The Work of Play: Supporting a Pervasive Health Behavior Change Intervention for US Middle School Students

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ABSTRACT

Technology-based health behavior change interventions involving passive on-body sensing and feedback interfaces show promise for increasing participation in physical activity. However, the majority of prior studies are small-scale interventions that heavily rely on research teams for programmatic support. In larger-scale deployments, participants may have to take over setup and maintenance tasks. In this paper, we examine the "hidden work" involved with the large-scale deployment of a behavior change application in American schools. We offer insight into the coordination required to maintain such deployments, and identify unique challenges that arise when schoolchildren are the target of a behavior change intervention. Our findings highlight the behind-the-scenes coordination and management work required of adult facilitators in order to support pervasive health interventions for children in school environments. We offer advice to researchers and project managers attempting integration of technology-based health behavior change applications for children.

Author Keywords

Health Informatics, Pedometers, Longitudinal study, Wellness, Articulation work, Children

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

With rising concerns about obesity and sedentary lifestyles, particularly in childhood, the CHI and CSCW communities have correspondingly been interested in understanding how pervasive and ubiquitous computing technologies such as passive on-body sensing can support health behavior change. In pilot deployments, researchers often provide logistical and support functions, such as setup and troubleshooting. As these technologies move beyond the pilot stage and into large-scale deployments, there is a need for a deeper understanding of the coordination work needed to support such deployments, and the structural and environmental challenges that emerge in the context of real adoption [1]. Moreover, little research has addressed the challenges involved in deployments with children. Child-focused interventions differ from those described in the literature because children lack the autonomy in their daily decision making usually assumed in adult-focused interventions (such as [2,6]); hence one must also consider the role of adults who support the deployment.

In this paper, we describe the experience of teachers who took local responsibility for a school-based health intervention for early adolescents called the American Horsepower Challenge (AHPC). Developed by Humana Games for Health and sponsored by the Humana Foundation[1], the AHPC used real-world fitness data to create a multi-week walking competition among schools. The AHPC was deployed in 61 schools on three different occasions, involving the participation of over 1,700 students. In each participating school, a team of approximately 20 students wore wireless pedometers. A base station within the school automatically collected step data. Individual and school standings were displayed on a password-protected website that could be accessed either in the classroom or at home.

At first glance, the AHPC appears to be a relatively simple deployment in a well-ordered environment. In promotional materials, the game was described as a "turnkey solution" requiring "minimum support" from schools [5]. The relative simplicity of the intervention design (commercial pedometers seamlessly connecting to base stations and a web interface) seemed robust enough to sustain a large-scale longitudinal deployment. Furthermore, as a student-focused health intervention without a required curricular component or mandated

CSCW 2012, February 11–15, 2012, Seattle, Washington.

[1] The philanthropic arm of Humana, Inc., a health benefits company.

activities, the AHPC looked like it would place minimal burdens on teachers. However, our study reveals a more complicated picture of the system in use. To make the system work, the role of the *teacher* is crucial. As pervasive health systems move out of the lab and into everyday use, it is essential to understand the support networks required to manage novel technological deployments.

RELATED WORK

Pervasive health interventions have been an object of study within HCI for several years. As opposed to "exertion interfaces" [7] that often enable real-time collaboration in a pre-defined setting, pervasive health interventions facilitate asynchronous interaction "in the wild," and offer computational support for individual health goals, augmented by tracking and visualization technologies [2,3,6]. There are two main types of systems in this area: personal informatics systems that focus on the needs of individuals [2], and group deployments aimed at small groups of friends [3,6]. These systems typically focus on healthy individuals, as distinct from other systems designed for those living with chronic conditions.

Pilot deployments of collaborative and pervasive technologies often involve significant researcher-provided support. For example, in Fish'n'Steps, an influential pedometer-based fitness competition, researchers employed Wizard-of-Oz techniques for data capture and goal management, and installed and maintained the central kiosk. Additionally, participants were selected from office workers in the same company, to whom the researchers had easy access [6]. In contrast to this pilot approach, Bardram and others have called for studies of pervasive health systems to move "out of the lab" and examine long-term deployments in real-life healthcare settings [4].

In all deployments, someone must perform what Strauss termed *articulation work*, or work that enables other work [10]. By its nature, articulation work is "invisible within rational models of work or work planning" and is generally "undertaken in support of a high level end goal" [8]. Without researchers to perform articulation work, participants must negotiate this invisible work themselves. Additionally, research suggests articulation work is cumulative, meaning that the longer a deployment, the more articulation work is likely to pile up over time [8]. In a distributed, minimally supported, long-term deployment like the AHPC, articulation work is likely to emerge but difficult to account for preemptively.

METHODS

After a small-scale pilot in the Louisville metro area, Humana conducted a large-scale field trial with 61 schools across the United States in 2009 and 2010, and ran three "heats" over two school years: one in Spring 2009, one in Fall 2009, and one in Spring 2010. The top performing schools in Spring 2009 and Spring 2010 received grants for fitness programs. Our independent research team studied the AHPC's impact and effectiveness during this period.

Participant Demographics

Schools were selected by The Humana Foundation based on high participation in the National School Lunch Program, a federally assisted meal program in the US; 73.5% of students in AHPC schools received free or reduced lunch. The schools were situated in a range of environments, from large cities to rural areas [11]. Thirty-seven schools continued in the AHPC across all three heats of the game; 1,377 students started in the first heat and 1,743 students participated in at least one of the heats. Most students were in 6^{th} grade (age 11-12) when they began the challenge, and in 7^{th} grade (age 13-14) when the challenge ended. Students joined or left the program for various reasons, including student transience (students sometimes became too busy for the program or moved schools) and teacher preference (teachers often lost daily access to students when they started 7^{th} grade, and some teachers recruited new students).

Data Collection and Analysis

During the field trial, members of our research team visited 15 schools participating in the AHPC, speaking with over 200 students and teachers. The profile of the 15 schools we visited was representative of the overall group socioeconomically (71.8% of students receive free or reduced lunch), demographically (male-female ratio=1.03, similar ethnic makeup), and regionally (covering 8 states and a mix of rural/suburban/small town/city schools). At each school we conducted a student-only focus group, teacher interviews and individual student interviews, and wrote field notes with observations of interest. We also gathered pedometer log data from each child, and surveyed participating students, teachers and parents. The bulk of our findings in this paper are from qualitative analysis of the interview and focus group data. During analysis, four researchers qualitatively coded and analyzed transcripts and field notes in a multi-step process aimed at identifying themes and stakeholder relationships. A more complete discussion of the AHPC evaluation can be found in [12].

Program Administration and Support

Our research team did not recruit schools, set up equipment, or provide technical support. Representatives from Humana contacted schools and enrolled them in the program, and were available to assist schools and teachers with setup and troubleshooting tasks. The AHPC project managers operated remotely, and each managed a region comprised of multiple schools. Teachers contacted them when they needed assistance. Each school selected a teacher or teachers responsible for the AHPC.

FINDINGS

The AHPC was, at first glance, technologically simple. Students wore wireless pedometers on their shoes all day during each period of gameplay. Their steps were automatically wirelessly uploaded via a base station at school, and students could access the game website from a web browser. In practice, however, the interaction between various participant groups proved much more complex, and the teacher emerged as an important stakeholder not to be overlooked in the design of school-based health interventions.

The AHPC Teacher as System User

Before conducting our on-site visits, we assumed that the students participating in the AHPC were the primary users of the system. They are, after all, the people whose behavior and attitudes the system sought to change. What was less obvious was the interconnectedness of several other stakeholders in the network: administrators, other teachers, friends, siblings, parents, and, most prominently, the teacher or teachers in charge of the AHPC at each school. Teachers responsible for administering the AHPC performed much of the articulation work required for the AHPC to function. For example, they selected students, worked with administrators for gym resources, contacted project managers at Humana to coordinate technology, set up the base stations with the help of the school's IT personnel, distributed pedometers, monitored students' progress using the website and organized physical activities for the participating students.

Therefore, the AHPC relied heavily on the teachers' ability to coordinate stakeholders. As the students' closest advocate within the school environment, teachers took on tasks the students could not do themselves, such as setting up technology and securing support from administrators. In Strauss's terms, they "meshed" the actors and activities without performing the step-gathering "task" at the center of the Challenge [10]. Although the teachers could to some extent observe and control the core interactions with the game—uploading steps, accessing the website, troubleshooting technology—the business of getting steps was largely left out of their control. Teachers' ability to coordinate and support students was thus their primary goal because they could not always accompany students as they acquired steps. Although teacher-supervised exercise took place, students also walked and played between classes and after school, and these are times outside a teacher's direct influence.

In the AHPC, teachers played a vital coordination role by encouraging students to be physically active and engaging with the program more generally. But they also helped mitigate two other larger challenges: limited computing and gym resources in the schools, and technology troubleshooting and repair. If the deployment environment was Oz, the teachers were definitely Wizards.

Resource Availability

A prominent feature of participating AHPC schools was the low socio-economic status of students and insufficient funding of school districts. When the AHPC was deployed in these schools, we observed two primary challenges with respect to school resources: computer infrastructure and availability of facilities and playgrounds for physical activity.

In the surveys, teachers cited limited computing resources as one of the primary de-motivating factors in the AHPC and we saw evidence of this in our site visits. The processor-intensive Flash-based AHPC website placed a strain on lab computers, and the limited availability of computer lab time in many schools created additional barriers. The AHPC also requires some involvement from school district IT personnel, who were often unable to resolve technical difficulties with the base stations or website as quickly as the teachers desired. Additionally, many of the schools we went to lacked adequate gym resources, including funding for equipment and facilities as well as regular access to PE teachers. For example, the teacher survey indicated that the average student-to-teacher ratio for PE classes was 247:1. Resource constraints became apparent in our site visits as well; one school we visited lacked an indoor gym, so students could not exercise when it rained.

These structural factors of the environment had a significant impact on the technical deployment. As CSCW systems engage with ever "messier" environments, accounting for the presence or lack of resources will become essential.

Troubleshooting and Repair

Troubleshooting and repair involved the greatest number of stakeholders and proved the most challenging administrative tasks for teachers. The scenario played out similarly at many schools we visited. If a student checked the website and saw no new progress recorded, he or she might mention it to the AHPC teacher, who would then attempt to troubleshoot the problem by contacting the project manager. The project manager might then send a replacement device. However, even this proved complicated. In one school we visited, no AHPC students in the school were able to register their steps at the beginning of the Fall 2009 heat. In this case, the teacher had to negotiate with the school district's IT department, the Humana project manager, and even a representative from the pedometer and base station provider in order to solve the issue. One AHPC teacher reported that:

We kept going back with the technology people… And for the first two weeks it didn't work at all. And I think for this year that's what lost the kids because they were coming up to me and they're like, 'I logged on and it's saying I have zero steps.' By the time we got it working…it was too late.

More than a technical glitch, this delay lowered student motivation and contributed to a steep drop in step-counts for the following heat. Had the teacher not been vigilant about coordinating support, the school might have dropped out of the program entirely. Teachers performed vital articulation work during these times, and the normally "invisible" technical infrastructure of the AHPC became painfully visible during these breakdowns [9].

Overall, it surprised us just how critical and complicated this troubleshooting process appeared to be. The apparent simplicity of pedometer/base station and connectivity belied the complexity of school firewalls, longitudinal hardware deployments, and the difficulty of troubleshooting in an environment without dedicated technical expertise. Additionally, as the deployment progressed and the technology experienced the stress of a long deployment, step upload failure became more common. Failures of this sort will be a challenge for any real-world deployment and one that future researchers in this area will likely encounter.

DISCUSSION: SUPPORTING SUPPORTERS

Despite expectations of a "turnkey" solution, the AHPC is far from automatic. We found that the program requires constant upkeep, both to support the technology across a long deployment, and to manage the students' experience of the game. While an analysis of all supporters is beyond the scope of this note, our analysis of the role of the teacher serves as a key example. Teachers took on additional work by helping students remember to wear their pedometer and by monitoring their progress in the game. They also had the additional responsibility of ensuring that students uploaded steps as well as dealing with lost pedometers and countering flagging motivation. As the central users of the AHPC, teachers deserved more support from the system, both in helping them see students' progress and more effectively delegating troubleshooting.

We must stress that this finding, which seems sensible and even obvious in hindsight, was not apparent to us or to the design team in advance. The extent of articulation work performed by teachers was truly hidden until our fieldwork exposed it. Therefore, in addition to conducting pilot trials to test hardware or software interfaces, researchers working towards large-scale or long-term deployments of this kind might want to conduct pilot trials that test the support networks. These pilot trials could be done by providing the technology with as little hand-holding as possible and studying the emergent practices that evolve to meet gaps in the design.

CONCLUSIONS

Pervasive health applications enter environments and lives already filled with existing practices, values and relationships. Even interventions that seem simple on the surface, like the AHPC, require nontrivial management and support as well as situated invention to make these interventions successful in the localized context.

ACKNOWLEDGMENTS

Thanks to our hundreds of participants, Humana Games for Health and the Humana Foundation for collectively making this research possible.

REFERENCES

1. Carter, S., Mankoff, J., Klemmer, S., and Matthews, T. Exiting the Cleanroom: On Ecological Validity and Ubiquitous Computing. *Human-Computer Interaction 23*, 1 (2008), 47-99.
2. Consolvo, S., McDonald, D., and Toscos, T. Activity Sensing In The Wild: A Field Trial Of Ubifit Garden. *Proc. CHI 2008*, ACM Press (2008), 1797-1806.
3. Consolvo, S., McDonald, D.W., and Landay, J.A. Theory-Driven Design Strategies For Technologies That Support Behavior Change In Everyday Life. *Proc. CHI 2009*, (2009), 405-504.
4. Hansen, T.R., Bardram, J.E., and Soegaard, M. Moving Out of the Lab: Deploying Pervasive Technologies in a Hospital. *IEEE Pervasive Computing 5*, 3 (2006), 24-31.
5. Humana Games For Health and Exergame Fitness. The Horsepower Challenge Overview. 2009. http://www.exergamefitness.com/horsepower-challenge-overview-humana-games.htm.
6. Lin, J.J., Mamykina, L., Lindtner, S., Delajoux, G., and Strub, H.B. Fish'n'Steps: Encouraging Physical Activity With An Interactive Computer Game. *Proc. Ubicomp 2006*, Springer (2006), 261–278.
7. Mueller, F., Gibbs, M.R., and Vetere, F. Towards Understanding How To Design For Social Play In Exertion Games. *Personal and Ubiquitous Computing 14*, 5 (2010), 417-424.
8. Sawyer, S. and Tapia, A. Always Articulating: Theorizing on Mobile and Wireless Technologies. *The Information Society 22*, 5 (2006), 311-323.
9. Star, S.L. and Ruhleder, K. Steps Toward an Ecology of Infrastructure: Design and Access for Large Information Spaces. *Information Systems Research 7*, 1 (1996), 111-134.
10. Strauss, A. Work and the Division of Labor. *Sociological Quarterly 26*, 1 (1985), 1–19.
11. US Department of Education. National Center for Education Statistics. 2010.
12. Xu, Y., Eiriksdottir, E., Miller, A. D., Poole, E. S., Kestranek, D., Catrambone, R., & Mynatt, E. D. (2011). *Assessment of Health Games in Secondary Schools: An Investigation of the American Horsepower Challenge*. GVU Technical Report.