Students' Investigations with Physical Activity Data Devices

Victor R. Lee, Maneksha DuMont, Utah State University, 2830 Old Main Hill, Logan, UT 84322
Email: victor.lee@usu.edu, m.dumont@aggiemail.usu.edu

Abstract: Through a design experiment, we explored the potential for a suite of commercial physical activity monitoring devices to be used as data collection tools. Two pairs of high-school students were asked to engage in a week-long set of data investigations of physical activity that culminated in the design and implementation of their own mini-studies. This poster reports on those mini-studies, the challenges associated with the technologies used, and the supports that needed to be introduced.

Introduction

There has been a great deal of interest in the Learning Sciences around the potentials for portable technologies to support engagement in authentic disciplinary practices (e.g., Aleahmad & Slotta, 2002). These potentials arise because such technologies allow students to model phenomena, record observations, test hypotheses, and gather data. The latter potential is of particular interest for the current work. We are exploring the use of a portable athletic technology as a data collection device that can be used to support student engagement with data modeling practices (Lehrer & Romberg, 1996). Specifically, we are exploring the use of portable heart rate monitors and accelerometers students can use to collect data about their physical activities. We began this work under the assumptions that (1) personal relevance can make data about one's self intrinsically interesting for students and (2) prior knowledge about one's body and activities can bootstrap understandings students must develop in order to analyze and make sense of personalized data.

Operating under those assumptions, we conducted a first-iteration design experiment (Brown, 1992) in which a week-long, out-of-school learning experience was designed and implemented. Over the course of five two-hour sessions, two pairs of high school students (ages 14-16) conducted four inquiries into bodily activity, two of which were researcher-designed and two were student-designed. We had multiple goals in conducting this design experiment. First, we wanted simply to determine the feasibility of repurposing commercial athletic devices as data collection instruments for students. Second, we wished to ascertain what supports might be necessary in order to engage students in data analysis practices when working with physical activity data. Third, we hoped to make some initial determinations regarding the quality of investigations students would design, with guidance, after having been introduced to these technologies.

Technological Devices and Software

For this design experiment, we obtained a Garmin ForeRunner 50 device set for each student. The ForeRunner 50 is a multi-instrument set consisting of a sport watch that wirelessly communicates with a heart rate monitor chest-strap and a "Footpod®" accelerometer secured to one's shoe. The chest strap, worn underneath one's shirt, calculates heart rate in beats per minute based on the natural electrical activity of the circulatory system. The Footpod® approximates speed and distance measurements based on specific changes in acceleration due to foot impact. Every five seconds, a reading from both devices is automatically stored on the watch's memory, producing a hundred data points within five minutes. These records can be immediately uploaded onto a Mac or PC via an included wireless USB antenna. Once uploaded, the data are stored in specialized, easily accessed .xml files. We developed a script to extract the data from these files and append them with additional metadata such as who wore the device and what activity was being monitored.

As a data exploration and modeling tool, we chose the TinkerPlots software (version 1.1) (Konold & Miller, 2005) as it allowed for rapid importation of our enhanced data files. Although recommended for grades 4-8, our initial exploration of the software and review of other interventions that used TinkerPlots led us to conclude it was powerful enough for our sample of students to use for their data analysis purposes.

The Learning Experience

As stated above, the students participated for five two-hour sessions facilitated by a single researcher during the students' summer break. On the first day, the four students were introduced to the devices, shown how to collect data, and given a tour of the athletic facilities they would be provided access to throughout the intervention. On day two, they explored the TinkerPlots software, collected heart rate data of themselves as they were sitting at their computers, and under the researcher's guidance, devised and executed a plan to collect data enabling them to compare heart rates and distances when playing the basketball game "H.O.R.S.E". against repeatedly tossing a flying disc (e.g., a Frisbee®). On day three, the students explored the previous day's data and worked in pairs to design a physical activity investigation of their own choosing. The student-designed investigations compared distances and heart rates in different running environments (tracks and treadmills) and compared heart rates when using two cardiovascular machines that involve fluid, cyclical motions (elliptical trainers and stationary bicycles). Data for these two student-designed investigations were collected by all participants on the fourth day, and then examined and analyzed by both pairs of students on the fifth and final day. Details of each investigation, such as the students' data collection plans and their results, will be presented on the poster.

Data Sources and Analysis

Video recordings of each pair's work with TinkerPlots on the computer and all group discussions of investigation planning were collected on days 1, 2, 3 and 5. Students completed short worksheets each day that served to help the researcher assess prior knowledge related to representing data, estimating heart rates, and students' perceptions of what constituted scientific and mathematical activity. Several of these worksheets were repeated at the end of day 5 in order to gauge any change in opinions, perceptions, or intuitions about mathematical and scientific practices and their bodies' reactions to physical activity. Finally, all ForeRunner-obtained data files and student-modified TinkerPlots files were collected.

Selected video clips of student pairs were transcribed and analyzed qualitatively. Codes were assigned based on the mathematical content being discussed (e.g., averages, distributions, rates of change), the students' understandings of what the data showed, and explicit references to personal knowledge of their bodies or the data collection experience (e.g., "that can't be right! I know I didn't work that hard then.") Design notes, video of group discussions, post-mortem review of the design process, and ad-hoc instructional modifications from the week were reviewed in order to generate design recommendations for future iterations.

Results

With respect to feasibility, our conclusion from the first design iteration is that these devices could be repurposed and used relatively easily by students for data collection. Students were generally successful in operating the devices, and at the end of the week, all reported the equipment was easy to wear and use "once you got the hang of it". All students reported that they often forgot they were wearing the equipment. During a closing discussion about the experience, all students expressed that the technologies provided interesting feedback about their bodily efforts and expressed interest in using them in their math or PE classes.

However, problems emerged in the preparation of the data. The students did not have the technical know-how to convert the data to the appropriate formats. Despite development of scripting tools, an effort on Day 1 to provide instruction on how to upload and convert data was unsuccessful. As a result, the lead researcher provided support by manually uploading, converting, and preparing the data in TinkerPlots between sessions. A refined software tool is currently in development to simplify data preparation and transfer.

Additional support was required to encourage student data analysis. On the first days of examining data in TinkerPlots, the students were quick to decide on an answer to an overarching question with only a cursory glance at the data displays. In response, the researcher added a set of open-ended data-related questions for students to answer on subsequent days. The written responses to these were generally poor, in that they were often sentence fragments and often did not answer the given question. However, the quality of discussions that took place with respect to the questions showed a great deal of sophistication and engagement with mathematical and statistical ideas, such as how to compare two populations or measures of center. Those observations were encouraging and validate some of our core assumptions about the utility of these devices.

During days 3-5, the students successfully devised and enacted data collection plans. However, despite having designed their own investigations, the level of engagement in the data analysis appeared much lower than in the researcher-planned investigations. This result was surprising, and we believe could be attributed in part to the predictability of the outcomes of the student-designed investigations; all students had easily predicted the outcome of their designed investigations. This suggests more actively steering student-designed investigations toward questions that produce ambiguous results may be more fruitful. We are hopeful that observation and other lessons learned through this first-iteration design experiment will support our planned classroom enactments to take place later this year.

References

Aleahmad, T., & Slotta, J. (2002, June, 2002). *Integrating handheld technology and web-based science activities: New educational opportunities.* Paper presented at the 14th World Conference on Educational Multimedia, Hypermedia and Telecommunications (ED-MEDIA 2002), Denver, CO.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the learning sciences, 2*(2), 141-178.

Konold, C., & Miller, C. (2005). *TinkerPlots. Dynamic Data Exploration. Statistics software for middle school curricula.* Emeryville, CA: Key Curriculum Press.

Lehrer, R., & Romberg, T. A. (1996). Exploring children's data modeling. *Cognition & Instruction, 14*(1), 69-108.