A Participatory Design Workshop on Accessible Apps and Games with Students with Learning Differences

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ABSTRACT
This paper describes a Science-Technology-Engineering-Mathematics (STEM) outreach workshop conducted with post-secondary students diagnosed with learning differences, including Learning Disabilities (LD), Attention Deficit / Hyperactivity Disorders (AD/HD), and/or Autism Spectrum Disorders (ASD). In this workshop, students were actively involved in participatory design exercises such as data gathering, identifying accessible design requirements, and evaluating mobile applications and games targeted for diverse users. This hands-on experience broadened students' understanding of STEM areas, provided them with an opportunity to see themselves as computer scientists, and demonstrated how they might succeed in computing careers, especially in human-centered computing and interface design. Lessons learned from the workshop also offer useful insight on conducting participatory design with this unique population.

Categories and Subject Descriptors
K.4.2 [**Computers and Society**] Social Issues – *assistive technologies for persons with disabilities.*

General Terms
Design, Human Factors.

Keywords
Participatory design, learning differences, cognitive disabilities, accessibility, STEM, education, human-computer interaction.

1. INTRODUCTION
One of the most pervasive obstacles to STEM education for many students is access [1], particularly for students with LD, AD/HD and ASD. Research in STEM education finds it essential for these students to participate in group problem solving and to follow common scientific practices in their courses so they have the practical experience to inform their consideration of a STEM major [1]. These immersion and inquiry-based experiences offer students, regardless of ability, time to test their own understanding and reasoning skills [2], and empower them to create a self-portrait of being successful in STEM [3].

We held a workshop at Landmark College designed to engage post-secondary students, all of whom self-identify with one or more learning difference (LD, AD/HD or ASD), and to stimulate their interest in computing fields. Faculty and graduate students from UMBC facilitated participatory design (PD), a frequently used design method in computing fields such as human-centered computing (HCC), to equip Landmark students to evaluate accessible mobile applications ("apps") and games. PD focuses on designers collaborating directly with intended users throughout the design and development process [4]; users are empowered to make decisions about the design as a part of the team. Researchers have worked with diverse user groups, including users with visual impairments [5] or memory impairments (e.g., aphasia, amnesia) [6], aiming to understand how to promote their involvement in the design process. Design methods often must be adapted to support the abilities of the target users, sometimes significantly [6]. Attentional and learning disabilities present a somewhat unique challenge in PD, requiring a focus on hands-on activities and frequent breaks, which we incorporated into our workshop.

The main goals of the workshop were (a) to enable UMBC students to better understand the needs of individuals with learning differences, and (b) to help Landmark students to gain an understanding of the interaction design process and to develop skills which they might perform in an HCC-related role.

2. WORKSHOP DESIGN
The one-day workshop was divided into three sessions. In the morning, we introduced the concepts of HCC and PD. We emphasized how HCC takes into account users' individual needs, preferences, and abilities when designing technology. As an ice-breaker and to gauge the interests of the Landmark students, we led a group discussion about their opinions on apps, games, and technology. This discussion also helped empower the Landmark students to feel that they had expertise to contribute in the design activities. In the afternoon, students interacted with the app and game prototypes in small, self-chosen teams (4 Landmark students and 1 or 2 UMBC researchers). After two PD sessions, the UMBC students presented how the designs had evolved that day. The day ended with group reflection, and the Landmark students completed surveys about their experience.

PD teams worked for 60 minutes with each of 2 (out of 4) game prototypes, developed for individuals with learning differences and multiple disabilities in a UMBC graduate-level Assistive Technology class. More information about the prototypes can be found at http://landmarkandumbc.wordpress.com/. The PD teams were introduced to the prototypes and asked to think of ways to strengthen the existing designs, to make them more usable, or to make the interaction experience more engaging. UMBC students facilitated the sessions, demonstrating the apps through both low- and high-fidelity prototypes. For example, working prototypes of the apps were demonstrated, and paper screenshots were also used. Teams captured ideas using both public (whiteboards and easels) and private (sheets of paper) record-keeping materials

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Figure 1. Graduate students facilitated the PD sessions, asking questions, showing prototypes and capturing ideas.

(Figure 1). The second design session extended the designs of the group who had evaluated the same prototype in the first session.

A total of 12 Landmark students participated in the workshop (2 females, 7 STEM majors), aged 18-22. All participants self-reported having two or more disabilities (9 students reported AD/HD, 5 students reported LD, and 4 students reported ASD).

3. LESSONS LEARNED

The workshop evaluation surveys revealed that the students felt they had had engaging, inquiry-driven conversations with the UMBC faculty and graduate students. According to all of the Landmark students, the PD sessions were the most interesting portion of the workshop, and for some, this experience either increased or confirmed their consideration of STEM careers. The surveys also revealed that the students enjoyed relating HCC methods to their own lives and interests. Observationally, Landmark students were enthusiastic about being team members, engaging in critical thinking, and giving feedback on how to make the apps and games more accessible for diverse users. The use of the hands-on PD method enabled these students to remain engaged, attentive and responsive throughout the activity. Small groups of 3 to 4 students allowed teamwork while still enabling each student to feel included. Of note is that the students became personally invested in the design process. Follow-up surveys indicated these positive feelings were retained after the workshop.

In designing such educational experiences, we recommend the consideration of (a) **communicative differences**, (b) **visual or verbal thinking**, (c) **personal context**, and (d) **inclusive empowerment**. For example, we developed strategies to encourage discussion between individuals with difficulties **communicating** with one another by focusing on small group interactions. Students were more willing to contribute their ideas during small group sessions compared to the large group session, and were more open to peer-instruction within the small groups. Second, students preferred either **visual or verbal** approaches to design. Some had little difficulty describing their design ideas, whereas others opted to diagrammatically represent ideas which were challenging to verbalize (Figure 2, sketched as the student described his ideas for the app). Third, relating the tasks to the **context** of students' daily lives (e.g., using apps and games) also helped generate student interest. The students were able to contextualize the designs, offering personal insights into how the applications would meet their own needs or the needs of their peers. Fourth, we aimed to be **inclusive**; by using both working prototypes and paper prototypes, every member of the team was hands-on during design activities. We suggest bringing multiples of each prototype: some students strongly identified with the working prototypes, while others preferred paper.

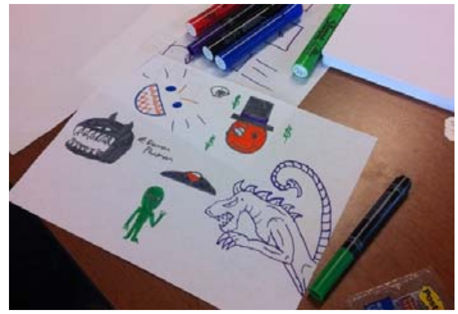

Figure 2. Image of drawings that students created while thinking about the design of a mobile app.

Based on our workshop, to implement a PD approach to teach STEM concepts or to generate STEM interest in students with learning differences, we believe that accessibility, novelty, and student decision-making must be incorporated into the lesson. Structuring the workshop in a hands-on approach allows students to come up with their own questions and gather data, imperative to make these topics accessible to students with learning differences. We hypothesize that students' personal investment resulted from several factors: (1) increased awareness of the methods employed by scientists, (2) recognition of the practical applications of PD, (3) understanding limitations of current technology, and (4) appreciation of the impact that computing fields have on the daily lives of diverse user populations.

Prior work has established the benefits for HCC students to participate in educational activities to increase their awareness of designing for disability [7]. This workshop focuses on the reciprocal relationship of including PD in STEM outreach for students with disabilities. We anticipate building on and refining this model in future PD workshops for students with learning differences to stimulate interest in computing fields and STEM.

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