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Approaches to Diversifying the Programmer Community – The Case of the Girls Coding Day

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***Abstract*—In this paper, we present Girls Coding Day, a one-day workshop designed to bring in young female adults who did not study computer science at college but wished to try out or learn computer programming. To study the effectiveness of the workshop on participants' future intention on learning programming and perceived coding ability, we conducted 2 separate surveys of participants of 32 Girls Coding Day events that happened between 2017 and 2019. Our contributions include participants' motivations; components in our workshop design that correlate with participants' learning outcomes; and implications for designs of similar events in the future.**

***Index Terms*—software engineering education, gender diversity, code camps**

I. Introduction

Interest in gender diversity in the programmers' community continues to grow. Studies have shown that high gender diversity in a software development team is associated with higher productivity [1] and reduces community smells [2]. Diversity is also generally perceived as being beneficial for tasks that require creativity and innovation [3], [4].

There have been many efforts to improve gender diversity in the tech community, for example, related to hiring [5] and college admission processes [6]. Such approaches, however, presume an individual's commitment to pursue a career in the field of computer science. To attract newcomers to computer science, there are a number of different programs which provide try-out opportunities for females before they attend colleges.[1][2][3][4] In addition to teaching girls programming, these organizations also aim to increase women's sense of belonging by accepting only female participants and hiring female instructors. Prior studies show that a high ratio of female peers can "enhance women's motivation, verbal participation, and career aspirations in engineering" [7], and interactions with female experts in science, technology, engineering, and mathematics (STEM) increases their interests [8], [9].

While there are abundant coding camps for young female students, there are also individuals beyond this demographic who wish to explore computer science [10]. They might be college students[5] who do not major in computer science but want to find IT-related jobs, women in the workforce who wish to switch jobs, girls or women who are still unsure about their career direction, or others. For these individuals, attending coding camps that take days or weeks is likely to interfere with their work or private life.

The aforementioned issues have created an increased interest in short-term events [11], such as workshops [12] or meetups that typically take place during a weekend or during after work hours so that they do not interfere with participants' jobs. As a result, they can reach a broader audience and allow more women to experience programming in their spare time. Such events are often organized in a hackathon-like fashion in that participants learn about using technology by forming teams and working on a project of their choice [13], [14]. The hackathon format, however, typically presumes the ability of individuals to work on a project of interest with minimal external guidance [15]. This cannot be expected from newcomers to the programming field who will need close guidance and support to be able to complete a project [15]. Moreover, hackathons have been criticized for fostering a competitive climate [16] that favors individuals that already possess technical expertise [17].

Therefore, to combine the project-based learning (PBL) format [18] of hackathons and provide tailored mentoring support [15], we created the Girls Coding Day[6] – a single-day event during which females can get first-hand programming experience by working on their own projects along with other female peers. Before the event, they receive study materials, attend a kick-off event, and meet with a mentor who will answer questions and provide supports during the entire process. In order to better understand the participants, we need to learn about their motivations for participating in coding camps. Thus, we aim to answer the following research question:

RQ$_1$. *What were the participants' motivations for participating in coding camps?*

[1]https://girlsofsteelrobotics.com/
[2]https://girlswhocode.com/programs/clubs-program
[3]http://cs.brown.edu/people/orgs/artemis/
[4]https://girlswhocode.com/programs/summer-immersion-program

[5]We use "college" to refer to higher education institutions, such as universities.
[6]In Chinese, "girls" (*nǚ shēng*) can be used to refer to female children or young adults.

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Moreover, we aim to study which aspects of the Girls Coding Day are related to the participants' interest in programming, to further improve the format. We are particularly interested in the participants' *intention to continue learning about programming* and *their perception of their own coding ability* since they can be perceived as key indicators for them to remain interested and potentially pursue a career in a technical field. We thus also aim to answer the following research questions:

RQ$_2$. *How was the design of the Girls Coding Day related to the participants' intention to continue learning about programming?*

RQ$_3$. *How was the design of the Girls Coding Day related to the participants' perception about their own coding ability?*

To answer these questions, we conducted a multi-case study [19] of 32 Girls Coding Day events that happened between 2017 and 2019. We first administered a survey that mainly included open-ended questions to identify potential aspects that can be related to the participants' perception of the event. Based on these aspects, we identified suitable scales and conducted a second survey to study their relationships. In the second survey, we measured participants' *perceived coding ability* and *future intention on learning computer programming* after the event and analyzed their correlations with our design of Girls Coding Day.

In summary, we make the following contributions: 1) We describe the design of Girls Coding Day, a one-day coding camp for young female adults who want to try out programming; 2) We conduct two rounds of surveys to assess the correlation of the design with participants' confidence and future interest in computer programming; 3) We report participants' motivations; 4) We analyze aspects in our workshop design that correlate with participants' learning outcomes; 5) We provide suggestions for the design of similar events in the future.

II. Related work and background theory

In this section, we will situate our study in prior work and discuss aspects from established theories that informed the design of Girls Coding Day.

A. Hackathon vs. workshop

Hackathons and similar time-bounded events have been utilized as a means of teaching in various formal and informal educational contexts [20]–[23]. Moreover, hackathons have successfully been utilized to attract newcomers that aim to, *e.g.*, learn about certain technologies [15], [24]. During such events, participants form teams and work on projects that are of interest to them [13], [14]. Hackathons generally operate under the assumption that teams are capable of working on projects on their own with minimal external guidance [15]. This approach is not realistic in our context since we specifically aim at attracting individuals that have no or very limited prior experience related to programming.

Moreover, most events have a competitive element [16] which can deter female and non-binary participants [25]. Instead of competition, women value opportunities to work with and/or to help others more highly than men do [26], [27]. Our aim is rather to organize an event that emphasizes educational objectives in that participants can come to learn a new programming language and complete a project, either alone or in groups, rather than competing with each other for an award. Porras *et al.* have shown that short-term collaborative code camps that focus on learning can decrease "the possible fear of programming" while providing good learning outcomes [21]. Moreover, Rails Girls[7] reported that "an interactive tutorial style combined with a small project" helps improve participants' interest [28]. Therefore, we organized one-day workshops that emphasize collaborative learning rather than competitions.

B. Girls' and women's coding camps

Prior works have shown that all-female coding events can increase female participants' interests in STEM. Dasgupta *et al.* conducted an experiment showing that the ratio of female peers in small groups can "enhance women's motivation, verbal participation, and career aspirations in engineering" [7]. Çakil *et al.* reported that, a full-day workshop with a game-design activity along with identity exploration principles "can be a promising strategy for stimulating young girls' interest towards computing" [12]. There are many organizations who organize female coding camps, such as Girls Who Code [29], [30], Rails Girls [28], and Black Girls Code [31]. In addition to coding education, Rails Girls also suggests that having "time for socializing" could be a useful additional element [28]. Furthermore, Lewis points out that coding education for female adults, who are not currently in computer programming, could provide them with more career choices and argues for increased work on engaging these people in STEM [10].

C. Project-Based Learning

Our approach is closely related to PBL in that we aim to teach participants computer programming through hands-on practice and self-exploration. The PBL framework requires participants to intentionally work on a project that helps them acquire new skills [18], [32]. PBL focuses on self-learning through actively engaging in authentic and real-life tasks. In this framework, teachers are facilitators, whereas learners actively investigate, create, collaborate, and solve problems [33], [34].

Prior studies have shown the benefits of PBL in STEM education match the goals of Girls Coding Day. Chanlin and Karaman *et al.* found that learners in PBL performed better in skill development, general ability, and knowledge compilation than those who were not [35], [36]. Moreover, prior studies have found that PBL increases students' positive learning attitudes towards science and technology [37], [38]. Furthermore, Tseng *et al.* found that PBL not only increases students' positive attitudes towards STEM but also influences their choices of a future career in STEM [33].

[7] A one-day workshop for young women and girls without prior programming knowledge to learn web application development using Ruby on Rails.

III. The design of the Girls Coding Day

We design our event to target women who wish to try out programming but lack opportunities to do so in their daily life. This includes women who are either in college but not majoring in computer science or related fields, in the workforce but not as a programmer, etc. Based on Dasgupta *et al.*'s finding [7], we recruit only female participants because a higher female ratio could reduce female participants' anxiety, encourage their participation, and inspire their future interest in computer programming. We will provide a detailed description of our design in the rest of the section.

Girls Coding Day's curriculum is designed according to the PBL framework, which can be summarized to five criteria [18]:

1) Projects are central, not peripheral to the curriculum.
2) Projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline.
3) Projects involve students in a constructive investigation.
4) Projects are student-driven to some significant degree.
5) Projects are realistic, not school-like.

We designed two sets of curriculum, one is on HTML/CSS, the other on Python. One week before the Girls Coding Day event, there is a kick-off event where we announce study goals, distribute study materials, help participants install the necessary software, and assign participants to smaller mentoring groups. According to PBL, the project should be central to the curriculum (criterion 1), thus, we announce the project at the very beginning of the kick-off event so that participants could start designing their project and have the goal in mind when learning the materials. For HTML/CSS workshops, the project is to build a personal website; for Python workshops, a web crawler. At the end of the workshop, we encourage them to post and deploy their code on GitHub, a tool that programmers need to be familiar with (criterion 5).

To follow PBL's framework, the handout is designed to guide participants to encounter problems and learn by investigation. We encourage participants to build their own project (criterion 2) instead of following some templates or instructions. In the handout, we do not provide detailed instructions on steps beyond the basic knowledge, such as for-loops or web servers. Instead, in the handout, we give the participants a list of websites they could consult when they had problems or wanted to learn about new functions (criterion 3).

At the kick-off event, participants are assigned to small groups of three or four led by a mentor, whose responsibilities include answering questions and solving technical problems. According to the PBL framework, mentors are expected to be the facilitator of the course rather than the leader (criterion 4). During the one week between the kick-off event and the actual event, participants are encouraged to read the handout and ask questions in their mentoring group.

Mentors were real programmers who were selected based on their programming experience and briefly trained. Some of them also gave light talks at some events to share their stories as programmers. We tried to recruit more female mentors because Cheryan *et al.* showed that non-stereotypical role models can have a positive impact on minority groups' interest in computer programming [39]. Unfortunately, due to the low ratio of female programmers, around 70% of the mentors were male.

During the coding day event, participants work on their individual projects. When they are stuck, they are encouraged to console the handouts, discuss with teammates, and ask their mentor. The learning process should be mostly student-driven (criterion 4). Therefore, mentors should encourage participants to find out answers by themselves and have them explain them back to mentors, instead of telling them the answers right away. At the end of the event, we encourage them to present their project.

IV. Empirical Method

To answer our research questions, we designed a multi-case study. After each event, we sent out a short survey with open-ended questions related to participants' experiences. From the first survey (§IV-B), we identified components of Girls Coding Day, *e.g.*, handout, that are important to participants and different aspects, *e.g.*, usefulness, that could be measured. We incorporated information we gathered from this first surveys in the design of our second survey. The second survey (§IV-C) assesses how different components of our event design are correlated with participants' intention to continue learning computer programming ($\mathbf{RQ}_2$) and their perception about their coding ability ($\mathbf{RQ}_3$). To answer $\mathbf{RQ}_1$, in the survey, we also asked questions on their motivations for studying computer programming, as well as their occupations, programming backgrounds, and other demographic information. In the rest of this section, we will first describe the design and data analysis method of the first and second surveys respectively. The findings from the surveys will be presented in §V.

A. Workshop participants

In 2017 and 2018, we organized 15 Girls Coding Day workshops on HTML/CSS in 12 cities in China with 489 participants. At these workshops, participants learned HTML and CSS by building a personal website. In 2018 and 2019, we organized 17 Girls Coding Day workshops on Python with 17 universities across China with 940 participants. At these workshops, participants learned Python by building a web crawler. All participants received two rounds of surveys: the first, short one after the event, and the second, longer survey designed based on the first survey.

B. The design and analysis of the first survey

1) Survey design: The main purpose of sending out a short survey after each event was to collect participants' feedback that could help us improve future events. In the survey, we asked participants two open-ended questions: *whether the event met their expectations and why*; *any feedback or critiques*. The survey also contained demographic questions and some simple questions like whether they were interested in future events and whether they would recommend our workshop to their friends. The survey was in Chinese.

2) Data analysis: We analyzed the first survey responses following an open-coding procedure. After collecting all survey responses, two of the authors, both of whom are fluent in Chinese and English, translated all answers independently. Afterward, they first independently identified aspects that can be related to how the participants perceived the Girls Coding Day before discussing their findings. The result of this discussion were several themes, such as mentoring experience and handouts, which both authors found to be related to the experience of Girls Coding Day participants.

C. The design and analysis of the second survey

1) Survey design: We utilized the aforementioned themes as a basis to identify suitable survey measures. If possible, we utilized validated survey measures. In addition, the survey also included questions about participants' background and their *motivations* (**RQ**$_1$) as well as measures that would cover the participants' *intention to continue learning programming* (**RQ**$_2$) and their *perceived coding ability* (**RQ**$_3$). All survey items were evaluated on a 5-point Likert scale anchored between "Strongly Disagree" and "Strongly Agree". In the following, we will discuss the scales we utilized in detail.

Participants' characteristics and motivations. To answer **RQ**$_1$, we assessed participants' motivation by asking them to rate how well some of the motivations we identified in the first survey align with theirs (shown in §V-A), as well as an open-ended field for other motivations. These questions were based on a larger survey instrument by Filippova *et al.* [40]

In addition, we included questions in the survey that covered basics demographic information such as their educational background and work experience at the time they participated in Girls Coding Day. For the question on their educational background, we utilized the distinction by the US Census Bureau while work experience was assessed based on self-reported employment status, role in their employment, and number of years spent in that role. The survey also covered the participants' computer programming education. For this, we included questions about how many courses during which they had to implement source code they participated in prior to Girls Coding Day, how they perceive their own coding experience, and how they perceive their coding skills in comparison to the other participants within their mentoring group. We included the latter scale because it has been found to be predictive of actual student performance [41].

Future intentions (outcome). To assess the participants' intentions to continue learning about computer programming, thus answering **RQ**$_2$, we utilized the theory of planning behavior (TPB) [42] as a basis. It stipulates that human behavior is mainly guided by *behavioral intentions* and *perceived behavioral controls*. To cover both aspects we adapted and included scales developed by Liao *et al.* [43] into our survey.

Perceived coding ability (outcome). We included the following scales to assess the perceived impact of Girls Coding Day on the participants' coding ability (**RQ**$_3$).

Comfort with learned technology is assessed by participants' rating of their comfort with technologies they learned at Girls Coding Day, including HTML/CSS or Python, and GITHUB.

Perceived coding capability is assessed by the set of scales developed by Ramalingam *et al.* [44] on computer programming self-efficacy. We used the statements from the factor concerning independence and persistence, such as if they could build a website if *"someone else helped [them] get started"*, *"[they] had only the language reference manual for help"*, *etc.*

Perceived learning ability is assessed by the same scales.

During Girls Coding Day. In order to assess how the design of the Girls Coding Day can potentially influence the participants' *intentions to continue learning about programming* and their *perception about their own coding ability*, we also covered their *learning experience satisfaction* and *learning outcome satisfaction*, using scales developed by Filippova *et al.* [40] for outcome satisfaction.

Handout. In addition to the aforementioned scales, we also included scales that cover aspects we found from the first survey. Since many participants mentioned how handouts helped their learning process, we adapted several scales to assess handouts' effectiveness. Proceeding these sets of statements, we used capitalized letters to inform the participants that the survey is independent of Girls Coding Day and the handout designers will not see their individual answers.

Satisfaction with the handout is assessed by participants' level of agreements with statements on the satisfaction with the outcome, developed by Reinig [45], *e.g.*, *"I am satisfied with the handout"*, and on the perceived ease of interpretation of a process model proposed by Davis [46], *e.g.*, *"Installing the software required for GCD was easy based on the handout."*

Perceived usefulness of the handout was measured by the scales developed by Liao *et al.* [43] based on the TPB [42], [47]. We asked the participants to indicate their level of agreement with statements on if the handout improved their productivity, effectiveness, and performance during Girls Coding Day.

In addition, we included two open-ended questions about what was good and what could be improved about the handout.

Kick-off event. We assessed the following two variables regarding the kick-off event.

Perceived usefulness of the kick-off event is assessed by the scales on perceived usefulness developed by Liao *et al.* [43], *e.g.*, if the kick-off event improved their productivity, effectiveness, and performance during Girls Coding Day.

Satisfaction with the kick-off event outcome, including installing software and setting environment, is assessed by the scale on satisfaction with outcome developed by Filippova *et al.* [40], *e.g.*, *"I am satisfied with the kick-off event"* and *"[m]y ideal outcome towards the kick-off event was met."*

We also included two open-ended questions about what was good and what could be improved about the kick-off event.

Mentoring experience. Instead of asking participants' impressions of their mentors, we decided to ask their impression on their *mentoring experience*. This is due to the concern that people might be hesitant to disclose their opinions of other people. Proceeding these sets of statements, we again used capitalized letters to inform the participants that the survey is independent of Girls Coding Day and no mentors will see their individual answers.

Impression of mentoring experience is assessed by participants' agreement with statements related to the mentoring experience extracted from the first survey §IV-B, *e.g.*, *"the mentor and students ratio was sufficient."*

Support received from mentoring experience is assessed by the scales on mentoring experience developed by Pamuk *et al.* [48]. Since the goal of Girls Coding Day is not intended for academic or professional improvement, we adapted the most relevant section, technical benefit, in our survey, including statements like *"[m]y mentor helped me learn new technical skills"* and *"[w]orking with my mentor provided me opportunities to learn/improve my knowledge on different technical skills."*

Satisfaction with mentoring experience is assessed by the same set of scales in [48], *e.g.*, *"[m]y mentor helped me recognize my personal strengths using technology"* and *"[m]y mentor helped me become more confident in learning new technologies."* In addition, we included the statements *"my mentor encouraged me to pursue programming,"* since this is one of the major goals of Girls Coding Day.

Voice is assessed by scales that cover the participants' perception of whether they could voice their questions or ideas in their group and their perception of how they interacted with participants outside of their group. Both scales were adapted based on existing scales developed by Filippova *et al.* [40].

We also included two open-ended questions about what was good and what could be improved related to mentoring.

2) Survey distribution: There were in total 1,429 participants of Girls Coding Day in both HTML/CSS workshops and Python workshops. The organizer of Girls Coding Day helped us distribute the survey via emails and Wechat groups created for HTML/CSS and Python Girls Coding Day events. The survey was opened for a month between February and March 2020. The survey was translated into Chinese by two of the authors.[8]

3) Data analysis: We received 60 responses in total, with 35 stemming from Python Girls Coding Day events and 25 from HTML/CSS Girls Coding Day events. We started our analysis by removing responses that answered the attention checking question incorrectly, which left us with 43 usable responses. Afterward, we computed Cronbach's α, for each of the scales we utilized to assess their reliability (Table I). To answer $\mathbf{RQ}_1$, we conducted factor analysis to identify the main motivations. We then calculated the Spearman correlation between each pair of measures to assess their connections to answer $\mathbf{RQ}_2$ and $\mathbf{RQ}_3$. We utilized Spearman as a measure because our responses were not normally distributed.

For the open-ended questions, the same two researchers coded the answers together following an open-coding procedure. We used different sets of codes for different components. Within each component, we first identified individual codes then merge them into categories that are reported in §V-B.

Section	Mean	SD	α
Handout			
Handout satisfaction	3.99	0.75	0.87
Handout usefulness	4.05	0.79	0.91
Mentoring experience			
Mentoring experience impression	3.92	0.52	0.84
Support from mentoring experience	4.26	0.75	0.95
Mentoring experience satisfaction	4.22	0.76	0.96
Kick-off party			
Kick-off event usefulness	3.82	0.89	0.98
Kick-off event satisfaction	3.87	0.79	0.96
Motivations			
Motivation for learning	4.52	0.61	0.85
Motivation for social	3.92	0.68	0.8
Motivation for career	3.85	0.90	0.87
Girls Coding Day event day			
Learning satisfaction	3.53	0.79	0.84
Outcome satisfaction	3.49	0.89	0.94
Voice	4.07	0.65	0.89
Support	3.92	0.43	0.86
Outcome variables			
Intention	4.03	0.68	0.78
Behavioral control	3.38	0.87	0.87
Perceived coding capability	3.65	0.77	0.88
Perceived learning ability	3.80	0.78	0.88

TABLE I: Statistics of the second survey's results.

V. Findings

A. The results of the first survey

From 1,429 participants, we received 260 responses, 114 from the HTML/CSS series (denoted by HP1-xx), and 136 from the Python series (denoted by PP1-xx).

Overall, our analysis revealed that participants had a positive perception of Girls Coding Day. They noted that it *"help[ed] women reduce the fear of programming"* (PP1-75), cleared their doubts about whether they *"would be able to do programming work as a girl"* (PP1-38) and helped them realize that *"programming can be very simple and interesting"* (HP1-75). Many participants also expressed their interest in future courses or in becoming a mentor for future events (PP1-38).

In the following, we will discuss themes that appeared to be mostly related to the participants' experience during the event. For each of the themes (shown in bold below), we created a survey scale that included one item per aspect that we discovered. [9] It should be noted that we turned the mentioned negative aspects into positive statements in order to arrive at a uniform scale.

Motivations. We identified the following motivations, such as *"[w]anting to have fun"*, *"[w]anting to learn new technologies"*, *"[w]anting to advance my career"*, and *"[w]anting to meet new people"*.

Mentoring. Mentoring was most often mentioned by survey participants as having positively influenced their experience. In particular, some participants mentioned that their mentors were very **patient** *"even when participants asked a stupid*

[8]The survey can be obtained at https://doi.org/10.5281/zenodo.4628831

[9]An overview is available at https://doi.org/10.5281/zenodo.4628831

question" (HP1-98). They perceived this to greatly *"reduce [participants'] previous fear of computer programming"* (HP1-65).

Participants also mentioned that they were satisfied with the learning strategy which focused on them **guiding participants to find solutions themselves**. They perceived this *"the right approach of learning programming from a perspective of thinking method"* (HP1-22). Mentors, however, also directly solved **technical problems** if participants would get stuck (*"I needed help with technical knowledge from mentors"*, HP1-11). This proved to be difficult on a few occasions, since some participants noted that they did not know *"how to explain [their] problems when the mentors came to help [them]"* (PP1-42).

Some participants, however, also voiced complaints. They mentioned that there were **too few mentors for the number of participants**. This is evident by them noting that *"the mentors were too busy to solve all participants' problems"* (PP1-34) and that *"a group could have more mentors"* (PP1-116).

Moreover, participants also criticized that mentors **did not answer questions in a clear way**. Instead, they sped through the material and did not provide sufficient examples. This was particularly problematic for participants with zero prior knowledge who hoped that the mentors could *"slow down and provide some concrete examples because these definitions are somewhat abstract"* (PP1-110).

Handouts. Handouts were also often mentioned by participants. While we sent out the handouts to the participants at the kick-off event, we also suggested the mentor lead a daily short reading group in the following week. We saw that some **participants found that reading the handouts before the actual event improved their productivity** (HP1-50, PP1-14). For example, ***"because we previewed the material, I was very productive on the day of the event"*** (HP1-50) or *"the material was too much for a day, it would have been better if we have read the handout beforehand"* (PP1-14). However, one noted that without mentors' help, ***"the handout was hard to understand"*** (PP1-135).

Kick-off event. The kick-off event was also mentioned as a theme that contributed positively to the participants' perception of the event. One reason is that **participants perceived it to make the actual event more effective** because it *"avoided a large number of installation environment problems"* by installing and configuring environment in advance (PP1-105).

	Behavioral ctrl	**Perc. coding**	**Perc. learning**
Handout satisfaction		0.60***	
Learning satisfaction		0.74***	
Outcome satisfaction		0.66***	
Future intention	0.70***		0.72***
Behavioral control	-	0.65***	
Perceived coding ability	0.65***	-	

TABLE II: Correlation analysis of outcome variables (bold ones are outcome variables).

	Impression	Satisfaction	Support
Voice within groups		0.63***	
Support from mentors	0.62***	0.62***	-
Learning (motivation)	0.68***	0.61***	0.70***

TABLE III: Correlation analysis results of mentoring experience.

B. The results of the second survey

In this section, we will discuss our findings from the second survey (c.f. Table I for an overview). We first outline our participants' demographic characteristics. Then we report findings from a factor analysis for motivations thus answering $\mathbf{RQ}_1$, before reporting findings from a correlation analysis to identifying means to improve participants' outcome thus answering $\mathbf{RQ}_2$ and $\mathbf{RQ}_3$. We only report on correlations with strong statistical significance ($p < 0.01$, denoted by ***) and a correlation coefficient > 0.6 from our correlation analysis, as reported in Table II. We use answers to the open-ended questions to better contextualize participants' ratings of different components of Girls Coding Day. We will denote participants to HTML/CSS's second survey as HP2-xx and Python's as PP2-xx.

Participants' demographic characteristics. From the survey, we found that most of our participants hold a bachelor or a master's degree (19 with a master's degree, 15 with a bachelor, 1 with a Ph.D., 2 with an associate bachelor, 4 with some college degree, and 2 with a high school degree). Most of them (37.21%) had taken 1 or 2 programming courses before Girls Coding Day, although some of them had taken more (max=10, m=1.19, SD=1.85). Most of them rated their programming experience low prior to the event (m=1.77, SD=0.92) and thought that they were about average in their mentoring group (m=2.26, SD=0.98). Among the valid responses, 46.51% were working at a company when they participated in Girls Coding Day.

RQ1: Participants' motivations. To answer $\mathbf{RQ}_1$, we conducted an exploratory factor analysis on the answers to our *motivation* scale which revealed three Eigenvalues corresponding to three factors: *advancing one's career* (similar to [10]), *social opportunities* (similar to [28]), and *learning new technology*. Taking the average of answers from each factor, we found that the biggest motivation was *to learn new technology* (m=4.52, SD=0.61), followed by *social opportunities* (m=3.92, SD=0.68), then *to advance one's career* (m=3.85, SD=0.90). It is not surprising that *to learn new technology* is the biggest motivation because learning computer programming is the major goal of Girls Coding Day. The *social opportunities* is in line with what Rails Girls suggests: having "time for socializing" is useful [28]. *To advance one's career* is in line with Lewis' argument that computer programming education for female adults could provide them career benefits [10].

From our correlation analysis, we found that the motivation of *social opportunities* has a significant correlation with *learning satisfaction* (0.61***). **This suggests that partici-**

pants who seek social opportunities were more likely to perceive their learning progress as positive. In the open-ended answers, many participants commented that Girls Coding Day *"[a]llowed [her to] meet many brilliant peers and excellent programming mentors"* (HP2-23). Some participants also mentioned that *"a female programmer talked about her career path was interesting"* (HP2-10). This finding agrees with Dasgupta's finding that higher female-ratio enhances women's motivation [7].

In addition to participants' motivations, from the open-ended questions, we coded obstacles that prevented them from learning to program earlier. The most common reason that participants mentioned for not trying out computer programming in the past was *the lack of suitable support*. One participant mentioned that there were *"[n]o related activities, no projects, no goals"* (PP2-3). Two noted that they were *"too busy"* to learn to program (PP2-18) while others mentioned that there was *"no mentoring"* (PP2-3) and *"online courses were not convenient to ask questions"* (PP2-32). Moreover, some participants commented that it was difficult for them to learn computer programming on their own, *"[e]ven though [she would] like to read books, [she] didn't know where to start, and self-learning is hard"* (HP2-22); *"[p]rogramming knowledge was too scattered and complicated, and many tutorials were not task-based learning methods, which was a big headache"* (PP2-25). This finding suggests that the use of the PBL framework fits with participants' learning styles.

According to our analysis, another obstacle for females to start learning computer programming was *the lack of awareness.* Because most participants were not in computer science or related major, many of them noted that they either *"did not have the awareness to learn to program"* (HP2-9), or *"[d]id not work in IT industry"* (PP2-11), so they *"[h]ad no such need"* (PP2-15). Another reason was that the educational system did not afford them the opportunity to explore computer programming, because *"[t]he exam-oriented education in the middle and high school and curriculum in the college was not reasonable. [she] didn't have the awareness to learn to program."* (HP2-9).

Overall, participants were satisfied with Girls Coding Day; all aspects of Girls Coding Day were rated above average. Comparing across components, *mentoring experience* was perceived as most useful (impression: m=3.92, SD=0.52; support: m=4.26, SD=0.75; satisfaction: m=4.22, SD=0.76) followed by the *handout* (satisfaction: m=3.99, SD=0.75; usefulness: m=4.05, SD=0.79) and then the *kick-off event* (usefulness: m=3.82, SD=0.89; satisfaction: m=3.87, SD=0.79). However, we saw a relatively low *learning satisfaction* (m=3.53, SD=0.79) and *outcome satisfaction* (m=3.49, SD=0.89).

RQ2: Future intentions. To answer **RQ**$_2$, we examine variables that are significantly correlated with the outcome variable *future intentions* and use responses from open-ended questions as additional context to interpret our findings.

Participants generally *intended to continue learning computer programming* (m=4.03, SD=0.68). However, participants did not perceive it was be *under their control* (m=3.38, SD=0.87) and that they had the *capability of learning a new programming language* (m=3.80, SD=0.78).

From our correlation analysis, we found that *future intentions* are significantly correlated with *behavioral control* (0.70***) and *perceived learning ability* (0.72***), implying that **participants that thought they were in control also intended to continue learning and with stronger confidence (and vice versa).** This finding is in line with the theory of planned behavior: intention and behavioral control are correlated and can jointly predict behavioral achievement [42].

In responses to the open-ended questions, many participants mentioned that they intended to continue learning programming and also call for more events (*e.g.*, *"follow-up courses"* (HP2-15), *"more events at higher frequency"* (HP2-4), *"expand to more cities"* (HP2-5), and *"more activities for people in workforce"* (HP2-4)). Many participants also hoped to build a community for them to continue learning to program together, because many participants could be *"busy with work and have low self-discipline, [but] it would be nice to continue to have communities"* (PP2-8).

RQ3: Perceived coding ability. To answer **RQ**$_3$, we examine variables that are significantly correlated with *perceived coding ability* and *perceived learning ability* and use responses from open-ended questions as additional context to interpret our findings.

On average, participants still ranked their *perceived coding ability* rather low (m=3.65, SD=0.77) with mild confidence for their *perceived learning ability* about computer programming (m=3.80, SD=0.78). Their *comforts with learned technologies* are also low (Python: m=2.66, SD=0.82; HTML: m=3.21, SD=0.87; CSS: m=3.00, SD=1.10; GitHub: m=2.7, SD=1.64).

The correlation analysis (Table II) shows that *behavioral control* is significantly correlated with *perceived coding ability* (0.65***). This suggests that **participants who perceived themselves to have more coding capability also perceived themselves to be more in control of continuing to learn**.

From the open-ended questions, we found some participants describing the experience as being *"brought to the gate to a new world"* (HP2-5). Some hoped for more Girls Coding Day events with *"more programming languages and interesting programming content"* (PP2-6). One participant also mentioned that she *"started exploring and learning Python programming"* (HP2-15) by herself after attending the HTML/CSS workshop.

Some aspects of Girls Coding Day's design were strongly correlated with the participants' *perceived coding ability*. First, the correlation analysis reveals that *learning satisfaction* and *outcome satisfaction* are both strongly correlated with *perceived coding ability* (0.74*** and 0.66*** respectively). This implies that **participants who were satisfied with what they learned also perceived their coding capability to be higher after Girls Coding Day.** This finding is underpinned by responses to related open-ended questions such as *"the course was efficient and effective"* (HP2-15).

However, *learning experience satisfaction* and *outcome satisfaction* have relatively low means, m=3.53, SD=0.79 and m=3.49, SD=0.89 respectively. One often mentioned reason we found in the open-ended answers is that the *"duration was too short"* (PP2-6) and *"it was haste"* (HP2-23).

Moreover, **mentoring experience was perceived to be the most useful by the participants**, especially the *support they received from their mentoring experience* (m=4.26, SD=0.75) and their *satisfaction* (m=4.22, SD=0.76).

From the correlation analysis results in Table III, we can see that *satisfactions with the mentoring experience* is significantly correlated with *voice within groups* (0.63***). This suggests that **participants who were satisfied with their mentoring experience also felt that their group members were actively engaging in the event and supportive of each other.**

Regarding the mentoring and learning experience, we found evidence in both directions. Both the *impression of the mentoring experience* and the *satisfaction with the mentoring experience* are significantly correlated with the *support received from mentors* (both are 0.62***). These correlations suggest that **people who received support from their mentors were satisfied with them.** Among the three motivations (*career*, *social*, and *learning*), *learning new technology* is significantly correlated with the *impression of the mentoring experience* (0.68***), *satisfaction with the mentoring experience* (0.61***), and *support from the mentoring experience* (0.70***). In other words, we observe that **participants, whose motivations were learning new technologies, were more satisfied with their mentoring experience.** These correlations suggest that mentors mainly focused on teaching participants computer programming. This finding is in line with a study by Nolte *et al.* [15], who found that satisfaction was related to mentors focusing on teaching participants rather than pushing them to finish a project.

From the open-ended questions, we identified the following **benefits** of the overall mentoring experience:

Mentors expanded participants' technology knowledge, because mentors *"[allowed her to] have the possibility of [...] accessing technology"* (HP2-7) and *"allowed [them] to learn simple programming knowledge"* (PP2-28). This echoes with the obstacles mentioned by some participants (§V-B), such as *"no mentoring"* (PP2-3) and *"online courses were not convenient to ask questions"* (PP2-32). This suggests that **having mentors to answer questions and solve problems can increase learning effectiveness.**

Expanded participants' social circles, because *"[t]hrough participants from different disciplines, [she] expanded [her] social circle"* (HP2-4). In addition to knowledge, having a mentor also allowed them to *"learn about programmers' thoughts"* (PP2-31) and *"eliminate ignorance across industries"* (PP2-15). One participant noted that *"[t]his kind of volunteer mentoring allows more people interested in programming to join the community"* (PP2-6). This is in line with Rails Girls' suggestion on having a social element [28].

Participants, however, also mentioned **unsatisfying aspects** about their mentoring experience:

Group assignment was arbitrary. Because participants were randomly assigned to groups, some ended up in a group whose members had different levels of prior programming skills. As a result, *"[m]entoring had to be conducted separately which reduced the mentoring efficiency"* (PP2-23). This is also reported in hackathons aimed at novice computer programmers [15]. This could be solved by grouping participants based on their prior programming knowledge or based on the similarity in their personal projects.

Mentor's professionalism was unequal. Some pointed out that their mentor *"was not very proficient in using the Python language and was not able to clearly solve problems"* (PP2-29). This could be solved by assigning multiple mentors to the same group or providing mentors some more prior training on the curriculum and some common bugs among novice programmers. Although we assigned participants into small groups, we also encouraged discussion between groups, so that maybe other mentors could help solve the problems.

Our correlation analysis also shows that *handout satisfaction* is correlated with *perceived coding ability* (0.60***), which implies that **people who were satisfied with the handout were more likely to perceive their coding ability to be better**. From the open-ended questions, we identified several **benefits** of the handout.

It was newbie-friendly because it starts with the basics. In the handout, we provided a step-by-step tutorial for installing the programming environment. Participants said the contents were *"very detailed and well organized; easy to review and understand"* (PP2-12) and *"[c]ontain necessary software installation instructions"* (PP2-15). Some participants noted that this was particularly helpful for beginners because it allowed them to *"fill in the knowledge student 'should' know before the workshop"* (HP2-11).

It helped the participants prepare for the event. Some participants noted that it *"allowed [them to] self-study in advance"* (PP2-17). While it prepared beginners with necessary basic knowledge, it also helped participants, who *"has a little bit of experience but hasn't touched it for a while, recall it"* (HP2-12). As a result, participants could *"get [their] hands on learning quickly on the day of the workshop"* (HP2-4). These comments echo the result from the scales that handouts were perceived to be useful in that *it improved their productivity and learning effectiveness*.

Both benefits reflect that having a handout that is designed according to the project can be useful because it can guide participants to encounter problems and learn by investigation (PBL criteria 2 and 3) [18].

Some participants, however, also pointed towards **unsatisfying aspect** of the handout, *e.g.*, that it needs to be more readable. For example, *"it could me more interactive"* (HP2-14). This agrees with Rails Girls' suggestion on providing an interactive curriculum [28]. Or the designers could *"add illustrations"* (HP2-14), *"use videos"* (HP2-21), or add *"some explanation on some programming statements"* (PP2-6) to make it more readable for *"who don't know about programming"* (HP2-21).

VI. Implications

In this section, we will discuss for each component, what are the design implications of our study.

A. *Duration of event*

The Girls Coding Day was designed to take place within one day with a brief kick-off event one week before because we wanted to make it light-weight and thus more accessible to a wider group of people. From the analysis, we found both voices complaining about the short duration and acknowledging that it was sufficient to get them interested in computer programming and help them overcome their fear. Since our original goal was to allow more females to try out computer programming, a light-weight short event could serve our goal.

B. *Kick-off event*

A kick-off event was perceived as useful because it stretched the short event to technically one-week long, allowing participants to prepare required software and preview learning materials. Although we encouraged participants to read and discuss the handout material before the actual event day, it was not required. Therefore, while keeping the event day itself light-weight, participants could spend as much/little time as they like on the material, making the workload flexible. Moreover, in some events where we could not hold a kick-off event, we saw participants complained about not being able to install the required software before-hand thus wasting the time of Girls Coding Day.

C. *Handout*

We found that having a handout helps participants prepare for the learning. Participants who are satisfied with the handout also reported higher perceived coding ability, implying that the handout improved the learning effectiveness.

D. *Mentoring experience*

Having mentors can reduce the obstacle of *lacking suitable support*, which prevented some participants from learning computer programming earlier. Our findings show that the mentoring experience was perceived as helpful in many ways, such as answering questions, solving technical problems, and providing social opportunities. Although Cheryan *et al.* have shown that non-stereotypical mentors have a positive impact on underrepresented groups' interest in computer science [39], unfortunately, we could not find enough female mentors due to the low ratio of female programmers. We invited female programmers though to give talks and received positive feedback from participants.

E. *Limitations*

Our goal was to study participants' perceptions of Girls Coding Day, a one-day workshop that aims to bring in young female adults who wish to try out and learn about computer programming but do not have a computer science background. Specifically, we conducted a multi-case study focusing on their background and motivations to attend one of the Girls Coding Day events and the relationship between their perception of the event and their intentions to continue learning, and their perception of their coding ability. There are, however, limitations related to our study design. We conducted two separate surveys among individuals that participated in one of the Girls Coding Day events in the same country over the past three years. It is thus possible that individuals who answered the surveys did not recall all the details about their experience because they participated in an event a long time ago before answering the survey. Moreover, our study population included individuals who had participated a long time ago and individuals who had participated recently which can affect the comparability of our findings. We accepted these limitations to be able to recruit as many of the former Girls Coding Day participants as possible. We also distributed the survey invitation through Wechat groups that was created for all prior participants of any Girls Coding Day event. Our findings may thus suffer from survivor bias because it is likely that only those prior participants that are still interested in computer programming would provide answers. This could also be one of the reasons for the mainly positive responses to most scales. Moreover, it should be noted that answers to the open-ended questions were given in Chinese and that the analysis of the respective answers was conducted by two researchers. While they conducted the translation and analysis independently at first, they subsequently discussed their findings which revealed differences in how they perceived certain answered by the participants. These differences were resolved by an open discussion between the two researchers. These limitations thus affect the extent to which the findings can be generalized, i.e., to other events organized for a different demographic in a different country. Finally, the coding camps took place only 2 to 3 years before we conducted the survey. We were thus not able to follow up with the participants to assess how many of them have indeed entered computer programming or related fields. This could be a follow-up project.

VII. Conclusion

In this paper, we presented a workshop, Girls Coding Day, designed to attract more women to learn or try out programming. We presented the theory support and the rationals of our design. We surveyed participants of two Girls Coding Day event series, HTML/CSS and Python, about how effective each component of Girls Coding Day was. Using correlation analysis and thematic analysis, we concluded a few insights that could help design workshops of similar purposes.

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