

THE IMPACT OF SERVICE-LEARNING ON “AT RISK” HIGH SCHOOL BIOLOGY
STUDENTS

by

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ABSTRACT

Students who may not graduate with their peer cohort are deemed “at risk.” This investigation studied the effect of service- learning on attendance, attitude, and achievement of at- risk high school biology students. Students participated in two community service- learning projects: raising trout for release into local streams and/or implementing a vegetable garden on high school property. Data collected included attendance records of students both prior to the projects and during the projects. Surveys and interviews were conducted to assess the confidence factor, and pre- and post-project content questions were administered to assess the achievement portion of the research. An improvement in confidence or attitude was documented, but it did not correlate to a significant improvement in attendance or achievement. Therefore, the results are inconclusive and indicate a longer-term study is warranted.

INTRODUCTION AND BACKGROUND

When I was introduced to service- learning as a teaching tool in 1998, I experienced an “aha!” moment. I realized it is a modality that fits my teaching style, and I believe it is a viable teaching tool. My research project was designed for an “at risk” population to determine whether service-learning fosters success on an academic level and whether it produces measurable positive change in attitude or character development.

Service -learning is defined as a teaching method whereby classroom learning is deepened through service to others. This process provides structured time for reflection on the service experience and a demonstration of the skills and knowledge the student has acquired. While preserving education as a central theme, service learning also provides students with meaningful practical application of their education in the community.

The goal in service- learning is for students to be so engaged in service tasks that learning takes place more naturally and efficiently, while providing clear benefits for both the community and the students. The development of long- term relationships is also at the heart of service- learning.

My action research project took place in ecology classrooms in Kingston High School in Kingston, New York. This is a high school of about 2300 students in grades 9-12 located in a city of 30,000 people. The demographics of the high school reveal that 73% of our students are white, 8% are Hispanic/Latino, 2% are Asian, and 16% are Black/African American. In addition, 35% of our students participate in the free or reduced lunch program. Our “at risk population” is defined as any student who may be unable to graduate with his/her cohort. Students are also deemed at risk if they have

failed 9th grade twice. The students I have identified as at risk in my classes are predominately English-as-Second Language (ESL) students, special education students, or students with serious attendance issues. The at-risk students in my ecology classes are generally not engaged and/or successful in classroom activities.

Kingston High School has been identified by the New York State Education Department as a school in need of improvement due to the low graduation rate of special education students, ESL students, and African American students. Many of these students do graduate but not with their cohort. For example, some students drop out but earn a Graduate Equivalency Diploma (GED), which does not fall into the category of graduating with their cohort. This said, it is to everyone's advantage that as many students graduate on time as possible. Due to an increased focus on our at risk population, my research was supported on many levels within the Kingston School District. This project has the potential to pilot many more forms of service learning in the District.

Kingston School District realizes the importance of attendance and the correlation of attendance with student success. Kingston School District Attendance Policy Objectives state that school attendance is both a right and a responsibility. The Board of Education states that each minor must attend school full time in accordance with New York State Education Law. Research supports the importance of attendance and its relationship to student achievement and completion of a high school diploma. Regular and uninterrupted classroom attendance is vital to the learning process and a major factor in the success of any child in school or subsequent career pursuits. Regular and timely attendance is necessary for learning as well as establishing the whereabouts of every

student for safety and school management reasons. Attendance data are used by the Kingston School District to identify student attendance patterns to plan timely and appropriate interventions and sanctions.

The first strategy listed by the Kingston School District is that the District will foster a positive and safe school climate aimed at encouraging a high level of student investment in the school which in turn should lead to increased attendance. The inclusion of service learning is one means of creating this positive and safe school climate. My research question addresses the District's belief that this environment should lead to increased attendance. It is interesting to note the District's choice of the word *should* as opposed to *will*.

The research questions that I addressed in my action research project are focused on whether service learning is a viable teaching tool in a science classroom. To evaluate students' success through service- learning, I posed these testable action research questions:

1. Will involvement in service- learning projects help at risk students become more successful learners in my science classroom?
2. What effects will outdoor gardening or raising trout in the classroom as a service - learning project have on at risk student academic performance on graded activities such as tests, quizzes, and in-class worksheets? What will be the effect on engagement in classroom activities?
3. What effect will student involvement in the garden project/trout in the classroom have on daily attendance?

4. What effect will involvement in the outdoor garden project/trout in the classroom have on increasing student confidence in the science community/classroom?
5. How does working on the outdoor garden project affect the teacher-student relationship?

CONCEPTUAL FRAMEWORK

Service learning is not a new educational tool to improve civic involvement or to encourage students to attend school. Service-learning has been a part of American education for more than 30 years, yet less than 30% of K-12 schools in the United States are participants in this form of education (Spring, Grimm & Dietz, 2008). The educational merit of service-learning is questioned despite research that shows consistent positive outcomes for students. Research that includes close to 70 studies documents positive impacts on academic, civic, personal, social, ethical, and vocational development for most participating students (Conrad & Hein, 1991; Furco, 1994; Anderson, 1998; Billig, 2000; Shumer, 2005). That said, the U.S. Department of Education specifies that evidence is secured only when the effects of an educational intervention are tested under certain research conditions. Of the 68 studies cited in the K-12 service learning literature, only 25% were tested under such research conditions. Those studies that have been conducted under research conditions show a consistent set of positive outcomes for students. These outcomes are categorized as improved academic achievement, improved student engagement in school and learning, enhanced civic responsibility and citizenship, and enhanced personal and social skills (Furco, 2010). However, more research that increases the status of service-learning as an evidence-based practice is required.

Much of the research that has been compiled about service-learning presents it as an approach to increase a student's awareness in the area of civic responsibility. One such study was done by the Circle Group *Center for Information & Research on Civic Learning & Engagement* (Billig, Root & Jesse, 2005), a study which was of particular help in my research into constructing a project of this nature. This study compared over 1000 high school students who participated in service-learning programs with those who did not participate. The schools were matched for similar demographics and student achievement profiles. A comparison was made to show the effects of service-learning and those of more traditional ways of teaching in similar subject areas. Although service-learning students scored higher than comparison students on several outcomes, most of the differences were not statistically significant. There was, however, an interesting result in one of the comparisons: service learning students were significantly more likely to say that they intended to vote and that they enjoyed school. This result sums up what I have seen over the years in service learning projects with which I have been involved. The difference seen is not quantifiable by an increase in test scores in part, perhaps, because some of my students just don't test well. They did, however, show an increased awareness of community need and a marked increase in compassion and activity to help or be involved with others. Still, for education to adopt service learning into curricula, quantifiable results obtained through research protocols and conditions must be produced.

Because one of the projects I am involved with is a community garden in our city, I chose to read an article on participatory action research as a form of service learning. This is popular in distressed urban and rural communities, according to Kenneth M. Reardon (1998). A community owned farmers' market in East St. Louis, Illinois, was

the outcome of the project. This was collaboration between a university and a community, with students of the university as the liaisons between the two stakeholders. The university compiled the data, the community got a farmers' market, and the students obtained hands on experience in working with community leaders as well as the university. Such experience is what my students had as they worked with the mayor and local councilman.

When educators look at what students gain from their 13 years of required schooling, they find different answers. Students need to acquire academic knowledge, but in addition most educators agree graduates should also be prepared for life as productive citizens who can problem solve, who can work in a team, who have good oral and written communication skills, and who care about others (Duckenfield & Drew, 2006).

Education, then, is a vehicle for making good citizens. The Massachusetts Constitution predates the U.S. Constitution by a decade and devotes an entire section to promoting better citizenship through education. Schools should educate citizens in many subjects but also promote both private charity and the public good (Bridgeland, 2007).

While high stakes testing contributes to the increase in drop-out rates, the disengagement of high school students is also reasonable cause for schools to develop curricula that connect what students are learning in the classroom with real life experiences and the real world, leading again to service- learning as a possible tool for engaging the disengaged (Bridgeland, 2007). This is a philosophy of education based in need and sharing. It reminds me of Rousseau's thoughts on education in *Emile* (1762). When a person needs to learn something, he/she will learn it quickly and well. Otherwise, he /she are learning for someone else's need. I believe that Rousseau could relate to

students of the 21st century in terms of education. If a student has a need or a desire to learn something new, he/she is, by definition, engaged or motivated. I believe that service- learning projects will engage students to a greater level of involvement with the community, with the science behind the project, and possibly with the school itself.

Data collection and analysis have been proven to be tricky; indeed, credible assessment of the quality and impact of service learning is just beginning (Pickerel, 2002). When dealing with at risk students, the assessment shows a greater sense of self, increased community awareness and better problem solving, but there has been no direct data gathering or analysis (Slavkin & Faust, 2002).

The best data collection and analysis I found were in the original study by the Circle Group (Billing, et al., 2005) noted earlier. Data collection was done by a mixed method approach with a collection of quantitative and qualitative data. Student surveys were administered in fall and spring. The pretest survey was scored by individual question with a mean, standard deviation, number of items, range, and internal reliability as measurements. The post test survey asked students about the quality of their experience - if they acquired academic and work related skills and how engaged they were in the project. Measurements were similar to the pretest survey. A chart prepared in this study which I found useful, was a comparison of student surveys/teacher surveys/interviews/observations. These were compared with students in other schools who did not participate. The study also provided bar graphs of each comparison.

There is a great deal of information on service learning as a concept, as a deterrent to dropping out of school and as a vehicle for making good citizens. The problem arises when looking for hard data. Does service -learning increase academic achievement?

What are contributing factors? Is the time involved as important as the project choice? What role does the teacher play in making it successful? How do we answer such questions with quantifiable results? More research needs to be done to make service learning an evidence-based educational alternative.

METHODOLOGY

Research Treatment

My students participated in two service-learning projects this year: an outdoor community garden and raising trout in the classroom. Two classes were involved. The first ecology class, composed of juniors and seniors, was an integrated class with six special education students and 14 regular education students with no special needs. There were 11 male students and nine female students. The second class was an ESL ecology class for freshman and sophomores that was taught over five weeks during July and August of 2010. Students were required to perform 18 hours of service between the first week in July and the last week in August. Students earned .5 credits toward the science requirement for graduation. Our students come from diverse backgrounds and have very different learning styles and academic abilities; one of the special education students in the group has a severe eye problem. I worked with a special education teacher in the first ecology class and an ESL teacher in the second. I asked the special education teacher and the ESL teacher to act as observers and journal their observations to share with me.

The research methodology for this project received an exemption from Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained.

The community garden had been in existence for two years, developed and maintained by other biology and ecology classes. The garden area is located in a courtyard approximately 10 feet from classrooms; and the area adjacent to the garden is utilized by students as an outdoor lunch area. Fruit trees have been planted along both 44-foot fence lengths to create a living barrier between the building and the garden. The garden area is 44 feet long by 27 feet wide. It includes eight raised beds, each designated for a separate growing purpose; we grow vegetables, fruits, flowers, and herbs for cooking as well as for medicinal use.

The service portion of this project was the planning, cultivating, growing and harvesting of the garden and taking the food home to families. The science education portion was in planning the garden and doing the necessary research: where to plant, what to plant, and how to plant. We did soil testing and started our own seeds in the classroom in early March. Each of the eight raised beds had a theme that has been researched. One theme is tomatoes from large to small with a basil ring for pesto; the bean theme includes tall to short to bush beans. There are also peppers, hot to sweet; medicinal herbs; a butterfly garden; a cut flower garden; and a strawberry and melon garden. Each criterion for each garden was researched, and the benefit the yield could provide was calculated. This is a service project, and therefore maximum yield is a factor.

Students researched and displayed the scientific name of each plant. After viewing the film *Food Inc* as a discussion starter, the class debated the value of good food. A long

winter season delayed the project, and the spring weather was very unseasonable. Because the weather was so unpredictable, our plans became very flexible, and a good weather day meant we were in the garden. There were very few of those days. We spent a total of 10 ecology class periods of 20-30 minutes out in the garden this spring. April 2011 was a month of rain. Only in the last two weeks of April could we begin to spring clean and plant in the garden 1-2 periods a week. May 2011 was our most productive month for periods spent in the garden, but we never had more than two consecutive days to work there. I continued the project through June 13, 2011, due to the weather conditions.

Consistency and continuity of lesson planning were challenging due to the unusual weather pattern. Classroom assignments included students designing controlled experiments for the garden and growing plants from seeds. Collectively, students researched the plants they would like to grow (See Appendix F). They spent 120 minutes in our school library determining which plants to start from seed in our classroom. We decided on criteria for which plants to start as seeds and used that information to begin our seed experiment. As part of an assignment, students determined that their garden is in the Northeast in growing zone 5. This is an important element in gardening because the zone determines the type of plants that will survive. It is also known as the hardiness zone or climate zone. The entire assignment was to choose a plant for the garden and design an experiment for seed growth and plant development, fulfilling the New York State Biology curriculum requirement for students to gain the ability to design a controlled experiment; this includes forming a hypothesis, determination of control, independent and dependent variables, data collection, analysis, and a conclusion.

One of the obvious approaches to gardening is inquiring and asking open-ended questions. In my teacher journal I documented student response to open-ended questions when we were outside in the garden as opposed to in a classroom situation under the assumption that the intimidation of a classroom setting disappeared in the garden and students would be more likely to take a risk in learning. I administered a confidence survey in November and after the project in June. I also collected attendance records for my students. The records were generated and maintained by the computerized high school attendance program. Students journal about their experience and were tested on appropriate topics. A pre test and post test were administered on appropriate topics including taxonomy and scientific naming, nutrient cycles, and elements of gardening.

Trout in the classroom was the other service project, and it generated a great deal of enthusiasm in the students. We obtained 80 brook trout eggs to hatch, raise and release into Black Creek, a local stream designated for brook trout release by the New York State Department of Environmental Conservation (DEC). None of the eggs developed due to a fungus that was present. We began again with 60 eggs, and of the 60 eggs, 50 developed. We then lost 20 newly hatched fish due to starvation; we simply did not feed them enough. The death of our first study population led to many discussions of the embryological development, and we received information and support from Trout Unlimited, an organization that supports conservation and education about the environment that affects trout. When considering the needs of brook trout to survive, students had many questions about macro invertebrates, dissolved oxygen content (DO), and water pollution. A representative from the DEC spoke to the class in January about watersheds. Students were responsible for checking the water quality and monitoring the

trout eggs for fungus on a daily basis. Their observations were documented in a daily log. The surviving trout were released to Black Creek on April 29, 2011. From December to April, students kept a journal about the trout project in which they answered specific questions and wrote about the progress of the project from both scientific and personal points of view. The journal questions were very clear, and short responses were acceptable. With special education students and ESL students, writing is very difficult; I was interested only in what they were thinking and not how they recorded their thoughts. The journals were pre-coded (positive or negative experience) to help make trends more easily documented.

During the week of November 15th-19th, five students from each class were interviewed as a follow up to some of the survey questions. The interviews were accomplished privately, with only one student and me present. Only three questions were asked, so there was neither a time issue nor a problem with needing a recording device.

The effect of the project on attendance and attitude was addressed because not only was attendance easy to document quantitatively, but it also affected all other results of the investigation. High absenteeism has historically been a major problem with the at risk population.

Because many of my students have serious language issues (ESL), and some have difficulty expressing themselves in writing (special education), for the survey I used the Likert scale, which is simple and has clearly stated questions. The interview was personal and did not require the student to read or write. The interview and the Likert scale survey helped level the playing field for expression and gave valuable data.

The acquisition of historical data on attendance and data from the Likert survey on attitude as well as the follow up interview gave insight into motivation to come to school or to stay home. Data collected indicated a possible correlation of community, attendance and attitude (See Table 1).

Table 1
Methodology of Addressing Action Research Questions

Research Question	Literature Review	Likert Survey	Pre & Post Test	Student & Teacher Surveys Pre & Post	Journal Entries
1. Will an outdoor garden service learning project help at risk students become more successful in science classroom? This will be tested by attendance records, achievement on tests, and participation.			X	X	X
2. Will an outdoor garden project help student connections between classroom learning and what is happening in the community?	X		X	X	X
3. Will being engaged in an outdoor garden project increase student confidence in the classroom?	X	X		X	X

Note. The journal entries are teacher journals as well as student journals.

The students were involved with two service learning projects: the garden project and trout in the classroom project. The garden project was a long- term project although not a daily commitment. Trout in the classroom was a service -learning project that was a daily student commitment. Trout needed to be fed, any dead needed to be removed, and water quality needed to be measured daily to assure a healthy environment for the trout.

Table 2 is the triangulation matrix of all the data that was collected and what data will be collected and compared.

Table 2
Triangulation of Data Matrix

Focus Question	Data Source 1	Data Source 2	Data Source 3
1. Outdoor garden project			
Attendance	attendance data	student interviews	journal entries
Achievement	pre - post tests	quarterly average	
Attitude (participation)	Surveys	student interviews	journal entries
2. Trout in the classroom			
Attendance	attendance data	student interviews	journal entries
Achievement	pre-post tests	quarterly average	
Attitude (participation)	Surveys	student interviews	journal entries
3. Connection with classroom Learning and community involvement			
	Surveys	Interviews	journal entries
4. Student confidence			
Attitude	Surveys	teacher & student interviews	journal entries

Information from each data source was analyzed independently and compared with the other data sources for triangulation. Analysis of three different data instruments helps to show data validity. I compared surveys to interviews (both teacher and student) and then to student journal entries. For achievement data, I compared pre- and post unit tests as well as quarterly averages pre and during treatment. I also looked at a difference in project grades pre treatment and during treatment. I compared this data with survey questions concerning achievement and service- learning. Attendance data were analyzed pre treatment and during treatment and then compared. The data were compared to

student responses in interviews and specific journal entries concerning attendance questions. Likert surveys were administered with pre treatment and post treatment to help determine student responses to questions about attitude and participation. The data from these surveys were compared to student responses to specific interview questions and journal entries.

DATA AND ANALYSIS

During this action research, 34 students were involved in the service -learning projects. Student responses to questions on attitude, attendance and achievement were collected and analyzed. A Likert survey was given to both ecology classes. The summer ecology class consisted of 100% ESL students. There were 14 students, seven male and seven female, all 9th and 10th graders. The second class was an integrated ecology elective which consisted of 11th and 12th graders, six of whom were special education students; 14 were regular education students. Of these 20 students, 11 were male and nine female. The survey was administered on November 10th to one ecology class. The same survey was administered at the start of the summer ESL ecology class in July 2010. The purpose of the survey questions was to collect baseline data with a focus on attitude. The survey was scaled 1-4, with 1 signifying strongly disagree and 4 signifying strongly agree. Analysis was completed looking at simple averages and frequency of response.

During the week of November 15th-19th, five students from each class, chosen at random, were interviewed as a follow up to some of the survey questions. These students were picked by assigning each student a number and drawing numbers from a beaker.

Three at risk students and two not at risk students were chosen in the regular ecology class, and all at risk in the ESL class. The interviews were accomplished privately, one on one. Because only three questions were asked, there was not a time issue or the need for a recording device. Together, three types of data collection addressed the research sub question on confidence and attitude .These data collection instruments were the Likert surveys, student and teacher journals, and interviews. The following questions are on the Likert survey given before service- learning projects were introduced. The questions were grouped together by common themes to be analyzed.

Q1. I look forward to attending my science class.

Q2. I feel confident about science.

Q3. I feel confident about speaking up in science class.

Q4. I would like to take another science class next year.

Q5. I learn best by doing hands on activities.

Q6. I am active in my community (outside of school activities).

Q7. I am interested in being involved in service learning.

Q8. I am interested in growing my own food.

Table 3 organizes the questions administered into themes and shows the comparison of averages of answers and frequency of responses by at-risk students (AR) and not at-risk students (NAR).

Table 3
Student responses to the Likert survey (N=34) Pre treatment

Category	Average (NAR students)N=14	Frequency disagree/ agree (NAR students)		Average (ARstudents)	Frequency disagree/agree (ARstudents only)N=20	
Attitudes towards science class Questions 1, 2, 3 & 4	3.15	36%	64%	2.65	16%	84%
Attitudes towards outside activities Questions 6, 7	2.95	19%	81%	3.10	0%	100%
Attitudes towards hands on activities Questions 5, 7, 8	3.13	33%	67%	3.03	29%	71%

Note. 34 students were surveyed. Of those surveyed, 20 students fall into the at risk criteria.

The average was calculated from the Likert scale of 1-4 for each category for comparison. For students not at- risk, the average score for questions concerning attitude about science class was greater by .50 than those students at- risk. This result reflects the student attitude about science before we started the service learning projects. There were greater similarities when comparing the students using the other question topics. Students at risk showed a slight increase (.15) in desire for community involvement. Both groups of students prefer hands on activities, although the average shows a slight increase (.10) in students who are not at- risk. Figure 1 shows a comparison of AR and NAR students as they responded to questions grouped as themes.

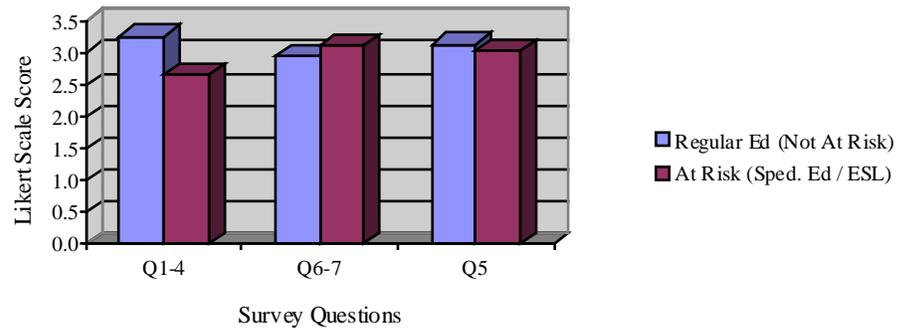


Figure 1. Student Attitudes Before Service Learning Projects (Pre treatment) with 14 students (NAR) and 20 students (AR), (N=34).

The frequency of responses of agree and strongly agree were averaged for each question set. Positive responses dominated the results on student attitudes about science class (Q1-4). A 20% difference is noted between NAR and AR students before service learning projects started. 100% of AR students had a positive response concerning outside activities with the community or the school. This is compared with 81% of the students NAR. I think many times students who do not excel academically find other avenues to feel success and many times that involves a hands-on activity. The data from this pre-service learning survey, found in Figure 2, was compared to data collected post service learning project.

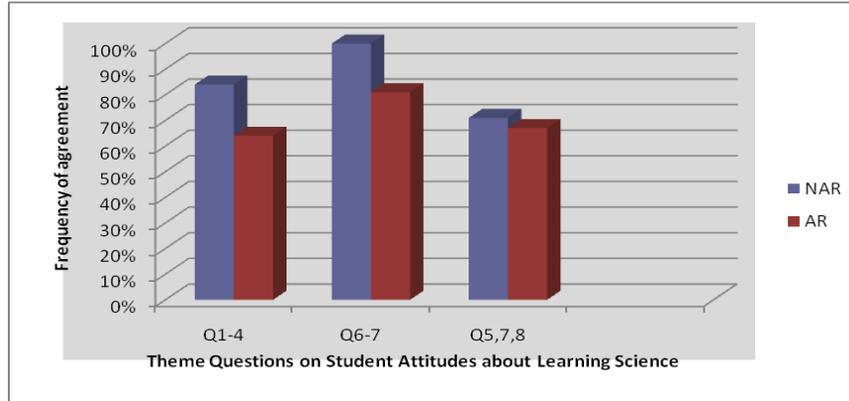


Figure 2. A Comparison of Agreement Responses to Theme Questions between 20 At Risk Students and 14 Students Not at Risk, (N=34).

The data in Table 4 is presented mostly in percentages. I looked at positive student responses to particular theme questions. I took the number of positive responses and divided that by the number of possible positive responses. I separated these responses into AR and NAR categories for comparison. Surveys, journal entries, and teacher observations were carried out both before the projects (pre treatment) and during the project. These data were documented in this table. The interviews were done only pre treatment and therefore no comparison could be considered.

Table 4
Data Collected on Attitude Pre treatment (before the project) and During Treatment on At-Risk (AR) Students (N=20) and Students Not At -Risk (NAR)(N=14)

Question Theme	Positive Attitude About School				Positive Attitude about Science				Positive Attitude about Service-Learning			
	AR Students		NAR Students		AR Students		NAR Students		AR Students		NAR Students	
Student Type	Pre	During	Pre	During	Pre	During	Pre	During	Pre	During	Pre	During
Survey	84%	80%	64%	73%	84%	84%	64%	79%	NA	88%	NA	79%
Interview	71%	NA	100%	NA	57%	NA	67%	NA	57%	NA	67%	NA
Journal	80%	80%	64%	78%	70%	75%	50%	78%	50%	90%	36%	85%
Teacher Observations	NA	Overall increase	NA	Overall increase	NA	No Change	NA	No Change	Na	Overall increase	NA	No Change

When analyzing data on attitude, the most valuable tool were the journal entries. Students wrote comments in their journals almost every day during the year. The journals were analyzed for positive comments, negative comments and/or neutral comments. Because journals were long term, a bad day or a great day were averaged out. The surveys and interviews were administered on one or two days; therefore student mood and a particular activity may have had significant impact on the responses. At risk students showed a general tendency, both before the projects and during the projects, to have a more positive attitude about school and science. This evidence is documented in surveys, journals, interviews and teacher observations. It was more difficult for many AR students to write with detail about their feelings and thoughts about school and science. Many of the AR students were ESL students and find attending school a privilege and know the power it can have on their future. These students have a positive attitude about school. I have a student who physically walked here from Central America and does not miss a day of class. He has a wonderful attitude about school. His dream is to become a doctor. Service- learning projects had a positive effect on all students as noted in the Table 4.

Journals were a part of almost every day's class work. Students spent the first five minutes of class responding to a question or two that related to the previous day's information or were an introduction to the new work of the day. Each question had an attitude response built in. Examples of language used to elicit attitude are: How do you feel about the film we watched on farming? Why do you think the farmers were committing suicide? What can be done to prevent this? Other questions were specific to raising trout in our classroom: How do you feel about releasing the trout in April? Do

you think we should keep them in the tank where they are safe? What are some of the greatest challenges that we have faced in raising the trout? What will be the trout's challenges when they are released and what were their challenges in the tank? These are the types of questions that students were required to write about in their journals. Once a month, I asked them to respond to how school was going, how ecology class was going, how they felt about the service-learning project, and how they felt about coming to school.

When analyzing journals for attitude or mood, I simply put a check for positive, a 0 for neutral, and a minus for negative. One student wrote in her journal that "one of the greatest challenges facing our trout in the tank was that they had to depend on the class for food. We didn't feed them enough in the beginning and we made a lot of them starve. It wasn't fair to them and we should have looked up how much food to give them. I felt bad that they died." This student continued later in her journal that she like having the trout and it made her like ecology class more. This was a positive response and recorded as such.

Although the students are anonymous in this paper, I kept track of them individually to show growth or no growth at the end of the project. Attitude and confidence are internal and therefore personal, and as such were compared on an individual basis. One at risk student became the poster child for service learning. Very shy, he is not very articulate and does not involve himself in class discussions or activities. He struggles academically and socially in a traditional classroom setting. However, he loves to fish and be outdoors. He adopted the fish in the project and was very involved in all matters having to do with the trout. His attendance was almost

perfect during our trout project, and he had the water chemistry completed and recorded before most students had entered the classroom. He loved the project, did not articulate that in his journal, but in a phone conversation I had with his mother, she said it was the best he has ever felt about a class and he loved coming to school to take care of the trout. She was very grateful the trout in the classroom project was available because it had hooked her son into coming to school voluntarily. One of the down sides to having this student take such responsibility was that it absolved the other students from being responsible for their assigned day to take care of the trout. Some students may not realize or just may not tell us how much growing food, or taking care of trout might impact them as students and human beings. Sometimes the realizations come later or when the project information can be applied at home or at work it becomes credible to them.

A survey was given post treatment that looked at how students value attendance, community involvement, achievement, attitude and participation. This survey (Appendix D) was given to ten ESL students, five special education students and ten regular education, not at risk students. They were separated into groups for individual and group analysis.

A surprising piece of data came from the whole group analysis concerning community involvement and school involvement questions. Students were asked, using the Likert scale values, how they felt about involvement in community projects, pre treatment and post treatment. The data were analyzed by calculating the percentage increase in post treatment responses of the 25 students who took the survey. Community involvement scored a 36.7% increase, and 60% (N=25) of the students answered positively to an increased interest in school involvement. 15 out of the 25 students had an

increase in positive response to a greater interest in school involvement. I was very encouraged by this data because it can lead to a greater sense of community within the school. Those students interested in service- learning increased by 50%. The data showed that 40% of all students felt they were more likely to attend class when they are involved in a service -learning project. One of my students said specifically that the service -learning project affected her attendance: “I don’t want to be late for first period because I might miss working in the garden.” She is a special education student who graduated in June and needed the ecology classes to graduate. She loved the garden and had perfect attendance every day we planned on working in the garden. The trout in the classroom project did not have the same effect on her attendance. It is important to be flexible in planning how projects can be supported by students and know that variety is important in trying to meet different students’ needs. I asked all students to journal about different types of service- learning projects and what difference they make on involvement, attendance, and achievement. 100% of the responses stated that the type of project was important in capturing their interest and therefore involvement. They also responded positively about having input in determining what the project should entail.

40% of the students felt that doing service -learning projects encouraged higher achievement. One student commented that a research paper would have been a good addition to each project. Students were required to submit a PowerPoint for a final exam grade on any topic we had covered. Several students stated in journal entries that the class could have had more rigor, or in their words, “it needed to be harder.” In the future, we can take this to a higher academic level with looking at the development of trout and what inhibits it and also work on soil chemistry.

Data was collected on attendance of all students involved in the study. Attendance data collected from September through November is considered a time period of pre or non-treatment. Of the 13 students not at risk, attendance for that time period was 89.87%. Attendance documented for the same students from November through June was 83.89%, which shows a change of -5.98% attendance during service learning projects. Attendance collected on at risk students during the time period September through November showed 74.92% attended class, and 80% attended November through June or during the service learning projects. A 5.08% increase in attendance was seen during service learning activities. When asked in a journal entry what would increase a student's attendance, 50% said if school started later, and 30% said if it was more fun with more hands on activities and field trips. The ESL student data were analyzed separately after being included in the total data analysis. These students showed an increase of 7.83% attendance during the treatment period. I separated this data set because the time period and circumstances of the treatment were different; this class was taught in July and August of 2010. Breakfast and lunch were provided, and the student group was homogeneous.

For each data set, one outlier was removed. The ESL group of 14 was reduced to 13 due to one student's pregnancy and the ultimate delivery of her son in October. Her class attendance had no basis in a service learning study. The at risk special education student group of six was reduced to five due to a student's severe vision problem, which keeps him from attending school in the winter months. The third outlier was a student in the not at risk category which decreased the study number to 13. His attendance was

limited all year due to family issues, and he eventually left class and got involved in an on line credit recovery program.

For a comparison of attendance and confidence, I have included more raw data on the Likert survey in Appendix E. Confidence levels were measured by surveys, interviews, and journal entries. When reviewing the triangulation matrix (See Table 2) as it relates to student confidence and connection with the classroom, the interviews and journal entries support the survey results. When asked what part of science class they enjoyed, students unanimously preferred hands on activities and labs. One at risk student stated that labs and working on projects were fun and made him want to be involved in class. He said, "If it is fun I want to be here and labs are fun." Only 30% of those students interviewed knew what service learning was, but 70% liked to be involved in the community. Initially student confidence was low, 40%. Throughout the year, journal questions concerning confidence in science class showed an improvement to 86%. I think the relationship that is built between student and teacher as well as between students throughout the academic year helps a student feel more confident in class. Students and teachers work closely on a project that has a goal of making someone or something's life a little better. Having a positive goal as the outcome and having collaboration between teacher and students builds trust and a spirit of cooperation which is more difficult to establish in a traditional classroom. The ESL teacher and the special education teacher both noted the differences in student communication with each other while in the garden. An AR student with garden experience instructed a NAR student, with a 95 average on proper planting technique. A respect between students had been earned that day. I don't necessarily think it means they are successful in science all the time, but they are willing

to take a risk. They feel safe in their surroundings and in their ability and their confidence increases.

The basic theme of the interview questions was how comfortable the student feels in science class. If the student likes science class, does he/she feel comfortable speaking up in class and working with their peers? Is the student interested in working in the community in a science -based project? At the conclusion of each interview, I documented positive, negative, or neutral next to each question and wrote down any significant comments. I was surprised that 100% of NAR students had a positive reaction to school but only 67% had the same reaction to science. These students are in the 11th and 12th grade and are happy to be leaving high school for college or the military. In my experience, NAR students that are enrolled in ecology are weaker science students who require a science credit to graduate. Their experience in science classes in the past has not been one of success. AR students had only a 57% positive response to being confident in science. This comes from a lack of prior success as well as a lack of comfort for ESL students in speaking up in class. AR students responded that “more labs, more hands on activities, and field trips would make them like science more.” One student asked if the class could visit a farm and a trout hatchery. That is now in next year’s plan for the ecology class.

For data on achievement, unit pretests and post tests were administered and quarterly averages pre treatment and during treatment were compared. Three discrete tests were administered to the ESL students in the summer program and to all other students during the service learning garden treatment. Table 5 compares pre and post unit tests during the garden project of both at- risk and not at-risk students.

Table 5
Garden Topic Unit Pre/Post Test Results AR students (N=20) and NAR students (N=14)

	Test 1 Scientific Names	Test 1		Test 2 Botany and Gardening	Test 2		Test 3 Nutrient Cycles	Test 3
Student Type	AR Students	NAR Students		AR Students	NAR Students		AR Students	NAR Students
Pre	46.8%	65%		61.3%	77.9%		35.7%	62.1%
Post	63.6%	75.7%		75.4%	86.4%		46.7%	75.7%
% change	+16.8	+10.7		+14.1	+8.5		+11.0	+13.6

All students improved their scores in the post tests of all the units. AR students had their greatest increase in improvement on Test 1. The ESL summer ecology program test scores all increased although as a group never reached passing and therefore did not reach mastery. The increase is important when language issues and the gaps in the education of ESL students are considered. For most at risk students, hands on activities that encourage an alternative way of processing information provide more opportunities for success.

Each test was aligned with NYS Education standards and was given in English.

Test 1 was language based in that scientific naming is in Latin, giving each student a common place to start. AR students had difficulty with this test (pre test 46.8%) and made the greatest gains in the post test although still not to a passing percentage (63.8%). The net gain for AR students' was 16.8 and this was their largest gain of all three tests. In my experience, testing about scientific names does not prove well for AR students partly because how the test is constructed. These students learned more in this section than in all others. This is a difficult area and their success was a gain of 16.8%.

The diagrams and language changes do not help students with language issues either as a special education student or an ESL student.

Test 2 was botany and gardening based. Students had been in the garden before the pretest, and some had experience with plants. There was also quite a bit of prior knowledge that students displayed in their responses which explains why AR students scored 61.3% on the pretest. This test also had more diagrams to make language skills less of an issue. AR students showed a net gain of 14.1%. They started with more knowledge and still increased to passing percentage. NAR students had a net gain of 8.5% which seems low until you look at the pre test value at 77.9%. All students had base knowledge about plants prior to the unit.

Test 3 was on nutrient cycles and was very difficult for them initially. Most students increased their base knowledge by quite a bit although AR students did not increase enough to pass the test. This knowledge is still quite abstract for many students. It is not uncommon for high school students to struggle with the details of nutrient cycling. There was not as much emphasis placed on this topic during the project. I will increase that in the future. AR students began this unit with the lowest knowledge base scoring 35.7% on the pre test. After the unit was complete, their scores increased to 46.7% with an 11.0% net gain but this is far below passing percentage. NAR students had higher pre test scores (62.1%), and raised them to a passing percentage of 75.7%. This was NAR students' greatest gain in test scores (13.6%). Nutrient cycling and limiting factors were abstract initially and had we spent more time on this unit, I believe AR students test scores would have improved.

I analyzed each test question for potential language difficulty, and I incorporated as many diagrams as I could for clarity. In my experience, at risk students have a more level playing field when the information on a test is communicated in pictures as well as words.

Students in the integrated ecology class had three pretests and post tests administered during the course of the trout in the classroom service learning project. The results follow in Table 6, divided into at risk and not at risk categories.

Table 6
Students Involved in Trout in the Classroom Pre/Post Unit Tests. AR students (N=6) and NAR (N=14)

Test	Test 1 Water	Test 1	Test 2 Trout	Test 2	Test 3 Nutrients	Test 3
Student Type	AR	NAR	AR	NAR	AR	NAR
Pre	43.3%	60.7%	71.7%	72.1%	48.3%	50%
Post	55%	77.9%	81.7%	86.4%	75%	72.1%
% Change	+11.7	+17.2	+10.0	+14.3	+26.7	+22.1

Test 1 included questions on water chemistry and properties of water. Because this information is abstract, students who are at risk have a more difficult time answering these questions correctly. Memorization is not as easy for these students and shows in the increase in their knowledge base, which improved but was not enough for a passing grade. Students who are not at risk had a 16.4% higher pretest score and a 22.9% higher post test score. These students also had an increase of 17.2% pre to post tests while at risk students had an 11.7% increase.

Test 2 included questions on characteristics of trout and their development. Students had prior knowledge before taking this pre test. Students had already done

journal entries on trout development research questions prior to this test. This is demonstrated in the high pretest scores. Both at risk students and students not at risk scored well and proved mastery on the post test scores.

Test 3 included questions on nutrient cycles and limiting factors. All students had difficulty with these questions in the pretest. These questions seemed abstract, and students had difficulty relating them to trout care. Between the pretest and post test, an activity was done to relate the nutrient cycling to an aquarium with trout. This activity brought the abstract to the understandable for students. Students at risk improved test scores by 26.7%, and students not at risk improved by 22.1%.

Quarterly averages were compared between at risk and not at risk students before service learning and during service -learning. When averaged, the quarterly course average of the at risk students, pre treatment, was 75, and during treatment it was 79. Scores of students not at risk showed an average of 82 pre treatment and 77 during treatment. Service- learning projects seemed to have a more positive effect on at risk students. Teacher observations noted that the at- risk students were very involved in the garden project and put in extra time after class in the garden. Teacher observations concerning at risk students participation in the garden project were very positive.

When analyzing data on service- learning projects for at- risk students, attendance and achievement are closely related. Attendance data for at- risk students show an improvement of 5.08% during treatment. Surveys showed that only 40% of students felt that attendance would improve if involved in a service- learning project. However, as enthusiastic and involved as students were in the garden and trout in the classroom, they did not take responsibility for their part in the project if they were absent. One student

wrote in her journal concerning attendance that, “it is nice not to worry about a job being done because there are so many of us. Someone else will do it today if I am not here and I will do it for them when they are not here.” Because friendship is such a strong motivator for attendance, I will try to pair up friends to be teams on future projects and encourage the fun and important aspect of their involvement.

The projects did not foster a need in students to attend even though journal entries were positive concerning attendance in class and involvement in the projects (84%). At risk students showed an increase in quarterly average during the service- learning projects, but students not at- risk showed a slight decrease. Achievement showed an increase on every post test given. 60% of students surveyed did not think that service - learning affected their ability or desire to achieve. The journal entries and interviews were more neutral on the topic of achievement. Students did not make the connection between service- learning and academics. I need to make that more obvious to them. As I continue with the garden project, I will design benchmarks of knowledge for each topic we enter. For scientific names, I will have them identify all the tomatoes that can be grown in our garden and research the common name and scientific name for each. That activity may help bring the concept from abstract to practical. It is easy for a teacher to put so much emphasis on the project itself, that making and keeping the connection between the project outcome and the service- learning goal can be lost.

INTERPRETATION AND CONCLUSION

Is service- learning a viable teaching tool in a science classroom? This question was posed at the onset of the project with a few sub questions to narrow the research field. To address this question, this study included students who are at risk of not graduating from high school with their cohort as the target population, and two ecology classes were the setting. The service- learning projects were an outdoor garden and a trout in the classroom project. The question, the study, and the answer encompass attendance, attitude, and achievement.

The attendance issue shows an increase for at risk students (5.08%). While the actual numbers show an increase, the survey questions, journal entries, and interview responses all have students verbalizing that service learning projects do not encourage them to come to school. When asked what does make a difference in attendance, the response was unequivocally social life and friends.

The ecology class in question was in session from 7:50 a.m-8:42 a.m. Many students had difficulty coming to school that early as many of them walk to school, and as the weather got colder, that walk to school got later. (This is an observation not documented in terms of a data set). This class is the first of the day, and the students are juniors and seniors. All these factors affect attendance. To encourage students to come to class, we began journal quizzes in late January. During the first five minutes of class, students took a quiz in their journal about the previous day's events. This encouraged students to come to class on time. I believe this action impacted the attendance data.

Attendance is such a major part in all other factors being studied. If a student is not present, all else is moot.

The ESL students' increased participation in the summer service -learning project, and this could be because breakfast and lunch were provided. These students traditionally have less food available than they need; therefore the incentive to attend could have been food rather than service learning. I have no data to support this statement, but I did observe that students took their lunch home to their families daily. The garden project allowed them to harvest vegetables and take them home to their families as well. I noticed on harvest days there were more students present. The ESL teacher, whom I worked with, also observed the increase in student attendance on harvest days although we did not document harvest days specifically. This observation is anecdotal, but it is a place for further research.

All students improved test grades on all unit tests. To look for an overall effect on academic performance, I compared students' first quarter and last quarter averages; the first quarter was pre treatment, and the last was during treatment. All at risk students improved academically during the service learning projects (+ 4 points). However, quarterly averages of students not at risk decreased by 5 points during the service learning projects. One variable to consider is that for many not at risk students this was the last quarter of their senior year and a lack of academic focus was obvious.

40% of students surveyed did not believe that service learning and academics had a correlation for them personally. During the trout in the classroom project, students took an interest in the fish, and many went to the tank as they walked into class. They argued about who was going to do water chemistry or feed them. Enthusiasm was sparked and

was documented in their journals. 94% of the journal entries were positive and showed correct information on questions concerning trout. The common criticism of our trout program was that more students should be involved more often.

The attitude of the learner who is classified as at risk is critical to success. 60% of all students surveyed said they were more likely to get involved in school projects and 50% in service learning projects. The impact of the relationship that is built between teacher and student as well as those between student and student during service learning projects is difficult to measure. The teacher can note a change in behavior, and the student may attend class more frequently. The student's journal that they liked coming to class more now, spent time researching plants or trout, and came to class with questions. Still, some changes, such as attitude, are not easy to quantify. The attitude portion of this study should actually be a long-term study.

Service learning is, in part, a character education program that has a goal to encourage students to become good citizens by becoming involved in the community. Character development takes time. There are many variables to take into consideration in an action research study like the one I have done. The type of service learning project is only one.

VALUE

Service- learning has been a passion of mine since 1998. I find it logical, engaging, and dynamic. When I was asked to choose an action research topic, service learning was an immediate choice. Service learning takes time and creativity. Keeping

the science in a project that is community based is sometimes difficult. That said, over the years I have seen students thrive emotionally in this atmosphere, but I did not take the time to document the impact of service- learning on personal and academic success until now.

Through service- learning projects, my students are learning how to grow their own food and to respect the environment. Some of my students volunteered to help on World AIDS Day at our community's remembrance. One week a month students bake cookies for Angelfood East to be delivered to people living with AIDS. My students are increasingly involved in community activities. Is this increase in involvement because of service- learning? The data show a 36% increase in community awareness and a desire to get involved. This data indicate that after students have experienced a positive service- learning experience, they are more likely to become involved in a community activity (60%). Forty percent of the students surveyed state they learn best when they are involved in community projects.

The data gathered and analyzed on at risk students' attendance show improvement in attendance (5.08%) and improvement in achievement (4 points). Long-term research could be done following students from 9th grade through 12th grade, as they are involved in service- learning projects. Research could be done in the middle schools to determine what projects are interesting to students and could be carried on to high school. The type of service- learning projects in different grades and in different subject areas could be addressed in further research. Having students involved in the decision- making process concerning project choice and community involvement could be another opportunity to see what works best for more students. A further place of research could look at gender

differences and how they relate to project types. There is also room for research on the impact of project duration on student attendance, achievement, and participation.

For this project to have been stronger, I would have liked to have done the service- learning projects in separate classes, one project per class. I do not suggest the overlap of two projects when doing an action research project. It is difficult to separate results when another variable is added. I also would have had a greater number of subjects involved with more classes, so the data would have more validity.

One of the most valuable reasons to be involved in service-learning projects with a group of students is to build relationships with students. Watching students work with each other and learn from each other is rewarding and inspiring. The person in our school who is charge of security is a retired FBI agent and a very imposing man. Our garden is very close to his office and he comes out when students are working there and talks with them and on hot days has offered them a cold drink. This is a relationship that was completely peripheral and very important to many students. Security guards, custodians, secretaries, and other teachers are all talking about our garden and talk to the students, ask them how it is going, what is happening with the groundhogs, the rabbits and is the fence really working. I had students planting fruit trees at the end of the school year, just because they felt like hanging out, talking and being in the garden. Students who don't speak English don't have to speak well or often in the garden so you form a relationship. "First is spending time, then you communicate on some level, and then there some laughter, some work, and some trust." My ESL teacher wrote that in her journal about relationships and the garden.

This action research will have immediate effect on my teaching. For example, I have not traditionally given pretests. This is a change I am planning to make in my teaching. With pretests, students will be aware of the expectations at the onset of a topic. Another value added to my teaching from this project is to encourage student involvement in the design and implementation of the service- learning project. Students can research a need, and I can facilitate the completion of the project. Students will own the project and not just be involved in it. I will also continue to document students' changes and successes as this project continues and others join it in future years.

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APPENDICES

APPENDIX A

TABLE OF DATA METHODOLOGIES FOR EACH TREATMENT

Table of Data Methodologies for Each Treatment

Data Collection Methods	Survey	Interview	Pre-Test/ Post-Test	Journal	Attendance	Participation	Final Survey / Interview
1. Does participation in service learning increase /broaden the academic environment Community Gardens Project		X	X	X	X	X	X
2. Trout in the Classroom Project	X	X		X	X	X	X
3. What impact does the service-learning project have on the teacher?	X	X	X	X	X	X	X
4. Does service learning have a positive impact on students with nontraditional learning abilities	X	X	X		X	X	X
5. Does service – learning increase students performance in the classroom (overall improvement)	X	X	X		X	X	X

APPENDIX B

LIKERT CONFIDENCE SURVEY

1. I look forward to attending my science class.
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

2. I feel confident about science.
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

3. I feel confident speaking up in science class.
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

4. I would like to take another science class next year.
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

5. I learn best by doing hands on activities.
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

6. I am active in my community (outside of school: examples could be a church group, sports, music, POOK, ENERGY, a band, a community garden, working with younger children).
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

7. I am interested in being involved in service learning.
1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

8. I am interested in growing my own food.

1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

9. I like having animals (trout) in the classroom.

1. Strongly Disagree 2. Disagree 3. Agree 4. Strongly Agree

Table 3. Student attitudes about science class as analyzed using frequency of response to Likert scale values. (Pre treatment). N=34

Frequency of response to Likert scale values 1-4	Questions 1-4 at –risk students N= 20	Questions 1-4 not at- risk N=14
1 strongly disagree	3%	14%
2 disagree	13 %	22%
3 agree	44%	50%
4 strongly agree	41%	14%

At-risk students responded more definitively that they enjoy science class.

Table 3..... Student responses to attitudes about involvement outside the classroom (community) as analyzed using frequency of response to Likert scale values (Pre treatment). N=34

Frequency of Response to Questions 6-7 using Likert scale values	Frequency of Response Questions 6-7 At–Risk Students N= 20	Frequency of Response Questions 6-7 Not At-Risk students N=14
1 strongly disagree	0%	0%
2 disagree	0%	19%
3 agree	64%	44%
4 strongly agree	36%	38%

At-risk students responded more definitively that they enjoy community involvement, although all students show a mostly positive response

Table 3D Student responses to questions concerning hands on learning activities as analyzed using frequency of response to Likert scale values. (Pre treatment). N=34

Frequency of response to Questions 5-7-8 using Likert scale values	Frequency of Response Questions 5-7-8 At-Risk Students N= 20	Frequency of Response Questions 5-7-8 Not At-Risk Students N=14
1 strongly disagree	5%	0%
2 disagree	24%	33%
3 agree	48%	33%
4 strongly agree	24%	33%

At –risk students responded more positively to hands on activities by 6%.

APPENDIX C

INTERVIEW QUESTIONS

My interview questions followed along the same line as the survey although with probative value.

1. Do you like science class?
 - a. What do you like and/or what don't you like?
 - b. What would make you like science class more?
2. Do you feel confident in science?
 - a. Are you comfortable speaking up in class?
 - b. Are you comfortable with your peers in science class?
3. Are you interesting in service learning?
 - a. Is there a particular area of service learning that you would like to be involved?
 - b. Are you involved in any community activities?
 - c. What type of community involvement do you participate in?

APPENDIX D

ATTITUDE SURVEY AND SERVICE LEARNING EVALUATION

ATTITUDE SURVEY														
Strongly Disagree					1	2	3	4	5	Strongly Agree				
Before										Now				
1	2	3	4	5						1	2	3	4	5
					I enjoy helping others in the community									
					I like being involved in school projects									
					I enjoy growing food for others									
					I enjoy raising animals									
					I learn best when I am involved in community projects									
					I would like to be a part of a community action project to grow food in my neighborhood									
					Service Learning is a way to learn that engages me									
					I am more likely to come to class when I am involved in a service learning project									
					When I am involved in a service learning project, I am happier and work harder in class									

6. Does the type of service learning project affect how involved you would be?

7. What would encourage you to attend school more consistently? Be specific.

8. What suggestions do you have for the service learning program in this class?

APPENDIX E

RAW DATA ON ATTENDANCE AND SURVEY QUESTIONS

Students Not At Risk

	Pre treatment	During Treatment	% change	
a	88.3	77	-11.3	
b	100	94.6	-5.4	
c	93.3	71.9	-21.4	
d	96.7	96.7	0	
e	93.3	96.7	3.4	
f	88.3	80	-8.3	
g	96.7	98	1.3	
h	90	77	-13	
i	81.7	57	-24.7	
j	80	89	0	
k	57	43	-14	outliner
l	77	89.8	12.8	
m	83	71.9	-11.1	
n	100	100	0	

Attendance Data AT RISK STUDENTS: A1, G1,Q1,R1,S1,T1 are all Special education students and A1 and P are not included in attendance calculations. These are outliers.

	Pre treatment	During Treatment	% change	
A1	85	52	-33	outliner
B	71.7	83.3	11.6	
C	90	94.6	4.6	
D	96.7	97.6	0.9	
E	70	78.2	8.2	
F	70	87.4	17.4	
G1	75	77.7	2.7	
H	83.3	88	4.7	
I	76.7	71.4	-5.3	
J	65	71.9	6.9	
K	63.3	78	14.7	
L	75	85	10	
M	70	73.8	3.8	
N	91.7	90	-1.7	
O	41.7	67.7	26	
P	31.7	66.4	34.7	outliner
Q1	66.7	51.4	-15.3	
R1	88.3	67.7	-20.6	
S1	61.7	86.4	24.7	
T1	91.7	89.8	-1.9	

APPENDIX F

SAMPLE WORKSHEETS

Name _____

Ecology (Dayton-Wolf)

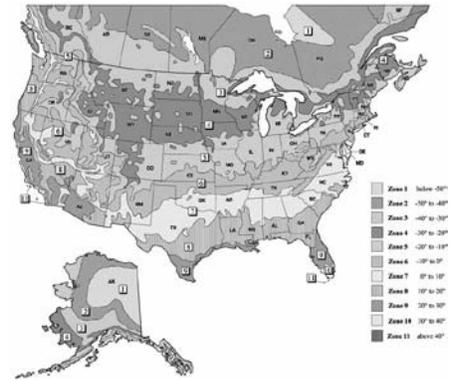
WEBQUEST: How Does Your Garden Grow?

Your task in this webquest is to find suitable plants for our garden this year. You will research plants that will thrive in our specific hardiness zone. The following list of website links may be useful.

[The National Gardening Association](#)

[Veggie Harvest](#)

[The Vegetable Garden](#)



I. Hardiness zone

What is a hardiness zone?

In which hardiness zone is Kingston located? _____

What is our estimated first freeze free date? _____

What is our estimated last freeze free date? _____

II. Choose 3 vegetable plants or herbs that could thrive in our hardiness zone that you would like to see in our garden:

1. _____

2. _____

3. _____

III. For each of the plants you selected:

	PLANT 1	PLANT 2	PLANT 3
Common Name			
Scientific Name			
Planting Timeline			
Harvesting Timeline			
Amount of Sun			
Nutrients			
Soil depth			
Advantages			
Special Concerns			

IV. Of the three plants you described, which is your top choice and why?

V. Experimental Design

Remember that a good experiment has tests only one variable at a time and uses controls make results clear. Design an experiment to test how germination is affected by soil medium (regular soil, peat pots, and vermiculite). Identify both dependent and independent variables.

Hypothesis: _____

Experimental Design: _____

Materials list: _____

Controls: _____

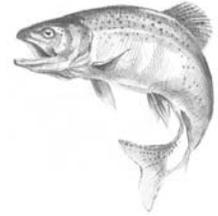
How will data be recorded? _____

How will data be analyzed? _____

Identify dependent variable(s): _____

Identify independent variable(s): _____

TROUT INSPECTION LOG



Week of: _____

Inspector(s): _____

Date	Temp °F	pH	Water: Clear? Level?	Ammonia mg/L	Nitrite mg/L	Nitrate mg/L	Number of Live Trout	Mortality (# dead removed)
MON								
TUES								
WED								
THUR								
FRI								

WEEKLY SUMMARY

Average Temperature: _____

Mortality (total number for week): _____

Average pH: _____

Water Change: [] 1/4 tank [] 1/3 tank [] 1/2 tank

Weekly Water Testing:

Dissolved oxygen: _____

Stress Zyme added (dates): _____

Observations: _____
