

Fostering Maker Identity and Collaboration: Affordances of the Connected Spaces Dashboard in Two Afterschool Makerspaces

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With a focus on learning through personally relevant projects, students in makerspaces engage in meaningful design. Maker portfolios are increasingly being used to capture and assess progress and learning in these spaces. The Connected Spaces Dashboard focuses on maker identity development and collaboration between makers in and across makerspaces. We implemented a prototype version of the Dashboard in Spring 2023, in two after-school makerspaces. Analysis of two student interviews and Dashboard profiles highlighted the aspects of the tool that were effective (e.g., student affinities) and those that needed improvement (e.g., its ambient presence). We utilize these findings to inform the development of the next version of the Dashboard.

CCS CONCEPTS • Applied computing → Education → Interactive learning environments • Applied computing → Education → Collaborative learning

Additional Keywords and Phrases: Makerspaces, Maker portfolios, Maker identity

1 BACKGROUND

Makerspaces are being recognized as a means for increasing equity in computing, by empowering students with the choice of how they want to engage in computing. In contrast to purely workforce goals, makerspaces are giving students the opportunity to explore alternative endpoints in computing that are relevant to themselves and their communities [1].

A common tool to express and assess student learning in these spaces are maker portfolios. Chan & Holbert (2020) approach online maker portfolios as a way to assess student maker journeys, with students focusing their portfolios on the progress of their projects [2]. As in [3] iterative maker portfolios focus on computational communication and reflection. In many such maker portfolios, the focus is often on the progress of the maker activities and projects.

For students who have previously been marginalized in the field of computing, seeing themselves as makers in these spaces and developing various parts of their maker identities is crucial for their computational empowerment. Further, in order for them to develop maker identities, it is essential that the makerspace reflects and builds on their previous experiences, interests and identities [1, 4]. Developing student identity can constitute various factors like competence, confidence, and interest development, as well as allowing recognition of the students as makers [5]. As highlighted by [6], maker portfolios are also being used as collaborative community building tools, to grow the definition of a maker community beyond the physical makerspace.

Makerspaces are emerging not only in formal spaces like schools and universities, but also in informal spaces like after-school programs and summer camps. Given that engagement and participation in these informal environments varies in frequency and consistency, fostering communities of practice in them has been a unique challenge for researchers [7]. According to [8], communities of practice are people who share knowledge and experiences by working in a common domain and engaging with its community. Students do not engage with each other on a daily manner like in school, requiring more external scaffolding and tools to create ongoing social interaction of a community of practice.

The Connected Spaces Dashboard design focuses on the development of student maker identity, with the intention of allowing students to express and develop their competence and interest in making. Further, the intention of the Dashboard as an ambient display in the makerspace is to foster a community of practice by connecting makers within a space, as well as across physical spaces with each other, in a persistent manner. Makers will be able to view other students' portfolios, recognizing each other as makers and finding opportunities for collaboration while developing maker identities and communities.

2 METHODS

2.1 Design of the makerspace activities

From February to May, we conducted weekly after-school makerspace sessions in partnership with two local community organizations, one all-girls and one all-boys, primarily consisting of African American students. Both organizations created dedicated spaces for these maker activities, which were designed and conducted in a similar manner. For the first four weeks, students followed instruction-based activities to understand specific physical computing elements for Circuit Playground Express (CPX), including on-board and external input and output components like lights and sensors. For the next two weeks, they worked with brainstorming tools to plan their final project. They then transitioned into building their own personal projects for the remaining six weeks. Within the first couple sessions, the students were introduced to the Dashboard as a profile to update at the beginning of each session. At subsequent sessions, students were prompted to update their profiles in a variety of ways (including addition of interests or affinities that had changed, or that reflected the projects they were working on).

2.2 Design of the Dashboard

The Connected Spaces Dashboard is a digital tool that allows students to create personal maker profiles that are displayed to everyone across physically distant but digitally connected makerspaces. Broadly, it is a system designed to do two

things: 1) promote collaboration amongst students in and across spaces; and 2) allow students to develop and represent their maker identities through displaying their affinities and maker projects.

We developed two prototypes: the first was built in Miro, the second in Google Slides. Our initial prototype was utilized in a college level class and gave us some general insights about usability and what users would be willing to do with limited functionality. Considering feedback from this initial prototype, we developed our second prototype in Google Slides to allow for increased personalization, to help users better express their identities. Given that the primary users of the prototype were going to be middle-school students, Google Slides was an accessible and familiar platform for them. This platform also allowed for the most flexibility as well as ability to personalize by changing colors, adding images from the internet etc. It also allowed for a wide “all slides” view that could act as an ambient display (see Figure 1), and students could change colors and fonts, and easily copy and paste images or GIFs from the internet to customize their personal slide.

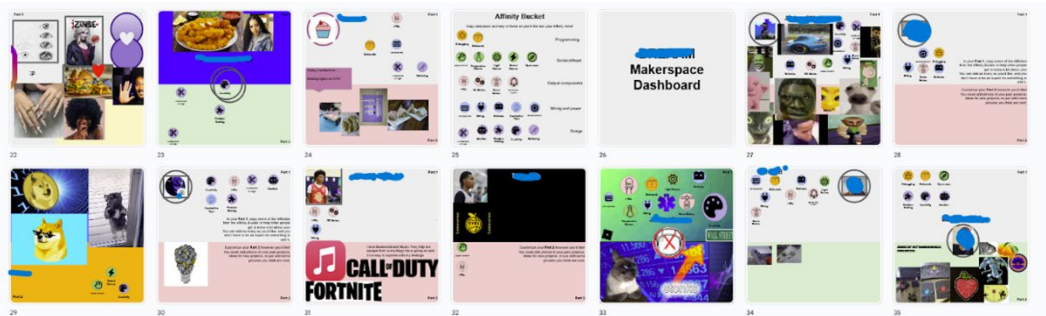


Figure 1: Ambient display view of the Dashboard (partial)

As suggested by Kumar & Tissenbaum [2022], we used affinities instead of expertise, for students to identify with various skills regardless of whether they were competent in them, allowing for dynamic, interest-based modification of maker identities [9]. Affinities would also form the basis of collaboration between students with similar or contrasting interests and skills.

Students made weekly updates to their individual profile (Google Slide). We had separate sections in the same deck for the two makerspaces, example profiles of the researchers (see Figure 2 (left)), templates for students to model their own Dashboard profile after, and the Affinity Bucket (see Figure 2 (right)) - a slide from which students could copy a range of affinity icons to their own profile. The slide templates had prompts for the students e.g.: an area for their name and profile picture, a section for affinities, and one for personal interest and maker activity representation.

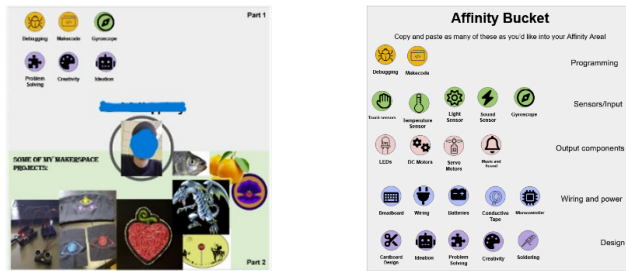


Figure 2: Researcher's example Dashboard profile (left) and Affinity Bucket (right)

2.3 Participants

Our participants were drawn from the middle-school students who participated in the afterschool makerspaces. Of the 18 students at the girls-makerspace, about nine were consistently present for most weeks. For this paper, we interviewed and analyzed Jiya's Dashboard, as she had attended most of the sessions and had worked on the Dashboard consistently. She was an eager student who had previous interests in coding, STEM, and building. For her final project, Jiya was passionate about building a flying car. At the boys-makerspace there were nine students who created Dashboard profiles, and only three attended consistently enough to modify their profiles in meaningful ways. For this paper, we interviewed and analyzed Oscar's Dashboard since he attended most of the later sessions, where he started designing his project and engaged with various aspects of the Dashboard. For his final project, he decided to create a moving robot assistant with an LED face. We also looked at the weekly Dashboard progress of three other students from each makerspace, who engaged with the Dashboard in some consistent manner.

2.4 Data Collection and Analysis

For this paper, we devised a coding scheme to quantify changes in students' Dashboards on a week-to-week basis, to identify potentially interesting trends. We tracked changes in their dashboards across five factors: self-identification, pertaining to students' names and profile pictures; their self-expression, pertaining to the images and descriptions students added to their profiles; statement of affinities, pertaining to the affinities that students copied onto their pages; description of maker activities, pertaining to images or descriptions relevant to the material in the camps; and interaction with other makers, pertaining to elements changed or added due to interaction with their peers. Researchers then coded the four students from each makerspace and ameliorated any disagreements in the coding through iterative discussions. The eight students were chosen to represent varying levels and types of engagement with the Dashboard – some more consistent than others – such that we might also observe some contrasting trends. The researchers then examined the codes to reveal trends across each factor for each student.

Using a grounded theory approach [10], we conducted a brief qualitative analysis of the semi-structured, one-on-one audio interviews with Jiya from the girls-makerspace and Oscar from the boys-makerspace to reveal four emergent themes of their Dashboard experiences. These themes arose based on observations about students' usage patterns, the most common elements added to the Dashboard profiles, and our original design intentions generated from our initial Miro prototypes.

3 FINDINGS

Qualitatively analyzing interview transcripts, students' iterative changes to their Dashboards, as well as the design decisions of the Dashboard, we drew out four aspects of the Dashboard design and utilization that Jiya and Oscar indicated in their interviews as impactful. Figure 3 shows Jiya and Oscar's Week 10 (the last week we analyzed their edits) Dashboard slides. Observing changes in Dashboard elements of eight students also contributed to these findings.

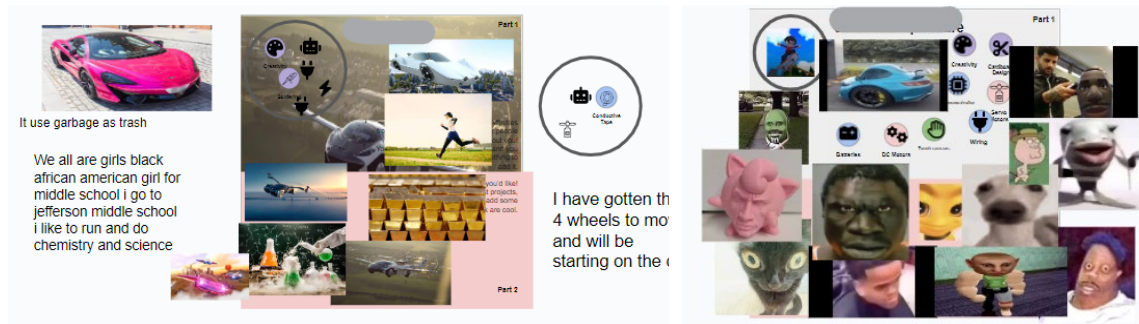


Figure 3: Jiya's Week 10 Dashboard (left) and Oscar's Week 10 Dashboard (right)

3.1 Use of affinities

Affinities were introduced to the students for them to represent the maker activities, tools, and skills they were interested in using. Observing the eight students' affinities over the course of the weeks, we see that most of them were comfortable adding more affinities as they updated their Dashboard slides. For instance, a student updated their affinities five times over a nine-week period. They initially started with an affinity for "creativity" and eventually added technical affinities (e.g., LEDs, sensors) over time. Some affinities seemed to be more common than others, e.g.: creativity and LEDs.

Jiya has various affinities on her Week 9 Dashboard, all of which she indicated she had an interest in. "[she added] creativity [...] because [she] has a great imagination. The robot because [she] wants to make robots ... and the wire... [she] likes using wires and electricity and stuff that has to do with plugging. For the tape one... [she] likes using that kind of stuff". However, she also mentions that the Dashboard doesn't really change how she sees herself as a maker.

Oscar's interview revealed that he added affinities for several different reasons. First, he added affinities based on the few skills he was comfortable with, then, as the program progressed, he added more that he was becoming more familiar with. "...as time went on [he] added more and more, because those new things became [his] new favorites." He also expressed that he would continue pursuing the new skills he added as affinities going into the future.

3.2 Identity expression

A unique feature of our current Dashboard is that we encouraged students to personalize their slides as much as they wanted. From Week 1 they were encouraged to add images and text that helped reflect who they were as people and what their interests were. As indicated by [4], building on students' previous experiences and interests allows for more effective and relevant engagement, while also allowing them to make connections between their learning and current identities. Students in both makerspaces used their Dashboards to express their identities, with food items, memes, fashion, celebrities, sports, and games. Most students did not change their identity expression on the Dashboard slides too much, occasionally adding a couple images or text when prompted. The data from the coding scheme reflected this trend as well.

We saw that six of the eight students evaluated did not change “self-identification” more than once, i.e., once a profile picture and name was added it remained the same for the rest of the weeks. Seven out of eight students made changes to the “self-expression” portion of the Dashboard three times or less during the nine-week evaluation period.

Jiya changed the background colors of her slide to begin with, and then started to add images of flying cars as something she was passionate about making. After a couple weeks, she added running and chemistry as things she enjoyed. Additionally, she added text about all the girls being Black African Americans and middle-schoolers. This was contrasting to other girls in the space, who started by adding hobbies and then transitioned into adding maker project-oriented pictures. Over the weeks, she added additional photos of flying cars, each displaying features she wanted to incorporate... She also added a picture of bars of gold because she “want[ed] to make a lot of money off [her cars].”

Oscar made the most changes Dashboard edits out of any of the students at his makerspace. Each week, he covered his profile in an entirely different set of memes: “I don't think there is a single meme that I've kept going...” He expressed that rather than putting in the amount of work to add all the memes to his profile to show to the other students in the camp, he did it “Mostly for [himself]”, but if others wanted to look at it then... maybe they'd get a laugh out of it.” As his profile changed to include more affinities, he noted that he’d “put more actual skills and stuff that [he] liked on there, it's still pretty bombarded with memes and stuff but it's just what [he] likes.”

3.3 Ambient presence of Dashboard

One intended feature of the Dashboard is an ambient presence to be displayed at the front of the makerspace where students can view others’ profiles as well as their own. This aspect provides legitimacy to students’ maker identities and acts as a launchpad for spontaneous collaboration between makers with similar affinities. In both our spaces, due to technical challenges, the Dashboard was not put up as an ambient display until about Week 6. Even after being brought to the students’ attention, the Dashboard as an ambient display did not make an impact on the students and their participation in the space. Towards the last few weeks, students started noticing the Dashboard as they entered the space, but soon forgot about it as they started engaging in maker activities. Jiya even goes on to say that she did not even notice the presence of the Dashboard or that it was being displayed in the space, and Oscar noted that after we added the flat-screen TV to the makerspace (where the Dashboard was displayed), it didn’t particularly change anything for him. Also, he expressed that even though he knew people could see his Dashboard, he wasn’t intentionally creating it for them to see.

3.4 Affordances of the Dashboard

Various parts of the Dashboard and its implementation were designed intentionally as indicated in the Methods. Students were given time to update their Dashboard at the beginning of each class, due to the inconsistency in exit times, but were encouraged to keep updating them as they felt necessary.

Jiya indicated that the Dashboard was difficult to use, because “[she] put down pictures and it [was] hard to write about things [she hadn’t] really made yet.” She said it would have been easier to do it at the end of each day “because then [she] would have been able to write down all the stuff [she] recently made.” In general, Jiya also talks about how she was not one who enjoyed planning, and wanted to immediately jump into making, so doing the Dashboard added resistance to her work. She liked working on the Google slides, stating that uploading progress photos instead of images from the internet would have been a better way to display her maker skills.

At Oscar’s makerspace, the students used personal Chromebooks that created technical challenges when used to access Google Slides. Sessions at this makerspace were less consistent as not all students attended each session each week, and for the first few sessions, we didn’t have the infrastructure to facilitate students’ use of the Dashboard. Later in the semester,

we obtained access to a wide-screen TV to display the Dashboard, and students were notified that they should bring their personal Chromebooks to access the prototype. Oscar expressed some concerns about the use of the Dashboard, indicating that he wasn't sure what he was supposed to do at first. He also expressed that in a future version, it would be nice to add the affinities from a drop-down menu, rather than having to scroll past everyone else's Dashboards to copy them and then scrolling all the way back down. He also added that if he had been using the Dashboard on his personal computer, he would have been able to add some of his art projects and previous work to his profile, which would have helped him express himself more.

4 DISCUSSION

Implementing the Google Slides version of the Dashboard in two different afterschool makerspaces allowed us to understand some of the design decisions that were beneficial (e.g.: affinities and customization), as well as some of the challenges that need to be addressed in future versions (e.g.: ability to add pictures and scaffolding interaction with the ambient display). We are developing a third version of the Dashboard in the Unity Engine WebGL, while keeping in mind our findings.

Overall, the students enjoyed being able to express themselves on the Dashboard. The initial weeks of using the Dashboard to express their identities as well as affinities allowed them to familiarize themselves with the platform. Allowing for this self-expression in the makerspace enables development of maker identity for the students, allowing them to integrate making with their previous interests. Many of the students customized their slides, creating agency in the space. Students engaged with affinities in a manner that showed not only their ability, but also their interest in maker activities, allowing for development of confidence, competence as well as recognition of self as a maker. Some affinities were interpreted differently than intended by the students, which we could clarify with our next version.

Few students made updates about their projects on the Dashboard, despite expressing that they would have liked to do so. Allowing for the ease of capturing and uploading media might allow students to make quicker and more regular updates, with less resistance. Furthermore, prompting the students to update their profiles towards the end of the day might allow them to document their progress more effectively.

A significant aspect of the Connected Spaces Dashboard is its ambient display, which is designed to spark collaboration and create community in and between makerspaces. In both our makerspaces, the Dashboard was put up in the space, starting only in Week 6. By this time, the cultural norms in the makerspaces had already been set up, and collaboration and mentorship were not natural to the space. In order for the ambient presence to be utilized by the students, in our next implementation, it will be present and centered in the space from the beginning, with students being encouraged to collaborate on learning and exploring it. Further, our makerspaces were conducted during different times in the week. Allowing for concurrent implementation can allow students to see real-time updates in the distant makerspaces, allowing for cross-space collaboration as well.

5 CONCLUSION

A key aspect of equitable makerspaces is their focus on project-based learning that can foster identity development and community building within and across these spaces [4, 6]. Students use the Connected Spaces Dashboard to express their identities and affinities, hence evolving in their maker identities. Display of maker learning, and identities can spark collaboration and recognition of makers in the space. However, judging from our findings, in order for tools like the Dashboard to be contribute towards creating a community of practice [8] in informal makerspaces, they need to be embedded in the culture of the space from the beginning. Student engagement with the Dashboard needs to be scaffolded,

not only in creating profiles, but also in viewing other profiles and asking for and providing help to peers in and across spaces. Students need to be made aware of the tool and its purpose, allowing them to use it in a manner most impactful to them. For this to further be effective, tools like the Dashboard should have low resistance in making updates about user progress and become a part of their making process and culture. Using these tools, students in makerspaces can begin to express their maker identities, while becoming a part of a community of practice through collaboration and recognition of other makers in and across makerspaces.

REFERENCES

- [1] Mike Tissenbaum, David Weintrop, Nathan Holbert and Tamara Clegg. 2021. The case for alternative endpoints in computing education. *British Journal of Educational Technology* 52, 3 (May 2021), 1164-1177.
- [2] Monica M. Chan and Nathan Holbert 2020. Insights on online mobile maker portfolios for process documentation in K-5 constructionist learning environments. *Constructionism* 2020, 365-373.
- [3] Debora Lui, Deborah Fields and Yasmin Kafai. 2019. Student maker portfolios: Promoting computational communication and reflection in crafting e-textiles. In *Proceedings of FabLearn 2019*. March, 2019, New York, NY, 10-17. <https://doi.org/10.1145/3311890.3311892>
- [4] Nicole Pinkard, Sheena Erete, Caitlin K. Martin and Maxine & McKinney de Royston. 2017. Digital youth divas: Exploring narrative-driven curriculum to spark middle school girls' interest in computational activities. *Journal of the Learning Sciences* 26, 3 (Aug. 2017), 477-516.
- [5] Ashita Bawankule and Mike Tissenbaum. 2023. Maker identity: What and how? *International Society of the Learning Sciences* (Jun. 2023).
- [6] Anna Keune and Kylie Peppler. 2017. Maker portfolios as learning and community building tools inside and outside makerspaces. *Computer-Supported Collaborative Learning Conference 2* (Jun. 2017), 545-548.
- [7] Kimberly Sheridan, Erica R. Halverson, Breanne Litts, Lisa Brahms, Lynette Jacobs-Priebe and Trevor Owens. 2014. Learning in the making: A comparative case study of three makerspaces. *Harvard Educational Review* 84, 4 (Dec. 2014), 505-531.
- [8] Jean Lave and Etienne Wenger. 1991. *Situated learning: Legitimate peripheral participation*. Cambridge University Press.
- [9] Vishesh Kumar and Mike Tissenbaum. 2022. Supporting collaborative classroom networks through technology: An actor network theory approach to understanding social behaviours and design. *British Journal of Educational Technology* 53 (Sept. 2022), 1549-1570. <https://doi.org/10.1111/bjet.13274>
- [10] Juliet M. Corbin and Anselm L. Strauss. 2008. *Basics of qualitative research: techniques and procedures for developing grounded theory* (3rd ed.). Sage Publications.