Co-Designing a Classroom Display to Support Behavior Management Plans

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Abstract
The paradigm of ubiquitous computing has the potential to enhance classroom behavior management. In this work, we used an action research approach to examine the use of a tablet-based behavioral data collection system by school practitioners, and co-design an interface for displaying the behavioral data to their students. We present a wall-mounted display prototype and discuss its potential for supplementing existing classroom behavior management practices. We found that wall-mounted displays could help school practitioners to provide a wider range of behavioral reinforces and deliver specific and immediate feedback to students.

Author Keywords
Classroom behavior management; ubiquitous computing; token economy.

ACM Classification Keywords
H.5.2 [User Interfaces]: User-centered design; J.4 [Social and Behavioral Sciences]: Psychology; K.3.1 [Computers and Education]: Computer Uses in Education

Introduction
Behavior management is a critical component of any classroom. Managing behavior involves defining clear expectations and rules, providing specific feedback, and contin-

Token Economy

A **token** refers to a tangible or symbolic reward (*e.g.*, sticker, point) given to reinforce desired behavior.

Tokens are collected over a period of time, then exchanged for a larger **reward** (*e.g.*, toy, activity).

The efficacy of this approach is derived from combining the immediate reinforcer for a specific behavior, with the back-up reinforcer from the sustained effort of working toward a meaningful reward.

In other words, a student is motivated each time she receives a sticker, and when she exchanges all of the stickers she has earned in order to play a game.

Figure 1: Token economy description.

uously adapting responses to behaviors of individual students. School practitioners in both special education and regular education settings implement a variety of behavior management programs informed by decades of evidence from behavioral psychology research. Behavior management programs have been shown to reduce problem behaviors, increase desired on-task and social behavior, and improve outcomes for young adults [11]. However, behavior management programs must be implemented with high fidelity in order to be effective. Fidelity is a measure of the degree to which implementation is comprehensive and consistent [1]. Implementation fidelity can be increased through training and consultation from school psychologists, but these approaches are resource intensive. High implementation fidelity is difficult to achieve, and once achieved, is also difficult to sustain [11, 1].

The token economy (Figure 1) is one of the most widely applied and studied methods of behavior management in institutional settings [4]. Yet despite its widespread use in classrooms, a significant rate of children with behavior problems continues to persist, with estimates ranging between 2 to 17% [4]. This disconnect suggests challenges in achieving effective implementation of token economies. More research has been recommended with a focus on supporting school practitioners in ensuring high fidelity of implementation with token economies [4]. School practitioners do not have enough tools and support for implementing token economies [8].

This problem is well suited to ubiquitous computing applications, if they are seamlessly integrated into classroom settings to supplement existing evidence-based practice. Our aims are to supplement behavior management programs without significant added time, effort, or expertise from practitioners. Over two years of fieldwork, an action research process led us to the opportunity of applying ubiquitous computing for monitoring token economies more collaboratively as a classroom. We report on a prototype of a wall-mounted classroom display, *Ribbit*, which we co-designed and evaluated together with school practitioners.

Related work

Our work complements a range of studies focused on behavior management at home, in individual therapy sessions, or other non-classroom contexts *e.g.*, [7] by addressing the challenges of classroom-based behavior management. The application of ubiquitous computing has shown feasibility, acceptability, and efficacy across special education (*e.g.*, [6, 9]) and regular education (*e.g.*, [3]). For instance, *vSked* is a ubiquitous computing system designed in part to support a token economy [6]. Combining a classroom touchscreen display for the teacher's use with mobile touchscreen device for each student, *vSked* was designed for facilitation and monitoring of task performance while providing students with a visual reference of the reward they were working toward. Matic and colleagues [9] developed a digital classroom display to enhance a school's use of a token economy system. At the end of each school day, the display uncovered a cooperative puzzle, with each piece corresponding to a student. Each student's behavioral data affected the degree to which their puzzle piece was revealed. Their study showed that visual reinforcers of behavior were a useful supplement to standard practice.

Building on the results of these studies, we focus on integrating a shared display into classroom structure and practices, in support of a behavior management plan. The novelty of our display is the exploration of providing behavioral reinforcers throughout the school day, and supplementing the verbal feedback provided by practitioners that is required for achieving high implementation fidelity.

Action Research Stages

Planning: We conducted preliminary diagnosis (e.g., contextual inquiry), data gathering (e.g., observation and interviews with school practitioners), and joint action planning.

Acting: Fieldwork began with deployment of a customized tablet-based behavioral data collection tool, *Lilypad*, in 4 classrooms across 3 schools [10]. Based on adoption and appropriation of *Lilypad*, our fieldwork evolved to include ideation and prototyping of interfaces and features in response to needs we observed.

Reflecting: Together with school practitioners, we identified main challenges, envisioned solutions, and discussed potential unintended consequences. Co-design was informed by reflecting on the transition from standard paper-based data collection to the *Lilypad* system [10], observing its use and effects over time.

Figure 2: Action research stages.

Methods

Our research process involved two main phases. First, we followed an action research approach [5] described in Figure 2 to investigate behavior management practices in four classrooms, grades K-8, staffed by 17 practitioners (*e.g.*, teachers, school psychologists, behavior analysts, social workers). Driving the formative stage of the work was **R1: how might ubiquitous computing support a classroom behavior management plan?** From design opportunities that emerged during formative research, we refined RQ1 into RQ1a and RQ1b (Figure 3). During the over two years of fieldwork, we conducted naturalistic observation (255 hrs), interviews (n=15) and focus groups (n=22). Figure 2 outlines some examples of how these activities were iteratively performed within the three stages of action research: planning, acting, and reflecting. We also identified use of a classroom display that was in line with our research questions. Barry[1], a regular education first grade teacher, had previously incorporated *ClassDojo* (a popular educational technology product[2]) as a display for his classroom's token economy. He approached us about the limitations of this tool and we began co-designing a display to better fit his needs. We started this co-design process by interviewing Barry and learning from his past experiences with *ClassDojo*.

During the second phase, we performed an iterative human-centered design process with a focus on Barry's needs, and informed by what we learned about behavior management across a range of classrooms through action research (Figure 3). During 10 months, we co-designed, deployed, and iterated on a prototype called *Ribbit*, with a focus on integrating it into existing classroom practices.

[1]All names are pseudonyms to protect anonymity.
[2]https://www.classdojo.com/

Findings from Action Research Phase

One of the biggest challenges of implementing a token economy was for practitioners to provide rewards that were coveted and motivating, but inexpensive and easy to keep a constant supply of[3]. Candy, toys, and privileges were commonly offered as rewards, but these rewards were not always effective. When a fourth grade student in Miriam's class was informed that he had not earned the opportunity to spend his recess outside, he responded with *"I don't care, I'll just play outside at home. I have better toys there anyway"*. In his class, Barry would give out candy at the end of each day, if time permitted. Each student was awarded one piece of candy for every token they earned that day, and this was the most consistent form of reinforcer provided for Barry's students. However, his students did not always want the candy, and some students were not able to eat them due to allergies. These observations led us to **RQ1a: How can a classroom display help teachers provide a wider range of behavioral reinforcers?**

Providing immediate and specific feedback is a common barrier to achieving high implementation fidelity. Although practitioners logged tokens to monitor progress toward rewards, little to none of this process was designed to actively engage students. Consequently, students in all classrooms were continually inquiring about the number of tokens they had earned. For example, a teacher would call on a student with a raised hand, only to find that the question was not about the lesson, but rather an attempt to check on their token status. Students in Kate's class would draw charts on their desks to track progress to a reward on their own. Barry found a way to visually display students' behavioral data, but his use of *ClassDojo* did not enable him to provide

[3]See [10] for more details about the findings from our action research process.

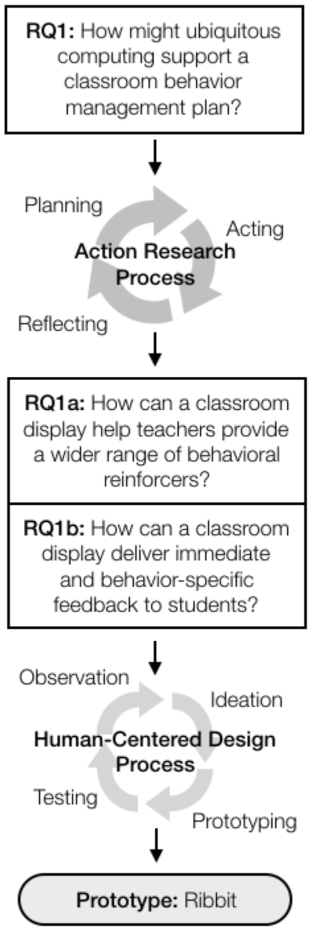

Figure 3: Research process.

behavior-specific feedback to individual students throughout the day. Barry reported that he was unable to deliver feedback that was immediate and specific enough for a student to connect a token to the behavior for which they had earned it. These needs led us to **RQ1b: How can a classroom display deliver immediate and behavior-specific feedback to students?**

Guided by these two research questions, our iterative human-centered design process resulted in a classroom display prototype, *Ribbit*, which we designed, developed and deployed in Barry's classroom over one school year (10 months).

Ribbit Prototype

Ribbit is a wall-mounted display that enables all students in the classroom to continuously check-in with their behavioral data throughout the school day. As a practitioner uses our tablet-based data collection tool, *Lilypad* [10] (Figure 2), the display pulls that data in real-time to generate a visualization for the students. Every time a student receives a token, two types of immediate reinforcers are delivered: a pleasant sound (*i.e.,* a splash), and a pop-up graphic containing the student's name and the behavior category in which they earned the token. The aim of *Ribbit* is to help students connect their behavior to a reinforcer, through immediate and behavior-specific feedback–provided automatically without additional work from the practitioner.

Helping Teachers Provide a Range of Behavioral Reinforcers
Rewards menu: As part of our solution, a rewards menu (Table 1) was printed on a large poster board and hung next to the display, helping Barry offer a wider range of rewards, and communicate to students clearly how many tokens could be exchanged for each of them. The prominent placement of the rewards menu next to the display showing real-time token status, served to motivate students by reminding them the value of their tokens, and that their efforts to manage their behavior will be rewarded. At the end of each school day, the students exchange their tokens for their chosen reward, and the display automatically resets to track the next day's tokens.

Token economy and Customization: *Ribbit* is designed to support token economies as they were realistically implemented in the classrooms we observed. One of the novel features of *Ribbit*, in contrast to available systems such as *ClassDojo*, is the ability to customize behavior monitoring for each individual student. Through a customization module, practitioners can enter any behavior to be monitored for each student. Instead of applying classroom-wide behavioral expectations, monitoring unique behaviors for each student results in tokens serving as reinforcers that are more specific and helpful to each student. In addition, as students make progress, monitoring can be updated to reflect new goals. For example, one student in Barry's class had trouble with social interactions, so Barry created an extra behavior category to specifically track each positive social interaction to be reinforced for this student.

Providing Students with Immediate and Specific Feedback
Visual feedback: The prototype is designed as a glanceable display [2], making it easy for students to quickly look up to the front of the class to check on their tokens without having to decode a chart or ask the practitioner. Each student in the class is represented by a frog sitting on a lily pad (Figure 4). A student's lily pad shows three numbers: tokens they have earned (above their name), reminders (in blue), and warnings (in red). We found that all four classrooms we studied used some form of punishment-based reinforcers, such as the reminders and warnings. In collaboration with the school psychologist, we devised a system whereby disruptive or undesired behavior would result

Reward	Tokens
Homework Pass	25
Simon Says Leader	20
Show+Tell/Computers	15
Reading/Drawing	10
Candy	7

Table 1: Rewards menu located next to the display.

Figure 4: *Ribbit*'s interface. When a student earns a token, a pop-up appears with the name of the student and the category that the token belongs.

in one reminder, then a warning if the behavior persisted, which placed students on a 'time-out' making them temporarily ineligible to earn a token. This compromise enabled Barry to feel that he could still enforce consequences, without using punishment-based reinforcers.

Auditory feedback: A sound is played when students receive a token for positive behavior, or when they receive a reminder or warning for demonstrating undesirable behavior. When students receive a token for positive behavior, a pleasant splash noise is heard. When a student receives a reminder, a bell is heard, and when a warning is given out, a thunderclap goes off. The sound is intended to help students connect their behaviors to its corresponding consequence. It was implemented to avoid the practitioner calling out or disrupting the class after inputting behavioral data, but rather the students can be alerted and turn their attention to the display at the front of the classroom.

Initial Deployment

We deployed *Ribbit* in Barry's first grade classroom with 19 students, under the consultation of a school psychologist, for one school year, about 10 months (including the iterative design process). In collaboration with the practitioner, a 40-inch display was chosen as the projection tool and mounted on the wall at the front of the classroom. It was tested to ensure all students, even those seated in the back, were able to read the screen. Our initial results are promising, during the first few weeks of deployment students were positively responding to the the display. Students would look up at the display every time they heard the splash, bell, or thunderclap noise, intrigued to see who had received it.

The practitioner expressed that the visual and audio feedback from *Ribbit* was less disruptive to the classroom environment and more reliable than his verbal feedback, enabling students to make stronger connections between their behavior and the immediate and behavior-specific feedback facilitated through the display. The classroom display application therefore represents the most immediate, reliable, and consistent form of feedback used in this setting. Additionally, the rewards menu gave students preferred reward options that they could choose from at the end of day (Table 1). The rewards menu was helpful to the practitioner who would remind a student whose behavior was starting to slip, that if they wanted to earn a reward, they needed to show appropriate behavior to earn enough tokens for that reward. Compared with Barry's verbal feedback or prior use of candy, this turned out to be a huge motivator for most of the students, who were now incentivized to display positive behavior to earn a desired reward. Students also reported going home and sharing information with their parents and guardians about *Ribbit*, how many tokens they earned, and which rewards they were trying to earn.

Discussion and Conclusion

We have described a collaborative research process with school practitioners motivated to improve their behavior management programs, and eager to incorporate ubiquitous computing tools to this end. Our wall-mounted display prototype showed that behavior management programs could be supplemented with automated reinforcers through the use of ubiquitous computing, especially when used with auditory and visual feedback. This prototype shows potential for automated reinforcers that could have vast implications for supplementing behavioral intervention in a variety of settings. Given the inconsistency of reinforcers provided by practitioners, particularly in challenging classroom settings, these types of tools should be explored further as a supplemental solution.

In future work, we plan to deploy our display using large sample sizes to show its efficacy in helping practitioners with classroom behavior management, as well as to test the generalization of our findings.

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