Computational Making Experience

Houda El Mimouni, Jennifer A. Rode
College of Computing and Informatics. Drexel University

Abstract
Using tangibles and maker spaces has been found to be beneficial for teaching computing and therefore promoting computational thinking. Since making E-textiles involves many computational activities (connecting cables and coding) in addition to other making activities (sewing and drawing…) E-textiles teach rather computational making. This study explores the learners' experience while they make e-textile projects. Tracking the feelings and thoughts entertained by the learners during the process of creating tangible projects reveals interesting findings.

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Contact: he52@drexel.edu, jar394@drexel.edu

1 Introduction

Traditional methods are not only highly analytical and focused on solving mathematical problems, manipulating text, or using predefined objects to create simple games (Boy, 2013) but also are focused more on getting to the only one right answer to the problem using a pre-dictated algorithm. On the other hand, maker culture thrives on bricolage and on recognizing the importance of the process not just the end result (Rode et al., 2015). Kafai, Burke, and Resnick (2014); Kafai, Lee, et al. (2014); Kafai, Searle, Martinez, and Brayboy (2014) have discussed the benefits of applying maker culture to computing education in order to promote computational thinking. Rode et al. (2015) have used e-textiles to teach what they labeled computational making since making E-textile projects involves many computational activities such as connecting cables and coding in addition to other making activities such as cutting, pasting, sewing and drawing etc. In this paper, we will explore the learners' experience while they make e-textile projects. Our objective is to track the feelings (joy, frustration, pride…etc) and thoughts (simple, complicated, challenging…) entertained by the learners during the process of creating tangible projects. This will help us learn about the learners' experience and whether E-textiles contribute to a positive enjoyable learning experience or not.

2 Background

While there is little evidence that tangibles support learning (Marshall, 2007), there are many studies (Buechley et al., 2008; Y. Kafai, Lee, et al., 2014; Weibert, Marshall, Aal, Schubert, & Rode, 2014) that have put forth E-textiles as good method for teaching computing. Buechley, Eisenberg, Catchen, and Crockett (2008) conducted a user study with children who designed soft wearables using LilyPad Arduino. The results suggested that e-textile workshops were engaging; they facilitated the exploration of art (aesthetics) and fostered gender diversity since e-textiles succeeded in engaging girls in computer Science Education using art. Y. Kafai, Lee, et al. (2014) examined the use of e-textiles for introducing key computing concepts. The study endeavored to understand students' learning by analyzing the circuits and program code created by students in pre-Advanced Placement high school computer science classes (AP classes give American students college credit) as well as their e-textile creations and their views of computing. The study recommended using crafts materials and activities such as e-textiles for designing introductory courses that can broaden participation in computing. Weibert, Marshall, Aal, Schubert, and Rode (2014) explored the appropriateness of e-textiles for teaching programming to mixed gender groups ages 8-12. The result of their study demonstrated that e-textiles have the potential of promoting both genders' computational literacy, thus disrupting binary gender roles that has been contracted by conventional "masculinist attitudes towards technology." Though all these studies argue that tangibles are beneficial for learning CT as an engaging method, no study has been done yet to demonstrate that kids entertain a good experience while making their projects. Little is known about their feeling and thoughts as they design, connect the circuit, code and sew and so on.

Learning about the experience of learners is crucial; it will verify the assumption that learning computation making using E-textiles is entertaining, interesting and engaging for children. It will further

help instructors identify the negative experiences and the positive experiences the learners encounter in each activity and project stage, learn from the positive experiences and improve the negative ones to support children in their learning process. Many studies highlighted advantages of non-traditional learning methods over the classic learning methods and found that the non-formal methods are more engaging (Benda, Bruckman, & Guzdial, 2012; Buechley et al., 2008). However, no study in the literature dived deep into the children's experience of learning computing using E-textile. In addition, since an experience is a process, it is paramount to explore the feelings and the thoughts of the learners in each stage and activity during the process of making.

To that end, we aim to answer the following questions:

a) What feelings/thoughts do students experience in computational making activities?
b) What feelings/thoughts do students experience in computational making stages?

Our conceptual framework is illustrated in the following diagram:

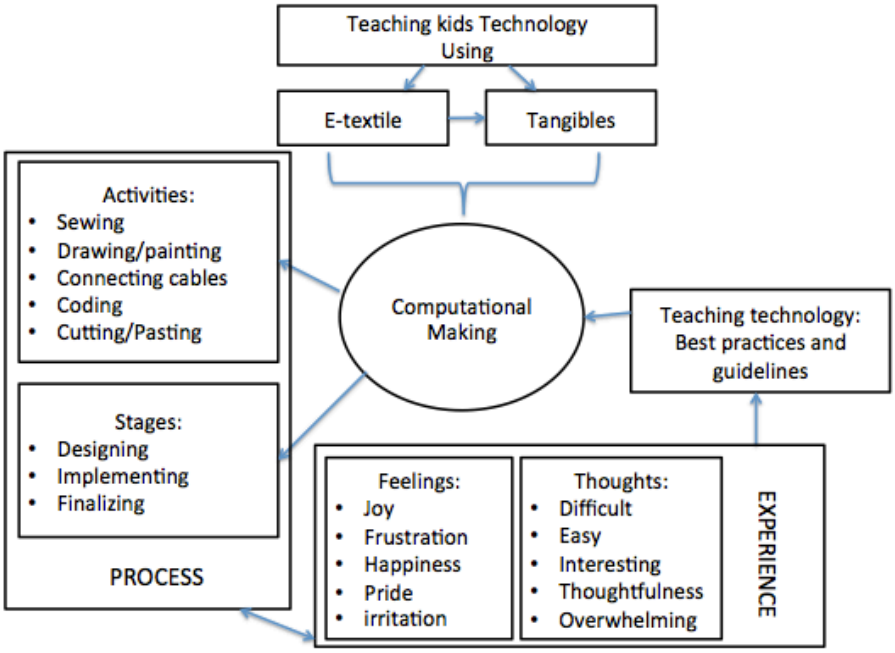

Figure 1. Conceptual framework

3 Methods

This study is conducted in a computer club where we employed e-textiles and the LilyPad Arduino to playfully introduce children to computational thinking. Children made their own projects using LilyPad Arduino, based on a modified lesson from the book of Buechley, Qiu, Goldfein, and de Boer (2013).

To answers the research questions, field notes as well as interviews with students are used. The field notes, written by tutors, were first jotted down during the fieldwork then enriched later to include the tutors reflections and thoughts as specified in John and Lofland Lyn (1995); Maxwell (2012). To maintain the confidentiality of the participants each student was given a name alias. The interview protocol included semi-structured questions and open-ended questions followed by prompts. Such question formats were deemed useful for this specific age category.

While coding the data, the objective was to check for instances where the different kinds of feelings and thoughts manifest during different activities and project stages. For instance, if a student is giving her/his club-mate a high five at the end of the project they are working on, that shows they are happy at the final stage of their project. While coding, we enriched the codes with sub-codes.

The coding categories are as follows:

COMPUTATIONAL MAKING

a) Activities: sewing, drawing/painting, connecting cables, coding, cutting/pasting
b) Project Stages: designing, implementing, finalizing

EXPERIENCE

a) Feelings: excitement, frustration, happiness, pride, irritation
b) Thoughts: difficult, easy, interesting, overwhelming, thoughtfulness

4 Discussion

The data yielded interesting results. The feelings and the thoughts experienced by the E-textile learners were rich. The following are samples from our data that reflect the computational making experience.

4.1 Activities: (This part answers research question 1)

a) Sewing:

- An example of thoughtfulness and concentration instance observed by a tutor.
  "While Inch was sawing, she was quite and concentrated. She tried not to miss the right needle spot as she would close the circuit otherwise."

- An example of the frustration feeling and the thought of task difficulty, as expressed the learner.
  "Sinatra said: I hate sawing, it is difficult to make nice stitches like my moms'."

b) Drawing/painting:

- An example of Ginny's thought about painting Vs sewing.
  "Ginny preferred the conductive paint over sewing. She said: it is easier and faster to use conductive paint than to stitch all day."

c) Connecting cables

- An example showing the feeling of pride.
  "Nile connected one LED to the Lillypad, then two, then three. She made the code show different colors that blink at the same time. She said: Look at these! they are all blinking at the same pace! Yaay!."

- An example of frustration expressed by the learner.
  "Inch tried to make her paper robot work, she tried several time then called me (tutor) and said: I don't know what's wrong with this robot, it hates me!"

d) Coding

- An example of determination as a feeling.
  "Sinatra still working on her code, for some reason, all her LEDs blink with green. She pondered for a long time on her code. I (tutor) approached her and said to her: sorry that your code is not working. Are you frustrated? She said: No, I am not, I just feel that I need to find the reason why it is not working and make it work."

- Ginny expressing her happiness when coding.
  "I feel awesome when I am coding, smarter than anybody else".

4.2 Project stages: (This part answers research question 2)

a) Designing

- Excitement example.
  "Ginny was so excited, using the components of her project on a piece of paper she tried to prototype where to place them in an efficient way. She rotated them in all directions while telling jokes about each unsuccessful prototype she made"

b) Implementing

- Feeling the Complexity in implementing prototypes
  "Nile and Inch collaborated on the jump rope project, they were discussing the placement of each element in details. They both decided to use one LED instead of two to make it less difficult."

c) Finalizing

- An example illustrating the feeling of pride and happiness during the finalization stage

"As the LEDs lit up, Inch and Nile gave each other a high five. Inch said I am happy that it finally worked. "

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