Self-evaluation of learning activities by children in a library-makerspace
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Maker education in the Netherlands – state of play and lessons for the future
Self-evaluation of learning activities by children in a library-makerspace: Development and validation of a visual instrument

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ABSTRACT

Learning activities in a makerspace are hands-on and characterized by design and inquiry. Evaluation is needed both for learners and their coaches in order to effectively guide the learning process of the children and for feedback on the effectiveness of the after-school maker activities. Due to its constructionist nature, learning in a makerspace requires specific forms of evaluation. In this paper we describe the development of an instrument that facilitates and captures reflection on the activities that children undertook in a library makerspace. Our aim is to capture learning in this context with multiple instruments: analysis of the artifacts that are made, observation of hands-on activities and interviews - which all are time consuming methods. Hence, we developed an easy to use tool for self-evaluation of maker learner activities for children. We build on the design of a visual instrument used for learning by design and inquiry in primary education. The findings and results are transferable (formative) assessment and evaluation of learning activities by learners in other types of education and specific in maker education.

KEYWORDS

Learner report, self-evaluation, maker skills

1 INTRODUCTION

Learning in makerspaces is informal and has multi-faced goals that depend on learners’ personal interest, prior knowledge, etc. However, even in such informal learning environment, learners and coaches need formative tools for feedback (ideally followed by feedforward) on their progress. In order to ‘grab’ these multi-faced goals we developed an instrument that could easily be used by children in after-school activities in the library makerspace. Children should be able to use this instrument at the end of an afternoon, (almost) without help of the supervisors. Our aim is to collect these learner reports on a large scale at the end of a maker cycle in order to collect children’s’ experiences and to compare and triangulate with observations and analysis of artifacts. Thus, this instrument adds to the evaluation of learning in the makerspace.

1.1 Maker learning activities

Building on constructivism (Piaget, 1950; Vygotsky, 1978), constructionist learning theory (Papert, 1991) states that learners construct knowledge specifically when they actively participate in the making and sharing of a physical object (Papert, 1991). Cohen (2017) distinguishes four elements to be essential maker activities: creation, iteration, sharing, and autonomy. Although the specific knowledge learners construct by making is very diverse, there are
several scholars that have focused on identifying more general learning outcomes in makerspaces. Bevan, Gutwill, Petrich, and Wilkinson (2014) observed participant learning activities in a museum-based tinkering program and identified four dimensions of learning: engagement (e.g., joy or frustration), initiative and intentionality (e.g., setting goals and overcoming failure), social scaffolding (e.g., sharing an helping) and development of understanding (e.g., explaining outcomes).

Chu et al. (2015) propose that making activities should be focused on developing a Maker mindset in children. They define three key determinants of the Maker mindset, i.e., self-efficacy, motivation and interest. Thus, preferred learning outcome of making activities should be a positive change in self-concept with respect to making, i.e., an increase in perceived ability ("I believe I can make things"), motivation ("I like to make things") and in taking initiative ("I want to make things"). Katterfeldt, Ditter and Schelhowe (2015) also state that activities in digital fabrication learning environments can facilitate a change of self (i.e., Bildung). They summarized three core ideas for learning environments aiming at Bildung: begreifbarkeit (i.e., making connections between the virtual and physical world), imagineering (i.e., creating objects with personal meaning) and self-efficacy.

1.2 Self-evaluation

Introduced by De Groot in 1974, the learner report can be defined as ‘an instrument to evaluate those learning goals, that are hard to evaluate in another way’. Through the years it has been used for several goals, especially as a didactical tool or instrument for evaluation of learning (Van Kesteren, 1993). A learner report consists of fill-ins that stimulate the learner to express what he or she has learned (i.e., about the content and about him or herself). The form can be open or closed. An open form may exist of open question and some sentences to complete ("I have learned that..."). Closed forms may submit statements about learning experiences and learners have to mark to what extend these apply to them.

The main inspiration that we used in the design of the learner report is the tool for self-evaluation of Ontdek-app, a digital learning environment for primary education that stimulates children to design and investigate. In order to make children conscious of their learning experiences, a visual instrument was developed in 2015, as shown in figure 1. This was inspired by various visual rubrics for assessment in art education (Maarleveld & Kortland, 2013; Redmond, 2004) and extensively tested and redesigned (Fraij & Zegers, 2016).

2 METHOD

In our research in the Amsterdam Central Library makerspaces (Pijls, Kragten & Van Eijck, 2018), a learning report will be used for self-evaluation of the learning goals as defined by the organization. This instrument contains closed statements (on the form’s front side) and open sentences (on the form’s back side). This choice was made because the makerspace mainly focusses on primary school children and a tool that would depend too much on language and writing would not be effective. We wanted the learning report to be approachable, intuitive and fast. Furthermore, we decided to submit statements that refer to activities in the makerspace and hypothesize that these activities represent learning experiences. For example, a child that reports to have helped other persons will have enhanced its social skills from that activity.

The learning goals of the makerspace are structured in three domains technology, socialization and subjectification (Biesta, 2014) and are closely related to the learning activities mentioned in paragraph 1.1. The first domain, technology, stands both for creating artifacts with digital fabrication, electronics, programming and for inventing and designing new prototypes, generating ideas, indicated as creativity (Buisman, Van Looon-Dikkers, Boogaard, van Schooten, 2017). The domain of socialization consists of helping others, asking for help, being engaged with the social and material environment. Subjectification has to do with motivation, empowerment, self-efficacy, self-expression and persistence. We operationalized those goals into seven categories (Table 1) and therefore formulated seven statements (items) to evaluate children’s learning experiences.

Figure 1: Self-evaluation instrument for students, Ontdekapp

Our research question in this design research was to develop a visual instrument that enables learners to reflect on their activities in the makerspace and to become conscious of their own learning in the domain of technology, socialization and subjectification.

The study was typically a design research (Mc Kenney & Reeves, 2012). The design process was carried out by a team of three researchers, a graphical designer and a research-assistant. The
expert group of designers and coaches of the project acted as critical friends.

The design research consisted of two design cycles and a third cycle will be carried out. First, a rough draft of the learner report form was presented to five children in order to test whether the visual invited children to color and whether they used different gradations. Then the design requirements were sharpened and the graphical designer made the first prototype. The first prototype was tested with five children and presented to a team of experts. This feedback led to some adaptations, which were carried out by the graphical designer. The second prototype was tested again in a validation session with children. In this session the answers in the learner reports were linked to observation and interview data in order to validate the items. The results of this session led to adaptations, which were made in the third prototype. The results of the third prototype will be presented in the conference session.

3 DESIGN CYCLES

3.1 Design requirements

The design requirements of the learner report form are:

1) It can be used by the children independently without too much explanation by the coach;

2) Minimally dependent on language and writing skills;

3) The symbols are ‘hollow’ and invite for coloring;

4) Children write their (nick-)name in the middle of the paper, to make it personal;

5) The item are represented by a symbol and a matching statement;

6) The symbols are small in the middle and become larger towards the periphery;

And some extra requirements:

7) The general image must be ‘quiet’;

8) The symbols must match the corporate identity of the makerspace;

9) In the final design each symbol will be represented five times;

10) The design anticipates on a digital version in future.

The backside of the learner report form contains open questions about learning experiences that could not be captured with closed statements:

- Date;
- What the child has been doing (‘I worked on…’);
- What the child is proud of (‘I am proud of…’);
- The intention for the next time (‘Next time I will…’).

3.2 First prototype

The first prototype was tested with five children in the makerspace. This yielded in two main remarks. First, it was concluded that there were differences in the way the children colored the figure. In the next design cycle we aimed to validate these differences with help of observations. Secondly, it also happened that children did not color in the symbol, but that they encircled the symbols. That is why we considered other symbols for the next prototype.

3.3 Second prototype – analysis per child

The second prototype was tested with seven children. They filled in the learner report form at the end of an afternoon in the makerspace and the results were first triangulated by interviews with the children.

The visual of child #1 - in Figure 1 - has high scores on all categories. In the interview child #1 shows enthusiasm “I like it very much with other kids here” and mentions that it often helps other kids, for example ‘if anyone cannot get the thread in the needle’. This child also includes earlier experiences in the makerspace in its evaluation, for instance with the item ‘Another person helped me’, where is

<table>
<thead>
<tr>
<th>Domain</th>
<th>Category</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Creating</td>
<td>‘I made something’</td>
</tr>
<tr>
<td></td>
<td>Creativity</td>
<td>‘I invented something new’</td>
</tr>
<tr>
<td>Socialization</td>
<td>Social scaffolding</td>
<td>‘Another person helped me’</td>
</tr>
<tr>
<td></td>
<td>Social scaffolding</td>
<td>‘I helped another person’</td>
</tr>
<tr>
<td>Subjectification</td>
<td>Intrinsic motivation</td>
<td>‘I liked it’</td>
</tr>
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<td></td>
<td>Self-efficacy</td>
<td>‘I can make it’</td>
</tr>
<tr>
<td></td>
<td>Persistence</td>
<td>‘I did carry through’</td>
</tr>
</tbody>
</table>
saying ‘not this time, but if I do not manage, then yes’. It also mentions that one of the things it is making is ‘super difficult’ so that it learns new things and says ‘I have to persist, I want to finish it, so I have to work very hard.’ and finally ‘I learned a lot, that is why I can do better now.’

The visual of child #2 - in Figure 2 - also shows enthusiasm and states in the interview that ‘I always like it’. This child is coloring the lowest score for both social scaffolding items and states ‘I always work alone’, ‘It is only the teacher who helps me’. The scale for the item ‘I made something’ is used in linear way as the child indicates that ‘the little bag [that I made, ed.] is almost ready’. The item ‘I invented something new’ is colored on the highest score, while the child mentions ‘I did not invent anything by myself’, so we conclude that the item is not valid. The items on persistence and self-efficacy have the highest score and the interview makes clear that the process was not easy, but that the child wanted to finish it and has the confidence to succeed.

The visual of child #3 - in Figure 4 - shows high scores on intrinsic motivation, self-efficacy and persistence, relatively low scores on social scaffolding – although in the interview the child mentions ‘I rather often help other children’. Probably the item ‘I made something’ is again interpreted linear, indicating the progress of the making process of a certain artifact.

The visual of child #4 - as shown in Figure 5 – contains high score on all items, except the item ‘Another person helped me’. The child explains ‘I understand everything, I do not need a lot of help’, which makes it remarkable that still such a high score is colored. The explanation for ‘I helped another person’ is ‘I do help a lot, I like to help other people, they learn from it.’ All other items do have explanations that support the high score.

The visual of child #5 – as shown in Figure 6 – is in line with the previous visuals: many high scores. And the explanation support the idea that the process of making is not easy, but that the child persists and likes to do so.

The visual of child #7 – shown in Figure 7 – contains a high score for intrinsic motivation, with the explanation ‘I like it, although it is not really my hobby’. This child has low scores on social scaffolding and mentions that giving and receiving help does not occur so much. This child has the lowest score on ‘I invented something new’, although it mentions that it has designed a bag. The item for persistence is colored with a score 4 and the child explains ‘This time I persisted, I did not become so angry’.

The visual of child #7 – shown in figure 8 – shows a 4 for intrinsic motivation, the item ‘I liked it’ and the child mentions that ‘sometimes it is rather busy’. This child has the greatest difference between giving (high) and receiving (low) help. Remarkable is the explanation of the middle score for ‘I invented something new’, namely ‘Nothing original’.

3.4 Second prototype – analysis per item

The results for each item of the learner report were as follows:

‘I invented something new’

This item operationalized creativity and inquiry.
The majority of the scores were 4 or 5 and children explained that they choose a lower score when they invented, ‘something’ or ‘nothing original’. An explanation for the lack of low scores, might be that the broken lamp is not attractive to color in. In the observations, no evidence was found for inventions by the children. This item seems to be valid, although the symbol of a broken lamp might better be replaced by a whole lamp.

‘I made something’

This item operationalized maker skills. The majority of the scores were 4 of 5 and children explained how they made something or what they made. Especially they explain how far they came with their making. This coincides with the fill-in on the backside of the learner report. The findings do match with the observations, were children were making something. This item is not valid for measuring to what extend children were making, it hardly adds information. So it will be replaced by another visual and another item, ‘I learned something.’

‘Another person helped me’

The average score is 2,5 with a minimum of 1 and a maximum of 5. Children explain that they have hardly been helped by others, or ‘only by the teacher’. This was confirmed by the observations. In order to separate instruction by the coaches from peer learning, the adaptation will be ‘Another child helped me.’

‘I helped another person’

The mean score is 3,7, with a minimum of 1 and a maximum of 5: the majority of the students mentions that he or she is helping from time to time. The observations confirm that children with high scores were helping often and low scores were helping a bit. No adaptations to this item.

‘I liked it’

The mean score was 4,8, minimum 4 and maximum 5. All children give the highest score, apart from one child that gives a ‘4, because sometimes it is rather busy’. The observations show that the children are working, talking, laughing, no quarrel was observed. No adaptations to this item.

‘I can do it’

The mean score is 4,2, minimum 3 and maximum 5. Two children give a ‘3’ because they think they
have learned a lot’ and a 5 because they think they ‘can make it’. It seems that this item does not measure self-confidence or self-efficacy, but rather learning experiences. We propose the adaptation ‘I dare it’.

‘I did carry through’

The mean score was 4.5, minimum 4 and maximum 5. All children give a 4 or 5 and explain afterwards why. The program seems to be quite challenging for children. The observations show that the majority of the children asks for help more than once. This could confirm the challenge of the activity. No adaptations to this item.

3.4 Third prototype

The third prototype is designed with all adaptations for the items and the requirement that the lay-out will fit the corporate identity of the makerspaces. This prototype will be tested with a group of 30 children. We intend to present the results of this tests at the conference in September 2018.

4 DISCUSSION AND CONCLUSION

What have we learned so far? We aimed at an instrument for self-evaluation of learning activities by children in an after-school context in a library maker space. The instrument consisted of a visual tool and a learner report. The learning goals (technology, social scaffolding, subjectification) were operationalized by seven items, which were visually represented in a coloring picture. The visual was attractive to fill in and most of the items yielded enough variation in answers. The items that represented maker skills were not (yet) valid in this visual; the items representing social scaffolding were valid and the items representing intrinsic motivation, self-efficacy and persistence.

The library maker spaces are still developing, this influences the learning activities that are stimulated: thus, the instrument evaluates both individual learning and learning environment. The instrument might help coaches and children to discuss the children’s learning activities.

Further calibration is needed to have a valid instrument for evaluation of the learning at large scale in the network of library maker spaces. Currently a system of badges is developed in the makerspace, in order to value maker skills and social skills for the children. Evaluation of the technological maker skills might be connected to these badges, whereas the visual and learner report capture children’s learning experiences. Thus, this learner report may help coaches to provide children feedback and feed forward and help them to develop as makers.

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