What Motivates Children to Become Creators of Digital Enriched Artifacts?

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What Motivates Children to Become Creators of Digital Enriched Artifacts?

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ABSTRACT
The advent of programming languages for children (i.e., Scratch) combined with accessible programmable hardware platforms (i.e., Arduino) makes it possible for teenagers to engage in creative development of digital enriched artifacts, like robots and interactive installations. But what are the important factors that characterize these development activities? And more specifically, what motivates children to participate in such software and hardware intensive activities? In this paper we present the results of an empirical investigation regarding the key aspects of a creative learning context. The goal is to understand what motivates children to participate in these development activities. In our empirical evaluation, a group of researchers and artists designed, implemented, and evaluated three workshop programs of 66 children total, with the final goal of exploring children's attitudes software and hardware-intensive activities. The workshops were based on the Reggio Emilia education principles, open source software Scratch and Arduino and were conducted in centers that use recycled materials for creative purposes. For the first phase of the evaluation, qualitative data was collected from 11 interviews and was analyzed using content analysis. For the second phase, we designed a survey grounded in motivational factors for technology. 37 survey responses were collected. For both evaluation phases, photos and observations were recorded and used to triangulate our data. The results showed that: (a) software and hardware intensive activities raise awareness of technology, intensify the experience, and invite students to explore boundaries and increase collaboration and the exchange of views and ideas, and (b) the activity's easiness and usefulness significantly affect children's intention to participate. These results have implications for those programming languages and hardware platforms for children, as well as for those setting up creative learning frameworks around such technology.

Author Keywords
Creative activities; children motivations; empirical evaluation; software and hardware development; physical–digital creativity; Reggio Emilia education principles

ACM Classification Keywords
H.5.3 [**Group and Organization Interfaces**]: Collaborative computing, Computer-supported cooperative work, Evaluation/methodology; K.4.m [**Miscellaneous**]

General Terms
Experimentation; Human Factors; Design; Measurement.

INTRODUCTION
Digital artifacts that enable people to exchange, create, and distribute information have, in the past couple of decades, profoundly reshaped the way we work and live [18, 19, 26, 27]. The creative production of digital artifacts in learning activities has been linked to teaching new computer literacy skills [3, 16]. Common inspiration is the work of Papert [22] that stresses the importance of creating a 'felicitous' environment to facilitate learning. The idea here is that the children benefit from being happy and in a carefree and creative environment. In accordance with Papert, Csikszentmihalyi's [7] research has exhibited that children's motivation is highly predictive of achievement; however, educational systems neglect creative activities. Educational programmes focus on recall and reproduction abilities instead of emphasizing the development of problem solving, creative thinking and decision-making abilities [25].

Digital artifacts have the potential to make the symbolic and abstract manipulations involved in creative procedures more concrete and manageable for young children [4]. For example, artifacts allow children to learn by iteratively testing, rebuilding their designs and working collaboratively [11]. The interactions between the children and the artifacts in a creative activity are vital [31]. A better understanding of several aspects from children's perspective could be valuable in designing effective creative activities. The purpose of the research presented in this paper is to build an understanding of the main interactions between children and the tools in creative activities and to consider improvements on the current processes.

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Another important issue regarding the success of software and hardware intensive creative activities is the adoption by the children. Several models and theories have been used to address children's adoption towards computer based activities [10]. The Unified Theory of Acceptance and Use of Technology (UTAUT) is one of the most widely and successfully used [21]. Other researchers have empirically explained (using UTAUT or its initial form of TAM) several issues regarding children's attitudes [35]. We aim to measure and investigate children's motivations, as successful activities largely depend on children's motivations [7]. In this light, variables related to children's motivation are chosen and applied to a creative development context. Then we conduct an analysis in order to identify which motivators lead children to participate in a creative activity.

The aim of this empirical study is to explore and understand software and hardware intensive activities and to then examine any potential effects of children's motivations and their intention to participate on any similar events in the future. Therefore, in our study children engaged into the world of creative development by building seventeen interactive projects and artworks (see example on figure 1). After children's experience, we measure and understand their beliefs regarding software and hardware creative activities, in order to be able to:

- Investigate what motivate children to participate on software and hardware intensive activities.

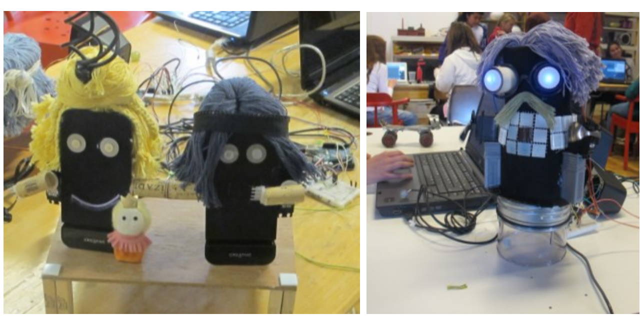

Figure 1: Enriched artifacts created by children.

The clarification of this goal is expected to contribute to the understanding of children's intentions to pursue creative software and hardware development activities (hereinafter, creative development activities) in the future.

The paper is structured as follows: the next section presents the background underlying the key variables studied in the paper and the related work. Sections 3 and 4 describe the creative development activities and the two empirical evaluation phases. The final section of the paper raises the key theoretical and practical implications of this research and discusses several ideas on further research in the area.

BACKGROUND AND RELATED WORK

This section introduces existing research and theories that provide a relevant background regarding the key aspects of computer based learning activities and the children's motivations for participating in creative activities.

Key aspects of the enhancement of physical–digital creativity

Beyond desktops, ubiquitous technologies not only allow a more active, physical engagement, but also provide the opportunity for novel and creative interactions. Physical and digital enhancement also provides the facility to convey experiences not possible in the physical world, for example, turning our thoughts into reality (i.e., through 3D printer). In turn, this physical and digital enhancement can provide opportunities to encourage or even enhance further exploration, discovery, reflection, and collaboration [24].

Price and Rogers [24] propose six aspects to explain how children make sense of and integrate the series of physical–digital encounters. They suggest that one of the key aspects of interacting in physical-digital environments is to raise the awareness of the children as to what they are doing with that. Another core aspect is that they provide a richer experience (compared with desktops), allowing children to make explicit bridges between their various perspectives and understandings of the physical-digital intersections. Another feature is the anticipation that is triggered when experiencing couplings between highly familiar physical actions and unfamiliar effects. The degree of authenticity of the experience and the amount of collaboration that results can also be greater – both of which are considered in the literature to be important aspects of active development [23, 24].

Children's Motivations for Creative Activities

Children's motivations are considered important determinants of their future decisions and learning success [3]; however, school activities are low points in children's motivation, despite being a critical time for developing the skills necessary to thrive in the adult world [33]. Both intrinsic (i.e., learning for enjoyment) and extrinsic (i.e., learning as a specific purpose) forms of motivation decrease across the school transition [21]. Creative activities are very beneficial for young children because they facilitate and improve their problem solving, adaptability, and self-expression [13]. Creative activities are highly affected by children's motivations [30]; however, reluctance towards adoption of the creative activities implies a need for further research to understand, more comprehensively, how children could be motivated.

Several models and theories have been applied to address issues of students' attitude and motivations and to identify the cause and effect of different factors on the adoption of activities for learning. For instance, the Unified Theory of Acceptance and Use of Technology [40], Theory of Planned Behavior [10] and Social Cognitive Theory [17, 28] are some of the most widely applied theories in the context of human behavior. In addition, Enjoyment (ENJ), Satisfaction (STF), Usefulness (USF), and Easiness (EAS) are some of the most commonly used motivation factors affecting children's intention to attend a respective activity (i.e., [10, 35]). There is, however, a lack of empirical evaluations on children's motivations and the effects of these motivations on their intention to participate in creative activities. In view of the above, we aim to measure these motivations and examine their effects on children's intention to participate in creative development activities.

Creativity in our lives

Although creativity is difficult to define and is widely debated, researchers and theorists tend to define creativity based on a schema that they frequently experience in several roles [39]. Their concept of creativity becomes more of a comprehensive belief of creativity than their definition may imply [5]. For example, Vygotsky [41] states: "Any human act that gives rise to something new is referred to as a creative act, regardless of whether what is created is a physical object or some mental or emotional construct that lives within the person who created it and is known only to him" (p. 7). It is widely accepted [39] that children need to experience creative learning opportunities. According to Aljughaiman and Mowrer-Reynolds [1], one of the most important challenges for creative opportunities is: "to establish an environment that promotes the children's interests" (p. 17).

This evolving definition of creativity results in the incremental growth of the research focus on creative activities and its underlying cognitive processes [2]. There is also an extensive body of work on the importance of individual's attitude in the process of creative activity [15, 34]. Creativity is one of the core resources for problem solving [13], and most problems need creative thinking to be solved; thus children must be motivated to participate in creative activities. To this end, Sims [36] proposes integrating role playing and collaborative learning into the creative learning environment to improve children's motivation and retention.

Software and Hardware development

Recent developments in the intersection of technology and physical fabrication have led to an improvement in the ability of humans to create an interesting and creative environment. For example, digital fabrication devices like laser cutters, 3D printers, and computer-controlled knitting machines are allowing for quick and mass customization, enabling people to quickly design and build their own objects [9]. Growing communities of people are sharing "know how" to build real world objects from clothes and sensors to robots and food on sites like Instructables [14]. Open source software and hardware communities promote the creation of technologies whose physical description is as open as their digital description. These technologies are growing around tools like the Chumby, the Arduino and the Scratch [25].

Computer technologies for the production of creative outcomes are also abundantly visible. Graphics or music software and word processors are used pervasively in production. Many tools to support creativity and idea generation have also been developed [3, 26]. In our study, we chose open source software called Scratch (scratch.mit.edu) and Scratch for Arduino (S4A) (http://seaside.citilab.eu/scratch/arduino) to illustrate both collaborative and creative learning. Both software are media-rich programming languages that allow youth to design and share programs in the form of stories and games. They use building block command structures; additionally, programmed objects can be any imported two-dimensional graphic image, digitally or physically made. This makes it particularly amenable to an array of young creative students who want to build their own software and engage in the participatory culture [3]. With 1.3 million registered members and over 2.8 million projects shared to date, the Scratch website is one of the most vibrant online communities. Scratch may also be used in small group formats (e.g., pair programming).

Our Research Approach

The challenge of how to motivate students to engage on creative development activities is still unresolved. In particular, our research is intended to fill this gap by conducting an empirical investigation that enables scholars and educators to efficiently design and develop creative activities in the intersection of software and hardware development. Our research follows a two-phase process (Figure 2). In the two consecutive phases: we explore/understand about what children liked and disliked about the software and hardware intensive activities through a qualitative approach (Phase 1). Afterwards, we proceed on the measurement and quantitative validation of the activity through children's experience (Phase 2).

In the following sections, phases 1 and 2 will be presented in more detail.

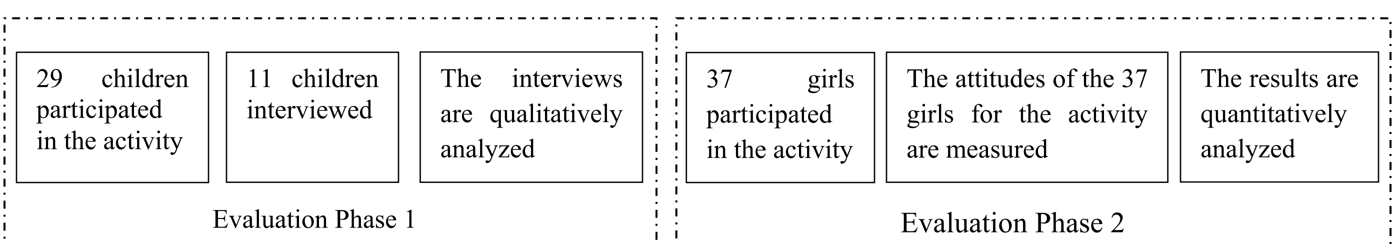

Figure 2: Phases of our research process.

EVALUATION PHASE 1: EXPLORATION OF COMPUTER BASED LEARNING ASPECTS IN A CREATIVE CONTEXT

Procedures and Participants

Two classes from two different schools participated in the first program of creative software activity; the workshops took place at a ReMida center, which collects and offers a variety of materials for use in creative and educational projects. The center is cooperation between the municipality, the education project Reggio Children, the municipal waste company (recycling), and the local business community. ReMida centers work according to Reggio Emilia education principles. Where the main idea is that the initiative for creative actions should spring from the child himself/herself. ReMida centers are creative places with a lot of appealing objects where students start to work without being activated by adults. The adults act as assistants. The adults act as assistants. The first phase of the evaluation was composed of two workshops. 15 children participated in the first workshop, and 14 children in the second. All participating children were 12 years old, and in each workshop we had three groups (compromised of 4-5 children) and each group had two computers.

The children attending the workshops were instructed and assisted by the programming artist, the leader of the ReMida center, a PhD student, four master degree students, a senior researcher, and a project manager. For the first phase, the children completed and published in total six interactive works. Record of the children's activities was kept through photographs, interviews and observation reports and used as data in this research.

The first workshop program was based on the open source software Scratch. In particular, it consisted of tutorials (T), creative sessions (CrS) and a final presentation by the students (PR):

CrS1. Create physical characters (see Figure 3, i)

T1. Scratch tutorial first part: sprite animation, change costume, movement, sound and graphic effect;

CrS2. Compose a storyboard and start creating scenes in Scratch. The story written by the students is now programmed in Scratch. Sensors are used to establish interactivity between the audience and the created characters;

T2. Scratch tutorial second part: change scenes, synchronization (broadcast and when-receive), check the value of a variable, actions from sensors;

CrS3. Make your story lively (see Figure 3, iii). The connections from Scratch to the physical world by means of light, sound, and touch sensors are implemented by homemade sensors connected to the PC by Arduino boards;

PR. When students have completed their artworks, they decorate a room for installing and presenting their work (see Figure 3, iv).

Students' projects are published on the Scratch Web site under the name [removed due to anonymity]. The scripts have been modified so that the projects run without the Arduino boards and connected sensors.

Data Collection and Analysis

In the first explorative phase of our evaluation, the data collected were mostly from interviews with the children. A semi-structured interview guide was used in the personal in-depth interviews with the children. Interview questions were designed to probe different aspects of motivation and creativity. The sampling process was done by convenience sampling, meaning we asked for volunteers rather than making a specific selection amongst the students; however, as we interviewed more than the 1/3 of the total sample (five students at one school and six at the other), we can assume that due to the qualitative nature of this phase, our sample was sufficient.

After the interviews were conducted and the material transcribed and evaluated, it became clear that the point of saturation was reached: interviewing more informants was not expected to provide radically different or more in-depth material. At the end, the text corpus covers of the interviews were 28 pages. Approximately half of the corpus represents interviews from boys and the rest concerns interviews from girls. After the students' interviews were collected, we proceeded with a content analysis. Two researchers (coders) read all responses first, coding important keywords until categories emerged from similar codes. The two researchers discussed and reached consensus in categories following the method described by Glaser and Strauss [12]. Coders inter-reliability was 0.703, exceeding the recommended guideline (Cohen kappa > 0.60), thus indicating high inter-coder reliability.

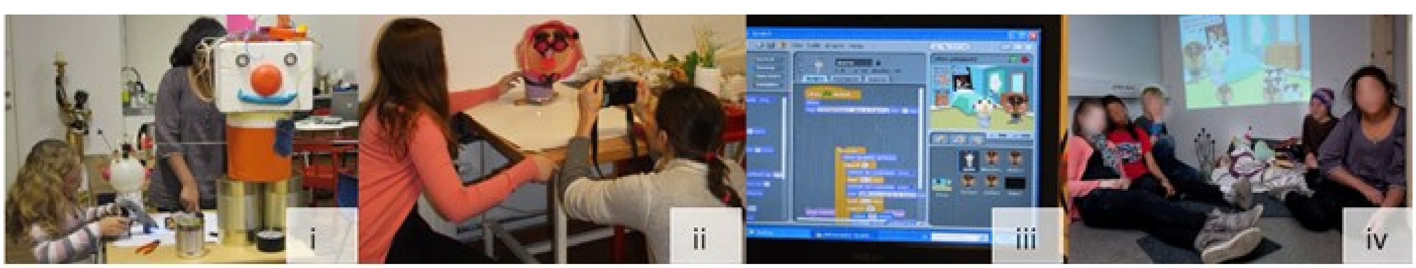

Figure 3: Depicts the flow of the 1st phase workshops.

Results

By analyzing children's responses, the content analysis procedures led us to the conclusion that awareness, experience, exploration and collaboration are highly important during the activity. Specifically, we can say that the creative development activities: (a) raise **awareness** for technology, (b) make the **experience** more intense, (c) invite children to **explore** boundaries, and (d) increase **collaboration** and the exchange of views and ideas.

Raise Awareness: By placing the software development in different settings, the awareness for both the software development and the setting has been enriched. To this end, children create richer basis about both:

> *Deborah:* **I realized** there were lots of different ways of using the program (means Software).
>
> *Nick:* **I found out, I did not really think** that you could make art with reused materials.
>
> *Emily:* **It kind of changes my mind**… But now **I found out** you can make movies and things for children too.

Make the experience more intense: The experience of interacting with the digital–physical couplings during the activities through more varied modalities, offers a greater diversity of information on which to reflect about the experience and the environment:

> *Paul*: I like to build, that we got to build it and not just make it on computer, but **we actually got to build it**, that was fun.
>
> *Janet*: When I have to make something, it is hard for me, but **if I then am just playing around with it, then its easier**.
>
> *John*: I thought it was really fun to learn about the computer, how to make that, and it was fun to make our own character and **experience how it was creating something of our own**.

Invite students' to explore boundaries: The activities encourage high levels of exploration and discovery in children. The rich environment enables a number of different combinations of actions and interactions to be experimented, therefore encouraging creative exploration on children:

> *Mike*: We came there, I thought "WOW" that was so cool, I went there and **I looked at everything and stuff, and I was, ohh maybe something**, every little corner has one thing on it.
>
> *Letizia*: liked that there were, was **lots varieties to make your own** character.
>
> *Gaby*: **I like searching** for new music or else…

Increase collaboration and the exchange of views and ideas: Based on the responses of the students, we can easily say that the collaboration greatly improves the value of the activities. In particular, children admit that working in groups helps them to get ideas and learn from others and make the activity more enjoyable and creative:

> *Mary*: It's much easier to **get ideas from others, and to learn from them**
>
> *Sam*: it's **more enjoyable to do it with others**, because you always have someone to talk to or... and you work maybe better with them
>
> *Liz*: It is easier to relax and to **try new things when your friends are there**.

EVALUATION PHASE 2: CHILDREN'S BELIEFS AND PARTICIPATION TO CREATIVE SOFTWARE PROGRAMS

Goal, hypotheses and rationale

The main goal is to investigate what motivates students to participate in creative development activities. Enjoyment, Satisfaction, Usefulness, and Easiness are some of the most commonly used factors [10, 17, 36] affecting children intention to attend a respective activity. Considering this, we aim to measure these factors on creative development activity and to identify potential effect on children's intention to participate on similar events in the future. Thus, the study's set of hypotheses is formulated as follows:

H1. The Enjoyment with the creative development activity has a positive effect on children's intention to participate on future similar activities.

H2. The Satisfaction with creative development activity has a positive effect on children's intention to participate on future similar activities.

H3. Usefulness of the creative development activity has a positive effect on children's intention to participate on future similar activities.

H4. Easiness of the creative development activity has a positive effect on children's intention to participate on future similar activities.

In order to address the above hypotheses, we proceed into the following procedures: 1) collecting data through surveys; 2) assessing the convergent validity of the aggregated data; 3) exploring potential correlation among the variables and; 4) performing an Analysis of Variance (ANOVA) between Enjoyment, Satisfaction, Usefulness, and Easiness and Intention to Participate in order to confirm or discard the hypotheses.

Participants and Procedures

For the second evaluation phase, one class participated in the first program, which consisted of two 2-day workshops with twelve girls each. Moreover, a group of 17-18 year old girls participated in a 1-day workshop. The 2-day workshops took place at a ReMida center, and the 1-day workshop in a university's creative room, which was similar to the ReMida center. The second program has similar structure and philosophy to the first one; however, through the exploratory evaluation from the first program, we made some amendments. Based on the results of the first workshop program, we decided that the investigation of females' attitude in smaller teams would valuably contribute to our initiative. The second phase of the evaluation was composed of three workshops. As such, each workshop contained 12, 10 and 15 girls respectively, and each group had one computer. The first and the second workshops consisted of 12 year old girls and were 2-day workshops. The third workshop consisted of 17 year old girls and was a 1-day workshop; however, all workshops followed the same structure.

Instead of using Scratch we used Scratch for Arduino (S4A), which is a special version of Scratch that allows the use of actuators (motors and lights) in addition to sensors. The second workshop program consisted of four steps:

CrS1. Create physical characters (Figure 4, left)

T. S4A tutorial, learn how to control Arduino, sensors, and motors

CrS2. Make Scratch programs which animate the physical characters with S4A and Arduino boards (Figure 4, middle)

Pr. When students have completed their artworks (Figure 4, right); they gave them names and they presented them to the other teams

At the end of the workshop a final discussion was held. Figure 4 gives an overview of what a project comprised in terms of creativity. Students' artworks of the second workshop program have been collected and presented in an official exhibition in the university.

Data Collection

A wide range of data was collected to address our research questions including surveys, photos and observations. During most of the sessions, one of the organizers was present to assist and observe the children. In the second phase, the main emphasis was the quantitative data. For the quantitative approach, we implemented a survey based on the rich information obtained from the interviews with the students and information from the literature review. Participants took the survey two days after the workshop, evaluating the measures (constructs) of:

a) Intention to Participate,
b) Enjoyment,
c) Satisfaction,
d) Usefulness,
e) Easiness

Table 1 lists the survey items used to measure each construct and the source of the literature review obtained. In all cases, 7-point Likert scales were used to measure the variables.

Data Analysis and Results

The Fornell and Larcker [8] proposed three procedures to assess the convergent validity of any measure in a study:

(1) Composite reliability of each construct,

(2) Item reliability of the measure,

(3) Average Variance Extracted (AVE).

First, we carried out an analysis of composite reliability and dimensionality to check the validity of the scale used in the questionnaire. Regarding the reliability of the scales, Cronbach`s α indicators were applied [6], and inter-item correlations statistics were employed for the items of the variable. As Table 5 demonstrates, the result of the test revealed acceptable indices of internal consistency in all the constructs.

In the next stage, we proceeded to evaluate the reliability of the measure. The reliability of an item was assessed by measuring its factor loading onto the underlying construct. Manly [20], recommended a factor loading of 0.6 to be a good indication of validity at the item level. The factor analysis identified the six distinct factors; (1) Intention to Participate, (2) Enjoyment, (3) Satisfaction, (4) Usefulness, and (5) Easiness (Table 2).

Figure 4: Left, Create physical characters; Middle, Make Scratch programs which animate the physical characters with S4A and Arduino boards; Right, One of the artworks.

Constructs	Definition	Items (Questions)	Source Adopted
Intention to Participate	The degree of students' Intention to participate in a similar activity	I intend to participate in similar activities in the future (ItP1)	[10]
		My general intention to participate in similar activities in the future is very high (ItP2)	
		I will regularly participate similar activities in the future (ItP3)	
		I will think about participating similar activities (ItP4)	
Enjoyment	The degree to which the activity is perceived to be personally enjoyable	Attending the activity was enjoyable (ENJ1)	[40]
		Attending the activity was exciting (ENJ2)	
		I was feeling good in the activity (EN3J)	
Satisfaction	The degree to which a person positively feels with the activity	I am satisfied with the activity (STF1)	[17]
		I am pleased with the activity (STF2)	
		My decision to attend the activity was a wise one (STF3)	
Usefulness	The degree to which an individual believes that attending the respective activity is useful for him/her	Attending similar activities improves my performance in arts and technologies (USF1)	[28]
		Attending similar activities enhances the effectiveness in arts and technologies (USF2)	
		Attending this kind of activities increases my capabilities in Art and Technologies (USF3)	
Easiness	The degree to which an individual believes that attending the respective activity is easy for him/her	I found the activity flexible (EAS1)	[10]
		The process of the activity was clear and understandable (EAS2)	
		It was easy for me to attain skills in the activity (EAS3)	

Table 1: The measures and its definitions

The third step for assessing the convergent validity is the average variance extracted (AVE); AVE measures the overall amount of variance that is attributed to the construct in relation to the amount of variance attributable to measurement error. Convergent validity is found to be adequate when the average variance extracted is equal or exceeds 0.50 [32].

Construct	Item	Mean	S.D.	Load	CR	AVE
Intention to Participate	ItP1	4.37	1.37	0.830	0.885	0.700
	ItP2	4.43	1.27	0.886		
	ItP3	3.74	1.54	0.862		
	ItP4	4.49	1.48	0.758		
Enjoyment	ENJ1	6.56	0.73	0.870	0.867	0.745
	ENJ2	6.25	1.08	0.853		
	ENJ3	6.06	0.92	0.866		
Satisfactio n	STF1	5.67	0.86	0.909	0.836	0.676
	STF2	6.03	0.91	0.813		
	STF3	5.69	1.37	0.736		
Usefulness	USF1	5.58	1.11	0.737	0.856	0.653
	USF2	5.14	1.20	0.843		
	USF3	5.53	1.18	0.839		
Easiness	EAS1	5.50	1.08	0.616	0.734	0.566
	EAS2	5.25	1.27	0.823		
	EAS3	5.31	1.37	0.801		

S.D Standard Deviation; CR Cronbach α; AVE, average variance extracted

Table 2: Summary of the measurement values

Consequently, it is possible to use a sole factor for representing each theoretical identified factor: (1) Intention to Participate, (2) Enjoyment, (3) Satisfaction, (4) Usefulness, and (5) Easiness (Table 2).

The level of enjoyment (6.29/7) and satisfaction (5.80/7) are high. The level of usefulness (5.42/7) and easiness (5. 53/7) are slightly lower. The participants' intentions to participate in similar activities (4.26/7) are not at such a high level (figure 5).

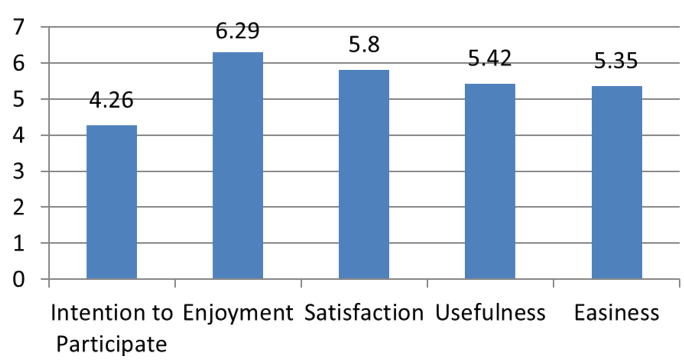

Figure 5: Average amount of each factor, based on its items.

Even though these constructs arise from an orthogonal rotation and are separable in terms of item loadings, they are correlated (Table 3). We employed Pearson's correlation coefficient between the factors, which is about quantifying the strength of the relationship between the variables. Pearson's test suggests that some of the factors are related, in some cases relatively strongly. More precisely, ItP is strongly related with USF and EAS. ENJ has correlation with STF and USF. Moreover, STF also shows significant relation with USF and EAS. Table 3 presents the exact results of Pearson's test.

	ItP	ENJ	STF	USF	EAS
ItP	1				
ENJ	0.204	1			
STF	0.077	**0.349***	1		
USF	**0.434****	**0.363***	**0.428****	1	
EAS	**0.339***	0.247	**0.465****	0.269	1

Correlation is significant at the ** 0.01 and * 0.05 level.

Table 3: Pearson's correlation coefficient between factors

To examine the research hypothesis regarding what motivates students to participate in creative software activities, we divided ENJ, STF, USF and EAS on low and high categories using a median split approach. Then an Analysis of Variances (ANOVA) was conducted, in which the four independent variables (ENJ, STF, USF, EAS) and the one dependent variable (ItP) were included. As the outcome data in Table 4 illustrates, the ENJ and STF exhibit an insignificant impact on participants ItP. On the other hand USF and EAS have indicated a significant effect on participants ItP.

Depen. Variable	Mean (S.D.)		F	p
	Low	High		
Intention to Participate	Enjoyment			
	4.02 (1.12)	4.42 (1.29)	0.89	0.353
	Satisfaction			
	3.93 (0.87)	4.64 (1.48)	3.07	0.089
	Usefulness			
	3.57 (0.53)	4.57 (1.33)	5.80	**0.022***
	Easiness			
	3.80 (0.86)	4.80 (1.39)	6.69	**0.014***

S.D. Standard Deviation; *p < 0.05

Table 4: Testing the effect of enjoyment, satisfaction, usefulness and easiness on children intention to participate.

Observing Table 4, we notice that ENJ has the lowest influence on ItP, and from Figure 6, it can be observed that ENJ has a slight increase. Furthermore, STF shows greater increase from ENJ; however, both ENJ and STF influences are insignificant. On the other hand, USF and EAS exhibited significant influence on ItP (table 4); Figure 6 clearly exhibits this positive influence.

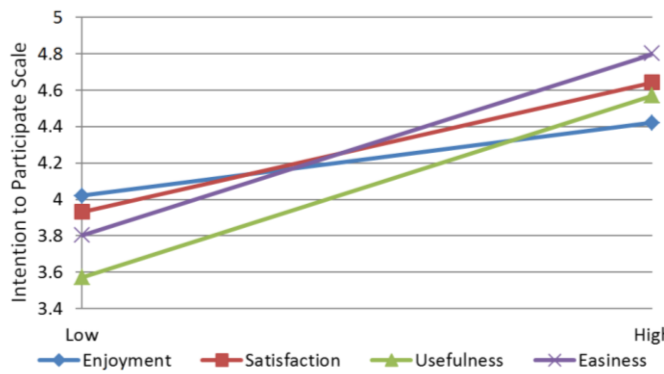

Figure 6: The effect of enjoyment, satisfaction, usefulness and easiness on children intention to participate.

In addition to the data provided by the rating, we gathered information from the participating children with an open question regarding their opinion for the activity. In order to understand the children's sense for the activity, we used the text corpus of their responses and generated a word cloud. Observing this word cloud (Figure 7, left), it is possible to understand that the general sense of students about the activity was positive, but it is very difficult to overview any details. By looking at children's responses we can easily see their positive attitude and their creative disposal occurred through the activity (Figure 7, right).

DISCUSSION AND CONCLUSION

In this paper we presented the results from the design, deployment and evaluation of the creative development activities. Children engaged in programming languages (i.e., Scratch) and programmable hardware platforms (i.e., Arduino), which enable them to engage in the world of creativity with digital enriched artifacts, like robots and interactive installations.

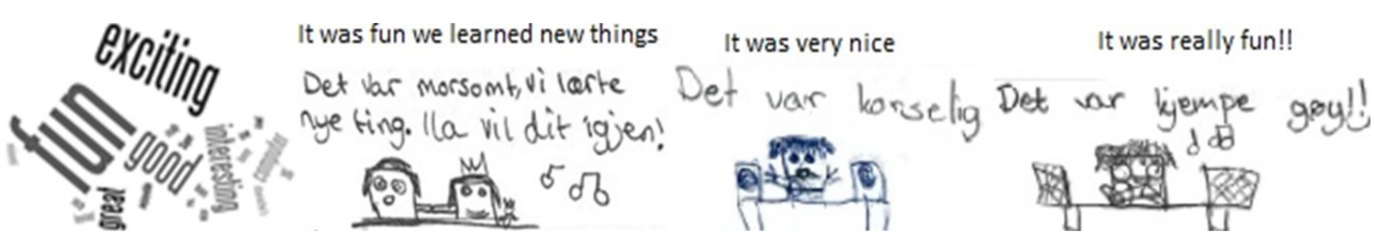

Figure 7: Word cloud generated from the children's feedback regarding the activities (left); drawings of the children in surveys (right).

Our empirical study consisted of two phases, an explorative-qualitative and a quantitative. In the first explorative-qualitative phase, data collected from 11 interviews and analyzed using content analysis. The results showed that the creative development activities: (a) raise awareness for technology, (b) make the experience more intense, (c) invite children to explore boundaries, and (d) increase collaboration and the exchange of views and ideas. For the second phase, we designed a survey grounded in motivational factors for technology, and 37 survey responses were collected and analyzed. The results from the second phase demonstrated that the key variables (Intention to Participate, Enjoyment, Satisfaction, Usefulness, and Easiness) exhibit a high degree of convergent validity in the context of creative activities. Last but not least, the results demonstrated that activity's easiness and usefulness significantly affect children's intention to participate.

The study has several implications for practice and policy. The results of this study verified that easiness and usefulness are important and influential factors in determining children's intention to participate in a creative activity. Scholars, educators and practitioners should focus on the creative activities usefulness and easiness because their predictive effect on children's adoption is high. Past research has also shown that strategies such as providing overviews of the tools used in the course, holding hands-on workshops with the technology [37], and providing an immediate technical service are an effective means of promoting users' perceptions of the easiness and usefulness. Activity designers and practitioners should strive to increase participants' intrinsic motivations, such as social norm and social influence, and provide a home-like environment. For example, the creative development activities should have some standard steps adopted from familiar school activities to make the children feel like experts.

Moreover, the instructors can treat the activities as an objective for the children to achieve learning targets. When children participate and achieve learning targets, they increase their perception that the outcome of their work could be improved through participation. With this in mind, they recognize the value of these activities in their lives. These findings help schools and institutions to understand the creative development activities take-up intention rate and perhaps call their attention to explore further the reasons why many children are not sure about their willingness to participate.

Although findings provide meaningful outcomes for the creative development activities understanding from children's perspective, this study has certain limitations. As in all empirical studies, the sample of the participants (e.g., gender, educational level, age) may have contingent effect on the results; this may limit the extent of the generalization of findings to other populations. However, the use of mixed method approach allows us to reduce this effect.

Our main interest, though, lies in young children and especially girls due to the problems they currently face in terms of technological literacy [38]. By performing an analysis among the responses from 12 and 17 year old children, we identified that the distribution of the responses were the same with no significant difference on each of the items. This also leads us to the decision that there is no reason to distinguish the responses.

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