

TECHNOLOGY-SUPPORTED MATHEMATICS ENVIRONMENTS

Telecollaboration in a secondary statistics classroom

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Introduction

The Internet, an exciting and radically different medium infiltrating pop culture, business, and education, is also a powerful educational tool with teaching and learning potential for mathematics. Web-based instructional tools allow students and teachers to actively and interactively participate in the learning process (Lynch, Moyer, Frye & Suh, 2002). The ways teachers use these tools can have a profound effect on the teaching and learning of mathematics.

One way web-based instructional tools can be used in teaching and learning mathematics is through telecollaboration. Harris (1998) defines three categories of "telecollaboration" activities: interpersonal exchange, information collection and analysis, and problem solving. Under these three categories are 18 activity structures that can be used to classify and describe the types of web-based learning projects and activities currently used in education. These structures range from "keypals," which enables students to collaborate on a specific curriculum-based task via email to "parallel problem-solving," which lets students solve problems together and share their solutions and problem-solving processes. Each structure allows students and teachers to use various forms of technology to communicate and collaborate around a common goal.

Telecollaboration has the potential to create authentic contexts and problem-solving environments for students, ultimately providing students with opportunities to apply their mathematics skills in a real-world context outside of the classroom. This article describes how one teacher used a telecollaboration project in his high school statistics course. It demonstrates how effective technology use can enhance students' learning of challenging mathematics content.

Choosing a telecollaboration project

An abundant supply of telecollaboration projects currently exist. Some projects are conducted synchronously on a fixed timeline while others take place asynchronously with ongoing timelines. Announcements of new and ongoing projects appear on listservs and in newsletters on a regular basis. The authors learned about the project chosen in this article through the HILITES listserv (gsn-hilites-list@topica.com) distributed by Global Schoolnet's Global Schoolhouse Organization (<http://www.gsn.org/lists/hilites.html>).

Choosing an appropriate telecollaboration project is important. Teachers should search for a project on the topic they wish to explore

and then review all of the information provided before deciding to participate. In addition to curriculum connections, teachers need to consider many other elements including timelines, interaction requirements, availability of technology and technical support at their schools, required supplies and materials, and school or district restrictions related to student access to email or the Internet. Teachers may want to consider choosing a simple project or participating with another teacher in the building for their first telecollaboration experiences.

The target in this case was a high school statistics course, so the project search was fairly narrow. The authors wanted to find a synchronous project that would take place near the beginning of the spring semester of the school year to coincide with the beginning of the statistics course for the semester. An information collection and analysis telecollaboration project called Fruit Loops to the Max: Online Project Spring 2003 was selected (www.technospud.com/projects/frootloops/frootloops.htm). This project was directed by Jennifer Wagner of Technospud.com (<http://www.technospud.com>). The timeline was a perfect match, and the content fitted very well with the plans for the course. Two high school statistics classes registered for the project.

The Fruit Loops telecollaboration project attracted over 300 participating classes from five countries. This amounted to hundreds of thousands of Fruit Loops counted and reported which resulted in an extensive database of information. Classroom activities for use with many different grade levels were shared through the project website. Data collection worksheets were available for different levels of classes including data comparison tables.

The project website provided instructions for collecting and analysing the Fruit Loop data. After a participating class collected data, data were submitted to the project director through a form on the project website. Cumulative data were presented on the project website each week in graphical and downloadable spreadsheet formats. The project director posted an initial hypothesis that the greatest colour frequency would be orange, so data were tabulated each week to show support or negation of that hypothesis.

The setting

One of the high schools that participated in this project was in a suburb and had a student population of approximately 1200. Seventy-five percent of the student population of the school attends a two- or four-year college upon graduation. The school operated on a four-period per day schedule with classes lasting one semester. The teacher, whose statistics class is described here, established an atmosphere in the classroom that allowed students the opportunity to construct the meanings of statistical concepts through the investigation of data-driven activities. During the project, students demonstrated that they felt comfortable working in small groups, asking questions, offering solutions, and discussing different perspectives, and that they were excited about the opportunity to utilise data from classrooms around the world.

Curriculum connections

There were four major themes studied in the Advanced Placement Statistics course during this project: exploring data, planning a study, anticipating patterns, and statistical inference. The Fruit Loops project became the common thread that united the course themes throughout the semester. Data collected from individual groups within the class, the class as a whole, and the telecollaboration project participants provided opportunities for analysis and discussion of the concepts.

The Planning a Study unit required students to design a study to collect data about the colour distributions in Fruit Loops cereal boxes. Students were told that the Fruit Loops data would be collected by classes ranging in grade levels kindergarten to high school, and that there were two kinds of Fruit Loops, regular and a new “melonberry” boxes containing pink Fruit Loops instead of red. This activity required students to think through the design process, paying special attention to the age range of participants so that all participants could carry out data collection with minimal teacher assistance. The website provided information on data that were also being collected by classrooms across the country.

Small groups of students discussed the steps they would use to gather the data and the possible data collection errors, and then presented their data collection processes to the class. As each group presented its procedures, the teacher and fellow students asked questions and provided feedback. This provided the opportunity for students to communicate key characteristics of a well-designed and well-conducted study. After discussing the groups' suggestions for data collection, students were shown the procedures required by the telecollaboration project as listed on the website.

During the Exploring Data unit of the course, students took on the task of counting the colours of Fruit Loops in several boxes of cereal. Before counting the Fruit Loops, students hypothesised about colour frequency. They then counted the Fruit Loops and recorded their data. Several students commented that the totals from the statistics classes might have distorted the overall project totals because of the use of the "melonberry" Fruit Loops. The class discussed this concern and what they would do differently as the project director. The teacher informed the students that once the final project data was posted on the project website, they would be able to determine how their class data affected the overall telecollaboration project data. The teacher also hinted that future discussions of the data would shed light on the situation, especially during the Anticipating Patterns and Statistical Inference units.

Once all data was collected and recorded, the students were assigned a Fruit Loop colour to analyse the data graphically and numerically. Students created various graphs — box-and-whisker plots, circle graphs, stem-and-leaf plots, and bar graphs — and discussed the key features of each graph including shape, centre, spread, and deviation. They also conducted numerical analyses encompassing the five-number summary (minimum, first quartile, median, third quartile, and maximum), central tendency (mean, median), spread (range, interquartile range, standard deviation) and position (quartiles, percentiles). colour distributions within the classroom were then compared to the data collected by all of the classrooms in the telecollaboration project. Students used the

information in the online environment to examine the similarities and differences in the graphical displays and numerical analyses of the various data sets, comparing their own data with data collected from the other school sites.

As part of the Anticipating Patterns unit, students used the Fruit Loop data to explore probability as relative frequency, the law of large numbers concept, simulation of binomial and geometric probability distributions, expected value of a random variable, and sampling. They were able to use their group data, class data, and the telecollaboration project data in experiments to investigate the probability concepts in a variety of settings. This helped students establish patterns that clarified their understandings of key concepts. One student commented, "The Fruit Loop data truly helped me understand the law of large numbers concept." Another student stated that she understood why probability involved looking at data patterns in the long term as a result of examining the class data and the data available online through the project website.

The use of group, class, school, and telecollaboration project data provided ample opportunities for students to develop statistical inference concepts. Their study included the examination of the following concepts: large-sample confidence intervals for a proportion, large-sample confidence intervals for a difference between two proportions, large-sample tests for a proportion, large-sample tests for a difference between two proportions, Chi-square tests for goodness of fit, and Chi-square tests for homogeneity of proportions. They were able to set up and perform each statistical test several times with the various data sets available from the online telecollaboration website. Without this large data set, many of these statistical comparisons would have been impossible to generate in just one classroom. A comparison of results when calculating the various confidence intervals and test of significance helped clarify concepts in the Anticipating Patterns unit.

Learning outcomes

The initial decision to collaborate with the Fruit Loops project involved three main goals:

1. Provide an authentic setting that could be used throughout the statistics course;
2. Provide “real data” to be used during the presentation and development of concepts; and
3. Provide opportunities for students to handle large amounts of data with the use of a variety of technology tools.

The teacher’s first goal was achieved because many of the concepts taught were presented through an activity related to the telecollaboration project. To assess the second and third goal, the teacher developed a final project and a written assessment entitled A Bowl Full of Fruit Loops. Students worked on this project during class individually and in small groups. They were required to use the data from the telecollaboration project to develop one investigative task for each of the four course themes and one investigative task that integrated at least two of the themes. The investigative tasks required that students model the AP Statistics investigative task questions.

Data were first downloaded from the project website into a spreadsheet and then into an interactive software program that was used to transfer the data into a graphing calculator format. This allowed the students to receive the data in three formats: paper copy, spreadsheet file, and graphing calculator format. One student summarised this experience when she said, “It enriched my understanding of statistics in a new way because we were formulating questions, not just answering them.”

The A Bowl Full of Fruit Loops final project provided the opportunity for the teacher to assess the students’ understanding of several statistical concepts. One question asked students to explain the type of variables used in the telecollaboration project and identify appropriate graphical displays that could be used to analyse the data. Another question required students to use the population colour distribution to determine which colours appeared to have equal distributions and provide evidence to support their claim. The true value of the telecollaboration project was

revealed in many of the students’ responses to the third question, which asked them to briefly explain how the project enriched/deepened their understanding of statistics. Several quotes from students describe the benefits of working with a telecollaboration project like this one:

...[this project] enriched my understanding of statistics by the numerous ways that the quantitative and categorical variables can be analyzed and compared. (Chris)

...it helped reinforce old concepts, about the planning of a study. (Drew)

It gave me practice on the different kinds of statistical tests and when to use which test. (Jenna)

[The project] deepened my understanding of the real-world application of stats. (Becky)

I think I learned more about statistics while doing the Fruit Loop project than I did all semester. The project made me think about how to ask questions and answer them.... Not only did I have to plan a study, I had to think of the topic in which to plan a study on. (Heather)

Recommendations

The authors highly recommend the incorporation of telecollaboration activities into the mathematics teaching and learning process. Telecollaboration projects, such as this one, can enhance a classroom unit of study and further motivate students. Real world data in large quantities from sites all over the country make students feel that they are part of the data collection process as well as the analysis of those data. Projects, such as this one, are readily available on the internet. Participation in the project typically requires little additional work on the part of the teacher. For example, the teacher in this project purchased two boxes of Fruit Loops for each of the two classes registered for the telecollaboration project and registered the class for participation. This represented a minimal amount of time and supply cost for the project.

As suggested previously, teachers can investigate telecollaboration options related to their curricula and find appropriate projects. In this case, the Fruit Loops project was a good fit for the existing class requirements of the statistics course and was held at a time that the class was studying the topic. This allowed the teacher and students to use the data from participating in the project throughout the semester. It also allowed the teacher to refer back to the project and use the data as other statistics topics were explored long after the telecollaboration was complete.

Some teachers also design and direct their own school-based projects based on topics they already teach in their classrooms. As teachers develop their own technology capabilities they are able to open the doors of their classrooms and share their project ideas with others. These telecollaboration experiences provide an avenue for sharing instructional practices with colleagues and the chance for students to take advantage of the collective knowledge and communication options that are possible when they interact using the internet as a learning tool.

References

- Global SchoolNet Foundation. *Hilites — The original online learning projects announcement list*. Retrieved 28 December 2002 from <http://www.gsh.org/lists/hilites.html>.
- Harris, J. (1998). *Virtual Architecture: Designing and Directing Curriculum-based Telecomputing*. Eugene, OR: International Society for Technology in Education.
- Lynch, M. C., Moyer, P. S., Frye, D. & Suh, J. (2002). Web-based learning: Using telecollaboration models to enhance mathematics instruction. In *Proceedings of the International Conference on The Humanistic Renaissance in Mathematics Education, September 2002*. Palermo, Sicily: The Mathematics into the 21st Century Project.

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Martin Gardner's Mathematical Games

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What a blast! The second recreational mathematics book I ever purchased when beginning my mathematics teaching career was Martin Gardner's *Scientific American First Book of Mathematical Recreations*. After that, I was hooked, and subscribed to *Scientific American* to find out what this remarkable man would write about next. One feature of the columns was a regular set of problems and posers. Of course, in the sixties, I had to wait months for the issue with the solutions and comments, but the wait was worthwhile. The magazine ceased to be interesting when his column stopped, and over the years, I ended up with a collection of his books. It was great to meet up with old friends again.

My classes made flexagons, and were given the latest problems from his column. The material kept on coming, and it is a tribute to Martin Gardner that the Mathematical Association of America decided to produce this CD with fifteen of his books on it.

Before you buy a copy for yourself, visit your optometrist and have your eyes checked out, because you will spend hours in front of the computer reading chapters and puzzling over the problems that pop up through the CD. This is perhaps a drawback as some people prefer the printed page. Still, schools do have printers.

You will learn how to balance eggs on the neck of a bottle, the various odd experiments carried out to see if eggs will break when dropped — in our kitchen the probability is 1 — meet Dr Matrix, discover interesting pieces of mathematical magic, be introduced to topology and other areas of mathematics, and be caught up in the whole business of enjoyment of the subject. The CD will expand your knowledge of mathematics, and that of your students.

Strangely, Martin Gardner always considered himself a journalist, and did not take any mathematics courses while at university. This