adapt is to use new methods of instruction, such as experiential learning. If teachers can learn new strategies in science instruction which could also apply to other subjects, such as experiential learning, students may be able to grasp more than just science. It has the potential to give them tools for the present as well as the future.

As indicated in the data section, variability of student data is based on a variety of factors. All students completed the pre-tests at the same time, but different students were administered post-tests at different times. Overall, even with the few levels of variability, results were clearly in favor of some amount of improvement based on experiential learning. A total of 93.7% of students had some level of improvement when utilizing experiential learning. This is dramatic data with an obvious push for the validity of some sort of hands-on learning for students. Along with this data, students themselves felt that experiential learning was useful and beneficial to their personal learning growth.

Future directions of this implementation would be to perfect the pre and post-test administration and be sure to stay consistent. Along with fixing test administration, I would also tweak the activities themselves. In my own classroom, I see students doing even more exploratory work rather than just being given directions and following them. When students are given the tools to learn on their own, they have the potential to be more effective. I would like to have activities that are even more engaging and experimental to push student thinking and life experiences. Overall, this data has shown me that my techniques as an educator are moving in the right direction, but I still have a distance to go in truly pushing student growth and development.

Experiential learning has the potential to be a great tool in any teacher's belt. From the information researched, many in the education field agree that experiential learning can have a huge impact on student interest levels and comprehension. From my own personal implementation, I have also shown that students can have marked improvement, with very few being adversely affected. Students today need to stay engaged in what they are learning, otherwise, many concepts will be ignored and that knowledge will be lost to them forever. As an educator, it is my job to connect material to student lives and make sure they understand how it can apply to real life. Experiential learning is exactly this. It is hands-on use of a concept or idea for higher comprehension. It is clear both from my data and other researchers' data that experiential learning can be a great asset for any teacher.

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