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CODING MUSIC FOR NO STRESS LEARNING

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Abstract

This research paper reports on a study conducted over 10-week Creative Coding workshops designed to encourage girls' involvement in STEAM fields. By using observations and interviews, this study investigates the participants' experiences, learning progress, collaborative interactions, and perceptions. Additionally, the research examines the potential of creative coding and audio-visual perceptions of music in creating captivating learning experiences and multimedia art. The observations indicate the girls' initial excitement and curiosity, their ability to comprehend coding concepts, and the positive impact of collaboration in creating an empowering and inclusive environment. Participants' testimonies highlight the significance of integrating creative elements in attracting girls to STEAM and enhancing their confidence and aspirations. The findings underscore the importance of nurturing curiosity, promoting inclusivity, fostering collaboration, and integrating creativity to inspire and empower girls in coding and STEAM disciplines.
Index Terms: Creative Coding, STEAM fields, audio-visual perception, Live Coding

1. Introduction

As we live in the era of liquid modernity [1], a society based on constant and rapid change, while technology swiftly substitutes manual labor, studies increasingly indicate a need for creative and innovative workers [2]. To thrive in information-age jobs, employees must possess deep thinking, creative problem-solving, teamwork, cross-cultural communication, adaptability to evolving technologies, and information management skills [3]. Current education systems face pressure to develop problem-solving, critical thinking, communication, collaboration, and self-management skills in students, enabling them to reach their full potential as adults [4].

As educators, we are fully aware of this pressure and strive to employ effective teaching methods that equip students with the most valuable knowledge [5]. Traditional educational models are being replaced with innovative approaches to equip the younger generation with critical thinking, problem-solving, and innovation skills, preparing them to meet the challenges of modern society and become future leaders, productive workers, and responsible citizens [6, 7]. This shift has led to the widespread adoption of STEM education (Science, Technology, Engineering, and Mathematics) and, more recently, the STEAM model, which incorporates the arts into STEM disciplines [8]. While arts and STEM may seem incompatible, they actually complement each other in generating new, creative ideas and thought processes[9].

The STEAM framework combines systematic thinking skills from both scientists and artists, promoting holistic learning [10]. It acknowledges that arts bring innovative ideas to artistic, scientific, and societal domains [11, 12]. Additionally, the diverse nature of arts enables students to explore human nature, comprehend complex world dynamics, and cultivate empathy, which is considered a vital 21st-century skill [13]. Still, gender disparity persists in STEAM fields, with men outnumbering women, especially in technical areas like engineering and computer science [14]. Even in Sweden, a well-known moral superpower [15], a country that tops all gender equality rankings, women are underrepresented in Swedish universities [16].

To tackle this notorious problem and to overcome the stereotype threat [14] we have designed the Creative Coding project at Chalmers University of Technology, Sweden. Creative Coding is a female empowerment project that combines interdisciplinary areas of coding and art to empower girls between the ages of 10-15. The project aims to provide the girls with knowledge, creativity, and social capital which are essential skills to make them feel confident in their future pursuits [17]. This project is trying to address the gradual loss of interest of girls in science, technology, engineering, the arts, and mathematics (STEAM) subjects which gradually leads to fewer women pursuing a career in this field[18]. Literature shows that efforts to address this issue have largely concentrated on fostering girls' interest during high school and college, but despite promising interventions, the gap remains [19, 20].

2. Creative Coding

The Creative Coding project undertaken at Chalmers University in Sweden involves a sequence of workshops spanning over a period of ten weeks. The workshops are designed to impart coding skills to young girls aged between 10 to 15 years using the Strudel tool, which can be explored at https://strudel.tidalcycles.org/. Strudel is a novel and intriguing tool that provides swift audio and visual feedback, facilitating music composition and live coding sessions. Live coding music is an emerging international phenomenon where the programmer communicates their musical intentions to the computer and receives real-time visual and auditory output[21]. The live coder, who is the person writing the code to produce sound in real-time, engages in the coding activity that is directly connected with artistic and music creation.

Despite the traditional separation of Art and Coding, in order to address the challenge of increasing girls' interest in STEAM, we have chosen to focus on Art as a final destination. Drawing on scientific research and our past experiences working with the Opera House [13], we have merged these interdisciplinary fields to create a unique and engaging learning experience for young people, which we hope will inspire them to pur-

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sue careers in STEAM. Through close collaboration with these experienced faculties from the Chalmers University of Technology, we believe that girls' social capital will be positively influenced. The Creative Coding project has been designed to respond to the social demand for more girls in STEAM fields and to contribute to addressing the underrepresentation of women in STEAM due to societal, stereotypical, and other factors, through a process that involves early intervention in schools to encourage more girls to pursue STEAM fields and thereby contributing to the empowerment of the female community[22][pg. 31].

2.1. Three Pillars of Creative Coding

The Creative coding project relies on three main pillars. The first pillar is focused on acquiring coding skills through informal learning practices, with a combination of art and technology as the end goal. The second pillar emphasizes the importance of social capital, by providing opportunities to meet new peers and role models. Finally, the third pillar encourages creativity, treating coding as a fun and collaborative creative outlet.

Regarding knowledge, the aim is to introduce the world of coding to young girls and dispel the societal stereotype that STEAM fields are gender-specific. Through this, a path is paved for them towards new and possible opportunities in the future. Studies indicate a general tendency where girls lose interest in the field of science and technology by the time they reach high school. Thus, we strive to provide knowledge about the possible opportunities in the field of STEAM and promote the notion that coding can be fun. Moreover, this project provides the girls with support to build positive STEAM identities through exposure to knowledge and experiences[23].

Regarding contacts, the goal is to connect the girls to female role models and bridge the gap in social capital and networking. Research indicates that by bridging the gap in social capital, better achievements and integration with society can be ensured. This can also mitigate negative stereotypes about sex-based abilities [23][pg. 61] and provide an understanding of the possible career opportunities in STEAM. During the creative coding sessions, girls will have the opportunity to meet like-minded girls from the community with whom they will work as a group for the concert. They will also have a chance to meet female role models who are Ph.D. students from the Department of IDSE.

Regarding creativity, the objective is to treat coding in a creative way, with a lot of fun and collaboration. This type of learning methodology can further enhance the interest in girls and open the way to interdisciplinary areas of education. Instead of following the traditional way of introducing coding, this project aims to introduce coding through art using the STRUDEL web application. Thus, the girls will be able to approach coding in a creative and more interesting way rather than considering it as a complex field to pursue.

3. Methodology

The Creative Coding initiative, which was developed at the Computer Science and Engineering Department (CSE) of Chalmers University in Sweden, was offered during the spring term of 2023, from March to June. Over a period of 10 weeks, a series of workshops were conducted, where young girls aged 10-15 were introduced to the art of coding, using the innovative Strudel tool. Participants were selected from schools in the Gothenburg region, based on their interest in coding and art. The sessions were organized as two-hour sessions on Thursdays and four-hour sessions on Saturdays, extending over the span of ten weeks. The venue for the workshop was the Department of Interaction Design at Kuggen, Chalmers University of Technology. The students were initially acquainted with the purpose of learning and the fundamentals of strudel tidalcycles. They were granted the opportunity to explore the logic of coding, the basics of live coding, and the concepts associated with strudel commands. Subsequently, they advanced towards coding music using these rudiments. Gradually, they learned to improvise their code based on their preferences and investigated working collaboratively in pairs and teams.

3.1. Observation:

During the session on Creative Coding, we conducted a close observation of the candidates, studying their interactions and approaches towards teachers and peers. Through the use of an observation diary, the participants' experiences, including their behaviors, interactions, and approaches were recorded. The diary also included contextual factors that may affect participants' engagement, such as their relationships with teachers and peers. Additionally, the progress and transitions on a weekly basis were recorded which created a longitudinal perspective on the participants' development.

3.2. Interview:

Upon the session's completion, an interview was conducted with the candidates to evaluate their progress and current motivation level in the program. The interviews included a blend of open-ended questions and a quantitative Likert scale to collect both qualitative and quantitative information, resulting in a thorough comprehension of the participant's experiences. Open-ended questions gave the participants the freedom to express their thoughts, feelings, and experiences in their own unique ways, resulting in very relevant qualitative data. Additionally, a Likert scale is used to gather quantitative data on the development and level of motivation of the candidates. The findings from these interviews were noted and analyzed. Since we were interviewing young children between the ages of 10-14, ethical considerations had to be taken into account. We ensured that parental consent was obtained to interview the candidates for research purposes.

The data collected from these observational sessions and interviews were collated and subjected to rigorous analysis using Braun and Clarke's six-phase framework for Thematic Analysis[24]. Braun and Clarke's six-phase framework for thematic analysis is a prevalent method utilized to scrutinize qualitative data and recognize recurring patterns or themes within the data. The framework presents a well-structured and rigorous method for evaluating textual data and producing significant insights[24].

4. Analysis and Results

In this section, we present the analysis of the collected data and its results. As mentioned above we analyze the Creative Coding project through observation and interview.

4.1. Observation

Through detailed thematic analysis of weekly diary data, we gained a more comprehensive understanding of the various aspects and experiences within the Creative Coding project.

Seven themes were identified. They read as follows.

4.1.1. Initial Excitement and Exploration:

Girls expressed enthusiasm and excitement during the initial sessions, particularly when unboxing and exploring the new coding equipment. Participants actively engaged in exploring new tools and features, demonstrating their curiosity about the coding process and its possibilities. The introduction of coding concepts and equipment sparked a sense of novelty and discovery among the girls, as they began to understand the potential of creative coding.

4.1.2. Learning and Retention:

Girls demonstrated the ability to understand and apply coding concepts taught in the sessions, showing progress in their learning journey. Some girls found it challenging to remember all the coding commands, suggesting the need for additional reinforcement and practice. Girls were able to recall and discuss previous session topics during the following sessions, indicating retention of learned concepts. It was also noted that the retention of code among younger girls was comparatively lower than that of older girls, leading them to favor a simpler version of the code.

4.1.3. Collaboration and Peer Learning:

The project fostered a collaborative environment where girls worked in groups, shared their work, and exchanged feedback. Peer learning was observed as girls actively listened to and commented on each other's music creations. The project created a supportive community where girls encouraged and motivated each other, contributing to a positive learning environment.

4.1.4. Overcoming Shyness and Fostering Inclusion:

Some girls were initially shy and required encouragement to ask questions and actively participate. However, over time it was noted that they seamlessly integrated with their peers, collaborating effectively in groups to deliver impressive duos and trios during the concert.

4.1.5. Iterative and Creative Process:

The project encouraged girls to experiment with sounds, colors, and coding techniques, fostering a creative and iterative approach. Participants were given the opportunity to edit and improvise existing code, promoting individual expression and creativity. By providing participants with the opportunity to experiment with existing code and develop their own unique programming styles, the project sought to encourage a mindset of innovation and exploration.

4.1.6. Concert Preparation:

The project's clear objective of preparing for a concert motivated girls to work towards their performances. Planning for solo, duo, and trio acts provided girls with the opportunity to take on different roles and face various challenges, promoting their personal growth and skill development. It was observed that the female participants willingly demonstrated initiative in both individual and group performances, which denotes a propensity for collaboration and collective achievement.

4.1.7. The Performance

: The performance of the candidates indicated the change they embraced during this project. From being reluctant to mingle in a team to performing together as a team, they came a long way in building collaboration and teamwork. Their confidence on stage was evident when they performed live coding in front of the audience.

4.2. Results of observation

By giving a deep, holistic look at these seven topics a number of conclusions can be drawn. The initial theme of excitement and exploration displayed by the girls indicates a strong curiosity to explore new tools and features, which is a crucial skill in technical fields. Furthermore, the girls demonstrated a surprising ability to comprehend coding concepts, even when faced with challenges in recalling specific commands. With more practice, they were able to improve their retention of these concepts. When collaborating in a supportive and safe environment, girls' group work, sharing, and feedback sessions demonstrate their great capacity for collaboration and peer learning. It also became apparent that proper guidance can promote inclusivity and encourage shy participants to engage actively, thereby ensuring an empowering and inclusive environment for all. To be more successful in supporting shy, introverted participants more carefully developed strategies should be planned to ensure closer teacher–participant relations. It is important to note, that the iterative and creative process involved in the project enhanced experimentation, improvisation, and individual expression through coding techniques. Together with the concert preparation, and performance, this fostered a goal-oriented approach promoting personal growth and skill development.

4.3. Interviews

Girls' first-hand testimony takes us to an even deeper understanding of the effects and capacities of the Creative Coding project. Here we present the analysis and results of the data collected through direct communication with the girls. In this communication, we used open-ended questions and a quantitative Likert scale [25]. Again, by using Braun and Clarke's six-phase framework for Thematic Analysis, we identified four themes. They read as follows.

4.3.1. Interest and Engagement:

There were participants who lacked prior experience in coding, while others had a basic understanding of block coding and Scratch, which served as their foundational knowledge. A few girls had previously engaged in coding using game platforms. Integration of music/art with coding made the learning experience more engaging. Girls found the combination of creative elements more interesting than traditional coding methods or games. One of the girls said "*I was interested in coding, but I like this combination better*" making a clear appreciation and preference for coding together with art.

Participants expressed a high level of interest in coding and art. The majority of participants expressed a strong passion for art, and when asked how many stars (from 1 to 5) they would give to art, all of them gave a rating of 5/5. Some girls mentioned attending guitar and piano classes, indicating their active engagement in artistic pursuits. The following quote clearly illustrates the relationship between coding and art. "*I would give a 4/5 for coding and a 5/5 for art.*" Girls found creative coding more enjoyable and stimulating compared to conven-

tional coding techniques or game-based learning approaches. The project's emphasis on creative expression through coding captured their attention and sustained their interest. A participant said, "*This combination of music and coding is better than coding with games.*"

4.3.2. Positive Experience and Confidence:

Girls reported a positive and enjoyable experience during the Creative Coding project. They expressed enthusiasm for attending the sessions and actively participating in coding activities. " *I joined Creative Coding as I like music and I thought it would be fun to learn to code music.*" said one of the girls. The Creative Coding project was described as a fun and enjoyable activity that some participants considered pursuing as a hobby. "*I feel like I have a new hobby now*" were exact words. The girls felt positive about their overall experience, indicating a sense of satisfaction and enjoyment.

Participation in the Creative Coding project contributed to an increase in participants' confidence in their coding abilities, leading to feelings of empowerment about their future in the science and technology fields. This is how they describe it. " *Strudel is fun, I feel like I have learned something interesting.*" "*Here I had the freedom to explore my own interests.*" Engaging in Creative Coding activities enhanced their belief in their own potential to succeed in STEAM fields. Girls' testimonies show that participation in Creative Coding workshops fostered a sense of empowerment and encouraged them to set higher goals for themselves.

4.3.3. Building relationships- social capital acquisition and feeling of well-being

Participants formed strong bonds with their teacher, built on trust, respect, and mutual understanding. Positive relationships with peers fostered collaboration, shared learning, and a sense of camaraderie. Teachers created a supportive environment that encouraged open communication and collaboration. Participants felt comfortable asking questions, seeking help, and expressing their ideas. One of the interviewees said, "*I felt secure and included in the group.*"

Collaborative activities and group projects allowed participants to bond with their peers. Sharing experiences and collaborating with other girls enhanced their sense of community and support. Participants desired more time for breaks and interactions with classmates, indicating the importance of socializing and connecting with peers. This is how they describe it "*Working together on a piece of code was fun, we made a horror theme for the concert.*"

4.3.4. Time Constraints and Attrition:

Some participants mentioned that time constraints and other activities might have contributed to a few participants leaving the course. The Creative Coding initiative was concluded with only 8 of the 16 girls. The limited accessibility and clashes with other obligations affected their capacity to completely engage in the project. The girls observed that incorporating flexibility in scheduling sessions and accommodating individual time constraints could be instrumental in mitigating the drop-out rate and enhancing retention figures. Adapting the project to fit participants' busy schedules would allow more girls to fully participate.

4.4. Results of interviews

Based on the findings derived from the interviews of the participants in Creative Coding workshops, and the analysis of the collected data, several conclusions can be drawn. The integration of creative elements into the teaching and learning processes has the potential to enhance engagement and attract girls to STEAM fields. The girls reported feeling more confident about their future in the science and technology fields, indicating that the project had a positive impact on their well-being, self-confidence, and aspirations. Furthermore, they felt supported and encouraged by their teachers, emphasizing the significance of representation and the need for more diverse role models to inspire girls in STEAM. Girls emphasized the importance of having opportunities to bond and collaborate with their peers to foster a sense of community, belonging, and support. Finally, when thinking of quite a high level of dropouts (almost 50%), one could argue that more methodological creativity and scheduling flexibility should be considered to accommodate more girls and their busy schedules and increase retention rates. The integration of music/art as a destination and audio-visual perception of music holds great potential in enhancing the interest of girls in the fields of coding and STEAM. The incorporation of audio effects on stress, emotion, and mental states can lead to immersive and emotionally engaging learning experiences for girls[26]. Additionally, coding visual elements to correspond with various aspects of music such as tempo, pitch, and intensity can further elevate the audio-visual perception, resulting in the creation of captivating experiences.

5. Conclusion

In summary, the Creative Coding project had a positive impact on the girls' interest, confidence, and aspirations in STEAM fields. The research findings show that creative coding workshops provide valuable insights into girls' engagement in STEAM fields. Girls demonstrated enthusiasm for exploring new tools and concepts and were able to improve their retention through practice. The guidance by the teachers played a crucial role in promoting inclusivity and empowering shy participants. The integration of creative elements in teaching and learning processes enhanced engagement and attracted girls to STEAM fields. The potential of creative coding and audio-visual perception of music in enhancing girls' interest in coding and STEAM was also highlighted. It is important to emphasize that substantial efforts are to be made to create a more inclusive and supportive environment, that ensures that all girls feel comfortable and empowered to engage fully. Overall, the findings underscore the importance of nurturing curiosity, providing guidance, promoting inclusivity and representation, fostering collaboration, and integrating creative elements in education to inspire and empower girls in coding and STEAM disciplines. Finally, we argue that Creative Coding has the capability to simulate synesthetic experiences by linking musical elements to visual elements, thereby enabling the creation of multimedia art that engages multiple senses simultaneously.

6. References

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