How Time Gets Used in Afterschool Maker Programs

Short Paper

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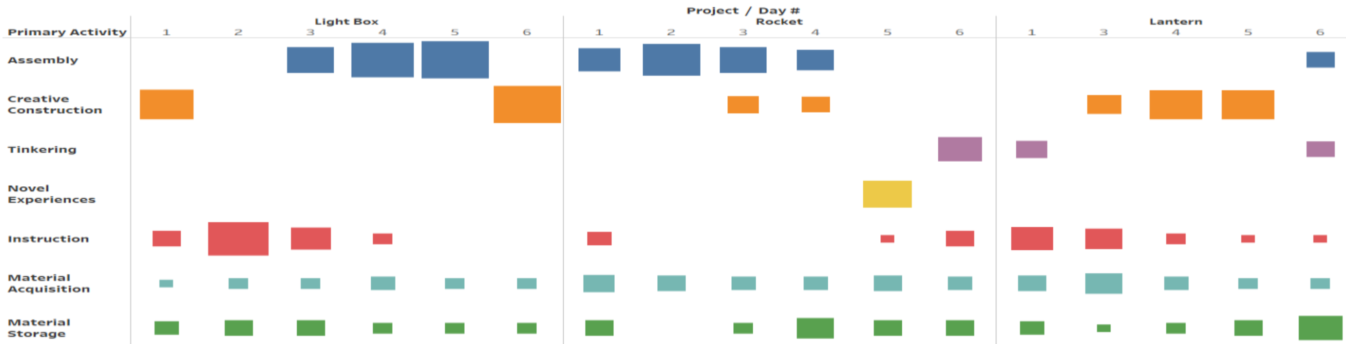

Figure 1: A visualization of time use in three six-week long afterschool Maker programs organized around specific artifacts that youth created. Size of each box corresponds to amount of time used during that day.

ABSTRACT

Makerspaces are situated in diverse settings and engage in differing projects. Consequently, it appears that there is variation in what activities are engaged in and how time is spent in makerspaces. To date, the time-use of these activities within makerspaces has yet to be explored. The present paper identifies seven primary activity categories and discusses how time is devoted to these activities across three maker camps.[1]

CCS CONCEPTS

• **Applied computing → Education**

KEYWORDS

Time use; makerspaces; afterschool

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1 INTRODUCTION

Over the last decade, Makerspaces, FabLabs, and other fabrication and Constructionist-oriented programs have steadily appeared in many different sites with the general intent of providing learning experiences that differ substantially from the sort of business-as-usual kinds of activities that typically take place in school classrooms. To date, we are gaining a number of encouraging accounts of how individual and small groups of youth are able to produce meaningful projects over one or more sessions in such spaces [1], [3] and identify some ways in which fabrication experiences produce unintended struggles that prevent students from making intended progress [3], [7]. We have even begun to see some evidence of longitudinal success at the classroom level when Making is infused throughout a school year [5]. All of these findings are informative as the Maker movement and its relationship to educational settings proceeds into its second decade. However, we believe that there are some basic qualities of Maker learning activities that we have yet to understand.

For instance, we may wish to note where one Maker program requires youth spend most of their time assembling digital artifacts from prepackaged kits whereas another required youth spend most of their time conceptualizing and creating prototypes of their own brand new artifacts. While both are related to Making, we would expect those are qualitatively different experiences. We believe that acknowledging these differences would be helpful for the field. In time, it may even help us to understand and appreciate how different Maker experiences are related to different learning outcomes.

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Thus, our goal for this paper is to spotlight some of those differences and do so through the use of a relatively simple categorization scheme we have developed. The long-term hope is that this coding scheme will be useful for others in broadly describing structure and sequence of activities in educational Maker programs. It should also be useful for characterizing what variation exists across different Maker programs and settings. At present, we use it to show how time has been used in three afterschool Maker programs offered at the same site. This analysis of time use is informative on its own in that it shows some tendencies and regularities that speak to the practicalities of afterschool Maker programs and highlights areas where we may potentially improve.

2 LITERATURE REVIEW

Activities and their duration in Makerspaces vary. For instance, Martin [10] noted that the duration of Maker activities could range from hours to years in some community Makerspaces and minutes to hours in some Museum makerspaces. Lee et al. [9] have observed that Library-based Maker programs can extend to multiple visits but also often have a drop-in quality and patron expectation that participants can appear at a single session and then leave with a finished product. Longer term programs [1], such as what would be seen in a classroom or afterschool club are often designed for weeks or months of continuous engagement and assume that youth will maintain extended pursuit of projects that will require many days of effort with each day of work being a few hours at a time.

Beyond variable amounts of time one is involved in Making, the quality of Maker activity can differ. Recently, Bevan [1] has identified from the literature three types of educative Maker activities. These include *assembly* Making, which tends to be highly structured and involves and emphasize tool familiarization (e.g., building from a kit or following a mentor as she goes through a series of established steps), *creative construction*, which emphasizes goal attainment given some known constraints (e.g., incorporate a motor and sensor into an object of our own creation), and *tinkering*, which moves youth away from use of formal instructions and instead involves open exploration and experimentation without a pre-set design goal necessarily being determined ahead of time (e.g., exploring ramps on a marble peg-board wall to see what happens with different assemblies).

Thus, there appears to be variation in time and type of activities involved in Maker learning settings. Yet, given the still growing in this area, time-use studies do not yet exist. It is our view that raising awareness of time-use in Maker programs could be beneficial for those developing and implementing Maker programs. Elsewhere, time-use research has helped to support the development of realistic productivity expectations [6] and help researchers identify correlations between how time is used and desired learning outcomes [8].

3 METHODS

3.1 Participants and Setting

Youth participants between the ages of 10 and 16 attended one or more 6-week Maker groups at a community Makerspace in Northern Utah. Participants registered to participate ahead of time and were expected to meet once a week for a scheduled period of one and half hours at a time afterschool. Employees of the Makerspace and parents acted mentors to the youth, with the mentor to youth ratio usually 1:4. Each group was advertised as focusing on a different project that would be completed by the end of the six weeks and had a different lead facilitator. The 6-week group projects included construction of light boxes (n=7, one female, six males), model rockets (n=12, all female), and lanterns (n=14, all female). These groups participated during the 2016-2017 academic year.

- In the light box group, each youth designed a scene to depict on the surface or inside of a cardboard box, which they then cut out by hand. They then planned out the locations for LEDs to incorporate into the scene flickering in a programmed sequence. The participating youth designed their circuits, soldered them, and programmed a basic microcontroller.
- In the model rocket group, the youth prepared model rockets which they then custom decorated with laser cut vinyl and other decorations of their own design. They then did a launch of their decorated model rockets at a local park, and finally explored the effectiveness of different potential rocket fuels.
- In the lantern group, the youth worked with Adobe Illustrator to prepare laser-cut shapes on four sides of a wooden lantern that had a RGB light that cycled through a pre-set sequence of colors. Nearly all the youth participating in this group participated also in the Rocket group. The organizer of the Rocket group had arranged for the youth to take a tour of a local laboratory that was involved in space launches, this tour had to take the place of one of the six scheduled days for the Lantern group, making this group only five sessions in total.

3.2 Data sources

As part of a larger ongoing project studying youth engagement in Making [4], we obtained video footage for nearly each meeting of the three project groups. In addition, each youth participant had consented to wearing a Go-Pro camera around their chest to get a continuous first-person video perspective of activities in the Makerspace. For days that did not have researcher-recorded video, due to equipment failure, the youths' Go-Pro camera footage was used. The day of the space lab tour, no video footage was obtained as the lab had strict recording and security policies in place.

3.3 Coding Scheme and Process

From iterative review of video footage and based on the prior work of Martin [10], Sheridan et al.[11], and Bevan [1], codes were generated to label the primary activity taking place in the Makerspace in five-minute increments. By primary activity, we refer to the overarching activity that most people in the space were participating in without specifying exact content or artifacts used. It should be noted that important information could be gleaned at the individual level, but the focus of this paper is on group activity. For example, if a facilitator had stated to everyone "Everyone should get a soldering iron and safety goggles" and that was proceeded by youth getting soldering irons and goggles and bringing them over to their own workspace, then we would consider the dominant activity as *material acquisition*; This would be assigned even if there was footage of a few youth who were sitting and talking with one another or sending text rather than gathering materials, as the expectation set by the facilitator was that that time was intended to be time for gathering materials. Alternatively, if the majority of the youth continued to soldering the dominant activity would be coded as *assembly*. The same would apply to *material storage,* which involved disposing of any waste materials, returning any common or shared equipment belonging to the space, and placing any intermediate products they were working on and would return to the following week in a locker or shelf for safekeeping. As another example, if the facilitator asked for everyone's attention and was demonstrating how to use a new tool, then the time dominant activity was designated as *instruction*. Similarly, if the facilitator was still presenting or leading discussion for a second five-minute segment, that time period was coded as *instruction* as well.

When work was taking place that involved designing or producing an artifact related to the overarching project (i.e., light box, rocket, or lantern), more specific educative Maker activity codes were assigned. These included *assembly*, *creative construction*, and *tinkering*. *Assembly* was determined primarily based on whether the materials used were part of a kit and if it involved some form of written or verbal instructions specifying how things were to be used or connected. *Creative construction* was assigned for times that where a goal was specified or implied and each youth was expected to develop their own unique instantiation, version, or decoration on their project. *Tinkering* was assigned as a code when there were a set of materials that youth were expected to interact with but an obvious goal or product was unspecified.

Finally, one other code was established that had a single day of use called *novel experience*. This code was used for only the rocket group on the launch day as the objective was for everyone to see their rockets and their friends' rockets get launched. In principle, this would also be used for the tour of the space launch lab, but absent any enduring video footage, we opted to leave that day un-coded.

Only one code was assigned for a single five-minute video segment, and it was up to the coder to determine what the dominant or more time consuming activity was during that five-minute segment. For instance, a youth may have begun to *Tinker* with some code or materials that she had already gathered, but the dominant activity for the group may be *material acquisition*. In that case, the five-minute segment would be coded as *material acquisition*. If *material storage* took place over the final 90 seconds of what was otherwise an *assembly* segment, then the segment was coded as *assembly*, and the subsequent segment was likely coded as *material storage*. Video segments were split among two coders who separately assigned codes.

3.4 Coding Reliability

Prior to separately coding their assigned videos, a coder introduced the coding scheme to the second coder. To assess reliability between the two coders, 34 randomly selected 5-minute segments of video were identified and independently coded. These codes were then compared, and reliability was deemed sufficiently high.

4 RESULTS

Results from this coding are shown in the visualization in Figure 1, which also shows the breakdown per meeting day. The numerical and percentage breakdown for each project is provided in the subsections below.

4.1 Time use in the Light Box project

Table 1: Distribution for Light Box Project

Primary Activity	Frequency	Percent
Assembly	54	35.1
Creative Construction	38	24.7
Instruction	33	21.4
Material Acquisition	12	7.8
Material Storage	17	11

During the six weeks of the Light box project, as depicted in Table 1, most of the time was spent on Assembly (35.1%), then Creative Construction (24.7%) and Instruction (21.4%). There were no segments coded as Tinkering. Material acquisition (7.8%) and material storage (11%) took the least amount of time of activities that were coded.

4.2 Time use in the Rocket project

Table 2: Distribution for Rocket Project

Primary Activity	Frequency	Percent
Assembly	44	34.9
Creative Construction	9	7.1
Tinkering	10	7.9
Instruction	8	6.3
Material Acquisition	22	17.5
Material Storage	21	16.7
Novel Experiences	12	9.5

Assembly (34.9%), Material Acquisition (17.5%), and material storage (16.7%) took the most time during the Rocket project. Tinkering (7.9%), creative construction (7.1%), and instruction (6.3%) were less frequent (Table 2). The rocket project was the only one coded as having the novel experience (9.5%) code, which was applied on the day of the rocket launches.

4.3 Time use in the Lantern project

Table 3: Distribution for Lantern Project

Primary Activity	Frequency	Percent
Assembly	4	3.8
Creative Construction	34	32.4
Tinkering	9	8.6
Instruction	20	19
Material Acquisition	18	17.1
Material Storage	20	19

As seen in Table 3, the most frequently applied code was creative construction (32.4%), followed by instruction (19%), material storage (19%), and material acquisition (17.1%). There was still some time coded as tinkering (8.6%) and assembly (3.8%)

5 DISCUSSION

The three camps differed in their distribution of time use for different primary activities, based on the current coding scheme. One regularity that should be acknowledged is the relatively large amount of time devoted to material acquisition and storage. It appears that over 150 minutes in each camp is used getting materials or returning them. While our observations in the Makerspace showed that this time was used as a buffer for late arriving youth or those who needed to leave early or for the facilitator to get some things ready, it does raise the question as to whether that time could be used more efficiently to maximize the amount of time youth are involved in educative maker activities. In classrooms, a common informal concern for certain interactive activities is that the amount of time needed to get and return materials greatly limits the amount of time available to actually do the intended learning activity.

Instruction also appeared in all of the camps. Given that there was a designated facilitator and mentors present and this was organized as projects to be completed in six weeks, the presence of instruction is not completely surprising. However, it is worth considering that part of Making in afterschool settings appears to involve time in which a knowledgeable adult may be lecturing or presenting to the youth who are present. The content is often related to the equipment that is to be used, and in a space such as a classroom where teachers may feel the need to make explicit connections to disciplinary areas, this may be additional time that is added in Maker activities.

Also, in this setting, there was more emphasis on assembly and creative construction, with Assembly appearing the most often across all three. While Bevan [1] espouses benefits for each type of educative activity, tinkering seems to be the least common in this setting and the most open-ended for youth. Bevan's examples of tinkering came out of museum settings, and it may be that afterschool programs and museum visits tend to favor different modes of interaction. That remains a question to be examined further in the future.

Ultimately, from this coding, we do appear to be getting at some differences and similarities in the ways time is used in these afterschool Maker programs. At a minimum, this coding can provide feedback for facilitators so that they can determine if this is how they would ideally like to use time in their respective programs. . It should be noted this pattern could be the product of how facilitators were trained, and that patterns may be different in museums or classrooms. The programming and structure from this particular Makerspace has been recognized as a model for other groups in the state and it is being imitated at other sites with local facilitators. A potentially interesting investigation in the future would be a comparison of similar projects at different sites to help determine how much of the time use distributions appear to be because of the specific facilitator, site, or project that is undertaken.

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