FieldREG Applications in a Classroom

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Description

As part of an ongoing investigation of random event generator (REG) anomalies, a proposal was made to use a middle school classroom as a venue for a FieldREG experiment. A FieldREG unit based on the HP Palmtop computer with a MicroREG random event generator was used to gather the data. The hypothesis of the experiment was that accurate predictions of deviations in the REG device could be made, based on the method of instruction and the observed engagement of the students.

Tolland Middle School in Tolland, Connecticut, was selected as the site of the experiment. Tolland Middle School is located in Eastern Connecticut. It is a suburban school with a student population of 840 in grades 5 to 8. Demographically, Tolland is mostly middle to upper middle class with a minority population of less than 1 percent. The FieldREG was set up in a seventh grade science classroom. Eight class periods per day were monitored. The eight class periods consisted of five science classes (periods 1,2,3,6 and 8), a teacher meeting (period 4), a skills for adolescence class (period 5), and a studies and reading skills class (period 7). The beginning and end of each period was indexed, and this information was used to extract the corresponding data, usually resulting in eight data segments per day. There were some exceptions as a result of half days and late openings. Data were taken over 37 days, beginning on January 4, 1999. The number of data segments per period ranges from 32 to 37, with a total of 284 segments across all days and periods.

All of the activities during the science class were recorded in a journal, noting the type of instruction, i.e. hands-on, group work, lecture, or multimedia. The other class periods were listed in the journal, but without any detail as to the type of instruction. Academic success over the course of the experiment was also recorded.

Results

Table 1 shows the composite Chisquare for the eight periods. There are two periods, four and five, which show a relatively strong positive deviation from expectation; and one, period seven, which has a highly significant deviation in the opposite direction, with a probability of a few parts in 1000. As independent test periods, the significance of any single period must be adjusted by a Bonferroni factor of eight. To estimate the significance of an unusually small Chisquare, such as that in period seven, the adjustment should be multiplied by a further factor of two, recognizing the acceptance of a two-tailed probability in the one-tailed context natural to the Chisquare test. This would result in an adjusted probability of 0.064. The grand composite across all days and periods is not significant. The database includes one segment showing an extraordinary large deviation, with Z = 4.8038. The associated Bonferroni-corrected probability for such a large deviation selected from the full database of 284 segments, and also corrected for a one-tailed assessment, is 0.00044.

Table 1: Composite Chisquares for Eight Periods

Period	Activity	Chisquare	DF	Probability
1	Science, Dave	37.282	35	0.365
2	Science, Dave	29.805	36	0.757
3	Science, Dave	29.445	37	0.807
4	Teacher Meeting	45.168	37	0.168
5	Empty & Skills	52.481	37	0.047
6	Science, Dave	28.523	36	0.808
7	Strategies, Other	16.057	34	0.996
8	Science, Dave	22.834	32	0.883
All		261.595	284	0.826

The primary hypothesis that there would be a correlation between engaging activities in the classroom and unusual deviation in the REG remains unproven. Prior to analysis, a subset of days, which seemed most likely to yield engagement, was selected.

This subset of days included multimedia Internet lessons, rocket building lessons and experiments to replicate the exploration of the nucleus of an atom. All of the subset days were chosen because of a high degree of engagement as observed by the teacher. This subset of days is presented in Table 2.

Table 2: Chisquares for Selected Days, Science Class

Period =	Activity	Chisquare	DF	Probability
1	Science, Dave	13.465	9	0.143
2	Science, Dave	10.032	10	0.438
3	Science, Dave	10.721	10	0.380
6	Science, Dave	7.957	12	0.789
8	Science, Dave	9.356	10	0.499
All		51.531	51	0.453

Although the REG was unable to capture the *Resonance* in the classroom, there are other indicators that demonstrate that the method of instruction used in the classroom resulted in very positive outcomes. Before looking at the methods and outcomes, it is important to define the role of the Middle School (6^{th} – 8^{th}) Science Teacher. The obvious role is to assist the student in developing such skills as observing, inferring, and experimenting. There are national, state, and local standards, that outline what students in particular grades should be taught. The other, perhaps more important, role of the middle school science teacher is to create an environment that fosters enthusiasm and a genuine interest in science.

In order to generate excitement about science, the teacher's own enthusiasm must be evident to the students. The teacher must model the high interest he or she hopes to cultivate in the class. A teacher's genuine excitement is contagious. It must be genuine because middle school students are not easily fooled. When students see that their teacher is sincerely enthusiastic about science as an avenue to adventure, their own enthusiasm grows.

Equally important in the middle school classroom is the teacher's ability to make the lessons fun. Lesson delivery can vary widely. The teacher whose methods engage the students while allowing them to have fun at the same time will meet with the most success. That success should be measured not only by the raw score students achieve, but also by the students' approach to science. Are they more actively engaged in debates about important science-related issues? Are they more likely to pursue after school and out of school activities relating to science? Affirmative responses to these questions lead one to conclude that the methods of instruction employed during this research did in fact yield very positive outcomes. Notable among them is student awareness that science can be a pleasurable pursuit as well as a professional one.

Methods of Instruction

The forty days of instruction that were correlated to the FIELDREG experiment were indicative of the type of lessons used all year. There was no significant change in the make-up of the classes, nor were there any special events or lessons to signify the start or conclusion of the research with the REG. The students were informed of the research and were aware of the recording with the REG and of the note taking.

The 7th grade science curriculum is integrated to include life science, earth and space science, physical science, science and technology, and the history and nature of science. Although there is a textbook, it was rarely used. The majority of the lessons were hands-on labs. Students enjoy *doing* science more than hearing about it, so whenever possible a hands-on approach was used.

Even an introduction to safety procedures and lab equipment can be a hands-on lab. For example, when the objective was for the student to demonstrate the proper way to hold a test tube, the test tubes, test tube racks, test tube holders, alcohol lamps, beakers with colored liquid, goggles and an "unknown substance" were distributed. The students were not informed that the liquid was colored water or the unknown substance was sand. After a demonstration by the teacher, the students put on the goggles, measured a small amount of liquid to pour into the test tube, racked the test tube, and lit the lamp. The students then held the test tube over the flame until the liquid boiled. They then returned the test tube to the rack. During that time the teacher corrected for safe lab practices.

Because they did not know they were merely boiling water, the students were very engaged. In fact, they consciously recorded their observations of everything that occurred.

The next part of the lab required that they put a few grains of the unknown substance into a test tube, again adding some of the colored liquid and repeating the process. However, this time because of the sand, there was some popping when heated and a little bit of liquid splashed out of the test tube. The students took this very seriously, yet they were having fun at the same time. The teacher was able to observe the reaction of students when a spill occurred, without having to worry about any chemical injuries. At the conclusion of the lesson, the class tried to identify the substances used based on the characteristics when heated. The teacher reviewed the proper way to hold the test tube and pointed out any discrepancies that occurred during the lab. The students observably gained valuable experience in using lab equipment safely. They enjoyed themselves immensely, being more engaged by the hands-on method than they would have been more than working with a ditto or a textbook.

Another important component of these lessons was that the students felt comfortable asking questions and taking positions. Too many times the student is intimidated by the subject matter and the teacher complicates that by always knowing the answer. This can become a major obstacle to truly engaging the student. In order to overcome this obstacle, on the first day of school the students received a sheet of paper with a variety of animal tracks that seemed to indicate at least some interaction between a few of the animals. There were also some lines that might indicate some sort of boundaries. The assignment was for the students to form groups of four and to interpret the data. After about fifteen minutes of group discussion, one individual from each group presented the groups' interpretation of what they observed on the paper. There were a variety of interpretations of what had occurred, and each group had some valid explanations. Of course, some were more logical than others. As a whole, the class discussed the validity of the various interpretations. Then as often happens, they looked to the teacher for the answer. However, the point of this lesson was to show that there may be different interpretations of the same data. The teacher's interpretation of what occurred was no more valid than the students'. The teacher could not answer questions

such as what a particular animal was doing at a specific time with any more degree of certainty than the students could. A follow-up lesson on tobacco research showed that scientists come to different conclusions even when using the same data. By beginning the year with this lesson, the students become more comfortable with risk taking and are less intimidated about the not having the "correct" answer.

Using the most appropriate medium to deliver instruction is critical for effectively engaging the student. A lesson on the parts and function of the human eye illustrates this point. The teacher could draw a picture on the blackboard and label the various parts of the eye. Another method would be to distribute a ditto sheet and have the students color code various parts. An overhead projector could be used to show a better picture of the eye to the students, and perhaps students can fill in the blanks or do some sort of exercise where they match part and function. All of these have been common practice in the past, but with current technology, teachers have the ability to do more. Moreover, the students have been brought up on very sophisticated video games and are often more adept at processing rapidly moving objects than they are at processing something off a chalkboard. Multimedia presentations have the ability to capitalize on the students' experience as well as capture the student's attention.

Students involved in this research learned about the parts and function of the eye in a variety of ways. In addition to the aforementioned strategies, the students were also exposed to a number of Internet sites allowing for an interactive lesson. Through the use of a multimedia projector and a single computer, students experienced virtual tours of the human eye; they studied pictures of an actual human eye through visits to medical school sites. A variety of lessons on perception used the Internet to demonstrate illusions that would be impossible to recreate in the classroom. Multimedia presentations, however, cannot replace hands-on experience; therefore the lessons culminated in the dissection of cow eyes donated by local butcher shops. The presentation primed the students for a lab that they found exciting and therefore effective.

Hyping the lessons also served to increase the engagement and the excitement of the students. The lessons would be hyped in much the same way that a soon to be released movie would be. The students would be given little snippets about the upcoming lesson and would naturally inquire about the lesson, only to be told they would

have to wait. Soon another piece of the lesson might be exposed. They would see the teacher setting things up days in advance or they might see a strange array of items suddenly appearing in the classroom. Their anticipation could sometimes take on the proportion of that of a child waiting for a holiday. Students would ask "When are we going to do...." or "When are we going to see....". Having students eagerly anticipating a lesson is every teacher's dream. The hyping of lessons has certainly enhanced the experience of the student and helped to create an exciting and enthusiastic environment.

Extending the excitement beyond the classroom has also helped to alter the students' approach to science. An example is a unit on rockets. A NASA curriculum was modified to meet the needs of the students. The project required that the students design a rocket using a 2-liter soda bottle, taking into consideration center of mass and center of gravity. They purchased materials from the teacher using a mock monetary system. Design and construction of the water-propelled rockets lasted about a week. As launch day approached, work on the rockets intensified. All 105 students were brought outside for launch day. Two launchers were set up in a field in front of the school. As the students launched their rockets, many faces of students in other classes could be seen pressed to the windows. Students inside the building and out watched some rockets reach altitudes of close to 200 feet. Afterward, students in the other classes made many inquiries about the rocket project. This not only served to make the students involved feel somewhat special, but it also began the hyping process for future students.

Positive Outcomes

Although the analysis of the FIELDREG data proved inconclusive, there are other indicators that demonstrate very positive outcomes. The indicators are not based on academic performance, although academic performance was analyzed along with the REG data. All of the students, for example were promoted to the next grade. Four to six percent of those promoted were performing marginally. The other indicators considered were the number of students signing up for science club, the number of students volunteering to participate in extra curricular science projects, and parent feedback.

The first of these indicators is the enrollment in the science club. During the time that the REG research was being conducted there were 15 students in the science club.

The club meets for an hour every other week. During this time, the club advisor initiated an approach like that used in the science class. The approach included hyping the lessons and making them fun. Remarks made by students not in the club underwent a transformation. Initial comments included the advice "Give it up" and that the club was for "geeks" and "nerds." By the end of the year, however, students were asking the advisor about the club and how to join. At the beginning of the succeeding school year, a notice went out for science club sign ups. The first meeting of the science club had to be held in the auditorium. There were 55 students in attendance. The club has had to be divided into two sections. Another thing that should be noted is that 26 of the attendees were female. This is significant because of the numerous studies showing that females are less inclined to become involved in science and math than their male counterparts. These are certainly indicators that there is increased engagement in and enthusiasm for science. One can also argue convincingly that this increased engagement and excitement can be attributed to the method of instruction and the ability to make students feel less intimidated amid an atmosphere of fun.

The second indicator demonstrating positive outcomes is the number of students willing to participate in other extra curricular science activities. A program was offered this year to the same group of students who participated in the REG research. The program is completely voluntary. Students were asked to write papers for submission outlining how they would use science and technology to solve problems facing us in the next century. Fifty students volunteered to participate. All the work is to be done outside of the classroom. The fact that almost one half of the students who participated in the research volunteered to do extra work in the area of science is indicative of their approach to science. They are more at ease debating important issues relating to science, and they show none of the intimidation normally associated with the rigors of scientific inquiry. Discussion of science issues carries over into other content areas. When students are asked to relate to literary topics, for example, the frequently refer to lessons learned in science class.

The final indicator that the methods of instruction were successful is the amount of positive feedback received from the parents. Parents frequently mention that their

child discusses science class with them. In these discussions it is not unusual for a parent to state that their child is really enjoying science.

If the student enjoys science is it not fair to conclude that there is a greater likelihood that the student will pursue science in the future? Whether or not this constitutes *Resonance* is open for debate, but to regard these other indicators as insignificant would be remiss.

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