Empowering Girls in CS: The Impact of Digital Girls Outreach Camp

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Abstract: In recent years, despite the growth of initiatives aimed at improving the gender gap in STEM disciplines, the number of girls choosing academic and professional paths in fields such as computer science (CS) remains limited. To counteract this phenomenon, initiatives like the Digital Girls Summer Camp, which has been running for over ten years for girls about to make university choices, offer practical and engaging experiences designed to spark interest in technological subjects. Through activities such as programming and video game design on advanced platforms like Unreal Engine, participants acquire technical skills and confidence in their abilities, supported by female educators and mentors who serve as role models. The camp follows a gradual learning approach, starting with simple concepts and progressing to complex projects, thus stimulating the participants' interest. This study aims to analyze the effectiveness of the most recent editions of the initiative by using a qualitative and quantitative approach to evaluate how the girls change their perception of their technological abilities and interest in CS. Through the submission of pre- and post-camp questionnaires, it is possible to assess the increase in interest in STEM careers, as well as analyze the perception of the figure of the computer scientist before and after the camp experience. The work describes how participation in the camp has significantly contributed to shifting perceptions toward computer science, showcasing how hands-on experience and exposure to positive role models can transform the image of the computer scientist, inspiring participants to view it as an inclusive and dynamic profession.

Keywords: Gender Gap, ICT Education, Data Analysis, Extracurricular Activities, Game Design.

1. Introduction

The United Nations' Sustainable Development Goal 5 (SDG 5) emphasizes the urgency of achieving gender equality and empowering women and girls as part of the broader 2030 Agenda. The EU's Gender Equality Strategy 2020–2025[1] explicitly aims to close gender gaps in the labor market, promote equal participation in decision-making, and combat gender-based violence. In education, the Digital Education Action Plan (2021–2027)[2] outlines targeted measures to reduce the gender gap in ICT and STEM fields, highlighting the importance of fostering digital skills among girls and women. However, recent assessments show limited progress, raising concerns about meeting the 2030 targets [3, 4]. Among the main categories of investment to foster gender equality in Europe, education has emerged as a critical focus, particularly in reducing stereotypes and encouraging greater participation of women and girls in STEM. Significant investments in educational reforms and initiatives aim to challenge cultural factors perpetuating gender disparities, fostering confidence among girls and women in pursuing STEM careers [5].

Despite these efforts, the NESET report highlights that women remain significantly underrepresented in STEM fields, with limited progress despite numerous initiatives [6]. Women comprise only 19.1% of ICT specialists in the European Union as of 2022, despite early academic parity or superiority in STEM subjects [7]. This persistent gap highlights the need for targeted, scalable interventions that address barriers across individual, institutional, and societal levels.

Bridging this gender gap is not only a matter of equity but also a pressing economic and societal priority. Equitable participation in STEM is critical for innovation, workforce equity, and global competitiveness. Effective strategies include mentorship and experiential learning, which improve engagement and confidence.

Research highlights the importance of experiential, hands-on learning environments and mentorship programs in fostering girls' interest in STEM [7]. These approaches emphasize interactive, contextualized learning in supportive settings, explicitly linking activities to STEM career pathways [8]. However, many initiatives lack scalability and systematic evaluation, limiting their long-term impact [9].

In this context, the Digital Girls Summer Camp, launched in 2014, represents a targeted initiative aimed at addressing the gender gap in computer science (CS). The camp offers young women practical and engaging experiences in CS, designed to build confidence and challenge prevailing stereotypes [6,10,11]. In recent editions, the program adopted the STEAM approach to provide a more holistic learning experience and effectively engage participants. This study evaluates the camp's effectiveness in transforming participants'

perceptions of CS and increasing their interest in STEM careers. Through an analysis of pre- and post-camp surveys, this work contributes to the broader discourse on strategies for achieving gender equality in STEM.

The remainder of this paper is structured as follows. Section 2 provides the background and reviews related work, highlighting the existing challenges and initiatives aimed at addressing the gender gap in STEM. Section 3 describes the Digital Girls Outreach Camp, detailing its design, methodology, and implementation. Section 4 evaluates the initiative's impact, analyzing the changes in participants' perceptions and interest in STEM careers. Finally, Section 5 concludes the paper and discusses directions for future work, focusing on scalability and potential improvements to the program.

2. Background and Related Work

Addressing the underrepresentation of women in STEM has become a global priority, with education at its core. The European Commission's Digital Education Action Plan (2021–2027) [2] outlines specific strategies to address gender imbalances, particularly through mentorship programs and experiential learning opportunities. For example, Action 13 emphasizes targeted interventions to break systemic barriers and foster inclusivity [2]. Despite these efforts, progress remains slow, particularly in the ICT sector, where women represent only 19.1% of specialists in the EU as of 2022 [5]. This gap is particularly pronounced in Italy, where the percentage of women ICT specialists is only 15.7% as of 2023, compared to the EU average of 19.4%, according to the European Commission's ICT specialist in employment report[1]. From 2013 to 2023, Italy - the country hosting the initiative discussed in this work - saw only a 9.03% increase in the share of women ICT specialists, significantly below the EU average of 16.17% and far behind countries like Spain and France, comparable to Italy in socioeconomic terms, which approach or exceed 20%.

While women account for 57.3% of EU tertiary graduates, only 20.8% pursue ICT-related degrees, with Italy lagging further at 12.6% [7, 12]. The issue persists in the workforce: women occupy less than 30% of STEM-related roles across the EU, with significant gaps in ICT and engineering fields [12]. These disparities stem from systemic barriers, including gender stereotypes and the lack of role models, which discourage girls despite strong early academic performance in STEM subjects.

These barriers often discourage girls from pursuing STEM careers despite their academic performance in STEM subjects, which often matches or exceeds that of boys during early schooling. While Dasgupta and Stout's analysis [13] a decade ago highlighted issues such as gender stereotypes, lack of female role models, and the societal perception of STEM as incompatible with communal goals, recent research by Merayo and Ayuso [14] indicates that these challenges persist today, demonstrating that efforts over the past ten years have yet to address these entrenched obstacles sufficiently.

An analysis [7] of 165 studies (2013–2023) on factors influencing girls' participation in STEM found that only 17 studies linked reduced female participation to personal factors like lack of interest or self-efficacy. In contrast, 100 studies identified cultural and environmental influences, such as gender stereotypes, societal expectations, and inadequate support systems, as primary barriers. This highlights the significant role of external factors in shaping opportunities and perceptions for girls in STEM. Strategies to bridge this divide emphasize hands-on, interactive activities in safe, enjoyable environments. Key recommendations include contextualizing science learning, fostering teamwork, and linking activities to STEM careers, aligning with the STEAM approach [8]. Evidence shows that participatory workshops, mentorship by female professionals, and exposure to real-world STEM applications significantly improve girls' interest and retention in these fields [12, 14].

Outreach initiatives like summer camps, coding workshops, and mentorship programs have proven effective in addressing the STEM gender gap. Research [13, 7] shows that camps emphasizing collaborative, hands-on activities in supportive environments boost interest and retention. Programs like Girls Who Code and similar European initiatives foster belonging and provide visible female role models. For instance, Dasgupta and Stout [13] argue that mentorship by women in STEM acts as a "social vaccine" against stereotypes, building resilience and increasing identification with STEM careers. Longitudinal studies reveal these initiatives have lasting effects, with participants more likely to pursue advanced STEM courses and careers [15, 16]. Camps incorporating real-world applications, such as designing robots or solving environmental problems, are particularly impactful as

[1] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment

they align with girls' motivations to address societal challenges [14, 7]. However, the sustainability of these programs often depends on institutional support and integration into formal education systems, a challenge yet to be resolved in many regions.

Tracking progress and evaluating the impact of STEM initiatives remains a challenge [10]. For example, Girls Who Code only began publishing impact reports in 2022, and in Italy, few initiatives provides publicly available impact evaluations [10]. Heybach and Pickup [17] highlight a flaw in many efforts: they often fail to challenge systemic biases, treating girls as inherently "defective" in STEM aptitude by offering "girl-friendly"[2] environments or superficial repackaging of STEM content. This approach undermines quality and neglects meaningful engagement with feminist critiques of science and technology, limiting potential for transformative change. To offer practical insights, the following sections detail the Digital Girls program and share findings from a comprehensive analysis of its impact.

3. The Digital Girls Outreach Camp

The persistent underrepresentation of women in ICT, particularly in Italy, underscores the urgency of initiatives like the Digital Girls program. By creating inclusive environments where participants build confidence and develop technical skills under the guidance of female mentors, such initiatives directly address barriers identified in the literature. These efforts reduce the STEM gender gap and expand equitable access to digital opportunities.

Since its inception in 2013, Digital Girls has evolved into a comprehensive program targeting the gender divide in computer science (CS). Initially designed for female students aged 16–18, it is now organized regionally as a summer outreach program. Collaborating with schools, organizations, and stakeholders, the initiative promotes diverse participation and raises awareness. It exposes students to real-world CS applications through site visits, guest speakers, and project-based learning, creating clear career pathways. Digital Girls has earned national and international recognition, featuring in the Case Study Library of the Observatory for Public Sector Innovation and the 2021 She Figures report.

The initiative provides a female-only environment to break stereotypes before university decisions. Research shows such environments foster engagement and confidence in STEM [18]. The program spans two weeks and includes 50 hours of lessons at university facilities. Participants learn to create video games using Unreal Engine, collaborating to design and develop games. This hands-on approach connects abstract concepts to tangible outcomes, engaging students effectively [19].

A promising strategy to address STEM gender disparities is the STEAM approach [20], which integrates arts into STEM to foster creativity, collaboration, and problem-solving. The Erasmus project STEAM Boosting Soft Skills (STEAM Bo.SS) has helped refine Digital Girls, offering insights to enhance its impact. The project emphasizes soft skills like teamwork, adaptability, and communication—critical for navigating today's job market. It equips educators with resources, including a MOOC and Community of Practice, to integrate STEAM principles into teaching.

Building on this foundation, Digital Girls now aligns more closely with project-based learning (PBL), a core STEAM element [20]. For example, the program transitioned from formal programming languages like Python to Unreal Engine. This change retains logical principles while removing syntax barriers using Blueprint, a visual scripting tool that makes programming accessible to diverse participants. Unreal Engine's extensive graphical library enables sophisticated results with minimal effort, fostering engagement and accomplishment. Participants focus on creative problem-solving and innovation, lowering technical entry barriers.

While Unreal Engine is renowned for video game development, it also supports short films, simulations, and other digital solutions. This versatility empowers participants to create projects aligned with personal interests and social issues, blending technical skills with artistic expression. For instance, participants have designed visual narratives addressing societal challenges.

Video games, in particular, effectively link CS concepts to real-world issues, such as environmental sustainability, social inequalities, and the promotion of inclusivity. By integrating Unreal Engine, Digital Girls inspires creativity,

[2] By "girl-friendly," the authors refer to superficial marketing actions, such as using colors stereotypically associated with girls

critical thinking, and confidence, helping participants explore CS career pathways. This approach builds technical skills and self-efficacy, enabling participants to envision themselves as future innovators.

Integrating STEAM principles represents a key step in Digital Girls' mission to address STEM gender disparities. Its focus on holistic, inclusive education serves as a model for other initiatives promoting gender equality in STEM.

4. Initiative Impacts

The present analysis, based on data collected during the 2022 and 2024 editions of the Digital Girls camp, utilizes a refined pre- and post-survey instrument developed over the course of a year to enhance the assessment process [10]. The camps varied in their activities; for instance, some incorporated block-based coding languages, while others employed text-based coding languages. Additionally, leadership differed across camps, with some being led by female instructors and others not. In the most recent editions, the initiative adopted a STEAM approach and employed Unreal Engine as the primary development tool.

Data collection was facilitated through online pre- and post-camp surveys administered via the LimeSurvey platform. Surveys were completed during class hours with teacher support to ensure accuracy, and participants were assured of privacy through personalized links and a rigorous anonymization process. After thorough data cleaning to remove incomplete or erroneous entries, a dataset of 194 observations was prepared for analysis.

This analysis has two primary objectives: first, to evaluate participants' overall satisfaction with the camp experience, and second, to investigate the potential impact of the summer camp on their likelihood of pursuing a career in computer science. Additionally, the study aims to examine whether specific characteristics of the camp influence key predictors of overall satisfaction and the propensity to choose a CS career.

To ensure a structured and efficient analysis process, we utilized Jupyter Notebook [21] as our primary analytical tool. Within this environment, the Pandas library [22] was employed for proficient data management and manipulation, while the Statsmodels library [23] facilitated our statistical analyses.

4.1 Formal Terminology

Table 1: Feature description

Feature Name	Type	Description
STEAM [CC]	Boolean	Whether a specific camp edition used the STEAM approach or not
Class size [CC]	Integer	Number of participants to a specific camp, ranging from 14 to 41
Block-based coding [CC]	Boolean	Whether a specific camp edition used a block-based coding language or classical text-based coding language
Main teacher female [CC]	Boolean	Whether the leading teacher of a specific camp was Female or not
Parent influence [t0]	Boolean	Whether one of the parental figures works or has a passion in a STEM field or not
Hours a week playing video games [t0]	Integer	How many hours per week the participant plays video games
Experienced coding before [t0]	Boolean	Whether experienced coding BEFORE the camp start or not
CS perception [t0]	5-Point Likert	Whether the participant has a positive perception of CS or not BEFORE the camp start
CS perception [t1]	5-Point Likert	Whether the participant has a positive perception of CS or not AFTER the camp start
CS understanding [t1]	5-Point Likert	Whether the participant has a better understanding of what CS comprises or not AFTER the camp start
CS path [t0]	Boolean	Whether the participant included a CS path in their future plans or not BEFORE the camp start
CS path [t1]	Boolean	Whether the participant included a CS path in their future plans or not AFTER the camp end

Feature Name	Type	Description
Express creativity [t1]	5-Point Likert	To which extent the participant was able to express her creativity
Made myself [t1]	5-Point Likert	Perceived knowledge mastery during project development
Had fun [t1]	5-Point Likert	Degree of enjoyment experienced during the activity
Teamwork [t1]	5-Point Likert	Evaluation on teamwork
Camp satisfaction [t1]	5-Point Likert	Camp experience overall satisfaction
Camp length [t1]	5-Point Likert	Evaluation on camp length
Camp project satisfaction [t1]	5-Point Likert	Satisfaction over project developed during the camp
Camp team belong [t1]	5-Point Likert	Team belonging perception during project development

This analysis defines specific conventions to enhance clarity and facilitate understanding of the used variables. We will use the abbreviation [t0] to denote variables associated with data collected during the Pre-Survey phase and [t1] to represent those linked to the Post-Survey phase. Additionally, we will utilize the abbreviation [CC], an abbreviation for camp characteristics, to indicate variables that relate to the unique attributes and features of the specific camp. Moreover, a concise description of each feature employed in the analysis is detailed in Table 1. The proposed feature list consists of a subset of the complete set of available variables since we included only Likert-type questions in the following analysis.

Furthermore, it is important to highlight that the specific context in which the initiative was implemented did not provide sufficient diversity in terms of race, ethnicity, or city of origin to include these dimensions in the analysis. Similarly, the variable representing the participants' school of origin was also excluded from the analysis due to its high degree of correlation with the Experienced coding before [t0] feature, resulting in an almost perfect overlap.

To rigorously evaluate the relationships between the variables and the target outcomes, we employed regression analysis as the primary method, given its suitability for quantifying associations and assessing the predictive power of multiple independent variables. To ensure the validity of the analysis, we conducted multiple iterations of the regression model, systematically refining the included variables. Variables identified as collinear through the Variance Inflation Factor (VIF) test were excluded to mitigate multicollinearity and improve model stability. Additionally, non-significant variables were iteratively removed, following statistical best practices, to optimize model performance. This approach aimed to balance explanatory power and parsimony by maximizing the adjusted R-squared value while minimizing the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC).

4.2 Camp Satisfaction Analysis

In this subsection, we aim to investigate the factors influencing participants' satisfaction with the camp experience, as measured by the Likert variable denoted as Camp overall satisfaction [t1].

Participants answered the question, *On a scale from 1 to 5, with 1 being strongly dissatisfied and 5 being very satisfied, how would you rate your overall satisfaction with the camp participation?* using a Likert scale. It is important to note that the Likert scale represents an ordered scale where the intervals between points cannot be assumed to have equal magnitudes. Consequently, the analysis is conducted using the ordered logistic regression method based on the available observations.

As stated, the analysis concentrates on a set of independent variables, each representing distinct participant responses or specific aspects of the camp that the participant encountered. Table 2 presents the results of the ordered logistic regression, where the target variable is the variable Camp satisfaction [t1].

Table 2: Ordered logit: Camp overall satisfaction.

Dep. Variable:	Camp Satisfaction [t1]	Log-Likelihood:	-190.54
Model:	OrderedModel	AIC:	417.1
Method:	Maximum Likelihood	BIC:	482.4
No. Observations: 279 Df Residuals: 261			
Df Model:	14		

	coef	std err	z	P> |z|	[0.025	0.975]
Main teacher is female [CC]	0.5406	0.300	1.802	0.072*	-0.047	1.129
Block-based coding [CC]	1.2158	0.308	3.951	0.000***	0.613	1.819
Hours a week playing video games [t0]	0.2004	0.134	1.495	0.135	-0.062	0.463
CS perception [t0]	-0.1542	0.147	-1.051	0.293	-0.442	0.133
Experienced coding before [t0]	-0.2872	0.297	-0.966	0.334	-0.870	0.296
CS perception [t1]	0.4086	0.172	2.378	0.017**	0.072	0.745
CS understanding [t1]	0.6362	0.188	3.385	0.001***	0.268	1.004
Express creativity [t1]	0.8851	0.203	4.353	0.000***	0.487	1.284
Made myself [t1]	0.1266	0.135	0.936	0.349	-0.138	0.392
Had fun [t1]	1.3018	0.220	5.922	0.000***	0.871	1.733
Teamwork [t1]	-0.5255	0.189	-2.785	0.005**	-0.895	-0.156
Camp length [t1]	-0.4675	0.217	-2.156	0.031**	-0.892	-0.043
Camp project satisfaction [t1]	1.5030	0.213	7.044	0.000***	1.085	1.921
Camp team belonging [t1]	0.2061	0.197	1.047	0.295	-0.180	0.592

Note: Marginality of p-values is highlighted with the notation: *p < 0.10, **p < 0.05, ***p < 0.001

The results illustrate how different variables affect the odds of progressing to higher levels of camp satisfaction for a one-unit change in the corresponding independent variable. In other words, this analysis provides insights into the magnitude and direction of each variable's influence on overall camp satisfaction.

From the outcomes presented in Table 2, several variables exhibit highly significant ($p < 0.001$), significant ($p < 0.05$), or marginally significant ($p < 0.10$) p-values, which provide evidence against the null hypothesis. The coefficients offer critical insights into the degree and direction of these influences. Notably, variables such as Had fun [t1] (coefficient: 1.3247, $p < 0.001$) and Camp project satisfaction [t1] (coefficient: 1.5062, $p < 0.001$) demonstrate strong positive associations with camp satisfaction. These findings reinforce the importance of fostering enjoyment and ensuring participants' satisfaction with camp projects to enhance the overall camp experience.

The variable Block-based coding [CC] (coefficient: 1.2277, $p < 0.001$) also stands out as a significant positive predictor, underscoring the appeal of block-based coding activities in engaging participants. Considering the diverse backgrounds of participants, including those from schools with and without computer science in their curricula, captured by the variable Experienced coding before [t0], we further analyzed the data by splitting the observations into two groups: those with prior coding experience and those without. This analysis aimed to explore whether block-based coding activities have an incremental impact on participants with prior exposure to coding.

The results reveal that the coefficient for Block-based coding [CC] is consistently positive across both groups, but the magnitude and significance differ. For participants with prior coding experience (coefficient: 1.1967, $p = 0.012$), block-based coding still provides a notable positive impact. In contrast, for those without prior coding experience (coefficient: 1.2956, $p = 0.003$), the effect is slightly stronger and highly significant. These findings suggest that block-based activities are universally beneficial, with a particularly pronounced effect on participants who are new to coding.

Additionally, the effects of other variables remained consistent, with only slight variations in their significance levels across the two groups. This robustness further underscores the reliability of the identified predictors in shaping overall camp satisfaction. In particular, Express creativity [t1] (coefficient: 0.9587, $p < 0.001$) and CS understanding [t1] (coefficient: 0.6198, $p = 0.001$) exhibit meaningful positive contributions, indicating that opportunities to express creativity and understand computer science concepts effectively elevate participants' satisfaction.

Conversely, variables such as Teamwork [t1] (coefficient: -0.5475, $p = 0.004$) and Camp length [t1] (coefficient: -0.4852, $p = 0.026$) are negatively associated with satisfaction. These findings suggest potential areas for further investigation, such as optimizing teamwork dynamics and ensuring camp duration aligns with participant preferences.

4.3 Future Choice Analysis

In continuation of our previous section's analysis, we pursued a similar approach to investigate the likelihood of students opting for a future Computer Science (CS) related study path. Given that this outcome is a binary variable, we employed a straightforward logistic regression to explore the factors influencing this decision. Logistic regression is a statistical technique used to explore the relationship between one or more predictor variables and a binary outcome variable. Specifically, we focus on understanding whether the available information could explain students' declared intention to pursue a CS-related path after high school.

The model's R-squared value of 0.527 suggests that over half of the variation in the outcome variable (CS path [t1]) can be explained by the predictor variables investigated. Key findings, summarized in Table 3, reveal that pre-existing intentions toward a CS path (CS path [t0], coefficient: 0.6329, $p < 0.001$) emerged as the most significant predictor, reinforcing the idea that prior interest plays a critical role in shaping future career aspirations. This is consistent with existing literature indicating that pre-existing interest and exposure to coding are powerful determinants of career trajectory [24].

Interestingly, satisfaction with the project completed during the camp (Camp project satisfaction [t1], coefficient: 0.0777, $p = 0.008$) also emerged as a positive predictor. This underscores the importance of hands-on, engaging activities in fostering students' interest in CS-related fields. Notably, these findings suggest that participants' sense of accomplishment in completing a project has a measurable impact on their career aspirations, aligning with pedagogical theories that emphasize experiential learning. The link between project satisfaction and future career aspirations suggests that providing opportunities for students to experience tangible successes in STEM activities can strengthen their confidence and motivation to pursue STEM careers.

Conversely, Parent influence [t0] displayed a negative coefficient (coefficient: -0.0805, $p = 0.017$), suggesting that parental influence may discourage some participants from pursuing CS aspirations. This result aligns with findings in the literature, such as the review by Msambwa et al., which highlights that environmental factors, including peer pressure and parental involvement, can have both positive and negative impacts on students' career decisions. This duality underscores the complexity of parental influence, warranting further exploration to understand its context-specific effects.

In summary, our findings emphasize the importance of pre-existing interest and hands-on project satisfaction in shaping participants' career intentions. While the camp's features and experiences play supporting roles, pre-camp predispositions remain the most critical drivers of future CS aspirations. These insights can guide the design of future interventions to maximize their impact on fostering interest in CS careers.

Table 3: OLS Regression: Likelihood of future choices including CS.

Dep. Variable:	CS Path [t1]	No. Observations:	278
Model:	OLS	Df Residuals:	260
Method:	LS	Df Model:	17
Date:	Tue, 26 Nov 2024	R-squared:	0.527
Time:	23:28:37	Adj. R-squared:	0.496
Log-Likelihood:	-75.944	F-statistic:	28.20
Covariance Type:	HC3	Prob (F-statistic):	2.53e-49

	coef	std err	z	P> |z|	[0.025	0.975]
Intercept	-0.7063	0.219	-3.226	0.001***	-1.135	-0.277
STEAM approach [CC]	0.0809	0.064	1.260	0.208	-0.045	0.207
Main teacher is female [CC]	0.0205	0.061	0.337	0.736	-0.099	0.140
Class size [CC]	0.0038	0.003	1.281	0.200	-0.002	0.010
Block-based coding [CC]	-0.0530	0.045	-1.172	0.241	-0.142	0.036
CS perception [t0]	0.0570	0.023	2.432	0.015**	0.011	0.103
Experienced coding before [t0]	0.0520	0.051	1.029	0.304	-0.047	0.151
CS path [t0]	0.6329	0.056	11.356	0.000***	0.524	0.742

	coef	std err	z	P> |z|	[0.025	0.975]
Parent influence [t0]	-0.0805	0.034	-2.395	0.017**	-0.146	-0.015
CS perception [t1]	0.0468	0.027	1.735	0.083*	-0.006	0.100
CS understanding [t1]	-0.0213	0.030	-0.709	0.478	-0.080	0.038
Creativity [t1]	-0.0045	0.030	-0.152	0.879	-0.062	0.053
Made myself [t1]	0.0300	0.021	1.460	0.144	-0.010	0.070
Had fun [t1]	-0.0064	0.031	-0.207	0.836	-0.067	0.054
Teamwork [t1]	0.0338	0.033	1.031	0.303	-0.030	0.098
Camp length [t1]	-0.0466	0.032	-1.443	0.149	-0.110	0.017
Camp project satisfaction [t1]	0.0777	0.029	2.670	0.008**	0.021	0.135
Camp team belonging [t1]	-0.0124	0.032	-0.388	0.698	-0.075	0.050

Note: Marginality of p-values is highlighted with the notation: *p < 0.10, **p < 0.05, ***p < 0.001

4.4 Impact of Camp Characteristics

Given the significant role of fun, project satisfaction, and creativity as predictors of participants' interest in pursuing a CS-related path, we investigated whether camp characteristics influenced these variables. To this end, a Multivariate Analysis of Variance (MANOVA) was conducted, with camp-specific features such as STEAM approach, block-based coding, presence of a female teacher, class size, and use of Unreal Engine as predictors. MANOVA was selected as it allows the simultaneous examination of multiple dependent variables, accounting for their intercorrelations, providing a holistic understanding of how these camp characteristics impact participants' overall experience.

The results indicate that camp characteristics significantly influence participants' perceived fun, project satisfaction, and creativity, with Wilks' lambda values for all variables achieving statistical significance ($p<0.05p<0.05$). The detailed results are presented in Table 4. These findings suggest that variations in the design and delivery of the camp activities systematically affect participants' engagement and satisfaction.

Table 4: MANOVA Results: Influence of Camp Characteristics on Fun, Project Satisfaction, and Creativity.

Predictor	Wilks' Lambda	F-Value	df	*p*-Value
STEAM Approach	0.864	14.209	(3, 271)	<0.001
Block-Based Coding	0.933	6.480	(3, 271)	0.0003
Female Teacher	0.964	3.412	(3, 271)	0.018
Class Size	0.948	4.919	(3, 271)	0.0024
Unreal Engine	0.925	7.375	(3, 271)	0.0001

Significant effects of camp characteristics on participants' perceptions of fun, project satisfaction, and creativity.

The inclusion of a STEAM approach ($lambda=0.864, p<0.001$) was the most influential factor, highlighting the value of interdisciplinary contexts in enhancing participants' engagement and satisfaction. Camps that incorporated block-based coding ($lambda=0.933$, $p<0.001$) were associated with higher levels of fun, project satisfaction, and creativity, indicating the accessibility and appeal of block-based tools, particularly for beginners. The presence of a female teacher ($lambda=0.964, p=0.018$) had a significant but smaller effect, suggesting the potential for role modeling to positively influence participants' experiences.

Class size ($lambda=0.948, p=0.0024$) was a significant factor, suggesting that larger class sizes may foster greater levels of fun, creativity, and project satisfaction in the context of these camps. This finding could indicate that larger groups provide more opportunities for peer interaction and collaborative dynamics, which are particularly relevant in project-based learning environments. Lastly, camps that utilized Unreal Engine ($lambda=0.925, p=0.0001$) were positively associated with the dependent variables, suggesting that advanced, visually engaging tools can enhance participants' enjoyment and creative engagement.

5. Conclusions and Future Works

This study emphasizes the meaningful impact of targeted initiatives like the Digital Girls Summer Camp in tackling the gender gap in computer science (CS). Through hands-on activities, mentorship, and project-based learning, the camp creates an engaging and supportive environment that has positively shaped participants' perceptions of CS, enhanced their satisfaction with the learning experience, and influenced their future career aspirations.

The findings highlight the value of designing outreach programs that cater to the diverse backgrounds of participants. Prior coding experience emerged as a significant factor in shaping future interest in CS, yet the camp's structure effectively supported both beginners and those with prior exposure. For participants without coding experience, activities like block-based coding and the use of visually intuitive tools such as Unreal Engine offered an accessible introduction to CS concepts. Meanwhile, participants with previous coding experience responded well to more challenging, interdisciplinary activities that incorporated STEAM principles.

Key observations also pointed to the influence of specific camp characteristics. Features such as having female instructors and ensuring high levels of project satisfaction played a notable role in enhancing participants' overall experience and shaping their intentions to pursue CS-related paths. However, teamwork presented a complex picture. While fostering a sense of belonging, group projects sometimes resulted in unequal distribution of technical tasks, particularly coding, which may have limited some participants' deeper engagement. Adjusting the management of team dynamics in future iterations could address this issue and further strengthen the camp's impact.

Overall, the Digital Girls Summer Camp serves as a powerful example of how mentorship, interactive learning, and an inclusive environment can work together to inspire greater interest in CS among young women. These insights can help shape future interventions, underscoring the importance of creating tailored, supportive, and experiential learning opportunities that empower more girls to consider careers in STEM fields.

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