AC 2010-1569: THE IMPACT OF ACTIVE LEARNING THROUGH COOPERATION ON SCIENCE FAIR PROJECTS ON ELEMENTARY SCHOOL STUDENTS

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The Impact of Active Learning through Cooperation on Science Fair Projects on Elementary School Students

Abstract

The purpose of this paper is to show that outside the classroom, active learning through science fair projects with assistance from RAMP-UP Fellows can positively impact fourth graders. A comparison of the students' third grade End-of-Grade (EOG) math scores to their fourth grade EOG math scores, after they have worked with RAMP-UP Fellows on science fair projects, is presented to assess the impact. RAMP-UP assisted fourth graders in 2007 had a 2.96% and an 11.43% improvement in their development scale score and achievement level respectively as compared to 1.99% and 3.59% improvement by their peers. The 2008 and 2009 assisted science fair students did not perform as well as their peers on the development scale score and regressed on the achievement levels.

RAMP-UP, a GE Foundation and National Science Foundation funded GK-12 Outreach Program at North Carolina State University, assists fourth grade students at a local, inner-city elementary school with their science fair projects. A RAMP-UP Graduate Fellow with assistance from RAMP-UP Undergraduate Fellows and Teachers works with 12-16 economically disadvantaged African-American, Latino and Caucasian students per year. The Fellows guide the students from conception to completion of the project that is then entered in their school's science fair. All projects are experimental so the student is guided through the experimental research, design, execution and presentation by the RAMP-UP Fellow.

Introduction

Students in grade four are required to participate in an annual science fair run by the PTA at a local, inner-city, elementary school. Many students do not have the means to successfully participate so RAMP-UP, a GE Foundation and National Science Foundation funded GK-12 Outreach Program at North Carolina State University, has stepped in to provide the necessary assistance. A RAMP-UP Graduate Fellow with assistance from Undergraduate Fellows and affiliated teachers works with 12-16 economically disadvantaged African-American, Hispanic and Caucasian students. This assistance began for the 2006 Science Fair. A working model has evolved over the years allowing the Fellows to successfully guide 12, 16, and 12 students, in the 2007, 2008 and 2009 Science Fairs respectively. The students are guided through the project from conception to completion which is then displayed in the cafeteria on the day of judging.

Dr. John Dewey, one of the founders of pragmatism in education, believed that learning was active and that math could be learned through everyday activities such as cooking.[2] The program, building upon this concept, has created original activities that anyone could recreate in their home to help teach math. For example, one of the program's most popular, original activities is the "Diaper Activity." Through this activity, the students

learn about liquid volume by using turkey basters to transfer water to baby diapers to determine their maximum capacity.

RAMP-UP also strives to create an environment where university fellows from the colleges of engineering and education are able to mentor elementary school students. It is believed that this bond is influential and helps inspire students to learn and love science, math and engineering. This is in agreement with Eccles who believes that students' choice of studies is influenced by their social relationships.[1] The program strives to create social relationships between the university fellow and student and to create fun learning experiences through active learning that inspire a desire for greater participation in the fields of math, science and engineering.

Following a pragmatist approach, RAMP-UP strives to teach by replacing words with activities as the means of communicating new concepts. The program does this through providing many out of classroom learning opportunities such as math clubs, energy clubs, tutoring, FAME (Fun Applications in Math and Engineering) and assistance with science fair projects.

This paper is an attempt to show how RAMP-UP Fellows impact fourth graders by assisting them with science fair projects. We will assess the impact by comparing the growth from their third grade End-of-Grade (EOG) math scores to their fourth grade EOG math scores after they have worked with RAMP-UP Fellows on science fair projects.

Definitions

For the purpose of this paper, any use of the word "student" refers to a child in the fourth grade, any use of the word "Fellow" refers to an undergraduate or graduate student from the university, and any use of the word "teacher" refers to a teacher in the Wake County Public School System.

The RAMP-UP Fellows work in the primary schools when the university semester is in session. This results in a 12-13 week presence in the schools. The program has had a presence in three, inner-city elementary schools and one middle school for the past six years. This paper focuses on our assistance in one of the elementary schools hereafter referred to as "the school".

The Science Fair

The school holds an annual science fair in February organized by a parent in the PTA. All fourth graders are required to participate while participation is optional for fifth and third graders. The students have the choice of performing an experiment, building a model or presenting a detailed research report on a topic in nature. In the former case, they are required to keep a journal, write a report and present the experiment research, materials, setup, data and conclusions on a tri-fold poster that is displayed anonymously

in the cafeteria on the day of judging. A report and display are required for the model and research topic but a journal is not.

There are four, fourth grade classrooms at the school with 20-24 students in each. Approximately 20-25% of the students in each classroom do not have the resources to complete the project on their own and the responsibility has fallen on the teachers to assist them. Four years ago, the program recognized the teachers' need for assistance with the economically disadvantaged students and pledged to help. In 2006, the program was new to the process and did not act quickly enough to help more than two students. However, much was learned and we were able to plan earlier for 2007 when we successfully helped 12 students. The greatest reward that year was seeing one of the boys standing proudly in front of his display in the cafeteria with a huge smile on his face. The following year we assisted 16 students and in 2009 we were only able to assist 12 due to snowstorms that cancelled two days of school.

Getting Started - *Planning and Preparation*

Planning begins in December when the Graduate Fellow meets with the fourth grade teacher coordinator. Prior to the meeting, the Graduate Fellow assesses the availability of Undergraduate Fellows in January and February. Based on this, the fourth grade teacher will ask each of the other fourth grade teachers to provide the names of 2-4 students requiring assistance. In the past, we have started with the names of three students per teacher for a total of 12 students. What has happened is that sometimes the student(s) cannot stay after school or the teacher decides to assist them instead. In this case, we either take the names of new students to work with or we move forward with fewer than 12 students. Based on our progress, as we get closer to the date of the science fair, we may accept the names of more students.

The teachers contribute construction paper, markers and space to work. The school provides computers and a color printer. RAMP-UP provides the tri-fold poster boards, glue sticks and materials for the experiment which are generally provided by in-kind support of various departments at NCSU such as Petri dishes from the microbiology department.

The Troops

The program consists of approximately 10-14 undergraduate Fellows managed by one graduate Fellow. Based on their availability, all Fellows are encouraged to participate. Starting no less than three weeks prior to the due date, we meet at the school every weekday afternoon (including Fridays) from 3:45 until 5 or 5:30 pm to assist the fourth graders. All the undergraduates help willingly since they find working on science fair projects with fourth graders very rewarding and fun. Anywhere from two to four undergraduates plus one graduate Fellow will help every day.

When the Fellows arrive every afternoon in their red, RAMP-UP shirts, it gives a very uniform impression which inspired a very grateful fourth grade teacher to announce, "The troops are here!"

In 2007, we tried a ratio of one Fellow to three fourth graders. This proved very challenging and not the most efficient means to success. Since then, we have tried to maintain a ratio of one Fellow to one fourth grader. We found that the student needs the individual attention to help him stay focused, especially while researching the topic. Occasionally the ratio becomes one Fellow to two fourth graders, which is feasible. It is always good to have one Fellow (usually the graduate Fellow) act as a "utility player" to step in when an undergraduate is ill or has an exam and can't help on a given day. We found that by using a one-to-one ratio, we can help a student from start to finish in about 3 afternoons or approximately five hours. In a pinch, two to three undergraduates can help a student complete their project in one afternoon provided the materials for the experiment are on-hand.

There are many advantages to the one-to-one pairing. One of which is that the student blossoms under the individualized attention and is better able to focus, especially when performing the comparatively dull task of researching and writing in the journal. Performing the experiment is always the highlight of the process and the part that inspires the student to want to do more experiments. Another positive outcome of the one-to-one pairing is that the student and the Fellow build a bond. Through this bond, the undergraduate shares their knowledge and university experiences. The Fellows will often help develop experiments for the students from their fields of study. For example, the graduate Fellow developed two experiments in the field of renewable energy that focused on solar and wind energy. The experiment involved measuring the DC output of a solar panel when one quarter, one half, three quarters and all of it were covered. Another experiment involved building a windmill out of a milk carton and having the student design three different shapes for the blades. The student then tested how quickly the windmill could raise a paper cup with each of the differently shaped blades.[3]

Working with the Students - *Conception to Completion*

Step 1 – Pairing, Topic and Paperwork
The first step involves pairing the Fellow with the student and having them figure out a topic. Often the student already has an idea in mind but needs help turning it into an experiment. For example, one boy wanted to throw a football as his experiment. We helped him convert throwing a football into an experiment by seeing how far he could throw the football using varying grips. If the student does not have a topic in mind, then the undergraduate can use their university experience to suggest a topic. For example, one nuclear engineering undergraduate was able to obtain a Geiger counter from the university. He used this to perform experiments where the student measured the radiation in various locations in and around the school. The Geiger counter experiment was particularly meaningful to one young lady who had just recently lost her mother to cancer. She became very interested in radiation and wrote an extensive research section in her journal about its medical uses.

Once the topic has been chosen, the next step is to determine a title and create a journal out of 12 x 18 construction paper and loose-leaf paper. The students are encouraged to decorate the front but are not allowed to put their names on the work.

It is important to ensure that the students are registered to participate in the science fair judging.

Step 2 – Research, Journal Entries
Use the Internet, child-friendly sites only, to research the topic and write down any pertinent information in their journal. It is helpful to have them look up three to five words related to the topic and write down their definitions in the journal. The Internet is helpful for any photos. Also, have them keep a reference section of the websites visited.

Step 3 – Materials
Write down a list of materials in the journal. This will help both of you determine what and how much is needed.

Step 4 – Experiment
Have them write out the steps of the experiment and if necessary, create a data table to record the results in the journal. At the next meeting, bring the materials and help them perform the experiment. If there is any danger of injury, make sure to use safety goggles and assist them with the experiment. If there is no of danger, have them do as much of the experiment as possible.

Take pictures of the experiment set-up. For example, if growing crystals, one will want to take a picture of the setup in the beginning and then at varying times to capture the growth of the crystal. The pictures will enhance the display. Make sure to capture the experiment only and not the student in order to preserve anonymity.

Step 5 – Data Collection
Perform the experiment and record any results in the data table in the journal.

Step 6 – PowerPoint
Use PowerPoint to type up all the information. PowerPoint is more flexible and easier to use than Word. Use one or more slides per topic and make the font as large as possible. For example, the materials list should fit on one slide with a font of no less than 48. Use WordArt to create the headers: Research, Materials, Experiment, Data, Conclusion and the title. The students enjoy playing with WordArt and manipulating the colors.

Step 7 – Display
Print out the PowerPoint slides and glue each slide to a piece of construction paper. Use varying colors of construction paper to provide a nice and colorful background. Glue to display in a logical format.

Step 8 - Report

The report is usually a one-page summary of the information in the journal.

Data

All students who worked with a Fellow performed an experiment. Three students in 2008 and three in 2009 performed a variation of the radiation experiment using the Geiger counter. At least one girl per year grew crystals and one boy per year did the "football" experiment.[4] The solar panel and windmill experiments were performed by at least one student each per year. Other experiments involved determining which brand of bubble gum created the largest bubbles, wrapping wire around nails to create magnets, measuring electricity in fruit, using a Tesla machine to light various types of lightbulbs, pop rocks, measuring the pressure on water as a function of height and more. All experiments involved active hands-on learning and an opportunity for the university Fellow to bond with the student.

The data consists of the EOG Development Scale Scores and the EOG Achievement Levels for the students. A comparison of their average performance at the end of the third grade, prior to working with Fellows on science fair projects, to their average performance at the end of the fourth grade, after working with Fellows is presented in the tables below. Data for each grade level as a whole is also provided as a comparison.

Not all the students' data is being used due to insufficient test score data from years prior to the fourth grade. Since we only worked with two students in 2006, their data will not be presented. The sample sizes for the past three years consist of 20 female students and 14 male students for a total of 34 students. The ethnic breakdown of the sample size consists of 21 African American, 10 Hispanic and 3 Caucasian students as shown in Table 1.

Table 1: RAMP-UP assisted students each year.

	Total	Female	Male	African-American	Hispanic	Caucasian
Science Fair 2007	11	7	4	5	3	3
Science Fair 2008	12	7	5	9	3	0
Science Fair 2009	11	6	5	7	4	0
Total	34	20	14	21	10	3

The breakdown of the sample size by gender and ethnicity is shown in Figure 1. The sample size consists of 12 African American, 5 Hispanic and 3 Caucasian female students and 9 African American and 5 Hispanic male students

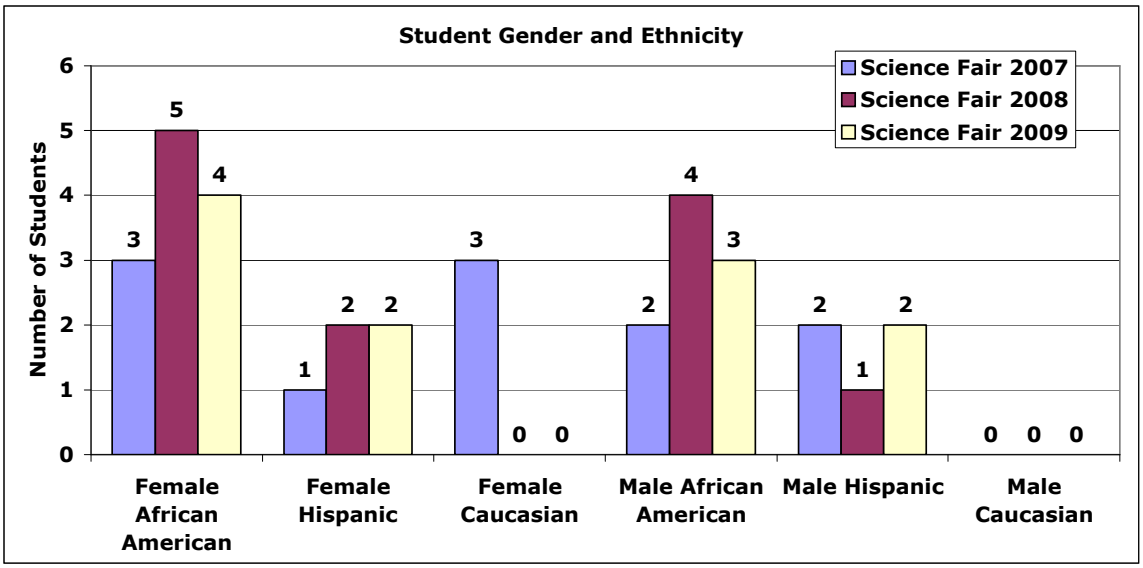


Figure 1: Breakdown of sample sizes by gender and ethnicity

Table 2 contains the average EOG development scale scores. The first two columns contain the average scores for the students assisted by Fellows. The first column is the average of their performance at the end of the third grade, prior to participating in the science fair. The second column is the average of their performance at the end of the fourth grade, after participating in the science fair. The third column is the percent change between the two years. The fourth and fifth column contain the average EOG development scale scores for the entire grade at the end of the third and fourth grades respectively. The final column is the percent change between the two years for the entire grade.

Table 2: Comparison of average development scale score between RAMP-UP assisted students and their peers

	Average of program assisted students	Average of program assisted students	% change	Average of Grade	Average of Grade	% change
	3rd Grade Dev. Scale Score	4th Grade Dev. Scale Score		3rd Grade Dev. Scale Score	4th Grade Dev. Scale Score	
Science Fair 2007	338	348	2.96	352	359	1.99
Science Fair 2008	340	345	1.47	348	355	2.01
Science Fair 2009	341	343	0.59	350	355	1.43

All students in the 2007 assisted group improved their score from third to fourth grade except for one who had a decline of two points. All students in the 2008 assisted group

improved their score with the exception of two students who dropped two points and one who remained the same. In the 2009 assisted group, one student dropped by six points, another by three and a third remained the same. The remaining eight improved.

Listed in Table 3 are the average EOG achievement levels. The first two columns contain the average levels for the students assisted by Fellows. The first column is the average of their performance at the end of the third grade, prior to participating in the science fair. The second column is the average of their performance at the end of the fourth grade, after participating in the science fair. The third column is the percent change between the two years for the assisted students only. The fourth and fifth column contain the average EOG achievement level for the entire grade at the end of the third and fourth grades respectively. The final column is the percent change between the two years for the entire grade.

Table 3: Comparison of average achievement levels between RAMP-UP assisted students and their peers

	Average of program assisted students	Average of program assisted students	% change	Average of Grade	Average of Grade	% change
	3rd Grade Ach. Level	4th Grade Ach. Level		3rdGrade Ach. Level	4th Grade Ach. Level	
Science Fair 2007	2.45	2.73	11.43	3.34	3.46	3.59
Science Fair 2008	2.67	2.5	-6.37	3.05	3.13	2.62
Science Fair 2009	2.64	2.45	-7.20	3.28	3.31	0.91

In the 2007 assisted group, three students improved from level 2 to 3, one student from level 3 to 4 and one student regressed from 3 to 2 for a net gain of three students improving by one level while the rest remained at the same level. This resulted in a 11.43% improvement as compared to a 3.59% improvement for the entire grade. However, the 2008 and 2009 assisted groups experienced negative changes of 6.37% and 7.20% respectively as compared to positive changes of 2.62% and 0.91% for the entire grade respectively. In the 2008 group only one student improved from level 2 to 3 while two students regressed from 3 to 2 and one student from 2 to 1 while the rest remained at the same level. In the 2009 group one student dropped from level 4 to 3 and one dropped from 3 to 2 while the rest remained at the same level.

Conclusions

If we look at the 2007 assisted science fair group and note the 2.96% improvement in development scale score and the 11.43% improvement in the achievement level as compared to their peers 1.99% and 3.59% respectively, one might be able to conclude that active learning with assistance from university Fellows has a positive impact. However, looking at the 2008 and 2009 changes where the assisted science fair groups

did not perform as well as their peers and even regressed in achievement level, one cannot be so optimistic. Further research must be done in order to be able to statistically conclude a positive or negative impact. One suggestion is to use the EOG reading scores as a baseline. It is possible that the low performance is a consequence of a reading disadvantage since some of the students' first language is not English. Another option is to compare the assisted science fair groups with a smaller sample size of the entire grade. This might provide a more equal comparison and constructive result. Future research may also include a comparison of their 5th grade EOG scores to see if there is any long-term impact.

The 2007 numbers are reassuring. There are many variables that could contribute to the success in 2007 and EOG scores may not be the best way to measure the effectiveness of RAMP-UP Fellows working with fourth graders on science fair projects. The use of Blue Diamond test scores that are given on a quarterly basis would provide more concrete results. A pre- and post-test given solely to the fourth grade students receiving assistance would be a better measure of growth and the effectiveness of the undergraduate – student pairing.

References and Footnotes

[1] Eccles, J. S. (1989). Bringing young women to math and science. In M. Crawford & M. Gentry (Eds.), *Gender and thought: Psychological perspectives* (pp. 36-58). New York: Springer-Verlag.

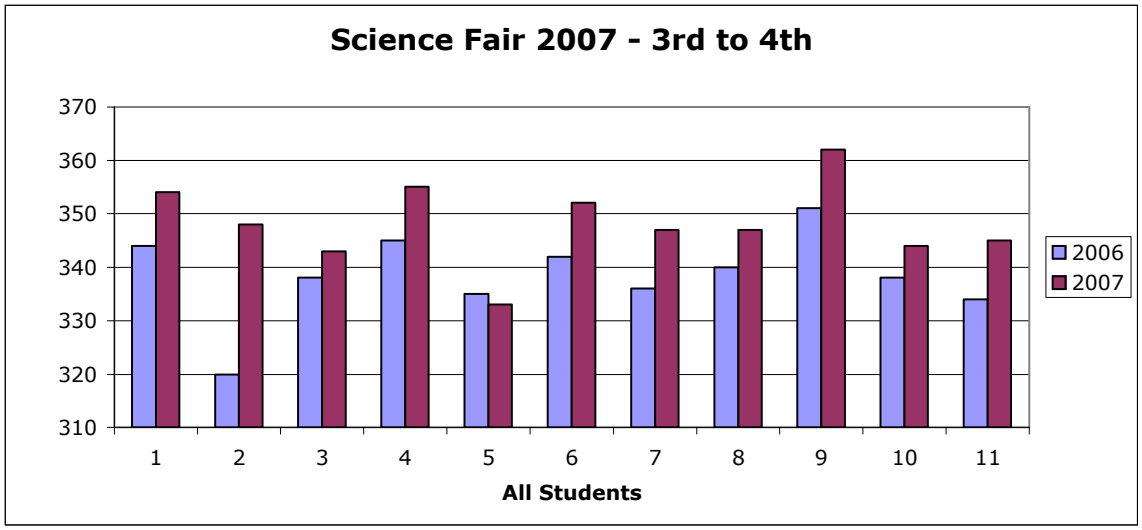
[2] Neill, J. (2005). *John Dewey: Philosophy of Education.* Retrieved Jan. 5, 2010, from Outdoor Education Research & Evaluation Center, New Hampshire. Web site: http://wilderdom.com/experiential/JohnDeweyPhilosophyEducation.html.

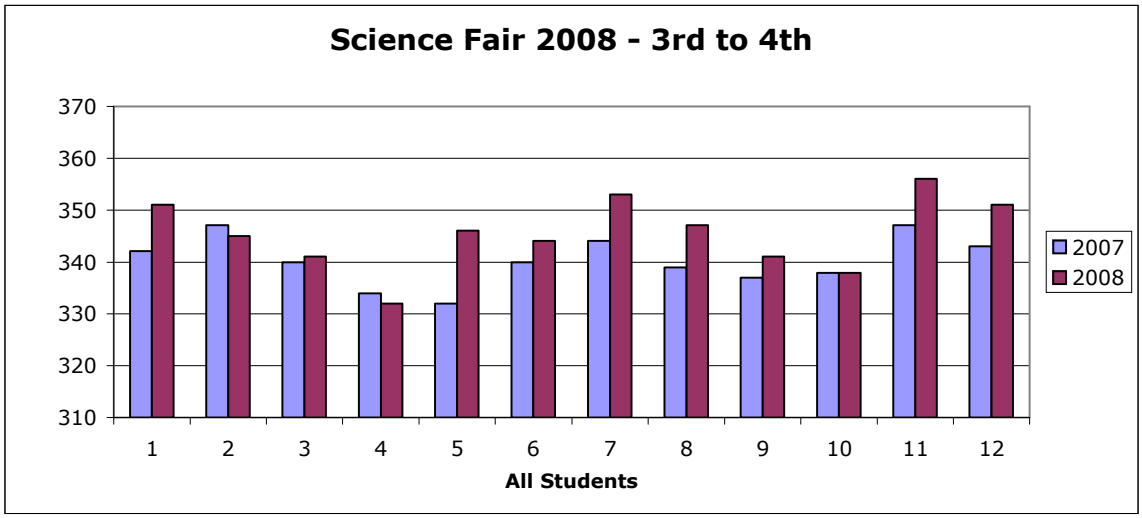
[3] Idea extended from activity in Engineering is Elementary workbook, "Catching the Wind." Cunningham, C. M. (2010). *Engineering Is Elementary.* Retrieved Jan. 5, 2010, from Engineering is Elementary, Boston, MA. Web site: http://www.mos.org/eie/index.php.

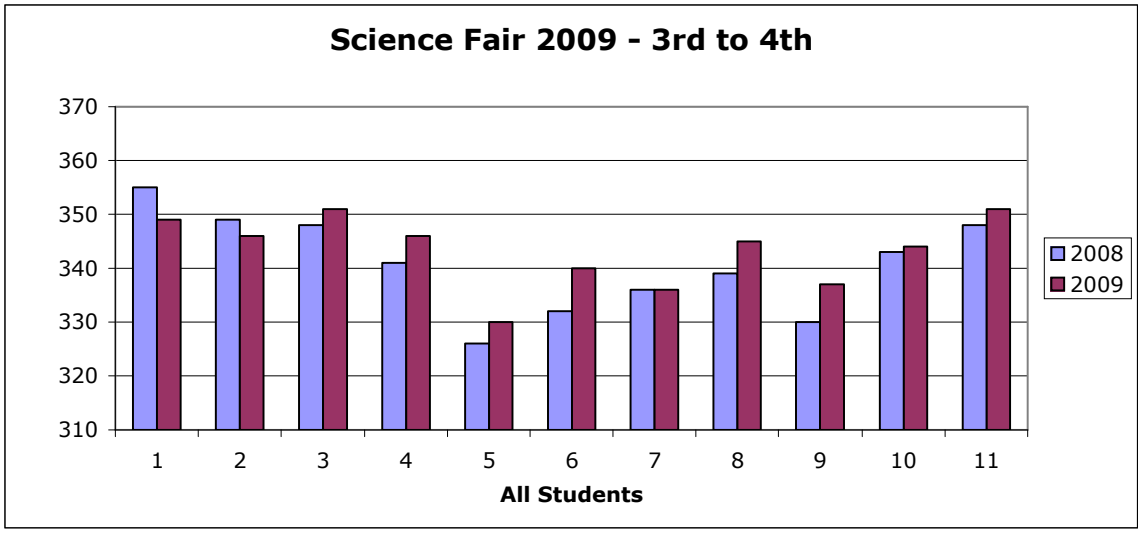
[4] The Geiger counter, football, solar panel experiments are original program ideas.

Appendix

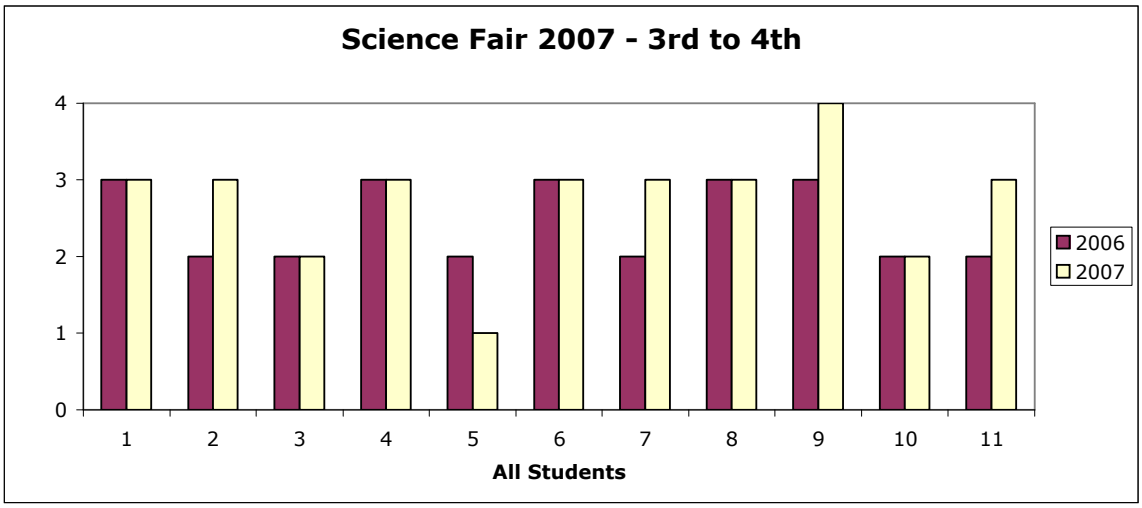
Development Scale Score of RAMP-UP Assisted Students arranged by the year of the science fair they participated in.

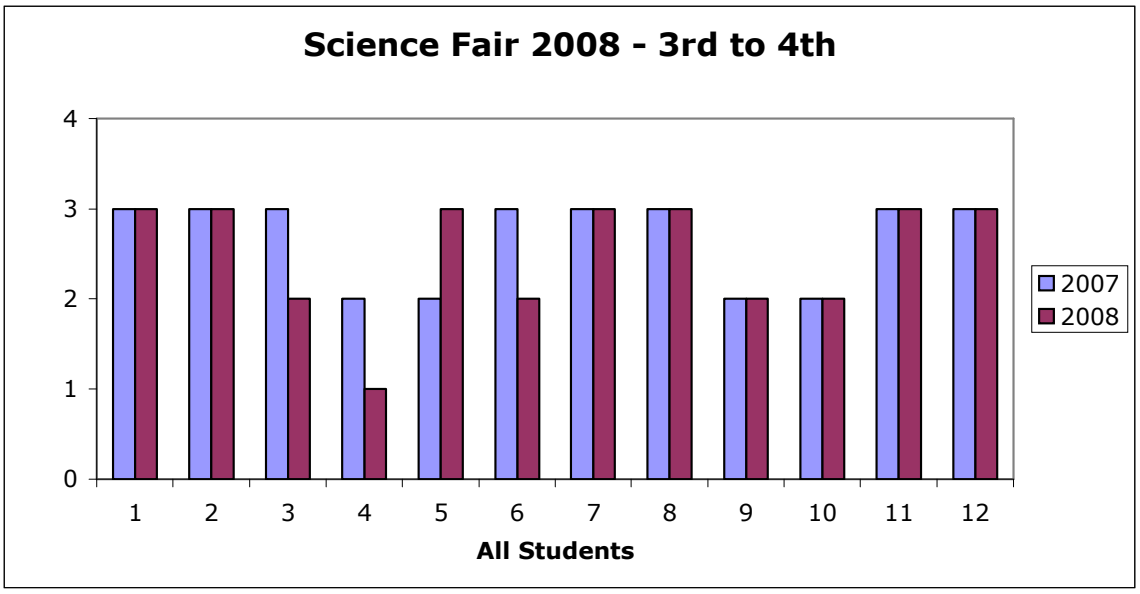






Achievement Level of Assisted Students arranged by the year of the science fair they participated in.




Science Fair 2008 - 3rd to 4th
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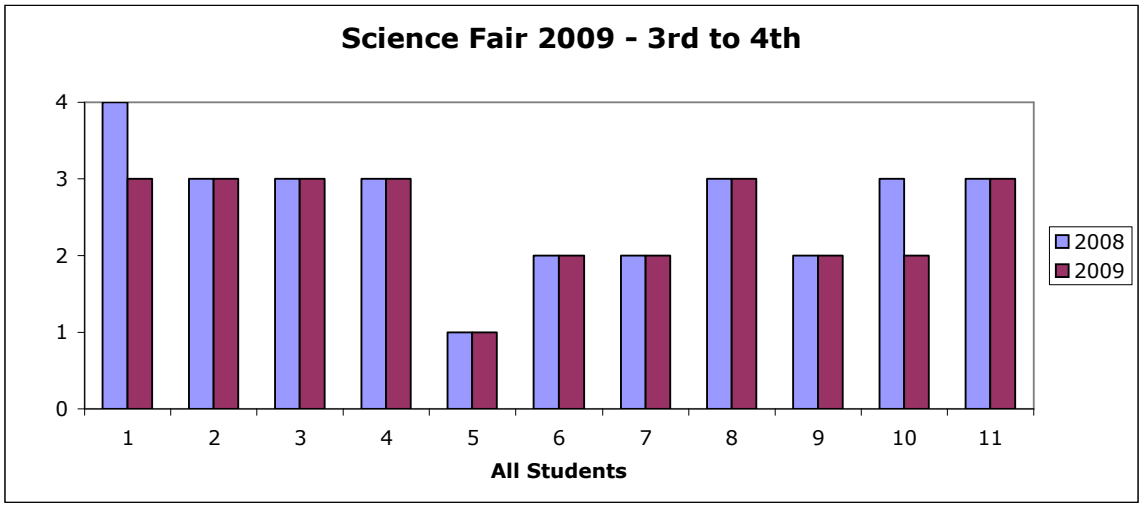
All Students
2007
2008


Science Fair 2009 - 3rd to 4th
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All Students
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2009