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TRIGGERING WOMEN’S INTEREST IN PROGRAMMING
WITHIN PHYSICAL COMPUTING CONTEXT

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In spite of numerous educational practices and initiatives in programming (Rubio, Romero-Zaliz, Mañoso, & Angel, 2015), women show less participation in learning programming compared to men (Faulkner & McClard, 2014; Harris, 2014). Lack of interest and motivation could explain the gender gap (Faulkner & McClard, 2014; Fisher & Margolis 2002, Park & Siklander, 2018). Interest can be raised and kept high by a variety of triggers, therefore they are key motivational factors, which leads to motivation and to engagement (Kangas, Siklander, Park & Siklander, 2018; Randolph, & Ruokamo, 2017; Krapp, 2003; Renninger & Bachrach, 2015; Siklander, Kangas, Ruhalathi, & Korva, 2017). This study aims to explore factors, which can trigger women’s interest in programming within physical computing context. Following research questions were formulated: 1) which educational factors work as triggers in physical computing workshops? 2) which aspects of women’s interest in programming are developed through the triggers in physical computing workshops? 3) how are the triggers correlated with the women’s interest in programming? 4) how the educational factors work as parts of triggering process for the interest development in programming?

Through case study data were collected by observing and interviewing participants with pre-planned format (Yin, 2014). The observation data were examined with time-series analysis and interview data were studied by applying inductive content analysis (Schreier, 2012). The data integration was implemented to see interconnectedness from two different data in the end of the analysis process (Moran-Ellis et al., 2006). The results showed various educational interventions originated from learning contents, facilitators, students and contexts potentially worked as triggers in terms of women’s interest in programming. The results indicate that it is important to take various triggers into accounts as parts of triggering process (Park & Siklander, 2018) because all triggers work in mutually supportive way (Renninger & Bachrach, 2015). This study implies educators are recommended to understand relationships between educational sources and learners’ interest development when designing programming courses to embrace diverse learners regardless of gender.

Keywords: programming education, women, triggers, interest development, physical computing
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1 Introduction

Computational inventiveness, visualization and modeling through programming are significant for success in a world where digital communication increasingly affect our society, science, economic and human interaction (Harel, 2017). It is therefore not surprising that programming becomes a necessary literacy just as reading and writing did in the past (Vee, 2013). Along with the needs, numerous educational practices and initiatives regarding programming were implemented throughout the world (Rubio, Romero-Zaliz, Mañoso, & Angel, 2015).

Despite the increasing attention and effort to promote programming to public, there remains one concern: women show less participation in learning programming compared to men (Alvarado, Dodds, & Libeskind-Hadas, 2012; Fischer & Margolis, 2002; Park & Siklander 2018; Patitsas, Craig, & Easterbrook, 2014; Price, 2016; Rich, Perry, & Guszial, 2004; Rubio et al, 2015; Varma, 2007). Especially, earlier studies argued that women are underrepresented in computer programming education (Klawe, 2013; Rich, Perry & Guszial, 2004; Varma, 2007) because educational programs fail to attract and retain women in learning programming (Rich et al, 2004).

Lack of promoting interest and motivation could explain the gender gap (Faulkner & McClard, 2014; Fischer & Margolis, 2002; Park & Siklander, 2018; Rich et al, 2004) in participation because those two factors play key roles in learner’s engagement in learning (Krapp, 2007; Hidi, 2006; Hidi & Renninger, 2006). Previous study identified that when a learner holds a developed interest, she or he tends to actively participate in and independently engage in certain learning contents (Renninger & Bachrach, 2015). Interest can be raised and
kept high by a variety of triggers such as objects, events, teachers, peers and ideas therefore they are significant motivational factors, which leads to motivation and finally to engagement (Kangas, Siklander, Park & Siklander, 2018; Randolph & Heli, 2017; Krapp, 2003; Renninger & Bachrach, 2015; Siklander, Kangas, Ruhalahi & Korva, 2017). It is therefore necessary to understand triggers as well as its interrelation with interest development so as to provide opportunities for women’s stable and persistent engagement in learning programming.

Recently, contextualized computing and physical computing approaches have drawn attention increasingly from researchers and educators as one of ways to enhance women’s interest in programming (Guzdial, 2007; Rubio et al, 2015). According to Guzdial (2007) contextualized computing approach is a teaching method in computer science programs by connecting programming with a wide variety of disciplines and domains. Meanwhile, physical computing approach is a way to teach programming by taking computational concepts out of screen and inserting them into the real world with sensors, actuators and microcontroller boards (O’Sullivan & Igoe, 2004). With these two approaches, programming becomes attractive and interesting through making a robot, animating a story, or creating video and music (Guzdial, 2007; Rubio et al, 2015; Ruthmann et al, 2010). However, there are few studies about how women’s interests are developed within contextualized computing and physical computing contexts, which can bring fundamental understanding about women’s engagement in programming (Park & Siklander, 2018).

In conclusion, this study aims to explore factors which can trigger women’s interest in programming and to examine these factors as parts of triggering process within contextualized physical computing context.
2 Literature Review

The purpose of the literature review is to place this study solidly in the current body of knowledge. In order to achieve the aim, this part starts by introducing existing researches and their limits regarding the gender gap issue within programming education as well as the contextualized and physical computing approach. Interest and triggers follow next to describe theoretical concepts which were salient backgrounds in the collecting and analyzing data processes of this research.

2.1 Gender Gap in Programming Education

Earlier studies stated that the number of women who are able to do programming is surprisingly low compared to men (Alvarado, Dodds & Libeskind-Hada, 2012; Patitsas, Craig & Easterbook, 2014). Low participation of women in learning programming is not only a problem in computer science field but great loss in terms of economic, social, cultural prosperity where diversity is prerequisite for its innovation (Nelson, 2014). Hence, it is important for researchers to pay attention to this phenomenon and to scrutinize it so that effective solutions can be suggested to stakeholders to promote more women’s participation in learning programming (Park & Siklander, 2018).

So far, researchers investigated factors obstructing women’s persistent engagement in programming. The pioneering study conducted by Fisher and Margolis (2002) identified four reasons which significantly hinder women to continue to learn programming in undergraduate level. First, motivation and interest of women to learn programming are different than men. To be specific, women tend to link their interest in computer science with other field such as business, medicine, arts and so on in comparison with men (Fisher &
Margolis, 2002). Once Rich, Perry and Guzdial (2004) shared the similar point in their study. They illustrated how female undergraduate students felt toward a traditional introductory programming class (Rich et al, 2004). Majority of women said that the class was not interesting because of its irrelevance with their own fields (Rich et al, 2004). Second, less women than men are exposed to hands-on computing experiences at the earliest age, which affects women when they take the same class with men who have more experiences in programming. Even though there is no gap between men and women in terms of ability to understand programming, women feel low self-efficacy due to the lack of pre-experience in computing (Alvarado, Lee & Gillespie, 2014; Beyer, 2014; DuBow, Kaminsky & Weidler-Lewis, 2017). Lastly, the stereotype of computer science culture which are well known with certain words such as ‘nerdy’ and ‘geeky’ can suggest women that they don’t belong (Dubow et al, 2017; Fisher & Margolis, 2002). Frieze and her colleagues (2012) claimed to offer new culture to integrate more women in computing, which both men and women can have benefit without ‘accommodating presumed gender differences’.

Over the last decade, empirical studies have been operated to find out practical implementations and their effect with respect to gender equality in the programing education as described in Table 1. Remarkable results were drawn from researchers centering on initiatives (DuBow, Farmer, Wu & Fredrickson, 2013; Hanson, Ayfer, & Bachmayer, 2014; Nesiba, 2015) and new methodological approaches in computing education (Frieze et al, 2012; Guzdial, 2010, 2015; Klawe, 2013; Rubio et al, 2015). When it comes to initiatives, the National Center for Women & IT (NCWIT) Aspirations in the U.S was launched in 2007 in order to facilitate women’s entry and persistent participation in computing by offering them sense of belonging in computer (Dubow et al, 2013). According to Dubow and her colleagues (2013), 71% of NCWIT Aspirations participants continued learning programming by
majoring either in Computer Science or in Engineering. Meanwhile, earlier studies examined the new teaching approach – contextualized computing approach – in introductory programming courses to see their effect on different perception about usefulness of programming between men and women. Through juxtaposing results between experimental group (new pedagogy) and control group (traditional pedagogy), the study showed that gender gap was significantly decreased in the experimental group (Rubio et al, 2015).

Table 1. *The Key Subjects and Literatures about Gender Gap in Programming Education*

<table>
<thead>
<tr>
<th>Topic</th>
<th>Findings</th>
<th>Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obstacles for women to engage in computing</td>
<td>Different interest in studying computer science</td>
<td>Fischer &amp; Margolis (2002)</td>
</tr>
<tr>
<td></td>
<td>Lack of pre-computing experience</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Geeky culture of computing</td>
<td></td>
</tr>
<tr>
<td>Factors to attract and retain women in computing</td>
<td>Factors to engage women in computing education</td>
<td>Dubow (2014)</td>
</tr>
<tr>
<td></td>
<td>Factors to encourage women in the computing industry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cultural factors to involve women in computing education</td>
<td>Frieze et al (2011)</td>
</tr>
<tr>
<td></td>
<td>Factors to lead women’s persistent engagement in computing</td>
<td>Dubow et al (2017)</td>
</tr>
<tr>
<td>Initiatives to overcome gender gap</td>
<td>The influence of NCWIT Aspiration program for young women</td>
<td>Debow et al (2013)</td>
</tr>
</tbody>
</table>
New teaching approach to overcome gender gap  

The result of computer science program reform on the number of women enrolled in the program.

Fischer & Margolis (2002) changed perception and failure rate in programming of women after new computing course.


Earlier studies contributed to deeply understand gender gap in programming education by covering mainly four topics as shown in Table 1: obstacles for women to engage in computing, factors to attract and retain women in computing, initiatives to overcome gender gap, and new teaching approaches to overcome gender gap. However, it still lacks to identify how topics work in terms of educational psychological perspective to fundamentally support women’s engagement in programming.

2.2 Contextualized Computing and Physical Computing Approach

Contextualized computing approach is one of the teaching methods in programming education by connecting programming with a wide variety of disciplines and domains (Guzdial, 2007, 2010, 2015). Contextualized computing approach views computing not as a certain skill or knowledge but as a literacy which embraces diverse purposes in different fields to engage students (Mitchelle, 2016). This perspective from contextualized approach is well reflected in the previous study as following:

Our approach ... is to emphasize context. Computing is broadly applicable to a wide variety of disciplines and domains—these are contexts. We use programming languages, lectures examples, and programming assignments
from those contexts that students recognize as being authentic and relevant for computing (Guzdial, 2007, p.1).

Contextualized computing approach enables students to learn basic programs with various media including programming robots (Cuéllar & Pegalajar, 2014), animating a story (Kelleher & Pausch, 2007), building artworks or making wearable devices (Kazemitabaar et al, 2016) instead of struggling to write an abstract program (Rubio, 2015). Although developing contextualized computing courses is challenging and expensive to prepare, this approach is worth to attract people in different backgrounds to encourage to learn programming (Guzdial, 2009).

Table 2. The Key Subjects and Literatures about Contextualized Computing Education

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>FINDING</th>
<th>LITERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contextualized computing course for undergraduate students</td>
<td>Through media computation and pair computing approach, retention rate among students passing the course was increased after introducing the course. By using LEGO Mindstorms to educate undergraduate students majoring in engineering, the study found advantages and limitation of contextualized computing approach. The study found that a contextualized computing attracts more wide audience in high school computer science course.</td>
<td>(Porter &amp; Simon, 2013)</td>
</tr>
<tr>
<td>Contextualized computing course for high school students</td>
<td>Girls using Storytelling Alice were more motivated to program by spending more extra time to continue working on their programs</td>
<td>(Cuéllar &amp; Pegalajar, 2014)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Wood et al, 2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Kelleher &amp; Pausch, 2007)</td>
</tr>
</tbody>
</table>
Highlighting the characteristics above, suitability of contextualized computing as educational courses has been discussed among researchers focusing on undergraduate students and high school students as described on *Table 2*. The previous studies have been proved that contextualized computing approach has potential to promote students’ persistent learning in programming. For instance, Porter and Simon (2013) drew effective results from contextualized computing classes to engage non-computer major students in programming and the classes were implemented to approximately one thousand undergraduate students in the U.S from 2008 to 2011. After three and half years of offering the course, they found significant improvement in students’ retention. In the 7 years before the changes of the course, the retention rate among students who passed the course was 71%. After these changes, however, the retention rate among students passing the course was turned out 89%. The positive findings were also shown in a high school context (Wood, Muhl & Hicks, 2016). Given the need for creative and engaging high school courses to broaden participants, the researchers developed a computational art course where students were able to learn key art, design, and programming principles to produce digital arts (Wood et al, 2016). The survey result from 28 students participating in the course illustrated that 71 percent of students are interested in taking similar courses more (Wood et al, 2016), which implies that the successful influence of the course on students’ interest.

Recently, physical computing approach – one of contextualized approaches – has been attracting researchers and educational practitioners in computer programming education. Richard (2008) defined physical computing as an activity to design, develop and build hardware and software systems so as to make conversation between the physical and virtual
world through computers and microprocessors. Earlier studies claimed that physical computing can show not only sensory richness which screen-based computing cannot (Papadimatos, 2005; Przybylla & Romeike, 2014; Richard, 2008) but also feasibility that students can learn abstract programming out of computer screen by building concrete objects using microcontroller, sensors and actuators (Przybylla & Romeike, 2014).

Table 3. *The Key Subjects and Literatures about Physical Computing Education*

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>FINDINGS</th>
<th>LITERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applying physical computing approach in computer science curriculums</td>
<td>Overlapping areas where physical computing and computer science meet are defined. Also, a syllabus is introduced after analyzing different physical computing programs and courses in other organizations and universities.</td>
<td>(Przybylla &amp; Romeike, 2014)</td>
</tr>
<tr>
<td>Teachers perspective about physical computing approach</td>
<td>Teachers’ expectation and difficulties in terms of using physical computing approach in their class were identified.</td>
<td>(Przybylla et al, 2017)</td>
</tr>
<tr>
<td>Learning environment for physical computing</td>
<td>In order to achieve Bildung (deep &amp; sustainable learning) in digital fabrication learning environment where physical computing approach was adopted, key conditions were introduced.</td>
<td>(Katterfeldts et al, 2015)</td>
</tr>
<tr>
<td>Improving gender gap in computer science course using physical computing approach</td>
<td>The study found that physical computing approach is affective to reduce gender gap in introductory programming course for undergraduate students.</td>
<td>(Rubio et al, 2015)</td>
</tr>
</tbody>
</table>

As shown in *Table 3*, topics of earlier studies in physical computing approach have been varied: potentials of physical computing as undergraduate programs, understanding physical computing approach from teachers’ perspective, proper learning environments for physical computing class, and physical computing class as a solution to overcome gender gap. So far,
empirical findings of the researches have convinced that physical computing approach is effective to deliver programming education to broaden range of participants with various hands-on activities regardless of age, gender and major (Przybylla & Romeike, 2014). The experimental study (Rubio et al, 2015) examined how a new introductory programming course designed with physical computing approach for undergraduate students closed gender gap in contrast to a traditional programming class where Powerpoint slides and multimedia were used to explain theoretical concepts and students wrote abstract code on screen. The study found that the new programming course was effective to reduce gap between men and women toward perception about programming and learning results. Further, other studies contributed to understand how physical computing is effective in programming education by examining teachers’ perspective on physical computing as a teaching method (Przybylla et al, 2017; Sentance & Csizmadia, 2017), computer science curriculum where physical computing approach is mainly reflected (Przybylla & Romeike, 2014) and learning environment (Katterfeldts, Ditttert & Schelhowe, 2015). But few explains how physical computing affects students’ learning or learners’ educational psychological changes as shown in Table 3.

2.3 Triggering Interest

2.3.1 Interest.

Interest refers to the psychological state or the disposition to take part in particular classes of objects, events or ideas (Hidi, Renninger & Krapp, 2004; Hidi & Renninger, 2006; Renninger, Hidi, Krapp, & Renninger, 2014). A learner who holds more developed interest tends to deeply participate in and independently engage in certain learning contents (Renninger & Bachrach, 2015; Kangas, Siklander, Randolph, & Ruokamo, 2017). On the other hand, a learner with a less developed interest needs support from external sources to engage in (Renninger & Bachrach, 2015). Previous researches claimed that interest and
engagement can be developed through various aids from tutors and peers or any other types of educational interventions (Carman, 2015; Harackiewicz, Park & Siklander, 2018; Smith, & Priniski, 2016; Siklander, Kangas, Ruhalahti, & Korva, 2017; Renninger et al 2014).

In educational research fields two types of interest have been mainly investigated as a mean to support for educators to design interventions, which is able to encourage learners’ interest development: situational and individual interest (Hidi & Renninger, 2006). Situational interest arises early stage in interest development which is defined as centered attention and the affective reaction triggered in the moment by certain environmental stimuli (Hidi & Renninger, 2006). Situational interest positively affects cognitive performance, integration of information with prior knowledge and level of learning (Hidi & Renninger, 2006; Schraw, Flowerday & Lehman, 2001). Meanwhile, individual interest refers to relatively stable disposition to a particular content compared to situational interest or immediate psychological state which usually appears later in the interest development (Hidi et al, 2004; Hidi & Renninger, 2006; Krapp, 2006). Individual interest can influence on learners’ attention, recognition, recall, persistence, effort, academic motivation and levels of learning (Hidi & Renninger, 2006).

According to Person Object theory of Interest (POI) by Krapp (2003), the development from situational interest to individual interest emerges in the interaction between environments, a person and influence of discipline (Figure 1). Under certain condition, the person-object interaction may first cause a longer-lasting domain-specific situational interest then a relatively stable individual interest of high personal relevance in later (Hidi et al, 2004; Krapp, 2005). Krapp (2005), the founder of POI theory, emphasized to deal the question of
how the interest development is controlled by conditions and functional principles at the level of ‘actual psychological processes’ during action and learning.

From the POI theory, interest is composed of four elements: knowledge factor (cognitive factor), feeling-related valence (emotional factor), value-related valence and intrinsic quality (Krapp, 2007). Knowledge factor is a person’s cognitive structures change in accordance with differentiated knowledge (high vs. low levels of stored knowledge) (Hidi & Renninger, 2006). When it comes to feeling-related valence, feeling of enjoyment, social-relatedness and stimulation and tension are the most typical examples (Krapp, 2007). Further, basic needs of competence, autonomy and social relatedness are also relevant with feeling-related valence (Krapp, 2003; 2005). Meanwhile, the value-related valence is described as ‘self-intentionality’, which refers to interest are related with the goals and volitionally realized intentions. Lastly, intrinsic quality means there is no gap between what a person should do and what the person wants to do from the POI perspective (Krapp, 2007).

*Figure 1*. The transition from situational to individual interest (as cited by Krapp, 2007, p13)
2.3.2 Triggers.

Even though Robert and Ousey (2004) defined triggers as “initial stimuli” to introduce each situation in problem-based learning, I agree more with the findings from several studies (Brauer, Siklander, & Ruhalhti, 2017; Renninger & Bachrach, 2015; Siklander et al, 2017) that triggers play important roles in general learning process, mainly on interest development. Triggers are defined as any interventions such as objects, events, teachers, peers, ideas and so on which spark a learner to become more engaged and to be interested in a certain learning activity or situation (Ainley, 2012; Park & Siklander, 2018; Renninger & Bachrach, 2015; Siklander et al, 2017).

Empirical studies found that different triggers are needed in different phase of interest development (Kiemer, Gröschner, Park & Siklander, 2018; Pehmer, & Seidel, 2015; Siklander et al, 2017). In the situational interest phase, for instance, interest is usually developed through external triggers such as concrete objects, teachers or peers supporting learning, scripted learning activities, workshops and so on (Knogler, Harackiewicz, Gegenfurtner, & Lewalter; 2015; Park & Siklander, 2018; Renninger & Bachrach, 2015; Siklander et al, 2017). Observational study identified eight triggers in the context of an out-of-school science workshop in situational interest: autonomy, challenge, computers/technology, group work, hands-on activity, instructional conversation, novelty and personal relevance (Renninger & Bachrach, 2015). In the individual interest phase, on the other hand, it tends to be “self-generated” depending on a learner’s motivation and curiosity (Hidi & Renninger, 2006; Renninger & Bachrach, 2015).

According to Renninger and Bachrach (2015), it is significant for educators to understand triggers, its process and triggered interest in order to provide better learning environments
which promote interest effectively. Ainley (2012) argued that well-designed learning environments and responsive educators can lead students to be more engaged in learning. For these reasons, many studies pay attention to the relationship between triggers and triggered interest nowadays (Renninger & Bachrach, 2015; Sun, Siklander & Ruokamo, 2018).

As explained so far, earlier researches contributed to understand various educational interventions working as triggers for interest in general learning situations but it has been merely discussed to see triggering process to the extent of a class or a course level in programming education field. This is the reason why triggering interest was selected as main theoretical framework of this research.
3 Methodologies

In order to seek triggers and changes of interest in real situation with rich description illustrating participants’ experience, thoughts, and feeling, this research used case study. Data were collected by observing participants’ behavior during the workshops, by following the pre-planned format and by interviewing participants based semi-structured questions in the end. The observation data were studied with time-series analysis and the interview data were examined by using thematic analysis which allowed to accentuate participants’ perception, emotion and experiences as foremost purpose of study (Guest, McQueen & Namey, 2011). The data integration was implemented to see interrelation from the two data (Moran-Eliis et al, 2006).

3.1 Research Aim and Objectives

This study built on the findings of the previous researches that women show less engagement in learning programming than men (Alvardo, Dodds & Libeskind-Hada, 2012; Patitsas, Craig & Easterbook, 2014) and perceive difficulty when they learn with traditional teaching methods (Rubio et al, 2015). The general aim of this study was therefore to explore factors which can trigger women’s interest in programming within physical computing context where new teaching approach was applied. Under this aim, four specific objectives were established.

The first objective is to navigate triggers in physical computing workshops. According to Siklander and her colleague (2017), external triggers play key roles to spark learners’ interest in the beginning phase of the interest development. Similarly, Krapp (2002) stated that interest-triggered stimuli such as learning activities and learning context are connected with
positive emotional experiences and triggering conditions ensuring the continuation of interest. From an educational point of view, it is necessary for researchers and educators alike to better understand triggers for creation and stabilization of interest related with learning (Krapp, 2003; Renninger & Bachrach, 2015).

The second objective is to explore elements of interest arising during the workshops. According to Krapp (2007), interest consists of knowledge factor, feeling-related valence, value-related valence and intrinsic quality. In this research, I studied which elements of interests arose during the workshops, which helped to understand changes of interest and interest development in programming of women as novice learners.

The third objective is to find interconnection between triggers and the interest development. In situational interest – the beginning phase of interest development, most interest related with learning or working is usually triggered by external incentives or educational interventions (Krapp, 2003; 2007). Hence, the researcher worked to see which trigger were effective to lead actual interest development of women. By understanding the relationship between triggers and interest, researchers and educators are able to design or plan creation and maintenance of educational interventions to promote students’ stable engagement in learning (Krapp, 2005).

The last objective is to figure out triggering process from the perspective of interest development. This objective was built on the earlier study that it’s important to understand triggering process in order to provide better learning environments (Renninger & Bachrach, 2015) where responsive educators can lead students to be actively engaged in learning (Ainley, 2012).
Based on those four objectives following questions were formulated to fulfill the aim and the objectives: 1) which educational factors potentially work as triggers in physical computing workshops? 2) which aspects of women’s interest in programming are developed through triggers in physical computing workshops? 3) how are the triggers correlated with the women’s interest in programming? 4) how the educational factors work as parts of triggering process for the interest development in programming?

3.2 Research Approach

Qualitative method, especially case study approach was used for this research to catch rich and vivid description of participants’ experience of, thoughts about and feeling for a particular situation – learning programming within physical computing context (Cohen, Manion & Morrison, 2013; Flyvbjerg, 2006). The benefits of the case study were desirable for this research because it supported the researcher to identify triggers and changes of participants’ interest directly from the real learning situation. In following parts, I described how this case study was conducted by explaining didactic triangle model, unit of analysis as well as data collection and analysis methods.

3.3 Didactic Triangle

The didactic triangle is a schematic representation of the correlation between teacher, learner and content which are the main components in instructional process (Figure 1) (Berglund & Lister, 2010; Goodchild & Sriraman, 2012; Kinnunen, 2009). When Johann Friedrich Herbart first brought the concept of didactic triangle to the world in 19th century, the triad was introduced with emphasis on the relation between teacher and learners which is not straight but contents place between them (Kinnunen, 2009; Kinnunen, Meisalo & Malmi, 2010).
Later, Kinnunen (2009) included context of learning situation as one more element of the didactic triangle as shown in Figure 2 because learning environment is vital components in a lesson. Even though this representation can be naive to simplify the complex characteristic of what happens in learning process during a lesson, the didactic triangle can be benefit as a starting point for scrutinizing the dynamics of teaching-learning (Berglund & Lister, 2010; Goodchild & Sriraman, 2012).

Figure 2. The didactic triangle in introductory programming (Berglund & Lister, 2010)

Moreover, several researches in computing education field used the didactic triangle in order to analyze published studies in meta-level with the aim to figure out the current state of computing education research and the needs for future studies. Berglund and Lister’s systematic review about computing education studies (2010) applied the didactic triangle model and identified what is missing in the current discussion. Much of studies help to grasp the detail of small pieces focusing on each vertex such as teacher, content or students but merely discuss about relationship between the nodes (Berglund & Lister, 2010). Kinnunen and her colleagues’ study (2010) also raises similar issue. They argued that there is demands to study computing education with the perspective focusing on process of instruction and interrelation between each node rather than dealing with only the vertex of the triad model.
In this research the didactic triangle was used as theoretical framework when the data analyzed. At the same time, I took into account what earlier studies concerned about – the correlation between each vertex – rather than understood this triangle model as combination of three truncated factors.

3.4 Unit of Analysis

According to Yin (2017), defining a case to be studied is fundamental problem in designing research process because it leads a study into clear and precise direction. The case can be individual, a group of people, communities, decisions, projects, organizational change and some events (Yin, 2017). In this study the unit of analysis – the case – was one-day intensive physical computing workshops. Under this case, three categories – women who are novices in programming as learners, facilitators and contents – were created based on the didactic triangle in order to scrutinize complex of nature of what happen in a class as described in Figure 3 (Berglund & Lister, 2010; Goodchild & Sriraman, 2012).

![Diagram of the didactic triangle](image)

*Figure 3. The unit of analysis of this research*
3.4.1 The Context of Learning Situation: One-day Intensive Physical Computing Workshop

The one-day intensive physical computing workshop (Figure 4) was designed on the basis of key concepts from contextualized computing and physical computing approach. Thus, participants were supposed to learn program with out-of-screen methods by exploiting daily materials and technique of craft thereby, lowering barriers of high level of building circuits and program (Guler & Rule, 2013; Kafai, Fields & Searle, 2014; Mellis, Jacoby, Buechley, Perner-Wilson, & Qi, 2013; Perner-Wilson, Buechley & Satomi, 2011; Qi & Buechley, 2010; Qi & Buechley, 2014).

![Figure 4. The participants are working on the tasks in the workshops](image)

Two workshops were conducted at different time, considering participants’ diverse schedules. Each workshop consisted of two sessions for three hours and each session was continued for one hour and half.
Learners: Women who are novices in programming

Women as novices in programming aged between 20 to 40 were participants of this research. As I described in the literature review section, the gender gap issue is important to be solved in computer programming field. Especially, women aged over 18 or 19 who cannot reach within K-12 education boundary have been in blind spot in discussions among researchers and educator despite necessity of learning programming as literacy in 21st century (Harel, 2017).

Purposive sampling was conducted to select this certain group of participants, which guided the researcher to make sure to study this case within the unit of analysis. Five women aged between 20 through 40 who had little knowledge and experience about programming were finally chosen. All participants were graduate students majoring in education science and they participated in the intensive workshops for three hours.

Teachers: Facilitators

Due to the lack of manpower understanding both physical computing and programming, the researcher (myself) and another expert who have created physical computing artefacts for five years were involved as facilitators of the workshops. Given the situation, the role of the researcher in this study was an insider by directly interacting with participants through guiding and supporting physical computing activities. Since the researcher worked with the participants during the workshop and became close, the in-depth interview was able to be done in a comfortable environment. This resulted in more honest answers from the participants. Another facilitator also played a similar role likewise. He usually helped
participants when they faced technical challenges with building a circuit or programming and explained about the problems and solutions.

Contents: Tutorial videos & Hands-on activities

There were two main elements consisting the contents of the workshops: Youtube video tutorials and activities to build interactive paper crafts. The video tutorials were primarily to introduce about the workshop and to show instructions for physical computing activities. The introduction video included information such as what the workshop was about, why the workshop was designed and what participants would do to help the attendee to draw a general map about the journey to learn programming in the workshop. The other videos for instructions were to introduce projects, to guide participants to build electronic circuits as well as to program on a microcontroller board. In the video, difficult terms and electronic schematics were changed into easy vocabularies and real pictures of circuit components by taking participants’ level of experience in electronic and circuits into account (Figure 5). Further, the instruction videos for programming part were made to support learners to comprehend a block of code as one unit rather than single lines of code so as to decrease the cognitive burden on working memory (Ramalingam, LaBelle & Wiedenbeck, 2004).
Figure 5. An example of the video instructions used in the workshops

Two different hands-on activities were developed and prepared for the workshops (Figure 6): music light box and motion detecting lantern. The music light box turns on LED when a mic sensor detects sounds and the motion detecting lantern is an interactive lamp which rotates based on movements which a motion detector recognizes.

Figure 6. The materials used for the first task (left) and the second task (right)
All two activities used Arduino board because of various advantages. Arduino board is open-source microcontroller. It is easy to practice for beginners (Hill & Ciccarelli, 2013; Rubio et al, 2015) and simple to utilize with diverse kinds of sensors. Moreover, numerous information concerning Arduino is opened on the Internet, which can be additional supplements for learners to solve problems, questions and curiosity (Mellis & Buechley, 2011). Also, there are alternatives to get Arduino board with moderate prices because it is open source hardware.

When it comes to using paper-crafts as instruments to learn program and technology in this workshop, the researcher referred to previous researches. Qi & Buechely (2014) claimed that paper is familiar to people as materials to do Do-It-Yourself activities and low-cost which is helpful not to feel afraid to make mistakes by “breaking or wasting precious materials” (p.6). This is the reason why paper crafts were chosen as primary activities.

3.5 Data Collection and Analysis Methods

As Figure 7 shows, data were collected through observation during the workshops in accordance with the pre-planned format, and through group interviews using semi-structured thematic plan in the end as described on Appendix A. The observation data were analyzed with time-series analysis and interview data were examined by using thematic analysis (Guest, MacQueen, & Namey, 2011). The data integration was applied to see correlations between two different data (Moran-Ellis et al, 2006).
3.5.1 Interview.

*Interview data collection.*

According to Krapp (2003), it is important to focus on description and explanation of interest-triggered action by dealing with processes and states in studying situational interest because it is result of the interaction between person and objects. Considering this point from the previous study (Krapp, 2003), this research chose to do in-depth group interview to collect data because it enables participants to be empowered and to make comments in their own words, which gives affluent data describing a certain situation of participants own thought (Robosson & McCartan, 2016).

The interview was planned with semi-structured questions. Because semi-structured questions can support researchers to examine details within the realm of a study, not losing the track of a research and to open possibility to see new findings by having chances to ask more questions when inspiration comes up in interview (Robosson & McCartan, 2016). The interview questions were developed based on the literature reviews regarding triggering interest and the didactic triangle to identify 1) triggering sources 2) triggered elements of interest and 3) interrelation between triggers and interest.
The interviews were conducted right after the end of the workshops as shown in Figure 7. Even though retrospective methods have possibility which can distort exact quality of interviewees’ experience during the interest-related activity, this method has been proven empirically sound and reliable when the decisive factor of distortion – the amount of time gaps between the activity and the administration of data collection – is removed (Krapp & Prenzel, 2011).

The interviews took approximately 30 to 60 minutes for each group. In the first group interview, two participants who joined the first workshop took part in (Figure 7). In the second group interview, two participants taking the second session was involved (Figure 7). All interviews were recorded and transcribed into written texts for data analysis process.

The email interviews were done with the first group to ask additional questions which were asked in the second group interview. The questions in this email interview were exactly same as the questions asked in the second group interview. With respect to one of the participants in the second group who couldn’t join the interview, the email interview was implemented with the same questions which I asked in the second in-depth group interview.

Data analysis.

The in-depth interview data were examined by thematic analysis. According to Guest, MacQueen, & Namey (2011), thematic analysis can examine the research questions by focusing on the human experience subjectively. Thematic analysis approach accentuates participants’ perception, emotion and experiences as foremost purpose of study (Guest et al,
2011). Particularly in this research, the thematic analysis helped to figure out the level of changes of participants' interests in programming in accordance with various triggers.

In order to organize and interpret the data, this study followed Saldaña’s (2015) data processing strategies which include three phases of data analysis operation as described in Figure 8: first cycle coding, second cycle coding and post-coding.

**Figure 8.** The data analysis strategies for the interview data and thematic analysis process

In the first cycling coding *structural coding* was applied to segment and frame the interview data (Saldaña, 2015). Namey, Guest, Thairu and Johnson (2008) pointed that structural coding is “acts as a labeling and indexing device, allowing researchers to quickly access data likely to be relevant to a particular analysis from a larger data set” (as cited in Saldaña, 2015). In this step, I created categories based on general topics of participants’ answers and the semi-structured research questions, which is well explained in the part 3 of *Appendix 1*.

After structural coding, *simultaneous coding* was employed in the second cycle coding step. Simultaneous coding is a coding method to apply more than single code to qualitative datum
(Saldaña, 2015). The study (Saldaña, 2015) described that simultaneous coding is appropriate when the datum’s content suggests multiple meaning that necessitates more than one code as intricate social interaction does not occur in neat and isolated units.

In this step, I developed codes as described in Table 4 based on the research questions and theoretical background of this study – the didactic triangle and the triggering interest. In terms of the didactic triangle, Berglund and Lister (2010) claimed that it is appropriate to isolate each node of the didactic triangle comprising content, teacher, student and context during research even though this approach can be naive viewpoint. I created therefore ‘content’, ‘facilitator’ (teacher), ‘student’ and ‘context’ as codes for ‘triggers’. Meanwhile, the sub-codes were labeled by referring to the interview data. With respect to the interest, two basic elements which form the interest were coded into ‘cognitive aspect’ and ‘emotional aspect’ (Krapp, 2007). As Krapp (2007) described, the cognitive aspect of interest is associated with value-related valence, changed level of knowledge and ability and acquiring competencies, which were labeled for sub-codes under the cognitive aspect in interest. Also, ‘feeling of enjoyment’ and ‘feeling of tension’ were sub-coded under emotional aspect.

Table 4. Simultaneous Coding System to Identify Triggers and Changes of Interest in the Second Cycle of the Thematic Analysis for the Interview Data

<table>
<thead>
<tr>
<th>CODE</th>
<th>SUB-CODE</th>
<th>ANALYSIS STRATEGIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content</td>
<td>Video instruction</td>
<td>Relying on theoretical proposition</td>
</tr>
<tr>
<td></td>
<td>Paper craft physical computing (activities + artefacts)</td>
<td>(the didactic triangle)</td>
</tr>
<tr>
<td>Facilitator</td>
<td>Classroom management skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knowledge or ability of subject matter</td>
<td></td>
</tr>
</tbody>
</table>
Student Personality
Previous experience

Context Time
Autonomy

**Interest**

<table>
<thead>
<tr>
<th>Cognitive aspect</th>
<th>Changed level of knowledge or ability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Changes of competences</td>
</tr>
<tr>
<td></td>
<td>Relying on theoretical proposition</td>
</tr>
<tr>
<td></td>
<td>(the interest construct in the Person-Object theory)</td>
</tr>
<tr>
<td>Emotional aspect</td>
<td>Feeling of enjoyment</td>
</tr>
<tr>
<td></td>
<td>Feeling of tension</td>
</tr>
</tbody>
</table>

Thanks to the second cycle coding process, the research could figure out various triggers and interest elements in the workshops. It was, however, demanding to see the interrelation between triggers and situational interest which were relevant with the final research question. In order to overcome the problem, the researcher matched a trigger to relevant interest arising or diminishing during the workshop in the post cycle coding stage as shown in Table 5.

**Table 5. The Categorization System to Identify Interrelation between Triggers and Interest**

<table>
<thead>
<tr>
<th>CATEGORIES (EXTERNAL TRIGGER) - (INTEREST)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video - Feeling of enjoyment</td>
</tr>
<tr>
<td>Video - Feeling of tension</td>
</tr>
<tr>
<td>Video – Change in cognition</td>
</tr>
<tr>
<td>Physical computing hands-on activity - Feeling of enjoyment</td>
</tr>
<tr>
<td>Physical computing hands-on activity - Feeling of tension</td>
</tr>
</tbody>
</table>
Physical computing hands-on activity – Change in cognition
Classroom management skill - Feeling of enjoyment
Time - Feeling of tension
Autonomy - Feeling of tension
The whole experience – Change in cognition

3.5.2 Observation.

Observation data collection.

Observational records can give researchers supplementary perspectives about interview data when studying triggering processes in certain learning activities (Renninger & Bachrach, 2015), which were the reason why I planned observation as one of data collecting methods for this research. Direct observation data were gathered by taking notes in chronological order during the workshop and another instructor reviewed the notes which allowed the researcher to check the written record was truthful (Renninger & Bachrach, 2015).

Observation data analysis.

*Figure 9.* The analysis method for the observation data of this study

The observation data were examined through time-series analysis (*Figure 9*). Yin (2017) stated that this analysis can follow complex patterns of case and draw a firm foundation for the conclusion of the case study. I used especially *chronological sequences* as one of methods
in time-series analysis to trace specific events in the workshops in time order and to investigate causal events affecting participants’ interests, (Yin, 2017). The four categories were developed as shown in Table 6 and the records in the field note were classified into the one of matched category.

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>DESCRIPTION OF THE WORKSHOP PHASE</th>
</tr>
</thead>
</table>
| Beginning stage  | It includes the time when the introduction video was played to introduce ...  
- what the workshop is about.  
- what the participants are going to do in the workshop.  
- why learning programming is necessary.  
- how the participants can learn programming during the workshop. |
| Middle stage     | It includes the time when the instruction video was played and the participants take part in hands-on activities. In this stage, participants build digital paper craft work and program with Arduino. |
| End of the stage | It includes the time when the participants completed tasks to build the interactive paper craft and tested their work by themselves.                                |
| After the workshop| It includes the time when in-depth interview conducted in retrospective way with the participants after the workshop.                                              |

3.5.3 Data Integration.

Lastly, the study applied the data integration by combining the interview and the observation data together to find compatible points from the different data (Moran-Ellis et al, 2006). This process helped to identify the influence and the role of triggering process to the changes of the interest of participants in time order.

<p>| Table 7. The Thematic Categorization System to Identify Interrelation between Items and the Roles of Triggers on Interest in the Workshops |</p>
<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower barriers</td>
<td>External triggers support learners who are novices in terms of programming to feel comfortable with learning a new subject.</td>
</tr>
<tr>
<td>Jump to Flow</td>
<td>External triggers enhance learners’ active engagement with positive emotion during learning programming by supporting learners to overcome challenges and difficulties. Also, external triggers support learners not to be afraid of making mistakes.</td>
</tr>
<tr>
<td>Visualize accomplishment</td>
<td>External triggers encourage learners to see their accomplishment through concrete objects after the workshop, which increase learners’ competencies in programming.</td>
</tr>
<tr>
<td>Interrupt immersion</td>
<td>External triggers bother learners’ active engagement, which cause negative emotion during the learning programming.</td>
</tr>
<tr>
<td>Lack authority</td>
<td>External triggers diminish learners to learn with authority, which gives learner more choice to control their own learning.</td>
</tr>
</tbody>
</table>

Before integrating the data, the researcher gathered the results of the interview and the observation analysis, keeping the two different perspectives derived from the original findings (Moran-Ellis et al, 2006). Then, the data integration was implemented in accordance with the following processes. First, the results of interview data were divided into the categories in Table 6 to see the identified triggers in time order and its relationship with the changes of interest. Based on this work, thematic categories (Table 7) were developed to identify the role of triggering process in the interest development. According to Saldaña (2015), thematic categorization is effective to create a broader theme to examine how items are related with each other, how causality happens between items and how items work holistically. Hence, this process gave richer understanding about the influence of triggering process to the participants’ interests in time order.
4 Findings

In the chapter Findings, I explained the results of the data analysis in the same order of the research questions presented in the earlier chapter. This chapter therefore is consisting of four parts; potential factors worked as triggers, interest emerged in the workshop, correlation between the identified triggers and interest as well as roles of the triggers as parts of the triggering process.

4.1 Triggers in the Physical Computing Workshops

Various sources were identified as triggers from the data. All triggers were categorized based on the didactic triangle schematics: content, facilitator, student and context (Figure 10). With respect to the content, there were mainly two triggers including the instructions videos and the handcraft based physical computing activities. Proper level of learning contents in the videos comprised of explanation about circuits and programming in novices’ language triggered cognitive aspect of interest. Interactive paper crafts activities, on the other hands, worked as triggers by affecting emotion-related interest. Especially, the diluted boundary between technology and paper crafts as well as the process of building actual items and making them move with program were discovered as triggering elements in the interactive paper craft activities.
When it comes to triggers relevant with students, there were personality and previous experience about programming. Those triggers primarily affected emotional aspect of interest in beginning phase of the workshops. However, their role as triggers became invisible during and in the end of the workshop.

Finally, the two triggers in context vertex – authority and enough time – functioned as triggers. To be specific, learning with authority played a role as a trigger to enhance cognitive and emotion related interest by giving students more “initiatives to actively engage” in introductory programming lesson. Similarly, “sufficient time to build participants’ own programs and test them out without pressure” was another crucial trigger.
4.2 Types of Interest Emerging in the Physical Computing Workshops

Diverse elements of interest in programming rose during the physical computing workshops except intrinsic quality characteristics (Figure 11). When it comes to cognitive characteristics, knowledge, ability and competencies in programming emerged significantly. The participants said that they feel “more knowledgeable” because they became to be able to see structure of programs after the workshops, which made them “more curious” about programming at the same time. Further, participants said that they are willing to learn and get to know more about programming after the workshops if they have similar chances.

![Diagram of interest types](image)

*Figure 11. Types of interest arising before, during and after the workshops*

With respect to emotional characteristics in interest, assorted elements appeared and disappeared dynamically. For instance, the participants expressed feeling of “uncertainty” and “low level of confidence” before the workshops. During the workshop, feeling of enjoyment such as “excitement”, “feeling of easy and comfortable”, “fearlessness about
making mistakes” and “positive feeling” which is “hard to describe intro words” emerged. At the same time, participants perceived being “frustrated” and “stressed” as well. Again, however, the participants said they felt “excitement” in the end when they saw what they accomplished.

Meanwhile, four different points were found as value-related characteristics in interest. Those are career-related, educating kids-related, making customized gifts-related and real life-related values. Two of the participants conveyed that learning programming will be useful for their “career as teachers” and it would be practical to “teach children” to guide them to be “in line with their generation”. The participants showed favorable impression about learning programming in terms of “making customized-gifts for their friends and families” and “tailored-items for themselves” which are not easy to find in markets. One participant pointed out that learning programming is helpful to “understand our surroundings in daily-life” which are operated by full of automatic computer machines from personal laptops to door lock sensors.

4.3 Interrelation between the Triggers and the Interest Emerging in the Physical Computing Workshops

As described in Figure 12, the triggers originated from contents, teachers, and students correlated with the various elements of interest which rose before, during and after the workshops. In terms of the triggers derived from contents – the video and the handcraft-based computing activities – in the workshop correlated mainly with emotional and cognitive characteristics of interest. For instance, the videos explaining about programming and electronic circuits with novice’s language showed relationship with feeling of comfortable and easy toward learning programming. Participant C said that
I thought that ‘what if I wouldn't be able to learn anything or couldn't do anything.’ (before the workshop). But after your first video, my feeling was changed. Because (the video’s) explanation was very clear and understandable and it was on our level in terms of understanding. I felt comfortable.

Simultaneously, however, the videos interrelated with negative emotional aspect of interest including stress and feeling of difficulties during the workshop, which was mostly caused by confusing instruction and unexpected problems popped up from hands-on activities. For example,

Participant E: When the pictures (on the video) were not completely correct, I was confused. And when I glued my servo with the wrong component (in the digital paper craft work), I felt frustrated.

Participant C: There were many marks (about a circuit design) on the video and it was challenging. Another one was that when we download the code, it didn't work. I felt bit stressed. At that moment, (I was thinking) ‘What went wrong?

Meanwhile, the handcraft-based physical computing activities were related with both emotional and cognitive changes in interest by increasing competencies in programming as well as desire to learn more about programming.

Participants B: Tinkering them and producing something for such a short period of time was an amazing experience. I have always considered myself as someone who has zero interest/history of this topic electronic and programming. To come home
with something tangible to show to my family made me so proud of myself. It gave
the feeling that I am capable of doing something I thought I couldn't. It triggered the
desired to learn more.

With respect to the triggers generated by the facilitators were primarily interrelated with
emotional aspect of interest. Specifically, facilitators’ classroom management skills creating
encouraging learning environment were linked with comfortable feeling of participants. Also,
facilitators’ expertise in programming which strengthened trust that learners could ask help
when they faced with challenges were associated with boldness in making mistakes.

Participant D: I have this feeling that you (the facilitators) are capable to help us.
Because I know that you are interested in this programming and craft. And this truth
made me feel comfortable. ‘Okay she knows how to do that. So, she will explain it.’

Participant E: It was very safe environment and I wasn't afraid to make a mistake. I
could see that learning as an experience. It was easier to learn in a comfortable and
stress-free environment.

Participant A: You (facilitators) get rid of the feeling of being frustrated because
you're giving us encouraging environment, which is nice. Also, I think it's really
important for people who have no idea about this field. Just to keep them encouraging
"it's okay".

The triggers from participants showed relationship with different types of emotional aspects
in interest. Negative previous experience or introvert personality that the participants
possessed were relevant with emotional tension such as “scare” and “negative feeling” about learning programming. For example, participant D said that

“I think that my previous experience was not for me. I had negative experience. … And I failed it (from the experience). I just want to say that lack of prior knowledge and this experience made me feel that it (programming) is so challenging and difficult to do. ... In the beginning, I was scared. Maybe "scared" is not a good word. But I have kind of negative feelings. But I cannot explain them. Because for me, I thought it is so difficult.”

But extrovert personality was positively connected with emotional characteristics of interest as Participant C described below.

“I am easily excited with new things and I really like that kind of stuff (programming). It was really nice.”

When it comes to the value-relate valence in interest, it was not directly related with specific triggers in the workshop. But it was proved that value-related elements were closely interrelated with whole and general workshop experiences. Participant C said that

“After the workshop experience, I have definitely interest in programming. I think my interests is more related with teaching. Because I could see all the opportunities that I can do with kids at school.”
Figure 12. Interrelation between the triggers and the arising interests before, during after the workshops.

Elements of interest arising by triggers during the workshops

Elements of interest arising by triggers after the workshops
4.4 Triggers as Parts of Triggering Process for Interest Development

Triggers played distinct roles to lead participants’ interest development in programming in accordance with each different phase of the workshops; beginning, middle and end of the workshops. The following described that how triggers worked as parts of triggering process with respect to women’s interest development in programming during the workshops.

4.4.1 Triggers in the Beginning Phase: “Lower Floor” before Learners Start to Learn Programming.

In the beginning of the workshop, triggers reduced negative emotion for interest development with respect to technological difficulties such as dealing with electronic circuit and programming. To be specific, the instruction videos through which participants were able to learn and finally understand about circuits and programming relieved stress and nervousness in technology. Participants D said as following:

“In the beginning, I was scared. Maybe ‘scared’ is not a good word. But I have kind of negative feelings. But I cannot explain them. Because for me, I thought it is so difficult. ‘What if I wouldn't be able to learn anything or couldn't do anything.’ But then when you started to explain everything and after your first video, my feeling was changed. And this was one of the moment when it (the feeling) changed. Because your explanation was very clear and understandable. It was on our level in terms of understanding. So, it was easy to understand.”
Triggering Women's Interest in Programming

**Figure 13.** Triggering process and the changes of the interest development in the workshops.
4.4.2 Triggers in the Middle Phase: “Support Immersion” in Learning Programming.

After getting rid of emotional tension about the technologies, following triggers helped the participants immerse in the physical computing activities in the middle of the workshop. Even though triggers in this phase sometimes provoked emotional tension of participants by making them face with unexpected challenges which were not easy to solve, triggers originated from facilitators supported participants not to be afraid of making mistakes and to get lessons from challenges. Participant A said as following:

“Actually, you (facilitators) get rid of the feeling of being frustrated because you're giving us encouraging environment, which is nice. Also, I think it's really important for people who have no idea about this field. Just to keep them encouraging "it's okay”.

On the other hand, several triggers in this phase such as insufficient time and lack of authority were discouraging development of emotional and cognitive aspects in interest. While working with the second group, a janitor in charge of our workshop venue came and insisted us to finish the workshop before the appointed time. Both facilitators and the participants were in hurry to end up the workshop. Participant C and D said that this moment bothered her working process.

Participant C: Time is very important. I want to explain about the moment (when the janitor came). I didn’t want to quit. But my motivation went down little bit. I didn't want to quit.
Participant D: For me there wasn't a situation that I want to quit. I am not sure if it is related, but I will say anyway. One external reason is that when he (a janitor) was saying that we have only half an hour. … It made me feel rush to move. I need to do it quickly. In this situation, luckily, we almost finished so that it didn't matter that much. But if you think about in general situation it (time) is important that. When there is a rush (moment), it makes me no time to think about this.

In the first group, the limit of time and authority also examined as an obstructive factor in terms of interest development. The workshop time was not enough to let the participants play and experiment with the given programs. Participants A and B said as following.

Participant A: The negative feeling maybe is the limitation of time. I wish we had more time to talk more about programming. It would have been a more enriching experience if the process of the content of the program was explored.

Participant B: I was expecting to write code by myself, so that was a little bit disappointing but because of the time limit, I understand.

4.4.3 Triggers in the Last Phase: “Maximize Feeling of Accomplishment”.

At the end of the workshop, triggers such as tangible artefacts that participants made enabled to feel accomplishment, which had influence on changes of cognitive and value-related aspects of interest. While reflecting their experiences in the workshop with the artefacts that they built, participants recognized that their knowledge as well as competency about technology improved. Also, they said that programming was worth to learn for its usefulness in their life or career.
Participant A: To come home with something tangible to show to my family made me so proud of myself. It gave the feeling that I am capable of doing something I thought I couldn't. It triggered the desired to learn more.

Participant E: I felt excited when I tried to turn on the lights of the Christmas-tree-task. It really worked!! And I did that!! It was little surreal.

4.4.4 The Whole Experience of the Workshop as a Trigger

In retrospective self-report after the workshop the participants answered that they became more knowledgeable and got ready to learn programming thanks to the whole workshop experience. Also, they said that programming is valuable to learn because it is helpful in their careers and it is useful to understand our daily life surroundings which are operated by computers and various sensors.

Participant A: The whole workshop gave me a positive feeling of the whole thing. … Tinkering them and producing something for such a short period of time was an amazing experience. I have always considered myself as someone who has zero interest/history of this topic electronic and programming.

Participant C: I want to learn how use that kind of simple stuff. Because it is related to my profession. It would be very cool with kids in educational fields (which is my career).
5 Conclusion and Discussion

This study aimed to explore factors triggering interest of women who were novices in programming. In order to achieve the aim, this research started by applying two theoretical frameworks as its roots; interest and triggers as well as contextualized and physical computing approach. Through the case study qualitative data were collected, which gave insights about correlation between educational triggers and interest of women in programming. In this chapter, the findings of this study are generally presented and discussed further.

5.1 RQ1) Which Educational Factors Potentially Work as Triggers in the Physical Computing Workshops?

This study found that there are heterogeneous factors acting as triggers. Those triggers were mainly from educational interventions such as learning contexts, learning contents, facilitators, and a student herself.

Support from facilitators was one of the key triggers. Especially, the role of the facilitators to create safe learning atmosphere where participants were able to enjoy learning without being afraid of making mistakes was an important trigger. Also, the facilitators’ capabilities to explain difficult concepts of programming into novice’s language was another significant trigger. This result corresponds to the earlier studies that teachers’ pedagogical and emotional encouragement is crucial to promote participation and satisfaction or learners (Dubow et al, 2017; Dukuzumuremyi, & Siklander, 2018; Kangas et al, 2017; Park & Siklander, 2018; Siklander et al, 2017).
When it comes to triggers from learning contents, there were two triggers identified: physical computing hands-on activities and video instructions. In the hand-on activities, ambiguous boundary between paper craft and programming triggered interest of participants. Researchers claimed that programming classes which are combined with wide range of topics such as arts, music and stories stimulate girls and women to discover programming is worth to learn (Baytak & Land, 2011; Guzdial, 2007; Kelleher, Pausch, & Kiesler, 2007; Kelleher & Pausch, 2007; Klawe, 2013; Wood, Muhl, & Hicks, 2016). In this research, building tangible objects also worked as a trigger for participants. Programming activities based on learning by doing approach tend to facilitate self-efficacy of learners (Katterfeldt et al, 2015; Qiu, Buechley, Baafi, & Dubow, 2013). However, overwhelming activities cannot act as triggers because they have potential to decrease self-efficacy of learners (Ramalingam, LaBelle & Wiedenbeck, 2004). Learning topics for students should be appropriately challenging in comparison with students’ competencies and resources (Park & Siklander, 2018; Siklander et al, 2017). In this study, video instruction performed as another trigger by helping participants manage advanced level of tasks. The video instructions explained about programming and circuit with using pictures and daily vocabularies instead of circuit schematic and difficult professional terms.

Lastly, the triggers from students included previous experiences in programming and personalities. But their role as a trigger became weak after the workshops started. This result is correlated with a previous study. According to Dubow and her colleagues (2017), previous experience in programming is not necessary to lead women to stick with programming, rather, social support is one of the key triggers (Dubow et al, 2017). As discussed earlier, facilitators were more significant as triggers in this research as well.
5.2 RQ2) Which Aspects of Women’s Interest in Programming are Developed through Triggers in the Physical Computing Workshops?

According to Krapp (2007), interest is composed of four elements; knowledge factor (cognitive factor), feeling-related valence (emotional factor), value-related valence and intrinsic quality. Knowledge factor and feeling-related valence were often identified during the workshop, whereas value-related valence did not arise until the end of the workshop. Moreover, intrinsic quality was not recognized at all. Probably, the time of the workshops was too short for participants to find value of learning (Harackiewicz et al., 2000; Krapp, 2007). Another possibility that can explain this phenomenon is that feeling related valence is decisive in situational interest (Ainley & Hidi, 2014; Chen, Darst & Pangrazi, 2001). As previous researchers claimed it is necessary for learners to have sustained meaningfulness of tasks and personal involvement in order to establish stable interest development (Harackiewicz et al., 2000; Hidi & Renninger 2006).

5.3 RQ 3) How are the Triggers Correlated with the Women’s Interest in Programming?

The research found that each trigger from learning contexts, learning contents and facilitators has closely related with all four elements of interest. However, it was hard to discover a particular relationship between a specific trigger and a certain element of interest. I assumed that a single trigger can affect learners in various ways including both cognitive and emotional factors of interest (Krapp, 2002). Also, a trigger has different influence in situational interest depending on a learner’s personality, cognitive status and emotional condition (Krapp, 2002). By taking this account, the research agrees that single element is not enough to stimulate motivation and engagement of students in learning (Fisher and Margolis 2002; Siklander et al, 2017).
5.4 RQ 4) How the Educational Factors Work as Parts of Triggering Process for the Interest Development in Programming?

The data of this research indicates that triggers played different roles in the beginning, middle and end phase of the workshops. In the beginning phase, triggers lowered barriers for participants in terms of programming and technology. Then following triggers supported participants to concentrate on the learning process and maximized feeling of achievement finally. From the finding, it is proved that each trigger is not divided and general interest development can be achieved when all triggers work in mutually supportive ways (Chen et al, 2001; Renninger & Bachrach, 2015). It implies that researchers and educators alike should understand about triggering process in order to provide effective and appropriate educational intervention to encourage learners in active engagement in learning (Chen et al, 2001; Krapp, 2002; Renninger & Bachrach, 2015; Siklander et al, 2017).

Previous studies contributed to the understand pedagogical resources to increase the number of women’s involvement in learning programming. Those researches involve new course designs (Rubio et al, 2015), institutional program reforms (Klawe, 2013), up-to-date educational tools (Kelleher & Pausch, 2007), pedagogical approaches (Baytak & Land, 2011; Rubio et al, 2015; Werner, Hanks & McDowell, 2004). However, there was still lack of fundamental understanding of how those solutions actually work in terms of psychological aspect – interest development, specifically – to promote more stable and prolonged interest of women in programming through educational interventions to overcome instant participation in a programming class.

5.5 Implication of this Study

By providing insights about interrelation between triggers and interest, this study contributed to understand educational psychological perspective of how to promote women’s stable
participation in learning programming. The study implies that educators are recommended to understand relationships between educational sources and learners’ interest development when designing and/or preparing programming workshops or courses to embrace diverse learners regardless of gender.
7 Limitation and Future Study

There are several limitations of this research. First of all, the findings of this study are hard to generalize due to the small sampling size (Yin, 2017). Also, the period of the workshops was so short that participants could not have enough time to explore programming by themselves. As a result, it was hard to investigate autonomy of learners which is imperative in interest development (Krapp, 2007). Deci (1998) stated that autonomy is “desire to be self-initiating and to have a sense of acting in accord with one’s own sense of self” (p.152).

In future study, it is recommended to investigate how the same triggering factors work to both men and women. By doing so, researchers can figure out educational interventions which can encourage both genders in learning programming. In order to examine this topic, case study which include men and women participants is necessary. The future study also needs to be further developed with bigger sample size in long-term period of time to see if findings are suitable to large population.
8 Evaluation

This research has been rigorously reviewed by members of the Fablearn Europe 2018 conference committee and published as an extended abstract (Park & Siklander, 2018). Furthermore, the researcher evaluated the quality of the given research design according to the four logical tests which involve construct validity, internal validity, external validity, and reliability by following the tactics as described on Table 8 (Yin, 2017). In this study, however, only three tests were reflected except internal validity because the main concerns of internal validity are for explanatory or causal studies (Yin, 2017). By taking the nature of this study account – exploratory case study – the researcher reflected construct validity, external validity and reliability in the research design, the data collection, the analysis and the writing results process in this study. The following part explained how the three tests were considered in this research.

Table 8. Case Study Tactics for Four Design Tests (Yin, 2017, p45)

<table>
<thead>
<tr>
<th>Tests</th>
<th>Case study tactic</th>
<th>Phase of research in which tactic occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>- use multiple sources of evidence&lt;br&gt;- establish chain of evidence&lt;br&gt;- have key informants review draft case study report</td>
<td>Data collection&lt;br&gt;Data collection&lt;br&gt;Composition</td>
</tr>
<tr>
<td>Internal validity</td>
<td>- do pattern matching&lt;br&gt;- do explanation building&lt;br&gt;- address rival explanations&lt;br&gt;- use logic models</td>
<td>Data analysis&lt;br&gt;Data analysis&lt;br&gt;Data analysis&lt;br&gt;Data analysis</td>
</tr>
<tr>
<td>External validity</td>
<td>- use theory in single case studies&lt;br&gt;- use replication logic in multiple-case studies</td>
<td>Research design&lt;br&gt;Research design</td>
</tr>
<tr>
<td>Reliability</td>
<td>- use case study protocol&lt;br&gt;- develop case study database</td>
<td>Data collection&lt;br&gt;Data collection</td>
</tr>
</tbody>
</table>
7.1 Validity

When it comes to construct validity, Yin (2017) suggested three strategies to meet the test of construct validity which are 1) to use multiple sources of evidence, 2) to build chain of evidence, and 3) to have informants review a draft of case study report.

Data triangulation was a beneficiary factor in this study. I collected two different data from group interviews with semi-structured questions and direct observations as I explained on the above for the sake of satisfying the construct validity. Moreover, the researcher concerned not only to collect information from various sources but also aimed at validating the same findings through the cross-data analysis. Because when each source of evidence is analyzed separately, it is not different as much as the comparison of conclusions from separate studies (Yin, 2017). In this research, the triggers identified from the interviews were checked twice from the observation data to see whether those triggers really happened during the workshop or not. However, the researcher acknowledges that the construct validity was not entirely achieved with respect to interest. As described earlier, the characteristics of interest construct include cognition and emotion which have possibilities to be distorted by memories of the participants. In addition, language was not enough to describe complex status of psychology which were one of challenges in this research to judge validity of the data about the interest development. From the researcher’s point, it was not able to recognize the changes of participants’ interest in palpable way only through direct observation.

The second strategies, a chain of evidence, refers to a principle which allows readers of the case study to track the origin of any evidence from beginning of research questions to ultimate case study conclusion (Figure 15). Considering this point, a chain of evidence, the study tries its best to show connectivity between the research questions, the theoretical
background, the research data method, the findings and the conclusions. Yin (2017) stated that it is one way to heighten construct validity to cite or footnote the actual evidence with key phrases or words in a case study report. Instead of demonstrating the data analysis result itself, the researcher quoted the information from the interview data directly as much as possible to provide readers why the results came out from which parts of the data.

![Diagram of maintaining a chain of evidence](Yin, 2017, p128)

Lastly, albeit it was not available to have all participants review the draft of this thesis, the researcher asked the facilitator who participated in the workshop to look through the draft so as to meet the third strategies of the construct validity test. However, it could be precisely said that there is still absence in the construct validity since the informant who had interviews for the case study were not involved in the reviewing process.

With respect to external validity, it concerns whether a study’s findings can be generalized beyond the immediate study without regard to any research methods (Yin, 2017). It is
suggested for researchers to relate single case study with certain theories or theoretical propositions of interest (Yin, 2017). With this approach, the single case study can be worked to ascertain whether the theories or propositions are true or not. Concerning this point, this study primarily used the theories of interest development and triggering interest so as to figure out the level of changes in women’s interest in accordance with triggers during the introductory programming workshop. Thanks to the theoretical backgrounds of this study, the researcher could determine the interest development of participants changing in different learning activities, support from the facilitators and educational supplies. Nonetheless, there is still limitation in this study to generalize the influence of triggers on interest development of women because the same triggers can affect diversely for the same students in different situation (Renninger & Bachrach, 2015; Siklander et al, 2017).

7.2 Reliability

The test of reliability is to demonstrate that a study can be operated repetitively with the same results. Yin recommended two tactics which can enhance reliability of researches: 1) to use case study protocol and 2) to develop case study database. Firstly, a protocol is major way to increase reliability and it contains instruments as well as procedures and general rules to be followed to conduct studies (Yin, 2017). In this study, the researcher prepared the protocol including overview of the case study with the aim, the objectives and the questions of the study, the detail of data collection procedure, the data collection questions to keep in mind during the collecting process, and the guide for the case study report (as shown in Appendix 1). In addition, this study tried to present sufficient evidence without interpretation by quoting words and phrases from the interviewees. Even though the study endeavored to increase the reliability, the researcher admits the truth that there are still boundaries in terms
of the test of the reliability on account of the changeable characteristic of initial phase of interest and the small sampling size applied in this research.

7.3 Ethical Issues

Discussions about ethical principle in social research revolve around four main area: harm to participants, lack of informed consent, invasion of privacy, and deception (Bryman, 2015; Finnish Advisory Board on Research Integrity [TENK], 2012). These four issues were taken into account during the research design, the data collection, the data analysis and the writing the result phases.

Not to harm to participants in either mentally or physically, the researcher uploaded a post about the workshop with detailed information including what the workshop for, what participants do during the workshop and what the study is about on Facebook to gather participants. People who apprehended the contents and the purpose of the workshop contacted the researcher by themselves to take part in the workshop. Before getting started the workshop, the researcher explained about the workshop again to the participants to reduce emotional or cognitive stress and to prevent deception issue. With respect to lack of informed consent, consent forms were distributed to the participants before collect the data and the researcher collected forms after they read and signed on the form. During the data collection process, questions which have potential to invade personal life were not asked and names of participants were mentioned as anonymously to keep participants’ privacy.
References

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TRIGGERING WOMEN’S INTEREST IN PROGRAMMING


Kinnunen, P. (2009). The instructional process in an introductory programming course from students’, teachers’, and organizations’ point of view - the system theoretical approach to the higher education at Helsinki University of Technology (Doctoral dissertation)


Papadimatos, P. (2005). Physical computing: using everyday objects as communication tools (Doctoral dissertation, UCL (University College London)).


Appendix 1

Data collection procedures

1. Plan for the workshops (on 17th December 2017)

1) The workshop with the first group

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:30 - 9:40</td>
<td>10m</td>
<td>1. Introduce the schedule of the focus group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Sign on agreement for the research interview</td>
</tr>
<tr>
<td>9:40 - 9:45</td>
<td>5m</td>
<td>Intro Video <a href="https://youtu.be/1UwjeU2XSw">https://youtu.be/1UwjeU2XSw</a></td>
</tr>
<tr>
<td>9:45 - 9:55</td>
<td>10m (Video)</td>
<td>[Activity #1: Music light box] <a href="https://youtu.be/EGWqqlQ0OE">https://youtu.be/EGWqqlQ0OE</a></td>
</tr>
<tr>
<td>9:55 - 10:05</td>
<td>20m (circuit)</td>
<td></td>
</tr>
<tr>
<td>10:05 - 10:25</td>
<td>20m (craft)</td>
<td></td>
</tr>
<tr>
<td>10:25-10:30</td>
<td>5m</td>
<td>Break</td>
</tr>
<tr>
<td>10:30-11:20</td>
<td>10m (Video)</td>
<td>[Activity #2: Snowmen lantern] <a href="https://youtu.be/SjWF1f0K8K">https://youtu.be/SjWF1f0K8K</a></td>
</tr>
<tr>
<td>11:20-11:25</td>
<td>5m</td>
<td>Break</td>
</tr>
<tr>
<td>11:25-12:15</td>
<td>55m</td>
<td>Interview</td>
</tr>
</tbody>
</table>

2) The workshop with the second group (on 17th December 2017)

<table>
<thead>
<tr>
<th>Time</th>
<th>Duration</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00 - 14:10</td>
<td>10m</td>
<td>1. Introduce the schedule of the focus group</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Sign on agreement for the research interview</td>
</tr>
<tr>
<td>14:10 - 14:15</td>
<td>5m</td>
<td>Intro Video <a href="https://youtu.be/1UwjeU2XSw">https://youtu.be/1UwjeU2XSw</a></td>
</tr>
<tr>
<td>14:15 - 14:25</td>
<td>10m (Video)</td>
<td>[Activity #1: Music light box] <a href="https://youtu.be/EGWqqlQ0OE">https://youtu.be/EGWqqlQ0OE</a></td>
</tr>
<tr>
<td>14:25 - 14:45</td>
<td>20m (circuit)</td>
<td></td>
</tr>
<tr>
<td>14:45 - 15:05</td>
<td>20m (craft)</td>
<td></td>
</tr>
<tr>
<td>15:05-15:10</td>
<td>5m</td>
<td>Break</td>
</tr>
<tr>
<td>15:10-16:00</td>
<td>10m (Video)</td>
<td>[Activity #2: Snowmen lantern] <a href="https://youtu.be/SjWF1f0K8K">https://youtu.be/SjWF1f0K8K</a></td>
</tr>
<tr>
<td>16:00-16:05</td>
<td>5m</td>
<td>Break</td>
</tr>
<tr>
<td>16:05-17:00</td>
<td>55m</td>
<td>Interview</td>
</tr>
</tbody>
</table>

2. Data collection process

1) Observation: During the workshop
2) Interviews: After completing each workshop

3. Data collection questions

1) Interview

[Feeling of enjoyment / Interest]
1. What was your general feeling during the workshop?
2. What do you feel about learning programming now? Did you enjoy it?

[Feeling of tension]
1. When do you feel stress of pressure during the workshop?
2. How were you able to overcome the moment? If now, why you were not able to?

[Changes of competencies]
1. What would be significant changes in terms of competencies after the workshop? What makes you so?
2. Do you now feel that programming is less difficult?

[Relationship with real life] / [Knowledge construction]
1. How do you think about usefulness of today’s experience? Do you think programming will be useful in your life?

[Social relatedness/Interest]
1. How much it would affect on you to motivate you to learn programming in online learning platform?
2. How much it is important for you to interact with people in terms of learning programming?

[Changed level of knowledge or ability]
Do you now feel that you can understand basic structure of programming?

**[Intrinsic quality]**

Are you *willing to learn programming* if there is *a chance like this*? Why?

2) Observation

<table>
<thead>
<tr>
<th>[Beginning phase of the workshop]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggers from</td>
</tr>
<tr>
<td>1) Content:</td>
</tr>
<tr>
<td>2) Tutors:</td>
</tr>
<tr>
<td>3) Students:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[Middle phase of the workshop]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggers from</td>
</tr>
<tr>
<td>1) Content:</td>
</tr>
<tr>
<td>2) Tutors:</td>
</tr>
<tr>
<td>3) Students:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[The end of the phase of the workshop]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triggers from</td>
</tr>
<tr>
<td>1) Content:</td>
</tr>
<tr>
<td>2) Tutors:</td>
</tr>
<tr>
<td>3) Students:</td>
</tr>
</tbody>
</table>
## Appendix 2

Structural coding system in the first cycle coding

<table>
<thead>
<tr>
<th>categories</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feeling of enjoyment during the workshop</td>
<td>The moment when the participants felt excitement, fun and curiosity during the workshop.</td>
<td>“I think general feeling for me was excitement. Because …”</td>
</tr>
<tr>
<td>Feeling of difficulties during the workshop</td>
<td>The moment when the participants felt challenges and difficulties during the workshop.</td>
<td>“If I should state about what the most challenging part is, it was at the beginning when …”</td>
</tr>
<tr>
<td>Feeling of frustration during the workshop</td>
<td>The moment when the participants wanted to give up during the workshop.</td>
<td>“I was frustrated when …” “There was no frustration situation. But …”</td>
</tr>
<tr>
<td>Changes of competencies during / after the workshop</td>
<td>The participants’ subject opinion about changes of their competence in learning programming during or after the workshop.</td>
<td>“I can't say I am competent but I would say …” “In terms of competence, I think …”</td>
</tr>
<tr>
<td>Changes in</td>
<td>The participants’ subject opinion</td>
<td>“I got ideas of what instructors were …”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
<td>Comments</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Knowledge and ability</td>
<td>about changes of knowledge and ability in programming during or after the workshop.</td>
<td>saying ….” “I learned that …”</td>
</tr>
<tr>
<td>Scaffolding from facilitators</td>
<td>The facilitators were mentioned by the participants as people who support the participants to develop knowledge, skill and understanding.</td>
<td>“The instructor explained me everything and …”</td>
</tr>
<tr>
<td>Safe learning atmosphere</td>
<td>The learning atmosphere was described as safe, which support the participants not to be afraid of making mistakes.</td>
<td></td>
</tr>
<tr>
<td>Instruction videos</td>
<td>Participants’ opinion about the video instructions in the workshop.</td>
<td>“The video was easy to understand for me. Because …”</td>
</tr>
<tr>
<td>Usefulness of Changes</td>
<td>Changes of perception regarding</td>
<td>“The video was interesting because …”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“It might be useful when …”</td>
</tr>
<tr>
<td>Programming</td>
<td>Usefulness of programming in their life.</td>
<td>“Me and my husband want to teach our son programming…”</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Previous experience about programming</td>
<td>Participants’ previous experiences about learning programming before the workshop.</td>
<td>“My previous experience is not for me. Because…”</td>
</tr>
<tr>
<td>Benefits of reflection</td>
<td>Participants opinion about the interview as reflection after the workshop.</td>
<td>“It is great that we have opportunities to reflect our learning to see how it went and how it happened.”</td>
</tr>
<tr>
<td>Limit of this pedagogical approach</td>
<td>Participants opinion about limitation of the workshop in terms of learning programming with interest.</td>
<td>“When you have this chance that you can reflect, then you can …”</td>
</tr>
</tbody>
</table>