

# vSked: An Interactive Visual Schedule System for use in Classrooms for Children with Autism

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## ABSTRACT

Children with autism often experience substantial challenges in understanding, structuring, and predicting the activities in their daily lives. The use of symbols to represent a series of activities, also known as visual schedules, have been shown to be an effective intervention technique for helping individuals with Autism Spectrum Disorder. In this paper, we describe the design and technical architecture for vSked, an interactive visual scheduling tool that allows group interactivity with content generated through end-user programming. We also outline a scenario that demonstrates how vSked extends the benefits of traditional visual schedules through both interactivity and automatic logging of use. This scenario also indicates the type of experience a user might have during a demonstration session.

## Categories and Subject Descriptors

K. Computing Milieux; K.3 Computers and Education; K.3.1 Computer Uses in Education - Computer-assisted instruction (CAI); K.4 Computers and Society; K.4.2 Social Issues - Assistive technologies for persons with disabilities, Handicapped persons/special needs;

## General Terms

Design, Human Factors

## Keywords

Visual schedules, autism, education, assistive technology, children, computer supported collaborative learning

## INTRODUCTION AND BACKGROUND

Visual tools are commonly used as part of interventions for individuals with Autism Spectrum Disorder (ASD). Of these tools, one of the most commonly used is visual schedules, which use visual artifacts and symbols as representations for activities that occur in a given sequence. Use of these visual artifacts, in particular for individuals with ASD, reduces the symptoms associated with cognitive, communication, and social disabilities [1, 2].

Visual schedules can be used in classrooms, homes, and private practice instruction to strengthen sequential

memory and language comprehension, while reducing anxiety in children with autism [3, 4, 5]. In schools, visual schedules can assist students with transitioning independently between activities and environments. However, creating and monitoring student use of visual schedules can be a substantial burden for teachers and classroom staff. Often, teachers have neither the time nor the tools to flexibly and dynamically deploy creative lessons during class. Furthermore, teachers lack an easy way to track usage which reduces their ability to reflect on the curriculum and student performance.

There has been minimal past work in creating interactive, computational visual schedules. Attempted solutions that use information technology for visual schedules do so with PowerPoint (e.g., [6]). Similarly, for neurotypical students, researchers created Classroom Presenter, a PowerPoint plugin that adds multi-user inking functionality and the potential to insert "quiz" slides into presentations [7]. These general purpose systems, however, do not address many considerations specific to children with autism.

We created an interactive visual scheduling system, vSked, that allows for custom design of lessons and activities by teachers and other caregivers. Through participatory design and iterative development, vSked was designed to include the benefits of traditional visual schedules as well as new functionality such as dynamic task creation, various forms of automated reinforcement, and real-time usage tracking.



Figure 1: Common paper based visual schedules.

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Previous work and a pilot deployment in 2009 has shown that vSked has proven to be effective assistive technology in education in terms of student and teacher adoption, successful class facilitation, and overall user enjoyment [8].

In this paper, we first present a technical description of vSked and its system components. We then describe a scenario that shows some benefits of using vSked in a classroom environment and indicate the type of experience a user might have during a demonstration. We conclude by presenting some future work and direction for vSked.

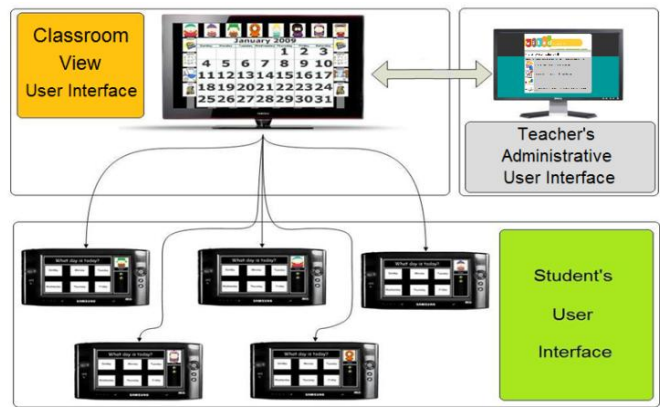
### vSked SYSTEM

vSked was designed through an iterative process involving observations of classroom activities, interviews and focus groups with relevant stakeholders [9], and participatory design sessions with teachers and staff members at one school [8]. Thus, the system is modeled on both best practices from the autism and special education literature and the experiences of particular teachers who have successfully used paper-based visual schedules in their classrooms (see Figure 1). For ease of reading, in the rest of this paper, we refer to the “teacher” when we mean teachers, classroom aides, and any other trained adults who might operate vSked. In this section, we describe vSked’s software and hardware components.

### Software Features

vSked supports both classroom staff and students. For both teachers and students, we created separate user interfaces (UI) to support their interactions (see Figure 2). vSked uses a client-server architecture and a MySQL database for data storage. The different interfaces used by teachers and students are wirelessly connected to the main classroom server. The network, classroom view, and student’s view were developed using Java and the Piccolo2D graphics framework while the administrator’s view was built to run in a web browser using PHP and AJAX. In the remainder of this section, we describe the functionality enabled through this architecture.

The teacher has two UIs, the first is the administrative interface, which allows the teacher to do all the end-user programming. Teachers can create and manage the class roster, student activities and schedules, and usage reports (see Figure 3). Second is the main classroom view, which



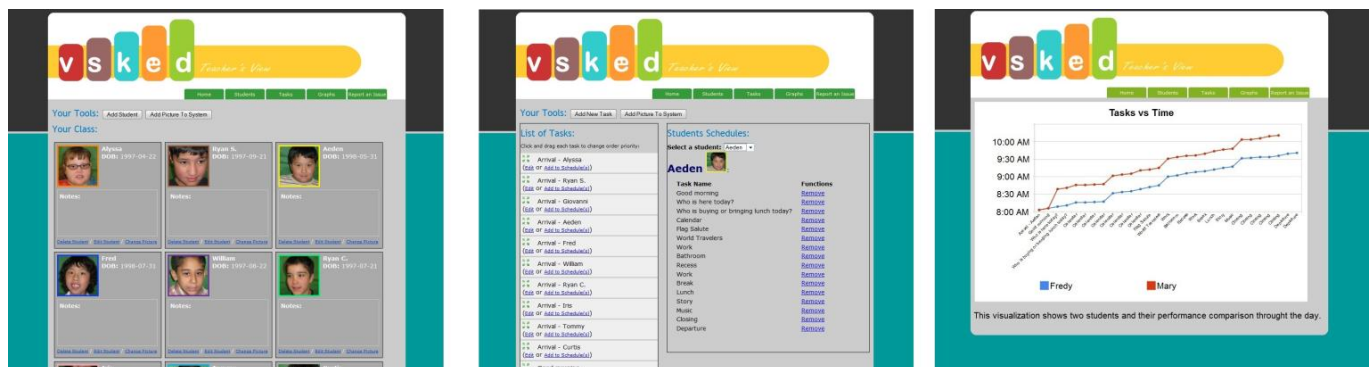
**Figure 2: vSked UI components designed to support each user’s interaction.**

the teacher uses to facilitate the activities during class (see Figure 4). Teachers can instantiate and delegate activities in the student’s schedule, manage student star reward tokens, and view who is present in class that day. The students have a single UI view on a personal handheld device, which allows the students to complete the activities delegated by the teacher in the classroom view. Students can also view their reward and the current number of tokens they have earned towards achieving that reward.

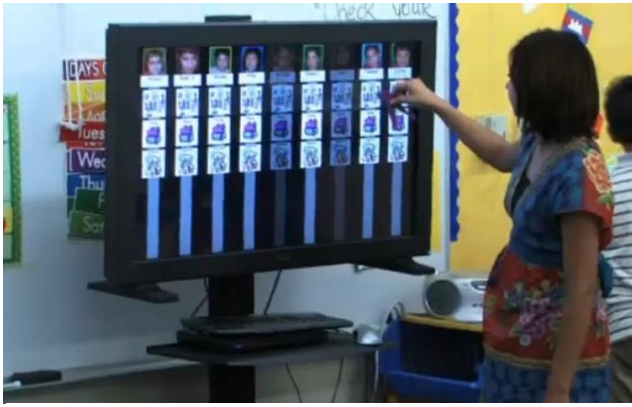
A teacher can create three main types of student experiences: voting, alerting, and choosing the correct answer. Voting tallies the student’s personal preferences on a given topic and displays a chart of the results in the main classroom view. Alerting prompts students to acknowledge the beginning of an event such as a greeting or a recess break. Choosing the correct answer engages students in problem solving activities.

These activities are presented in a choice series consisting of prompts and choices created by the teacher in the administrative view. For example, a choice series may consist of a prompt that asks students to “Select your goal!!” Reward choices could consist of pictures of toys, food, extra activities that students enjoy, or anything that the teacher deems appropriate for a reward.

In creating activities, teachers assign meaningful pictures selected from the vSked picture library. The teacher populates the vSked picture library by importing pictures



**Figure 3: The administrative view for building and managing the class roster (left), creating activities and schedules (Middle) and viewing usage data and reports (right).**



**Figure 4: The vSked classroom view displays all student schedules. Grayed out student schedules indicate that the student is absent for the day.**

from the Internet, hard drive, or digital camera. All pictures, activities, and choices are reusable in vSked, which allows the teacher to focus on developing a diverse and creative daily schedule.

Consistent reinforcement of appropriate behaviors and rewarding correct answers is of particular importance in managing an autism classroom. Thus, we developed an explicit reward activity in vSked. The reward activity allows students to select a reward goal (from a list of offerings pre-selected by a member of the classroom staff) and work towards achieving that goal by earning star tokens from the teacher for good work or behavior. Teachers instantiate the reward activity and distribute star tokens by using various input gestures on the large classroom view UI. The classroom view UI displays all student schedules and current star token counts, so that teachers are constantly aware of each student's reward state allowing them to manage behavior accordingly. Each student's goal and star tokens are displayed at the bottom right corner of the student's UI (see Figure 5). The reward activity is an integral component in vSked providing motivations and assessments of behavior and performance.

Another key vSked reinforcement feature is the automated fireworks animation. Each time students complete activities on their devices, they are prompted with a three second fireworks animation congratulating them. When students receive their fifth star token, the fireworks animation is displayed to the whole class in the classroom view, encouraging social and group interaction.

For the "choose your answer" activities, vSked incorporates an automated helpful hint system. When students select incorrect choices, correct choice shakes for a brief moment and one of the incorrect answers is removed. If students continue to answer incorrectly, vSked continues to remove each incorrect answer until only the correct answer remains. This process mirrors the kind of scaffolding and prompting systems demonstrated in classrooms already. For example, an aide might gesture slightly towards the correct choice, point directly, or even use hand over hand guidance. At the same time, if a child struggled with a field

of too many choices, an aide might remove a choice until only the correct choice remains.

The nature of individualized education plan and assessment for children with autism necessitates that their teachers have particularly intense documentation and reporting requirements. Thus, all of the interactions in vSked are logged and made accessible to classroom staff through visualizations for progress or report creation. These features automate some of the classroom monitoring and reporting so that teachers can focus on classroom instruction. The records also enable teachers to reflect on student progress over time and specific classroom events.

### Hardware Components

vSked has several hardware components that create the interactive experience. The hardware was chosen to best suite the user needs and functionality requirements of the system. For the classroom view, we used a single 42" touch-screen LCD connected to a laptop running the vSked server. For the student view we used several WiFi-enabled 7" touch-screen ultra-mobile PCs (UMPC). The touch-screen input mimics the highly touch-based visual prompts in use in the classroom currently and accommodates students with varying hand-eye coordination and fine motor skills. The small form factor fit well on student desks, while the mobile functionality allowed the students to take their schedules around the classroom when needed. A wireless router was used to connect all the components to the vSked server.

### SCENARIO

Over a weekend Janet, a special education teacher, wants to design an activity to help her students participate with their vSked in an activity about the nationalities of the world. Janet plans to ask students "where did we go yesterday?", "where are we today?", and "where are we going tomorrow?" Janet makes a list of all the places they have or will visit. She uses the internet to find pictures that represent the countries and saves the pictures on her USB drive. On Monday morning half an hour before class begins, Janet uses her laptop to access vSked's



**Figure 5: Choice series for the reward activity. Also shown in this figure are the 2 stars earned by the student so far. In this classroom, 5 tokens/stars earns a reward—time playing on the swings in this case.**



administrative view in order to upload the pictures to the vSked library. To add the new world-traveler activity, Janet creates three choice series to prompt the students with questions. She assigns each question a specific answer from a list of possible choices represented by pictures. When the new world-traveler activity is completely created, vSked stores it in its activity library. To add the new activity to each student's schedule and assign it as a morning activity, Janet finds the world-traveler activity from vSked's library, drags the traveler-activity high up in the activity list, selects "add to schedules", and marks the check box "add to all students".

When the students arrive, Janet says, "Get your vSked!" Each student grabs his or her device from its charging station and sits at a desk. Janet explains to the class that they are to recall which country they visit on which day.

First, students choose their rewards for the day. Janet touches the image for the activity she wants to start in the classroom view. This action distributes the activity choice series to all the students. Once they have all chosen a reward, Janet touches the images for the activity. The students are prompted with one of the three questions and several pictures of different countries. Students touch the UMPC's to select their answers. vSked automatically rewards students who answered correctly with a fireworks animation. For students who are having trouble selecting the correct answer, vSked uses its built-in hint system to help identify the correct choice. Janet awards stars to students who answered correctly on their first try. She awards one star for students who take repeated tries.

One of the students, Ronald, answers all the questions on the first try, which gives him enough stars to receive his reward. The classroom view displays a large fireworks animation letting the whole class know that someone has reached their reward. Janet asks the students to look at vSked's classroom view, see who had reached five stars, and call out the achiever's name. All the students identify Ronald and call out his name. Ronald gets excited, claps his hands, gets his toy car reward, and selects the next reward towards which he wants to work from his vSked device.

At the end of the week, Janet uses vSked's administration interface to view visualizations of each student's individual performance or in comparison to the whole class. Janet then generates reports that can be sent home to parents and stored for student records.

## CONCLUSION

vSked has been developed as an assistive technology for individuals with ASD. Through participatory design, vSked was developed to encompass the benefits of existing interventions and to expand the tools teachers can use in their creative processes. In our future work, we are interested in integrating new features into vSked, including personalized animations for reinforcement, new forms of prompting, mini-games, and instructional slideshows. We

are also interested in making vSked more collaborative, both in terms of student participation and for teachers using the system in multiple schools. Thus, we are also exploring the inclusion of instant messaging and collaborative help amongst students and the ability to share resources as part of a vSked online community for teachers. By continuing work in this domain, new iterations of vSked will expand its features and accommodated a greater variety of users.

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