
Cities and the Environment

2008

Volume 1, Issue 1

Article 5

Implementing an authentic research project on eastern coyotes at an urban high school

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Abstract

The need for inquiry oriented authentic activities is imperative to engage high school students in the active involvement and associated learning of science. Herein, we describe our experience of involving high school students in the process of studying wild coyotes in and around the communities where they live. We found that many became aware and familiar with the program but few participated to the point of being contributing members of the scientific community. To make this project sustainable in the long-run three important things must happen: one, there must be reliable point person (such as a graduate student) who can focus on the ecology side of the coyote project while others can focus on the educational components of the collaboration; two, mechanisms must be put in place to provide incentives for participants; and three, funding must be reliable and substantial over time.

Key Words

Authentic activities, coyotes, hands-on activities, inquiry, Massachusetts, place-based education.

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Way, J.G. and Eatough, D. 2008. Implementing an authentic research project on eastern coyotes at an urban high-school. Cities and the Environment 1(1): article 5, 12pp. <http://escholarship.bc.edu/cate/vol1/iss1/4>.

Introduction

There is mounting evidence that the science education reform process must include a sustained effort toward making the study of science accessible to more students (Jones 1997). For example, it was found that only 7 percent of all positions in science and engineering were held by minorities despite constituting 24 percent of the current United States population (National Science Foundation 2002). Furthermore, reports have indicated that United States students rank very low in science scores with only 2 of 20 nations behind them in international tests (Glenn Commission 2000). When race is considered, the difference is even more pronounced: while the scores of white students in the U.S. were exceeded by only three other nations, black children were outscored by every single nation (Berliner 2001). Despite this disparity, documents clearly put forward the idea that all students, regardless of culture, gender, and/or race, are capable of understanding and doing science (National Research Council 2002). Because 53 % of African-Americans live inside cities and 88 % reside in metropolitan areas (United States Census Bureau 2001), it is critical to engage and motivate urban students to learn science in order to achieve many of the goals of the National Science Foundation (2002), such as diversifying the workforce.

Authentic learning opportunities are one way to make science more relevant to all students (Bouillion and Gomez 2001; Fusco 2001; Rahm 2002). Chinn and Hmelo-Silver (2002) described authentic scientific inquiry as designing complex procedures, controlling for non-obvious confounds, planning multiple measures of multiple variables, using techniques to avoid perceptual and other biases, reasoning extensively about possible experimental error, and coordinating results from multiple studies that may be in conflict with each other. That statement could simply be paraphrased as engaging students in scientific activities similar to those engaged by scientists (Barab and Hay 2001). Authentic means different things to different people (Chinn and Hmelo-Silver 2002; Hay and Barab 2001). We view authentic science activities as providing an opportunity for students to learn how scientists conduct their research; this could be by directly participating with scientists or in simulations (Barab and Hay 2001) such as videos taken from research activities (indirect participation) that are brought to schools. The important thing is that inquiry-based activities allow one to experience, not just imagine, reality (Thomson and Diem 1994). A key link between informal experiences and learning is reflection, or thinking back on an experience.

One way to involve students in an authentic project is to engage a topic with local relevance (Rickinson 2001). For example, coyotes are often in the news (Nejame 2005) across the country due to their nationwide range (Parker 1995), and some students who normally wouldn't be interested in a science issue might be attracted to coyotes because of the publicity involved and the fact that they are a large predator that is potentially dangerous.

Many studies (Bouillion and Gomez 2001; Fusco 2001; Rahm 2002) have noted the importance of local community events to aid in students' learning science. For example, in Fusco's community based urban gardening project she found that the practicing culture of science learning was important and relevant because: it was created from participants' concerns, interests, and experiences in and outside science; was an ongoing process of researching and then enacting ideas; was situated within the broader community. The results from these studies underline how children can become masters of the science embedded in their everyday communities and practices if provided with opportunities to do science that is meaningful and real to them (Rahm 2002).

By involving urban students in the direct implementation of a research study on urbanized eastern coyotes students may be exposed to many of the goals and objectives of education such as educating all citizens and being involved in inquiry based activities (Goodlad 1993; National Research Council 2002; Pine 2002). Teachers and students have the opportunity

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to be part of a team participating in authentic ecological field studies that will aid in their intellectual development. Place-based activities in informal (or non-formal) outdoor settings (Howe and Disinger 1988) encourages participants (teachers, students, and community members at large) to achieve local ecological and cultural sustainability (Hungerford et al. 1998; Thomson and Diem 1994; Woodhouse and Knapp 2000; Yerkes and Haras 1997).

The eastern coyote is an excellent model system for students to learn about science concepts. The species is widespread in Massachusetts, having been documented in every county aside from Martha's Vineyard and Nantucket (J. Cardoza, MassWildlife, personal communication). In addition, coyotes lives in 49 of the 50 U. S. states, Hawaii excluded (Parker 1995). Thus, studying this ubiquitous carnivore in Massachusetts can provide a model framework (Schofield 1990) for other areas of the country that desire to use coyotes or other widespread/common animals as a tool for teaching students science.

School-University Partnerships

Reform literature in recent years has suggested that public schools as they exist today do not adequately prepare American youth for their roles as citizens and workers in the twenty-first century (Abdal-Haqq 1991; Kennedy 1990). This viewpoint seems to have stemmed from the publication of *A Nation at Risk* in 1983 (National Commission on Excellence in Education 1983). It has become apparent that the structure of many public schools inhibits knowledge-based teaching practice (e.g., inquiry-based learning or exploratory learning – Hay and Barab 2001), and as a result, student learning may be inhibited to think clearly and critically, live honorably and productively, and function effectively in a social and political environment (Abdal-Haqq 1991; Clark 1999).

In response to public concerns about education, state and local governments have taken steps to increase children's achievement in school. Many states have adopted rigorous content standards, which describes the information that students should master (e.g., Massachusetts Department of Education and MCAS testing, <http://www.doe.mass.edu>). National, state, and local efforts to improve education are intended to create a fundamental shift in what students learn and how they are taught (American Institutes for Research 1999). The Massachusetts Department of Education (2001) has created standards and frameworks to guide education.

One way to improve student learning in science and inquiry-based activities is for schools to form partnerships with universities. In our view, an academic partnership consists of a person or people from a secondary school working with at least one person from a university. It can be as small as one person working with one other person (Handler and Ravid 2001) or as large as entire secondary schools working with a university – these latter partnerships are often called professional development schools (Murray 1993; Pine 2002). In the case of this study, we are involved more closely with the former, where the senior author worked mainly with a participating teacher (i.e., the second author) and his students for the past six years.

Partnerships are K-12 schools that have entered into collaborative partnerships with universities to assist in the preparation of students and to serve as sites for research and development (Metcalf-Turner 1999; Shive 1997; Sykes 1997). University faculty typically teach the foundation and theories of learning, along with various teaching methods while public schools provide the hands-on practice where prospective educators try out their skills in working with students (Bacharach and Hasslen 2001). In the context of pre-service science education, the concept of a partnership centers on the collaborative relationships that are built among school faculty, students, and administration and university science education faculty and students (Westbrook et al. 2000).

The need for collaboration in science is important (National Research Council 1996). Arguments for the development of partnerships in science abound (Richmond 1996). Richmond (1996) cited a common rationale for these partnerships: In order for significant and long lasting

change to take hold in the way science is taught in schools, there must be substantial interaction between those with knowledge of scientific content (e.g., university personnel) and those with knowledge of students and schools (e.g., in-service school teachers). Hence, modeling pedagogical content knowledge is an important goal of science partnerships as this may positively affect student learning and interest in science (Doster et al. 1997; Shulman 1987). In order to address improving student learning, a number of partnerships have emerged recently in science related issues (Clark 1996; Fradd et al. 1997; Hay et al. 2000; Lasley et al. 1992; Sterling and Olkin 1997; Tallman and Taylor 1997). Providing students with authentic experiences has been a common theme and a critical component for these partnerships to succeed.

One way to provide students the opportunity to engage in authentic activities is to partner schools with scientists (Barab and Hay 2001; Hay and Barab 2001). In this collaboration, students can learn the scientific process through their mentors (i.e., scientists) while the scientists can provide important community outreach and at the same time receive assistance in collecting valuable data (Hay and Barab 2001). While the need for scientists and schools to form partnerships is important and potentially beneficial for all sides (Waksman 2003; Wormstead et al. 2002), especially when engaging in an authentic scientific project, it is just as important to document the effectiveness of these partnerships.

Our paper describes the school – university partnership that was forged between Boston College and Revere High School which involved studying wild coyotes in the north Boston area. This is an account by a scientist familiar with coyote studies who teamed with a teacher and his high school students. In this paper, we describe how the partnership worked on a day to day basis, share our experience implementing this project in a high school, and offer suggestions to make the project more realistic in the future. This project, along with an associated curriculum unit (Way 2005) on coyotes, gave students and teachers the tools, knowledge, and opportunity to participate in a science apprenticeship program where students were learning at the heels of researchers, whereby novices were gradually enculturated into the coyote study with the goal of becoming an expert in the field of study (Hay and Barab 2001).

The purpose of this manuscript was to address the question “Were students seen as effective contributors to this authentic and collaborative scientific study on eastern coyotes?” We offer our views of how realistic a study like this is by describing our experiences of a scientist and educator (secondary level) studying eastern coyotes with students in an urban school. Herein, we provide an outline of the project, our experiences with the research collaboration, then our recommendations for future projects of this nature.

The Partnership Begins

The partnership began in 2001 with discussion about initiating a study of coyotes in the Boston area. Previously the senior author studied coyotes on Cape Cod for three years (Way 2000). Wanting a more urban focus for the study to address a sustained effort toward making the study of science accessible to more students, we collaborated with the Urban Ecology Institute (UEI) at Boston College (Barnett et al. 2004) to expand our study area to include highly urbanized coyotes. We selected Revere High School to collaborate with because of the second author’s sustained interest in the project, his knowledge of science, his proven capability in other projects (such as water quality monitoring and bird biodiversity surveys) with UEI, and most importantly, because coyotes are known to live in the wild in Revere and surrounding communities on the north edge of Boston. We began the project in spring 2002. Students who participated in the coyote study had to volunteer and do the study outside of class time; i.e., the school did not offer a formal research methods class for students to get credit for conducting research on coyotes.

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The City Revere in Context

The town, with 44,000 residents, is a multi-cultural city located on the north edge of Boston. Sixty percent of the city's total 4,054 acres (6.3 mi²) was developed for industrial, commercial, residential, and transportation uses and of this total 70 percent was used for housing. There are 6,984 people per square mile in the city. For its size, this small city is a more complex community than most, which is the result of its multi-cultural population, its older residential neighborhoods and housing, and the numerous specialized regional facilities that were located within its borders. Ninety-one percent of its residents are Caucasian, 3.8% are Hispanic, 3.5% are Asian, 1.3% are African American, 0.2% are Native American, and 0.2% are listed as other races (Revere High School brochure 2001-02). Despite the majority of students being white, we viewed this study as valuable in the context of urban education in that it addressed the needs of an urban school district within the immediate vicinity of a large urban center (i.e., Boston). Furthermore, Revere High School consisted of 1,338 students, 43 percent of which are from families with incomes at or below the poverty level. The National Science Foundation (2002) clearly puts forth the need to provide learning opportunities for all students (including urban and poor) and acknowledges the fact that urban students typically are under-represented in scientific fields.

The area is predominantly a blue-collar city that was dominated by several industries, the largest being services, followed by wholesale and retail trade, finance insurance, and real estate. The community's current unemployment rate is 4.2 percent. The town has eight public elementary schools, two of which also housed the city's middle school programs, one public secondary school, and two private elementary/middle schools. There are over 140 teachers at Revere High. In spring 2000, Massachusetts Comprehensive Assessment System (MCAS) scores at Revere High was 228 for English Language Arts, 224 for Mathematics, and 222 for Science/Technology compared favorably with similar statewide averages of 229, 228, and 226, respectively (Revere brochure 2001-02). Thus, this school was representative of an average Massachusetts school based on standardized test results.

The Coyote Study at a Glance

Our study was conducted from 2002-2005; however, the study is on-going in nature and we hope to continue the project over time (Way 2007). Students that volunteered to participate in the project worked directly with a professionally trained scientist (the senior author) as well as with their teacher (who is a scientist in his own right!). Most students took one of the second author's courses and joined or volunteered for the project during that academic year; however, some students, through word of mouth, heard about the project and approached the second author without any prior history with him.

The second author informally surveyed the school by discussing with students and other teachers in order to estimate how many people were aware of the project (see Table 1). Additionally, the coyote study was mentioned in announcements, emails, and newsletters, giving a high proportion of students (and faculty) awareness of the project at Revere High. We defined involvement in the research project as students that went into the field with us to assist us with checking box traps, radio-tracking coyotes, and/or participating in a capture and radio-collaring event where we sedated, radio-collared, then released a coyote. We then assessed other measures of participation shown in Table 1.

The main component of the free ranging coyote ecology study involved trapping and radio-collaring (Way et al. 2002), then releasing coyotes in order to study their behavior such as home range size and territoriality (Way et al. 2002), movement and activity patterns (Way et al. 2004), sociality (Way 2003), and denning behavior (Way et al. 2001). A major component of the project was to trap coyotes in large box or cage traps in order to fit them with a collar. Trapping

was the most time consuming part of the project yet the component of the study that students were most easily able to participate in; for example, it was easier to convince parents to let their children commit to checking a trap at 6 AM and 4-6 PM (dawn and dusk, respectively) than to tracking a wild coyote from 10 PM to 2 AM (these nocturnal blocks of time are common shifts when scientists track coyotes to study movement patterns). Students often monitored radio-collared coyotes with the second author in order to learn how to radio-track coyotes and where to track them. The goal was for students to become trustworthy and self-sufficient where they could collect valid and robust data when we were not with them.

Our experience with the coyote study

The coyote project was successful in involving students in the hands-on involvement of a local, place-based science issue. We captured eight coyotes in the study area and tracked them over time. Select students became directly involved in the project while others were familiar with it because of word of mouth within the school system yet they did not actively participate. We had about 30 (never all at once) students involved with the coyote project. Some of the students that have graduated continued to work with us during summer. Table 1 depicts the different levels of student involvement in the coyote study.

Table 1. Levels of student involvement participating in the eastern coyote ecology project at Revere High School.

Level	Level of involvement in the project:	# students*
1	Hearing about the project through word of mouth	1000
2	Being in D. Eatough’s classroom where coyotes are mentioned	100
3	Having curriculum on coyotes provided as part of the academic experience	15-20
4	Having taken field trip(s) to our coyote study sites	15-20
5	Collecting data such as checking traps or tracking coyotes	5-10 ⁺
6	Being reliable in repeatedly checking traps, radio-tracking coyotes, and providing the data that they collected to us	1
7	Being self sufficient where students select their own project and carry out a research project independently on coyotes	0
8	Entering data into our coyote data base such as radio-recovered telemetry locations	0
9	Analyzing data and performing statistical analyses	0
10	Co-authoring scientific papers	0

* = approximate number per year participating.

⁺ = does not include returning students (i.e., students that have graduated and returned to work on the project).

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As acknowledged in Way (2005), student knowledge of coyotes improved dramatically and in a short period of time when exposed to the coyote unit. Students became interested and knowledgeable of coyotes and advocated for better protection and acceptance of the creatures, even in an urban landscape. Some students enjoyed the unit so much that they wanted to further the project by having the scientist (i.e., the first author) back to conduct more work on coyotes with them (Way 2005). However, the focus of this study was to describe the effectiveness of our implementing the research (not education – i.e., student interest and understanding) component in a high school setting. In that regard, we feel that we were moderately successful in our expectations of student performance.

At the outset of the project our goal was for students to become involved in the study to the point of them becoming self-sufficient research colleagues on our study team. For example, we hoped that they would be able to check, bait, and arm/set traps on their own so the authors could focus on other tasks. We also hoped that the students would be able to independently radio-track coyotes when we had collared animals to monitor. We envisioned the students collecting and recording data and for them to translate their findings to us. Lastly, we had hoped that students would be productive by entering field data into our existing databases on our coyote study subjects.

As indicated in Table 1, many students were exposed to the project yet few became substantial contributors to the coyote study. Thus, we felt that we were successful in reaching a wide audience and capturing people's attention about our study. This gave many students an interest in a topic that they probably did not think they would experience at Revere High School (i.e., studying a wild animal like the coyote in an urban area). The fact that some of the students went to some of our captures and experienced a capture first hand was outstanding (Figure 1). However, we did not feel that the students became true apprentices to our study team as described by Barab and Hay (2001) and Hay and Barab (2001).

Figure 1. Revere High School students with the second author holding a 32-pound female coyote named “Maeve” and the senior author (2nd from right)



In fact, few to no students reached the level of being dependable and capable of carrying out their own research projects. No students were near the point of helping us analyze data and author scientific papers; however, this is something that might not be expected until students were

at the undergraduate level. Thus, the most frustrating part of the study was not having enough students participate to the point of helping us regularly check traps or something similar to that – tasks that we consider reasonably easy for high school students to engage in and that would be immensely useful for assisting in collecting valid scientific data.

What We Learned

We hope that this section provides practical advice for people and organizations that hope to forge future partnerships in science based projects. Our experience over the years has taught us a number of lessons:

One, the way that the project was carried out was yet another example of intensification, as described by Apple (1986). The project brought another major time commitment to already busy people. For example, the senior author received a Ph.D. in science education by writing a dissertation on student learning of a coyote created curriculum (Way 2005); however, the output from publications on wild coyotes (see references) stemming from his master's thesis on coyotes was nearly another on-going dissertation in its own right. On certain days the senior author conducted night tracking sessions that began at 2 AM. When finished (about 8 AM), that researcher immediately went to Boston College for teaching and academic duties that often did not end until the evening. Similarly, the second author was lead teacher in the science department at Revere and frequently worked 10 to 12 hour days before he even tended to this projects needs, which was usually another two hours a day.

Two, student interest varied over time and most were not reliable. While students could have saved the authors significant amounts of time doing mundane tasks such as checking traps, student involvement sometimes added a time commitment to the second author's schedule because he frequently double checked the traps to ensure that they were properly tended by the students. For this project to be sustainable, a reliable point person such as a graduate student just focusing on studying coyote ecology, must be part of the equation. Therefore, data could continue to be collected in a robust manner that will preserve the academic and scientific integrity of the project while student involvement can predictably cycle back and forth. Additionally, a high school course (such as "Independent Study Field Research") that gives student academic credit for conducting the research would be very beneficial. It would not only give students an incentive to participate in a helpful manner (i.e., collecting valid data for us) but it would also give a teacher a mechanism to grade them based on their mandatory effort for the students enrolled in that course. This would be a best case scenario for students, teachers, and scientists alike as students would get credit for doing the research, the teacher would have a finished product from the students, and the scientist would obtain scientific data from the partnership.

Three, funding must consistently be provided. This project, given its relatively sophisticated nature (e.g., using radio-tracking technology), actually had a small amount of funding ear marked for it. The project was initiated with a \$2,500 UEI grant to purchase a few radio-collars and a receiver and antenna back in 2002. Most travel money (which can be considerable) and miscellaneous supplies (such as batteries, trap accessories) came out of the authors' pockets. Boston College generously purchased radio-collars (\$260 each) in piecemeal fashion (1-3 at a time) to keep the project afloat. The project was literally a part of our lives and we love doing what we do. While this certainly gave the coyote study a more personalized meaning, which is important for any place-based study, it also would spell doom if we lost interest; in other words, our enthusiasm and strong interest in the project was essentially the only thing that kept the project going on a day-to-day basis, similar to other science projects with a dedicated core of teachers (Bouillion and Gomez 2001; Fusco 2001; Rahm 2002).

Finally, we believe very strongly that it was our moral imperative to provide urban students with an opportunity to experience authentic outdoor science (e.g., see Siegel, 2002), and,

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while this coyote study only took place at one high school, we did reach a number of students in a short amount of time (Table 1). Thus, despite the fact that no students became proficient as independent researchers in our project, it was notable that we exposed many students to this type of research and they seemed to become interested in the subject. Future studies need to assess the efficacy of involving urban and multicultural students in the authentic participation of science topics.

Limitations

There were a number of limitations to the project. The first constraint is temporal. It often takes years to obtain robust data on a large mammal and this can limit student involvement. Although the authors understood the project goals (i.e., articles were written intended for peer reviewed journals and that we were having a positive role in how people view coyotes in urban areas), students often lacked the ability to see how their contribution played a role in the larger picture. They would have liked to have seen a "product". Most successful community projects are initiated and completed within a school year. For instance, community garden projects such as Rahm's (2002) and Fusco's (2001) have a tangible product (food) and are completed within a growing season. Our project couldn't offer that type of instant gratification as our study sought to document the lives of potentially long-lived animals. It is likely that only undergraduate and/or graduate students would get to level 9 and 10 of our participation level (Table 1) in authentic scientific activities.

Future studies might consider proper student training as well as demonstrating the importance/value of the projects to get students and keep them involved. Authentic research is most effective when the research has personal value and meaning, thus providing students with a sense of purpose for engaging in the tasks. Similar studies might want to consider building in milestones along the way (e.g., certificates for number of days participated, number of traps checked, number of coyotes radio-collared) for students to experience a sense of purpose and accomplishment.

The second constraint involved the nature of student participation. Students who were involved in the project were typically committed to a variety of other projects, clubs, and/or teams (e.g., one student was in the National Honor Society, Interact, track, student council, soccer, works at movies and takes four upper level courses) - therefore their time was limited. Students checking traps once or twice a week did a good job while students given full responsibility for a given trap (and checking it twice a day when set for capture) did a mediocre to poor job.

The third limiting factor was community apathy. Many people in the community, including teachers and administrators within the school, didn't understand the complexity or value of the project. Most teachers viewed the coyote project as little more than a hobby - a diversion. The lack of positive feedback from the recent article in Teacher Magazine (Capone 2005) was a testament to the lack of interest demonstrated by colleagues. Not surprisingly the teachers that did respond were those that were engaged in very time consuming extra-curricular projects as well. They had a first hand experience with investing huge amounts of time in a project without a commensurate acknowledgement. We feel that this project should be celebrated as a unique achievement for the school, students, community and sadly it was not. It also would have been important if other science teachers took a greater interest in the project - e.g., the second author had hoped new teachers would want to get involved the study yet none have to date.

In summary, the project was inherently structured as an add-on to students' and teachers' already busy high school responsibilities. The project could have been designed differently, in our opinions, by providing students with credit for conducting the research and/or possibly reducing their course-load (e.g., by one class). This incentive-based mechanism may facilitate sustained

engagement in the coyote study (Barnett et al. 2004) and help students, teachers, and administrators better grasp the purpose and value of the project.

Conclusions

The place-based authentic nature of this project was unparalleled. Students were given the opportunity to participate, even leisurely, in an on-going project of a relatively large carnivore living amongst them. They were provided inquiry-based opportunities as part of their high school experience which is important for local and national curriculum mandates (Massachusetts Department of Education 2001; National Research Council 1996, 2002). However, for the project to be sustainable more resources need to be provided so the project could have meet the educational and scientific demands in order to be rigorous on both fronts – that is, to have students involved in inquiry-based hands-on activities while robust ecological data was gathered on coyotes. Like most novel investigations, the current model of overworking teachers and researchers is not sustainable if the coyote (or a similar) project is to continue into the future. Thus, we recommend a focused national and state effort to provide more sustained funding for these types of research projects. With additional resources/support (e.g., hiring a scientist to conduct this type of partnership), it is possible to conduct a robust scientific and educational study which will address state and national frameworks for achieving authentic, hands-on scientific research, while potentially reducing collaborating participants' responsibilities. These types of authentic scientific studies should be encouraged at the local, state, and national levels, and there should be some type of support system for teachers and scientists to have the opportunity to initiate these partnerships without greatly burdening their workloads.

Acknowledgements

This project would not be possible without the support from Drs. Eric Strauss and Mike Barnett and the Environmental Studies Program, Urban Ecology Institute, Biology Department, and Lynch School of Education at Boston College. In-kind donations from Tara Eaves, the Way, Moore, and Cifuni families and Fiore's Meat Market and The Meat Market (in Winthrop) were invaluable. JGW would like to thank Pete Auger, his former high school teacher, for many of the ideas and techniques that we used to involve students in authentic research projects. DLE wishes to acknowledge personnel of Revere Public Schools. Three anonymous reviewers improved the manuscript.

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