



The Wicked Problem of Dropouts

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The Wicked Problem of Dropouts

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ABSTRACT

Why do young girls leave coding classes? The research presented in this report takes a deep dive into the exploration of the complex factors influencing the dropout rates of girls involved in a Creative Coding project. Creative Coding initiative targets female empowerment, girls aged from 10-15, by combining the worlds of coding and music in one learning environment. The project's primary objectives are to empower girls in the realms of technology and creativity, enhance their social capital, and foster their engagement in Science, Technology, Engineering, Arts, and Mathematics (STEAM) disciplines. Despite its noble intentions, usage of the interesting innovative audio-visual tool, and collaboration with specifically chosen mentors and teachers that collaborated on this project, we observed a substantial dropout rate during its initial phases. This study honestly and rigorously investigates the underlying reasons for 50% attrition looking at it as a wicked problem, and explores potential remedies.

CCS CONCEPTS

• **General and reference**; • **Software and its engineering**; • **Human-centred computing**;

KEYWORDS

innovative teaching, girls' empowerment, wicked problems, STEAM, Strudel, Live Coding

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1 INTRODUCTION

In recent years, a substantial number of research looked at the promotion of young girls in pursuing STEAM fields due to the lack of female representation in these specific sectors [38]. The Creative Coding project at Chalmers University of Technology, aimed to contribute to this cause [27]. The project aims to instil more interest in STEAM fields in young girls by combining the interdisciplinary field of Art and Coding. Despite having a promising goal, the project experienced a substantial dropout rate of 50% during its early stages (during the first half of the project timeline). This

study is mainly focused on identifying the intricate elements that resulted in the attrition rate thereby revealing critical elements such as social bonding, educational engagement, self-esteem, cultural differences, clarity in project objectives, perceived difficulty and age as the significant factors that contributed to the dropout rates. To address these issues, we propose various tailored interventions including fostering social bonds, enhancing intrinsic motivation, bolstering self-esteem, and accommodating diverse learning styles. In the following sections, we delve into these findings, discuss their implications, and propose potential solutions to address this complex issue.

2 CASE DESCRIPTION: CREATIVE CODING WORKSHOPS

The Creative Coding project, conducted at Chalmers University in Sweden, encompasses a series of workshops spanning ten weeks. These workshops have been meticulously crafted to impart coding proficiency to a cohort of youthful female participants, aged between 10 to 15 years [30]. The project began with 16 girls from diverse cultural backgrounds in different areas of Gothenburg, Sweden. They were primarily selected through an open call that used multiple channels such as websites, posters, and social media. To increase the motivation for coding and to make it more fun, the pedagogical instrument of choice was the "Strudel" tool [29], an innovative resource for live coding. "Strudel" represents a pioneering and captivating utility, which rapidly provides both auditory and visual feedback, thereby facilitating the composition of music and the practice of live coding. The phenomenon of live coding music has gained international prominence, whereby the programmer engages in direct discourse with the computer to realise real-time visual and auditory output [19]. This live coder, the individual responsible for authoring code to produce real-time sound, thus partakes in a coding endeavour intrinsically intertwined with the realms of artistry and musical creation.

Despite the historical schism between the domains of Art and Coding, the Creative Coding project, as a strategic response to the imperative of augmenting young girls' interest in STEAM (Science, Technology, Engineering, Arts, and Mathematics), has elected to emphasise Art as its ultimate destination. In Creative Coding, we use artistic expression, music, in coding to engage students, enhance critical thinking, and foster creativity [3]. Drawing inspiration from empirical research and past collaborations with the Opera House [26], this initiative synthesises these diverse disciplines into a distinctive and immersive educational journey for young minds. It is hoped that this fusion will serve as a wellspring of inspiration, motivating these young participants to contemplate careers in STEAM [13]. Collaborating closely with accomplished faculty members from the Chalmers University of Technology, we anticipated a favourable impact on the social capital of the female demographic.

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The Creative Coding project has been engineered to address the societal demand for increased female representation in STEAM fields and to confront the issue of women's under-representation therein, which can be attributed to societal stereotypes and other multifaceted factors. This project aims to institute early interventions in educational settings to implant enthusiasm among young girls for STEAM disciplines, thereby contributing to the empowerment of the female community and our society [12].

2.1 The Three Pillars of Creative Coding

The Creative Coding project rests upon three foundational pillars. The first pillar centres on the acquisition of coding skills through informal learning methodologies [6, 20, 24], culminating in the fusion of art and technology as the ultimate objective. The second pillar accentuates the significance of coding skills through informal learning methodologies by affording opportunities for young participants to forge new connections with peers and establish role models [1]. Lastly, the third pillar champions creativity and performing arts as another means of personal empowerment [14, 15, 21], treating coding as an enjoyable and collaborative form of creative expression hoping to deliver a WOW factor [3].

In the realm of knowledge dissemination, the primary aim is to introduce the realm of coding to young girls, thus dispelling the prevalent societal stereotype [38] that STEAM fields are inherently gender-biased. This endeavour paves the way for these girls to explore new and prospective opportunities in the future. Research indicates a general proclivity whereby girls tend to lose interest in science and technology as they progress through their high school years. Consequently, our objective is to furnish knowledge of the myriad possibilities within the STEAM domain while promoting the notion that coding can be an enjoyable pursuit. Additionally, this initiative provides the participants with the support required to cultivate positive STEAM identities using exposure to knowledge and experiential learning [36]. Concerning social connections, and bridging capital acquisition, we aspire to connect the girls with female role models, thereby bridging the chasm in social capital and networking for those who live in disempowered neighbourhoods or come from disempowered cultural backgrounds. Research indicates that by ameliorating social capital, enhanced accomplishments, and societal integration can be ensured [12]. This can, in turn, mitigate detrimental stereotypes regarding gender-based aptitudes [36], thereby fostering an understanding of the prospective career avenues within STEAM.

Throughout the Creative Coding sessions, the participants had the opportunity to interact with like-minded girls from their community, collaborating as a cohesive group for the forthcoming concert. They also had the privilege of encountering female role models who are PhD. candidates and teachers from the Department of Interaction Design and Software Engineering. As for the realm of creativity, the central goal was to approach coding in a creative and enjoyable manner, fostering a sense of collaboration and amusement. Such a pedagogical approach has the potential to heighten the participants' interest and broaden the horizons of interdisciplinary education by introducing art [3]. Rather than adhering to traditional methods of introducing coding, this project aspires to introduce coding through the medium of art, utilising the "Strudel"

web application. This innovative approach empowered the girls to engage with coding in a creative and captivating manner, alleviating the perception of coding as an intricately complex field of study [12]. Yet, 50% of girls who started Creative Coding workshops dropped out. With this study, we want to cast an honest look and investigate the reasons behind this high dropout rate observed during the initial phase of the project, as well as explore potential solutions to mitigate attrition.

3 RESEARCH METHODOLOGY

To investigate the reasons for students dropping out of the Creative Coding project, we primarily employed a qualitative approach. This method allowed us to gain a more comprehensive understanding of the factors contributing to the high dropout rate and helped us identify effective strategies to reduce attrition. Although we attempted to complement the qualitative data with quantitative data, the low response rate for surveys from the dropouts made it challenging to utilise the data for quantitative analysis. For collecting qualitative data, we primarily conducted interviews and observations to gain insights and perspectives from the participants. We relied on semi-structured interviews by asking about the experiences, motivations, and challenges of the participants to gain the individual perspectives of the candidates and a quantitative Likert scale [40]. During observations, we documented the interaction, activities, and a few observable factors that could contribute to dropouts. This gave an insight into the dynamics of the Creative Coding workshop. In addition to this, we discussed the issue with the instructors and mentors of the workshop to identify the challenges faced during the workshop and potential solutions. It helped further to gain their perspectives on the workshop and the dropout issue.

To further support the data obtained from thematic analysis and contextual analysis, a mess map has been created (see Figure 1) to visually represent the complex problem within the project. Mess map helps to tackle complex issues with no solution by collecting and evaluating information about the problem and thus creating a common mental model of the problem, showing the important chunks of information and their relationships with each other [39]. Agreeing with Suheimi that visualisation is necessary as the wicked problem is too complex and cannot be fully understood through written descriptions alone, we created a mess map to include interconnections between the themes. By using the mess map, we gained a deeper understanding of the challenges and were able to effectively organise our efforts. This, in turn, helps us identify the key areas where interventions are needed in the project.

To construct a mess map for the Creative Coding project a combination of thematic analysis [5] and contextual analysis [32] was done to analyse the collected data from interviews and observations. This approach was adopted to examine the project from a wicked problem perspective [39] as the dropout rates in the project are influenced by a multitude of factors (like social bonding, educational engagement, self-esteem, cultural differences and perceived difficulty) that interacted in complex ways. Accepting the debate that usage of the wicked problem could be seen as rhetorical, or discouraging for stakeholders, we use the wicked problem concept as a critical/emancipatory tool to discuss practices and look for coordinate activities [23].

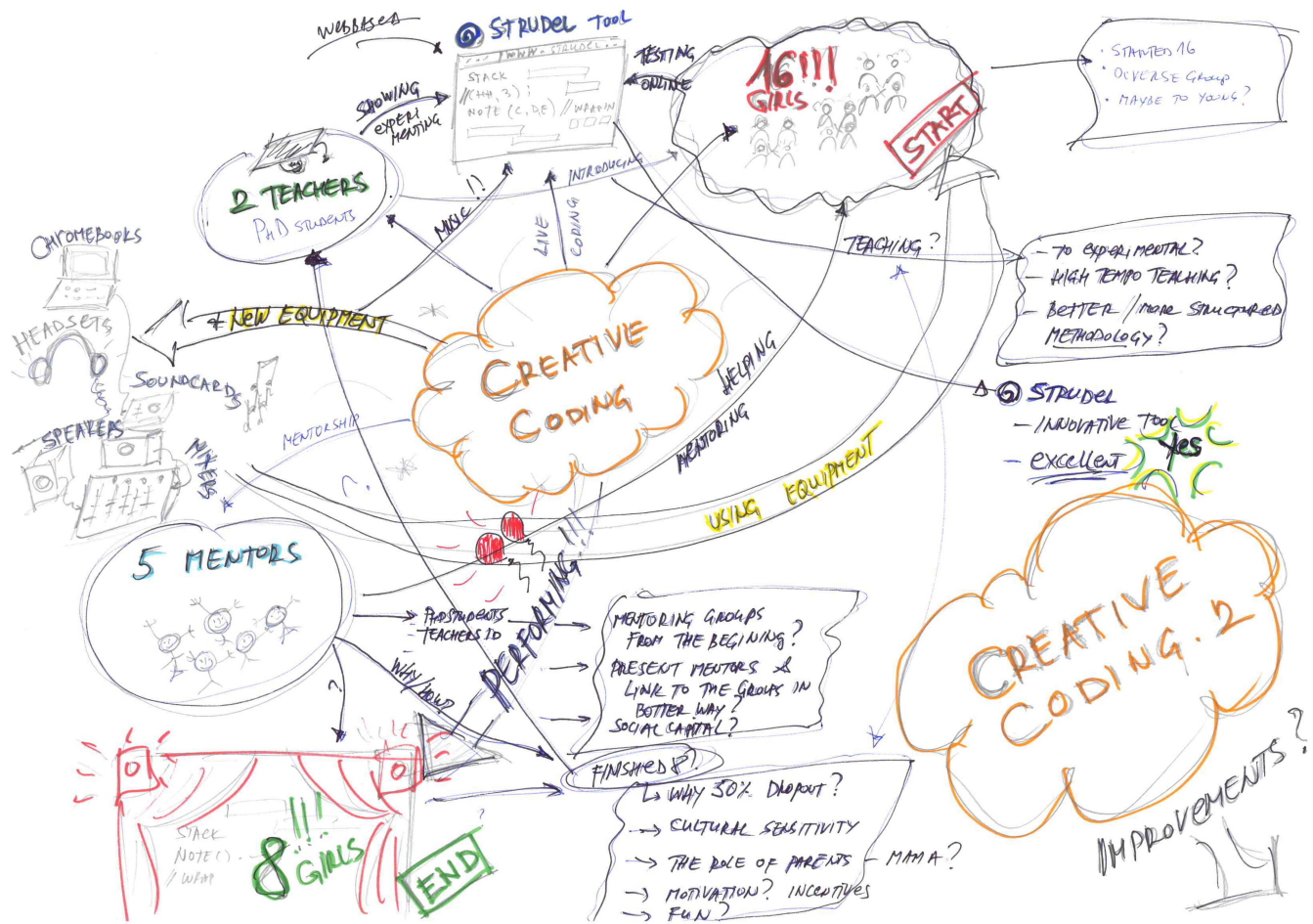


Figure 1: Mess map for Creative Coding

The Creative Coding mess map (see Figure 1) visually represents the most important factors and relations within the whole project run. The project started with 16 girls who used the “Strudel” tool for Live Coding executed in the browsers of their Chromebooks. The process of learning coding/music making happened as a series of workshops [43], and it was supported by 2 PhD students as teachers and 5 mentors, female role models. Also, to help learning and performing a set of new equipment was delivered - Chromebooks, headphones, sound mixers, speakers, and sound cards. In collaboration with teachers and mentors, a public performance is prepared. Finally, only 8 girls performed at Visual Arena.

During the contextual analysis, we examined the context of the Creative Coding project, taking into account participant ages, cultural backgrounds, parental influence, and cultural attitudes toward extracurricular activities. We also considered the project’s structure, including program duration, workshop pace, and tools used. In the thematic analysis, we looked for patterns in observations and interviews, categorising them into themes such as social bonding, self-esteem, self-concept, and cultural aspects. These themes

were derived from specific details and evidence gathered during interviews and observations.

4 RESEARCH FINDINGS AND IMPLICATIONS

In our research findings, we have discovered several major factors that contributed to attrition in the Creative Coding project. These factors included a lack of social connections among mentors and participants, certain students lacking persistence, some participants lacking inner drive and genuine enthusiasm due to lack of self-esteem, project objectives not being clear, and the perception of difficulty in a fast-paced learning environment. Furthermore, we found that a lack of emotional and cognitive engagement throughout the workshop played a significant role in attrition. Additionally, due to time limitations, learning methods tailored to the participants’ needs were not present. In the subsequent sections, we will explore each of these obstacles in more detail.

4.1 Social bonding and Commitment

The dropout rates observed in the Creative Coding project prompt a more thorough examination of the factors that impact the decisions

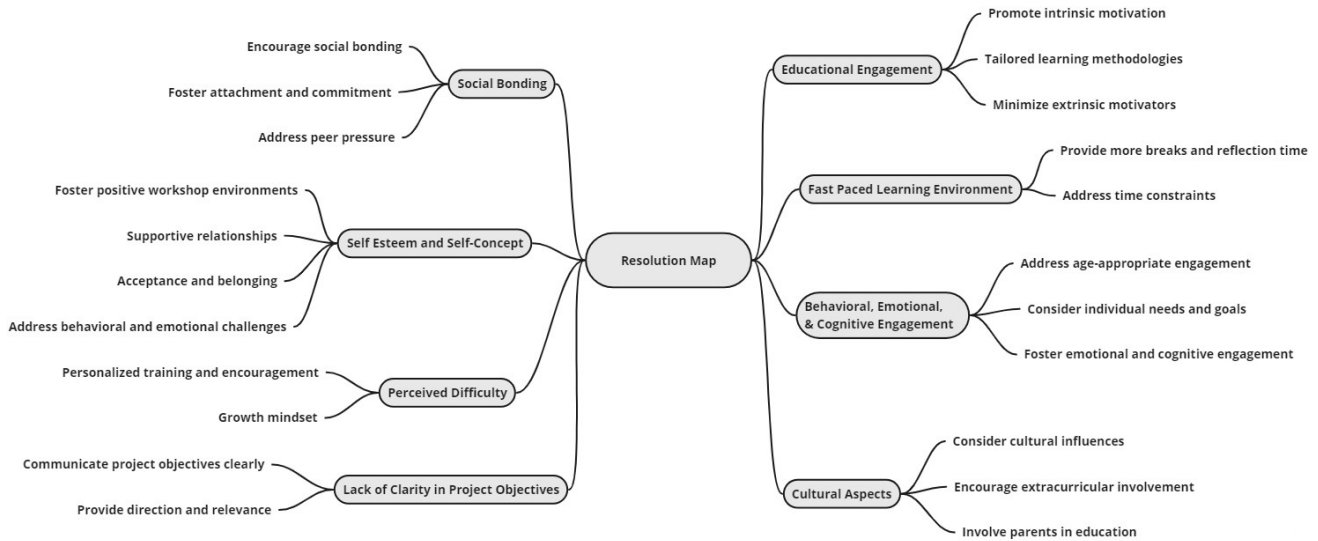


Figure 2: Mapping different dimensions

of participants. Looking for the ways of interpretation we utilised sociological viewpoints. Therefore, the control theory of deviant behaviour [7] presents a valuable framework for understanding the interplay between social bonds, commitment, and how they affect educational involvement. Even though we find word "deviant" to hard for this context, it is well proven that individuals who engage in social networks and cultivate social capital, are inclined to establish more robust social connections with fellow members within those networks [2, 25]. Social capital provides the foundation for social bonding by creating networks of relationships that facilitate the acquisition of knowledge and assets [34]. Based on the control theory of deviant behaviour, social bonding within a socialisation unit (teachers and peers) leads to a sense of connection, which can foster commitment and perseverance in education [7]. Those who failed to build these connections exhibited a higher likelihood of dropping out, influenced by peer pressure and their sense of attachment to the project [9].

Social bonding is a phenomenon that is specific to gender and age [8]. During the Creative Coding project, when working in a group, the girls had to establish connections and relationships with their peers, teachers, and mentors. The emotional and psychological attachment within a group can enhance a sense of belonging and commitment within the group and ultimately in the project. To derive the benefits of role models in the project, attachment, which is an emotional bond between the girls and a teacher/mentor, was essential. Additionally, the impact of peer pressure, which refers to the influence exerted by one's social circle to drop out, was observed in cases of girls who ultimately discontinued their participation in the Creative Coding project.

Another important aspect was commitment, which refers to the willingness to persist in the Creative Coding project. This aspect played a crucial role in retaining the girls in the project. It was noted that a lack of endurance or passion for challenging tasks,

coupled with a negative mindset, can lead to a decreased sense of perseverance [28]. Ultimately, this lack of perseverance has a detrimental effect on one's commitment to the project. Finally, it was observed that the girls who were unable to establish strong social bonds and demonstrate commitment towards the project tended to drop out of the workshop.

4.2 Educational engagement

Educational engagement, particularly intrinsic motivation, emerged as a vital determinant of attrition. Girls with a genuine passion for coding and music exhibited higher commitment and engagement, while extrinsic motivators like parental influence showed limited effectiveness in the long run. Therefore, creating intrinsically motivating environments through tailored learning methodologies and materials is crucial for mitigating dropout rates [18].

Intrinsic motivation pertains to participating in an activity solely for the sake of the activity itself, finding it inherently enjoyable or interesting. It is fueled by internal factors and personal satisfaction instead of external rewards or pressures. Throughout the Creative Coding project, it was noted that the girls who possessed intrinsic motivation and a passion for coding and art effectively completed the workshop and actively engaged during the sessions. Additionally, it was observed that the students who were intrinsically motivated devoted more time and effort to exploring various aspects of the assigned tasks, and they collaborated better as well. During the project run, extrinsic motivation factors were minimal, given that no stipends were offered for attending the course. Parental influence can be considered an extrinsic factor where parents encourage their children to participate in the workshop. However, it was observed that parental influence could be effective in driving positive behaviour when they attend a session, but in the long run, it may undermine intrinsic motivation. Consequently, it can be concluded that girls lacking intrinsic motivation dropped

out of the course as they lacked interest and enthusiasm to persist in the workshop. Eventually, it is important to mention that this project also supports young girls who do not have the support of their parents and who reside in a society that has an unfavourable attitude towards women in STEAM fields.

4.3 Self-esteem and self-concept

Self-esteem and self-concept were identified as critical factors affecting retention. Positive workshop climates, characterised by support, acceptance, and a sense of belonging, were associated with girls who completed the project. Conversely, those who dropped out likely faced challenges in these areas. In addition, behavioural, emotional, and cognitive engagement, influenced by internalising and externalising behaviours, were observed as significant contributors to attrition, particularly among younger participants. Hyperactivity, attention issues, worry, and negative moods affected engagement levels [11]. Maintaining healthy self-esteem is essential for students, particularly when they encounter new social situations or unfamiliar social scenarios. We had a wide range of age groups in the project which had a significant impact on both the collective and individual self-perception. Studies indicate that fostering a positive environment, supportive relationships, acceptance, and a sense of belonging can help cultivate and reinforce healthy self-esteem in young girls. As such, it can be concluded that participants who completed the Creative Coding workshop generally viewed the workshop in a positive light, exhibiting a positive trajectory in their activities and performance. Conversely, those who dropped out likely had a negative perception of various aspects of the project, feeling unsupported and subsequently experiencing diminished self-concept and self-esteem.

4.4 Cultural Aspects

Cultural aspects played a notable role, with Indian and Chinese students exhibiting higher retention rates and persistence. While fully aware that culture is a fluid concept and can not be only based on racial/ethnic factors, in this report we use cultural variable assessed from the perspective of nationality only. As the descriptive statistics of the official Swedish reports on success in schooling present an image of students of immigrant background as those who achieve less in school than native pupils, we find this broad usage of culture adequate for this work [4]. This might be attributed to cultural emphasis on extracurricular activities and parental influence on education and career choices [41] and the Asian style of education, which places great importance on workshops and training outside of the regular curriculum. Parental influence in Asian countries is quite significant, with parents exerting greater control over their children's learning preferences and career aspirations. It is good to have in mind that the integrative mode of acculturation, which involves acquiring skills for participation in the host culture while maintaining adherence to traditional cultural patterns, can contribute to better adjustment and persistence [22]. The role of parents in providing instructional and emotional support can be instrumental in the persistence and aspirations of the children [41]. It seems that the emphasis on academic achievement in Asian cultures is stronger, and activities aligned with such achievements are

prioritised. With this in mind, culturally sensitive approaches are needed to deliver for girls of all cultural backgrounds.

4.5 Lack of clarity in project objectives

In the context of our study, a significant issue emerged related to the lack of well-defined project objectives. This deficiency posed a substantial challenge as participants encountered difficulty in aligning their personal aspirations with the overarching goals of the project. The problem became apparent through observable signs of confusion and disengagement among select participants who appeared to struggle with a comprehensive understanding of their roles and responsibilities during workshop sessions. Effective communication of workshop objectives is pivotal, and when this communication falls short, participants may grapple with perceiving the purpose and value of their involvement. Consequently, doubts may arise concerning the workshop's relevance to their individual aspirations, potentially leading to a loss of direction and reduced self-assurance [18]. It is noteworthy that even when the acquisition of necessary skills demands minimal effort, an absence of clear objectives can foster a perception of difficulty, ultimately causing participants to lose interest in the project as a whole.

Moreover, it is essential to acknowledge that the entire project was driven by improvisation and lacked adherence to a specific methodology. While this improvisational approach may have been suitable in certain contexts, music improvisation in relation to children's creativity [35] and dance improvisation to attune to the world [33], in the context of coding it posed challenges, particularly in dealing with younger participants. Given that the instructors primarily consisted of PhD students without significant experience in instructing young individuals, a more tailored methodology would likely have been beneficial in facilitating the teaching process.

4.6 Fast-paced learning environment and Perceived difficulty

A fast-paced learning environment can impact students' perceived difficulty of tasks and their engagement in the learning process [31]. Although the Creative Coding project spanned ten weeks, the participants were only allotted two hours of classroom time per week. In an environment characterised by rapid pace, numerous factors could potentially pose challenges to young girls. One such factor identified was limited breaks and reflection time, which failed to provide adequate opportunity for the participants to assimilate and reflect upon the concepts they have learned. Consequently, some girls may have been apprehensive about falling behind, thereby leading to stress, anxiety, and eventual dropouts. While increased support from the mentors may have assisted in addressing these issues, the methodology employed by the mentors and time constraints significantly limited the extent of such interventions. Though the purpose of the workshop was to foster accelerated learning through various techniques like multi-sensory learning and active participation, the time constraints led to the creation of a fast-paced learning environment.

The Creative Coding workshop encompassed learning the fundamental principles of coding, music and novel software, "Strudel". The most fascinating feature of "Strudel" is the REPL (Read + Evaluate + Play + Loop), which enables real-time playing and editing of

"Strudel" patterns within the browser. "Strudel" combines auditory and visual feedback with the live coding feature. As such, it was a foregone conclusion that the attendees would encounter various challenges and face confusion during this project. This, in turn, created a perception that the workshop was exceedingly arduous, resulting in a decline in initial enthusiasm and confidence. The perceived difficulty, if it continues to escalate, could eventually lead to a lack of motivation and ultimately, attrition and dropout. Consequently, it was imperative to incorporate personalised training and encouragement in the workshop process to aid those who faced difficulties. The mentors could have played a significant role in fostering a growth mindset in the participants by encouraging them to view the obstacles encountered as opportunities for personal and educational development.

4.7 Behavioural, Emotional, and Cognitive Engagement

During the Creative Coding project, which involved girls between the ages of 10 and 15 working together, we observed certain challenges in terms of student engagement, particularly among younger children. Externalising and internalising behaviours were identified as significant contributors to these issues [31] due to age aspects. For example, hyperactivity and attention problems among younger girls were found to negatively impact behavioural engagement and lead to dropout rates. Additionally, some older girls exhibited internalising behaviours such as worry, lack of interest, and negative moods, which in turn affected their emotional and cognitive engagement in the project. In addition to this, contextual factors and individual factors can interplay to contribute further to the lack of student engagement [16]. For instance, the person-environment perspective - a theoretical model that examines the fit between individuals' needs and goals and the opportunities available to meet those needs and goals in their environment [16] - can critically influence the emotional and cognitive engagement of the participants during the workshop. When young participants can't correlate their needs and opportunities, then it will lead to disengagement.

5 PROPOSED INTERVENTIONS

To address the aforementioned challenges, a thorough analysis was conducted, involving discussions with individuals, consultation of relevant literature, together with the creation and analysis of a comprehensive mess map (see Fig.1). Consequently, several different problem dimensions were identified and targeted interventions were devised (see Fig.2). These proposed interventions encompass the cultivation of social connections, the enhancement of intrinsic motivation, the reinforcement of self-esteem, and the accommodation of diverse learning styles. Furthermore, the significance of effectively communicating project objectives and the necessity for mentors to offer personalised support are underscored. Additionally, the cultivation of a growth mindset to confront perceived difficulties can foster engagement and retention. In this section, we will briefly discuss all of them.

5.1 Teacher reflection leading to identifying Learning style

Research indicates that teacher self-reflection correlates positively with the proficiency to teach students effectively, as well as challenge and alter teaching methods and convictions [10]. It is imperative to adjust the learning approach to cater to each age group in the classroom; otherwise, it can result in frustration and disinterest. This also holds for student involvement and retention. Teacher reflections help the teachers to understand the diverse interests and learning styles of students, especially in workshops that have interdisciplinary areas. Some students might be more interested in art while some others will be more inclined towards coding. Through self-reflection, they can identify this, and design activities that cater to a wide range of abilities and preferences. This further ensures adaptability and flexibility in teaching methodologies that keep the students more engaged. Through teacher reflection the teachers can also understand age-appropriate engagement as younger students need a more exploratory approach and older students need a more structured and in-depth approach to teaching methodologies. We believe that it is important to have a reflective teacher session after each workshop session. During this session, teachers can analyse the activities, evaluate their effectiveness, and potentially make changes or adaptations for future activities. The goal is to ensure that the activities are suitable for the age group they are working with, striking a balance between being neither too simple nor too complex.

5.2 Culturally responsive teaching

The Creative Coding workshop displayed a concerning dropout rate amongst non-Asian students. To promote diverse perspectives in the curriculum, culturally responsive teaching may have been a beneficial option [10]. Culturally responsive teaching promotes an inclusive and supportive learning environment that values students' cultural backgrounds, encourages engagement, and nurtures positive relationships. Those students who were less engaged could have been given additional support in self-assessment and time to reflect on their learning perspectives. This can involve asking students to reflect on how coding and art relate to their own lives, cultures, or interests [42]. Encouraging them to express their unique viewpoints through their projects can make the learning experience more meaningful and personally relevant. By doing so, their engagement and motivation would have been enhanced as they found learning to be more relevant and meaningful to their own experiences. By offering a variety of hands-on and interactive experiences during the workshops, students will be able to explore and apply their knowledge in real-world contexts, fostering curiosity and interest. In addition to this, teachers can encourage student-led investigations and inquiry-based learning, where students have the freedom to explore their questions and design experiments, fostering curiosity and critical thinking skills [42]. By integrating real-world challenges and problem-solving scenarios into Creative Coding sessions or any STEAM activities, students will be able to see the practical applications of their knowledge that can foster a sense of purpose and interest in STEAM.

Table 1: Research Findings, Implications, and Interventions

| Findings | Implications | Interventions |
|--|--|---|
| Social bonding and Commitment | Social bonding is crucial for retention. Lack of commitment leads to attrition. | Foster social bonds with peers and mentors. Promote commitment through emotional attachment. |
| Educational engagement | Intrinsic motivation is key for retention. Extrinsic motivators are less effective. | Cultivate intrinsic motivation. Tailor learning environments. |
| Self-esteem and self-concept | Positive workshop climates aid retention. Negative self-esteem contributes to dropout. | Establish supportive and accepting environments. Enhance self-esteem and self-concept. |
| Cultural Aspects | Indian and Chinese students show higher retention. Cultural emphasis on extracurricular activities. | Consider cultural factors in program design. Involve parents in education and career choices. |
| Lack of clarity in project objectives | Unclear objectives lead to confusion and disengagement. | Communicate project objectives clearly. Ensure alignment with participants' aspirations. |
| Fast-paced learning environment | Limited reflection time affects engagement. | Allow time for reflection and assimilation. |
| Perceived difficulty | Participants perceive the project as difficult. | Foster a growth mindset. |
| Behavioural, Emotional, and Cognitive engagement | Age-related challenges in student engagement. Externalising and internalising behaviours affect participation. | Tailor teaching strategies to age groups. Address behavioural and emotional issues. |

5.3 Focus on Intrinsic Motivation

To decrease dropout rates, teachers must allocate more time to investigating what motivates their students and establish an intrinsically motivating environment through specially prepared learning methodologies, materials, and proper learning outcomes. As intrinsic motivation is more advantageous for long-term learning outcomes, innovative learning strategies can cultivate a sense of ownership and involvement, which can further enhance their interest in STEAM disciplines [18].

Establishing clear learning outcomes is critically important for intrinsic motivation as students will understand what they will achieve and how their skills will grow through participation in the workshop. In addition, they must be given a choice of autonomy to decide on the type of project they want to work on [37]. Offering opportunities for self-directed learning, problem-solving, and exploration by providing meaningful and relevant tasks that allow for choice and creativity can further enhance intrinsic motivation. The sense of autonomy can act as a powerful motivator as the students will take ownership of their learning experiences. Such an approach can further be complemented by encouraging curiosity, curiosity-driven exploration, and a growth mindset.

In addition to this, it is essential to foster a sense of community through collaborative projects with like-minded peers and by celebrating achievements to boost their self-esteem by demonstrating that their contributions are valued. The influence of parents, especially mothers and teachers can also indirectly impact student achievement by influencing intrinsic motivation [17]. Parents and teachers should not only be supportive but also provide the girls with autonomy support, positive feedback, and strategies to build self-efficacy in an enthusiastic manner. The influence of parents was evident in the case of the participants who completed the Creative Coding workshop. Parents from the software sector demonstrated their intrinsic motivation and showed enthusiasm and interest in Creative Coding, thus inspiring and motivating their children to develop their intrinsic motivation [31]. Still, we must not forget that projects of this kind should be able to deliver motivation and attrition of all kids, especially those who do not have support from their parents.

Utilising the mess map (Figure 1) and the Mapping of different dimensions of the problem illustrated in Figure 2, we can derive insights regarding potential interventions outlined in Table 1. If we implement these proposed interventions (see Table 1), we argue that it is justifiable to expect a more effective resolution of the identified issues, ultimately leading to an increase in participant retention in projects such as Creative Coding.

6 CONCLUSION

The main objective of the Creative Coding workshop was to combine two interdisciplinary areas of coding and music to provide a more engaging, empowering learning experience for young children to increase their interest in STEAM fields. However, during the implementation of this project, we realised that more emphasis was given to the coding aspect rather than the music. We advocate for achieving a more optimal equilibrium between coding and music to ensure that individuals with a stronger affinity and engagement in the artistic aspect of the Creative Coding Project will be more inclined to persist with this project. Girls who had the desire to take part in this project to produce music might have harboured the belief that they would be able to create authentic music similar to what they heard online, however, the musical composition based on Live Coding could have bewildered them and ultimately caused them to lose interest.

Additionally, our research indicates a necessity for a specially formulated pedagogical approach when young girls learn the skill of coding music. While improvisation can offer a sense of freedom, it carries an element of unpredictability and has the potential to yield adverse results. Finally, in this paper, we emphasise the importance of targeted mentorships, arguing that fine-tuning of mentors' activity could be done only through several iterations of the project and placing mentors in the centre of the teaching methodology. After a close collaboration with the girls where methodological improvements would be based on their feedback, we can determine which kind of assistance is the most effective. All of above mention needs and activities make exploratory projects of this kind extremely expensive and it is no wonder that such endeavours are rare. However, we argue they are needed if we really want to cater

for more long-term results and have girls in STEAM. This research provides valuable insights for educators, policymakers, and organisations aiming to empower girls in STEAM disciplines through Creative Coding projects. It underscores the multifaceted nature of attrition and offers a comprehensive framework to address these challenges, ultimately promoting gender diversity in technology and the arts.

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