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Survey Development for Assessing Student Computing Career Intentions

Technical Report

Yvonne Kao, PhD
WestEd
ykao@wested.org

Daniel Murphy, PhD
WestEd
dmurphy@wested.org

Aleata Hubbard Cheuoua, PhD
WestEd
ahubbar@wested.org

Priya Kannan, PhD
WestEd
pkannan@wested.org

Jennifer Tsan, PhD
WestEd
jtsan@wested.org

Kyle E. Jennings
Google
kej@google.com

Heather Smith
Google
heathersmith@google.com

Shameeka Emanuel
Google
shameeka@google.com

Emily R. Miller
Google
emilyrb@google.com

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Introduction

In spring 2022, WestEd conducted a literature review to summarize the major frameworks used in career intentions research and the evidence supporting each framework, as well as to develop an initial set of constructs to guide the development of a brief, culturally sensitive computing career intentions survey measuring individual, situational, and societal factors. In summer 2022, WestEd developed a draft computing career intentions survey aligned to seven constructs, and then conducted preliminary validation testing of the survey through a series of cognitive interviews and a small-scale field test with 50 respondents. The draft survey performed well in the small-scale field test, so we conducted further testing to establish the survey's psychometric properties. There were 32 computing-related items on this version of the survey, plus demographic questions. All computing-related survey questions appear in Appendix A. Demographic questions appear in Appendix B.

Individual Factors

1. **Coding self-efficacy** (4 items): The degree to which an individual feels they can be successful in coding-related tasks.
2. **Coding self-efficacy (barrier coping)** (2 items): The degree to which an individual feels they can overcome barriers to entering a coding career.
3. **Interest in coding** (5 items): The degree to which an individual believes coding is a positive or worthwhile activity and has intrinsic motivation to learn about and engage in coding.
4. **Intention to pursue a career that involves coding** (5 items): The degree to which an individual wants a coding career or sees value in a coding career.

Situational Factors

5. **Practical support for pursuing a career that involves coding** (5 items): The degree to which an individual has time and access to physical and human resources that will enable them to develop the skills needed to pursue a coding career. In some sense, these questions assess whether the individual perceives barriers that need to be overcome.

Social Factors

6. **Social support for pursuing a computing career** (5 items): The degree to which an individual feels like part of a community of coders.
7. **Sense of belonging in computing** (6 items): The degree to which an individual believes they would be accepted in a computing career.

This technical report is a companion to our 2023 paper presented at the 19th ACM Conference on International Computing Education Research (ICER) (Kao et al., 2023). The ICER paper describes the background and motivation for the survey design and the initial survey design and validation through interviews with leaders and participants of informal computer science education programs. This technical report contains additional details about the field testing of the survey that did not fit within the page limits of the ICER paper. This report contains the results of two studies: (1) a large-scale field test to more robustly establish the instrument's reliability and test for differential item functioning (DIF), and (2) a test of the survey's test–retest reliability with a subsample of participants from the large-scale field test.

Study 1: Large-Scale Field Test

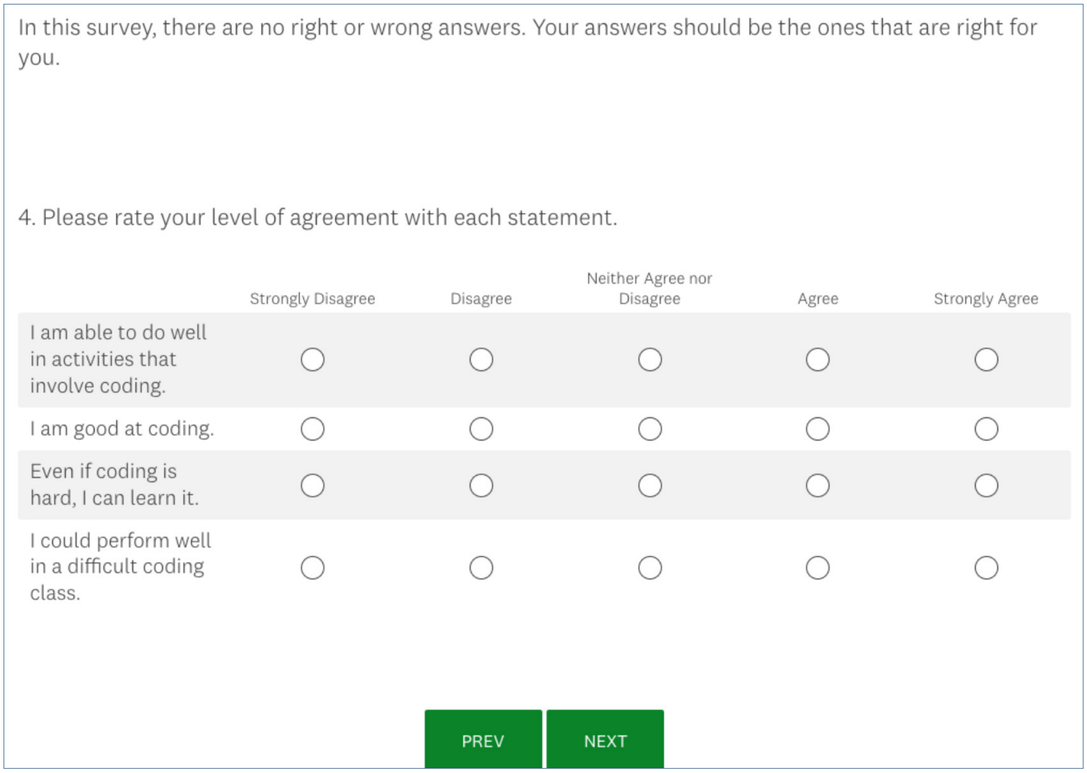
Participants

WestEd recruited participants from five computer science education programs, including several Google programs. WestEd sent informational text about the survey in English and Spanish to program leaders, who then forwarded the information and survey links to their participants. If the program served minors, the program leaders also sent informational text about the survey to parents and guardians, who were given the opportunity to opt their children out of having their survey data included in the analysis; none did. Participants responded to the survey between August 22, 2022, and October 24, 2022, spending an average of 5.5 minutes to complete it. WestEd received a total of 758 survey responses during this time period. This number includes participants who began the survey and did not complete it. A total of 732 participants completed the original survey; of these, 552 responses were retained for subsequent analyses after data were cleaned (see the section Data Cleaning Procedure).

Data Collection Procedure

Participants began the survey by completing a consent form. All items for each construct were shown together on one page in a matrix question. The top of each page included the following instructions: "In this survey, there are no right or wrong answers. Your answers should be the ones that are right for you." The prompt for each matrix question read, "Please rate your level of agreement with each statement." All items were implemented as 5-point Likert items, with strongly disagree, disagree, neither agree nor disagree, agree, and strongly agree as response options. See Figure 1 for an example of how the survey items appeared to participants.

Figure 1. Example of How Survey Items Appeared to Large-Scale Field Test Participants


In this survey, there are no right or wrong answers. Your answers should be the ones that are right for you.

4. Please rate your level of agreement with each statement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I am able to do well in activities that involve coding.	○	○	○	○	○
I am good at coding.	○	○	○	○	○
Even if coding is hard, I can learn it.	○	○	○	○	○
I could perform well in a difficult coding class.	○	○	○	○	○

PREV NEXT

At the end of the survey, participants completed a series of demographic questions which are shown in Appendix C. Participants also had the opportunity to provide general feedback on the survey in an open-response text box. Then participants selected a retailer and entered their email address to receive a $25 e-gift card as compensation for their participation.

Data Cleaning Procedure

WestEd applied a rigorous screening procedure to the survey data in order to remove low-quality responses. All responses that met at least one of the following criteria were removed:

- Multiple submissions from the same IP address (all submissions from that IP address removed)
- Multiple submissions from the same first and last name combination (all submissions with that name removed)
- Multiple submissions listing the same email address (all submissions from that email address removed)
- Respondents who provided an email address from email aliasing services (e.g., 33mail.com, anonaddy.com)
- Respondents who submitted the same response to all questions

- Respondents who did not answer any questions
- Respondents who submitted multiple responses during the retesting window

In setting these criteria, we erred on the side of removing legitimate responses to ensure a high-quality sample for analysis. For example, it is possible that we removed legitimate responses from students who may have completed the survey at school and therefore shared an IP address, or from sibling groups who completed the survey at home and therefore shared an IP address and possibly the same parent email address. In total, 180 responses were removed at this stage, leaving 552 responses for analysis.

Results

Participant Demographics

Tables 1 through 3 show the demographics of the final analytic sample, broken down by age, gender, race, and ethnicity. The percentage of Black and Hispanic respondents in the sample is similar to the percentage of Black and Hispanic people in the U.S. population and greater than the percentage of Black and Hispanic students taking advanced placement computer science exams (Code.org, n.d.). Asian respondents were overrepresented, comprising nearly half of the sample, while White respondents were underrepresented.

Table 1. Analytic Sample for the Large-Scale Field Test, by Race/Ethnicity, Gender, and Age

Race/ethnicity	Men and women in all age groups
Asian	235 (47%)
Black or African American	80 (16%)
Hispanic, Latino, or Spanish	85 (17%)
White	71 (14%)
All other races/ethnicities	34 (7%)
Total	**505 (100%)**

Note. Of the 552 final responses (after data cleaning), 11 respondents identified as transgender or nonbinary, 34 had missing gender responses, and 2 had missing age responses. Also note that the percentages in each cell represent the percentage of each age/gender group represented by the racial/ethnic subgroup (e.g., of the 20 participants overall who were men under the age of 18, 9 of them [45%] were Asian). Totals may not sum to 100 because of rounding.

Table 2. Analytic Sample for the Large-Scale Field Test, Men in All Age Groups

Race/ethnicity	Men <18	Men 18–24	Men 25–34	Men >35
Asian	9 (45%)	78 (45%)	18 (45%)	2 (8%)
Black or African American	3 (15%)	31 (18%)	5 (12%)	1 (4%)
Hispanic, Latino, or Spanish	5 (25%)	37 (21%)	7 (18%)	6 (24%)
White	2 (10%)	16 (9%)	7 (18%)	15 (60%)
All other races/ethnicities	1 (5%)	11 (6%)	3 (7%)	1 (4%)
Total	**20 (4%)**	**173 (34%)**	**40 (8%)**	**25 (5%)**

Note. Of the 552 final responses (after data cleaning), 11 respondents identified as transgender or nonbinary, 34 had missing gender responses, and 2 had missing age responses. Also note that the percentages in each cell represent the percentage of each age/gender group represented by the racial/ethnic subgroup (e.g., of the 20 participants overall who were men under the age of 18, 9 of them [45%] were Asian). Totals may not sum to 100 because of rounding.

Table 3. Analytic Sample for the Large-Scale Field Test, Women in All Age Groups

Race/ethnicity	Women <18	Women 18–24	Women 25–34	Women >35
Asian	9 (43%)	99 (57%)	17 (50%)	3 (17%)
Black or African American	3 (14%)	31 (18%)	3 (9%)	3 (17%)
Hispanic, Latino, or Spanish	5 (24%)	22 (12%)	2 (6%)	1 (5%)
White	3 (14%)	12 (7%)	8 (23%)	8 (44%)
All other races/ethnicities	1 (5%)	10 (6%)	4 (12%)	3 (17%)
Total	**21 (4%)**	**174 (35%)**	**34 (7%)**	**18 (4%)**

Note. Of the 552 final responses (after data cleaning), 11 respondents identified as transgender or nonbinary, 34 had missing gender responses, and 2 had missing age responses. Also note that the percentages in each cell represent the percentage of each age/gender group represented by the racial/ethnic subgroup (e.g., of the 21 participants overall who were women under the age of 18, 9 of them [43%] were Asian). Totals may not sum to 100 because of rounding.

Tables 4 through 9 show other characteristics of the analytic sample. For example, Table 5 shows that 38 percent of the sample had earned a high school diploma or other type of high school equivalency, and 50 percent had at least some college experience, with 7 percent having earned an associate's degree, 21 percent having earned a bachelor's degree, and 7 percent having earned a master's degree. Additionally, although a 61 percent of the sample participants were born in the United States (Table 7) and 79 percent spoke English fluently (Table 4), 76 percent had at least one parent who was born in another country (Tables 8 and 9).

Table 4. Analytic Sample for the Large-Scale Field Test, English Language Fluency

Characteristics	*n*	%
English learner intermediate fluency	16	2.9%
English learner advanced fluency	70	12.7%
Learned English as a small child, fluent in English	140	25.4%
Native English speaker	297	53.8%
Missing	29	5.3%

Table 5. Analytic Sample for the Large-Scale Field Test, Highest Degree Completed

Characteristics	*n*	%
Some high school	30	5.4%
High school, GED, or equivalent	211	38.2%
Some college	81	14.7%
Associate's degree	37	6.7%
Bachelor's degree	115	20.8%
Master's degree	40	7.2%
Doctorate or professional degree	2	0.4%
Other	4	0.7%
Missing	32	5.8%

Table 6. Analytic Sample for the Large-Scale Field Test, Locale

Characteristics	*n*	%
Small town	51	9.2%
Suburban	251	45.5%
Urban	221	40.0%
Missing	29	5.3%

Table 7. Analytic sample for the Large-Scale Field Test, National Origin

Characteristics	*n*	%
United States	336	60.9%
Other country	185	33.5%
Missing	31	5.6%

Table 8. Analytic Sample for the Large-Scale Field Test, National Origin of Parent 1

Characteristics	*n*	%
United States	117	21.2%
Other country	401	72.6%
N/A	6	1.1%
Missing	28	5.1%

Table 9. Analytic Sample for the Large-Scale Field Test, National Origin of Parent 2

Characteristics	*n*	%
United States	94	17.0%
Other country	417	75.5%
N/A	9	1.6%
Missing	32	5.8%

Respondents had experience with a wide variety of computer science education programs. Of the 486 responses to this question, 32 percent participated in more than one program. Of the 329 respondents who participated in only one program, 6 percent participated in community-building computer science programs that begin in or before high school, 73 percent participated in computer science programs that target college students, and 18 percent used a coding education app. Two percent of respondents only participated in professional engineering societies that are not computer science–specific and include college graduates. Two respondents indicated participating in a coding boot camp.

Respondents were geographically diverse. Table 10 shows the geographic spread of respondents across the contiguous United States. The two states with the largest number of survey respondents were California, which had 100 respondents (18%) and New York, which had 88 (16%).

Table 10. Location of Survey Respondents in the Contiguous United States

State	Number of respondents	Percentage of respondents
California	100	18%
New York	88	16%
Texas	41	7%
Florida	33	6%
Illinois	25	5%
Georgia	21	4%
Alabama, Arizona, Arkansas, Colorado, Connecticut, Delaware, Idaho, Indiana, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin	between 0 and 21	between 0% and 4%
Iowa, Kansas, Maine, Mississippi, Nebraska, North Dakota, Oregon, Tennessee, Wyoming	0	0%

Item Analysis

The technical quality of the items was evaluated using classical statistics including item means, item discrimination (item–total correlations), and reliability (coefficient alpha) statistics shown in Tables 11 through 17. Appendix C provides response distributions for each item.

Table 11. Classical Statistics for All Survey Items, Coding Self-Efficacy

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
1.	I am able to do well in activities that involve coding.	3.91	0.80	551	0.58	0.93
2.	I am good at coding.	3.59	0.90	550	0.63	0.93
3.	Even if coding is hard, I can learn it.	4.41	0.61	550	0.45	0.94
4.	I could perform well in a difficult coding class.	3.73	0.89	551	0.54	0.94

Table 12. Classical Statistics for All Survey Items, Coding Self-Efficacy (Barrier Coping)

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
5.	I know how to prepare for a job interview that assesses my coding skills.	3.41	1.07	551	0.56	0.94
6.	Someone who has been coding longer than me has told me I am good at coding.	3.18	1.04	550	0.49	0.94

Table 13. Classical Statistics For all Survey Items, Interest in Coding

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
7.	I want to keep coding.	4.47	0.73	546	0.61	0.93
8.	I like coding.	4.35	0.74	546	0.59	0.93
9.	I find coding to be interesting.	4.48	0.62	546	0.52	0.94
10.	Coding will help me reach my career goals.	4.46	0.76	546	0.63	0.93
11.	It is important to me that I keep coding.	4.43	0.77	546	0.65	0.93

Table 14. Classical Statistics for All Survey Items, Intention to Pursue a Career That Involves Coding

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
12.	I am considering a career that uses coding.	4.46	0.85	540	0.65	0.93
13.	I want a career where I code every day.	3.80	1.05	541	0.64	0.93
14.	A career where I code every day would be interesting.	4.03	0.94	542	0.59	0.93
15.	Having a coding career would help me live the kind of life I want to live.	4.26	0.88	541	0.59	0.93
16.	It is important to me to have a career that uses coding.	4.00	0.98	542	0.64	0.93

Table 15. Classical Statistics for All Survey Items, Practical Support for Pursuing a Career That Involves Coding

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
17.	I have regular access to a computer so I can practice coding on my own.	4.57	0.70	537	0.41	0.94
18.	I have regular access to high-speed internet so I can learn about coding on my own (i.e., from websites or videos).	4.44	0.75	534	0.38	0.94
19.	I have the financial resources to get the technology and other supplies I need to study and practice coding (e.g., textbooks and other instructional materials, devices, programming tools).	3.73	1.14	535	0.36	0.94
20.	When I have the time to code, I feel mentally and physically able to do so.	3.82	0.94	535	0.57	0.93
21.	I know who to ask or where to go for help if I have a question about coding.	3.68	1.09	536	0.54	0.94

Table 16. Classical Statistics for All Survey Items, Social Support for Pursuing a Career That Involves Coding

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
22.	There is a person in my life who uses coding in their career (online or face-to-face).	3.51	1.40	532	0.22	0.94
23.	I follow coders on social media.	3.37	1.28	530	0.40	0.94
24.	I chat with people online about coding (e.g., through social media or a chat server like Discord or Slack).	3.39	1.22	531	0.54	0.94
25.	People who know me think that I should become a coder.	3.66	1.01	531	0.64	0.93
26.	I know who to ask or where to go for advice on pursuing a coding career.	3.67	1.10	530	0.49	0.94

Table 17. Classical Statistics for All Survey Items, Sense of Belonging in Computing

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
27.	I feel comfortable talking to coders about coding.	3.76	1.04	525	0.70	0.93
28.	I feel comfortable asking other coders for help with my coding.	3.85	0.98	526	0.59	0.93
29.	I feel like I belong to a community of coders (online or face-to-face).	3.48	1.14	525	0.67	0.93
30.	Someone like me could do well in a coding career.	3.97	0.86	526	0.64	0.93
31.	I feel I would belong in a coding career.	3.94	0.90	525	0.73	0.93
32.	I think of myself as a coder.	3.68	1.08	525	0.73	0.93

The 5-point Likert items were coded such that “strongly disagree” was given a score of 1, the middle (neutral) option was given a score of 3, and “strongly agree” was given a score of 5. The item means shown in Tables 11 through 17 are all greater than 3, and in some cases greater than 4, indicating that participants tended to agree or strongly agree with the items. Items with mean scores greater than 4 can be considered to have ceiling effects, making them less than ideal for a survey aiming to measure changes over time.

The item–total correlations shown in Tables 11 through 17 are used to measure how well an item discriminates among high- and low-scoring respondents. They are computed as correlations between participants’ scores on an individual item and the sum of their scores on all the other items in the survey. It is expected that respondents with high scores on a particular survey item will have higher total survey scores than participants with low scores on that item. Item–total correlations greater than or equal to 0.40 are considered to have good discrimination properties. It can be seen from Tables 11 through 17 that all but three items on the survey had item–total correlations greater than 0.40, and therefore have good discrimination properties.

The coefficient alpha statistic (Cronbach, 1951) is an estimate of score reliability based on participants’ item scores. Coefficient alpha is a measure of an instrument’s internal consistency—the extent to which the items on an instrument are related. Alpha values greater than or equal to 0.6 are generally considered acceptable, and values between 0.8 and 0.95 are considered very good. Using those guidelines, the survey’s alpha estimate of 0.94 is very good. Tables 11 through 17 show alpha estimates with the item deleted from computation. When alpha decreases with the item deleted from computation, it is evidence that the item contributes to the internal consistency of the survey. Conversely, when alpha increases with the item deleted, it is evidence that the item detracts from the internal consistency of the survey and may be a candidate for removal. None of the items were found to significantly contribute to or detract from internal consistency, indicating that all items on the survey performed equally well in contributing to the survey’s overall internal consistency.

Differential Item Functioning

Differential item functioning (DIF) occurs when student groups with similar levels of the trait being measured, in this case coding career intentions, have, on average, systematically different responses to a particular item (AERA, APA, & NCME, 2014). DIF analyses were conducted using the standardization method for DIF (Dorans & Kulick, 1986), and the results were classified using the ETS DIF criteria (Zwick, 2012).

The standardization method in DIF takes the average *p* value for each item at each score point, calculated for both the focal groups (P_{fs}) and base (or reference) groups (P_{bs}). The difference in *p* values is weighted at each score point across all the score points to get the "standardized" difference at the item level:

$$D_{STD} = \frac{\sum_{s=1}^{S} K_s \left[P_{bs} - P_{fs}\right]}{\sum_{s=1}^{S} K_s},$$

where $[K_s/\Sigma K_s]$ is the standard or common weight applied at score level *s* to weight differences in performance between the focal P_{fs} and base groups P_{bs}. Those weighted differences in performance between the focal and base groups are summed across all scores and divided by the sum of K_s across all scores to compute the standardized method in DIF In this study, K_s was equal to the sum of the number of people at *s* in the focal and reference groups.

The ETS criteria (Zwick, 2012) used to classify DIF results puts items into three categories: A (negligible or nonsignificant DIF), B (slight to moderate DIF), or C (moderate to large DIF). Categories are further classified by a plus-or-minus (+/–) sign, indicating whether the item shows DIF in favor of the reference group or focal group, respectively. Zwick recommends using a minimum group size of 200 students in each group to have adequate statistical power to detect DIF.

The following student demographic groups were evaluated for DIF:

Demographic Groups (Reference/Focal)

- Men/women
- White/Asian
- White/Black
- White/Hispanic
- Native English speaker/English Learner (EL)
- Postsecondary/high school
- Urban/rural

The results are displayed in Tables 18 through 24. Although several items show slight to moderate DIF (i.e., B+/–), the item "I follow coders on social media" was the only one to exhibit moderate to large DIF (i.e., C+). The C+ ETS categorization indicates that Asian participants were more likely to follow coders on social media than were their White counterparts with similar coding career intentions. It should be noted that the White, Black, Hispanic, high school, and rural demographic groups did not meet Zwick's recommended group size of 200; therefore, analyses involving those groups may have had inadequate statistical power to detect DIF.

Note that in Tables 18 through 24, B+ and C+ show DIF in favor of the focal group (e.g., White or male). B− and C− show DIF in favor of the reference group (e.g., Black or female). Items that load significantly on factor 1 are color-coded light orange. Items that load significantly on factor 2 are color-coded light green. Items that load significantly on factor 3 are color-coded light purple. Items that load significantly on factor 4 are color-coded light blue.

Table 18. DIF Categories for All Survey Items, Coding Self-Efficacy

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
1.	I am able to do well in activities that involve coding.	A	A	A	A	A	A	A
2.	I am good at coding.	A	A	A	A	A	A	A
3.	Even if coding is hard, I can learn it.	A	A	A	A	A	A	A
4.	I could perform well in a difficult coding class.	A	A	A	A	A	A	A

Table 19. DIF Categories for All Survey Items, Coding Self-Efficacy (Barrier Coping)

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
5.	I know how to prepare for a job interview that assesses my coding skills.	B+	A	A	A	A	A	A
6.	Someone who has been coding longer than me has told me I am good at coding.	A	A	A	A	A	B+	A

Note. Items that load significantly on factor 1: item 5 (White/Asian); item 6 (postsecondary/high school).

Table 20. DIF Categories for All Survey Items, Interest in Coding

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
7.	I want to keep coding.	B−	A	A	A	A	A	A
8.	I like coding.	B−	A	A	A	A	A	A
9.	I find coding to be interesting.	B−	A	A	A	A	A	A
10.	Coding will help me reach my career goals.	A	A	A	A	A	A	A
11.	It is important to me that I keep coding.	A	A	A	A	A	A	A

Note. Items that load significantly on factor 1: item 7 (White/Asian); item 8 (White/Asian); item 9 (White/Asian).

Table 21. DIF Categories for All Survey Items, Intention to Pursue a Career That Involves Coding

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
12.	I am considering a career that uses coding.	A	A	A	A	A	A	A
13.	I want a career where I code every day.	A	A	A	A	A	A	A
14.	A career where I code every day would be interesting.	A	B−	A	A	A	A	A
15.	Having a coding career would help me live the kind of life I want to live.	A	A	A	A	A	A	A
16.	It is important to me to have a career that uses coding.	A	A	A	A	A	A	A

Note. Item that loads significantly on factor 1: item 14 (White/Black).

Table 22. DIF Categories for All Survey Items, Practical Support for Pursuing a Career That Involves Coding

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
17.	I have regular access to a computer so I can practice coding on my own.	A	A	A	A	A	B–	A
18.	I have regular access to high-speed internet so I can learn about coding on my own (i.e., from web sites or videos).	A	A	A	A	A	B–	A
19.	I have the financial resources to get the technology and other supplies I need to study and practice coding (e.g., textbooks and other instructional materials, devices, programming tools).	A	A	A	A	A	A	A
20.	When I have the time to code, I feel mentally and physically able to do so.	A	A	A	A	A	A	A
21.	I know who to ask or where to go for help if I have a question about coding.	A	A	A	A	A	A	A

Note. Items that load significantly on factor 1: item 17 (postsecondary/high school); item 18 (postsecondary/high school).

Table 23. DIF Categories for All Survey Items, Social Support for Pursuing a Career That Involves Coding

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
22.	There is a person in my life who uses coding in their career (online or face-to-face).	B+	B+	A	A	A	A	A
23.	I follow coders on social media.	C+	B+	B+	A	B+	A	A
24.	I chat with people online about coding (e.g., through social media or a chat server like Discord or Slack).	A	B+	A	A	A	A	A
25.	People who know me think that I should become a coder.	A	A	A	A	A	B+	A
26.	I know who to ask or where to go for advice on pursuing a coding career.	A	B+	B+	A	A	A	A

Note. Items that load significantly on factor 1: item 22 (White/Asian, White/Black); item 23 (White/Asian, White/Black, White/Hispanic, native English speaker/English Learner); item 24 (White/Black); item 25 (postsecondary/high school); item 26 (White/Black, White/Hispanic).

Table 24. DIF Categories for All Survey Items, Sense of Belonging in Computing

#	Item	White/ Asian	White/ Black	White/ Hisp	Men/ women	NES/ EL	Post/ HS	Urban/ rural
27.	I feel comfortable talking to coders about coding.	A	B–	B–	A	A	A	A
28.	I feel comfortable asking other coders for help with my coding.	A	A	A	A	A	A	B+
29.	I feel like I belong to a community of coders (online or face-to-face).	B+	A	A	A	A	A	A
30.	Someone like me could do well in a coding career.	A	A	A	A	A	A	A
31.	I feel I would belong in a coding career.	A	A	A	A	A	A	A
32.	I think of myself as a coder.	A	A	A	A	A	A	A

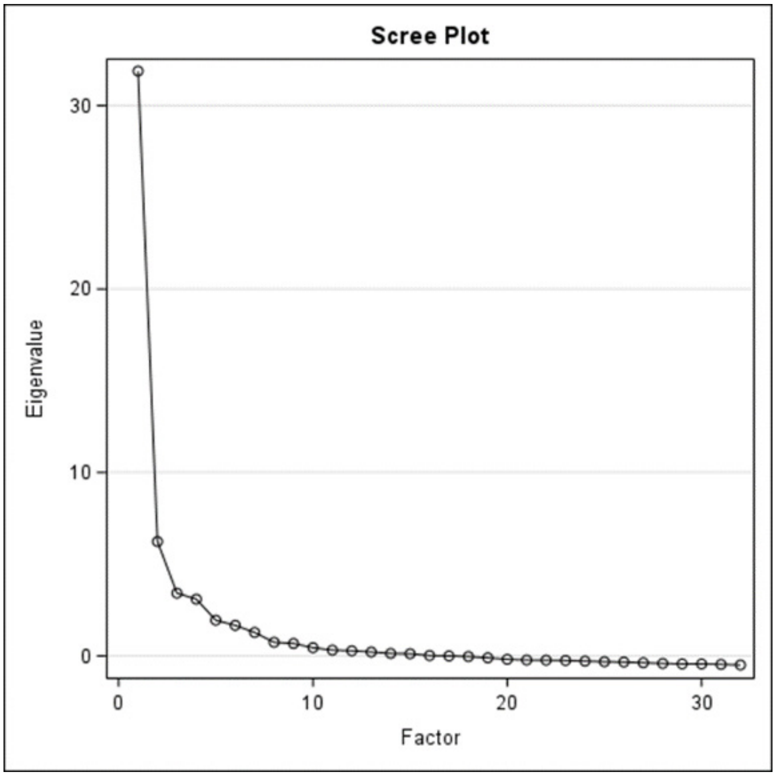
Note. Items that load significantly on factor 1: item 27 (White/Black, White/Hispanic); item 28 (urban/rural); item 29 (White/Asian).

Exploratory Factor Analysis

Exploratory factor analysis (EFA) is a method used to identify the factor structure explaining covariation within a set of data. EFA is typically conducted in a series of steps that require somewhat subjective decisions to be made at each step. In this study, the steps taken to identify the number and nature of factors within the survey response data included analyzing a scree plot test (Cattell, 1966), the variance explained by each factor, and the interpretability of the solution. The EFA procedure used maximum likelihood to extract the factors and used varimax and oblimin rotations to facilitate interpretation of the factor pattern matrix.

A scree test is conducted by examining a scree plot, which depicts the eigenvalues associated with each factor. As depicted in Figure 2, factors are numbered on the horizontal axis and eigenvalues are listed on the vertical axis. When using a scree test to inform an EFA, researchers look for a "break" between factors (also known as the "elbow of the curve") that separates factors with relatively large eigenvalues from those with smaller eigenvalues. The factors that appear before the break are assumed to be meaningful and are retained in the model; those appearing after the break are assumed to be unimportant and are not retained.

Figure 2. Scree Plot of Survey Factors



The plot in Figure 2 displays a large break between factors 1 and 2, and then a smaller but still relatively large break between factors 2 and 3. Factors 3 and 4 appear close together, and then there is a small break between factors 4 and 5. After factor 5, the breaks between factors become difficult to discern as the curve begins to level out. Because there is a relatively large break between factors 2 and 3, factor 2 can be viewed as a relatively important factor. The breaks after factor 2 are more difficult to interpret, and therefore the scree test by itself was insufficient to make final decisions about the number of factors to retain within the model.

The second criterion used to interpret the EFA results analyzes the proportion of common variance explained by the factors. Table 25 presents the eigenvalues and percentage of variance explained by the top seven factors in the survey. When making decisions about the significance of various factors, researchers sometimes retain any factor that has an eigen-value greater than one. Using this criterion, we would retain all seven factors in the survey; however, this method has been criticized for retaining too many factors within the model (Cattell, 2012).

Table 25. Eigenvalues and Percentage of Common Variance Explained by the Top Seven Survey Factors

Factor	Eigenvalue	Percentage variance explained
1	31.88	66%
2	6.24	13%
3	3.43	7%
4	3.09	6%
5	1.95	4%
6	1.67	3%
7	1.28	3%

Another method researchers use to guide their decisions about factor significance retains any factor that explains a minimum threshold (typically 5 percent or 10 percent) of the common variance (O'Rourke & Hatch, 2013). As shown in Table 25, the first and second factors explain 66 percent and 13 percent of the variance, respectively. The third factor explains 7 percent, the fourth factor explains 7 percent, and the remaining factors explain less than 5 percent of the variance.

Whether to use 5 percent or 10 percent as the threshold to retain factors is an arbitrary and subjective decision, which is a limitation to this approach (Kim & Mueller, 1978). Using 10 percent as the threshold would retain two factors, and using 5 percent as the threshold would retain four factors in the model.

Because the first two steps of the EFA analysis did not provide clear evidence about which solution was the best fit for the survey, we used interpretability as the primary guide to make the final number-of-factors decision. Below are four things we considered when analyzing the interpretability of the solution (O'Rourke & Hatch, 2013).

1. Are there at least three items with significant loadings on each retained factor?
2. Do the items that load on a given factor share some conceptual meaning?
3. Do the items that load on different factors seem to be measuring different constructs?
4. Does the rotated factor pattern demonstrate "simple structure"?

We analyzed the interpretability of six different solutions that retained from two to seven factors. The first interpretability criterion suggests a solution is less satisfactory when a given factor is measured by less than three items. The five-, six-, and seven-factor solutions each had factors measured by only two items (i.e., two items had significant factor loadings). In addition, every solution except the four-factor solution had three or more items that did not measure any factor. The four-factor solution had one such item.

The second and third interpretability criteria are related. The second criterion suggests items that load on a given factor should share conceptual meaning and measure the same underlying construct, while the third criterion suggests items that load on different factors should measure different constructs. Within the two-, three-, four- and five-factor solutions, items within the same subscales loaded on the same factors, providing evidence that they measured the same underlying construct. In contrast, within the six- and seven-factor solutions, items within the same subscales loaded on different factors. These items did not appear to measure different constructs across different factors and therefore did not meet the third criterion.

The fourth interpretability criterion suggests the rotated factor pattern should demonstrate simple structure, which is defined by two characteristics:

1. The items have relatively high factor loadings on only one factor, and near-zero loadings for the other factors.

2. The factors have relatively high factor loadings for some variables, and near-zero loadings for the remaining variables.

None of the varimax orthogonal rotation solutions had a simple structure because each solution included complex items loading on more than one factor, which occurs when factors are correlated. The advantage of orthogonal rotation is that it characterizes the true factors, but it does not allow correlated factors. Oblique rotation can be used to provide a simple structure to factors that are correlated. When oblique rotation is used, though, the factor pattern loadings are weights for estimating factor scores and may not represent the true factor structure. We therefore used both rotations to inform our decisions about the final model. The varimax orthogonal solution was used to make decisions about the final survey (Tables 26 through 32), and an oblimin oblique rotation was applied to provide simple structure to the factors (Tables 33 through 39).

Note that in Tables 26 through 39, factor loadings greater than or equal to 0.40 are indicated with an asterisk (*). Items that load significantly on factor 1 are color-coded light orange. Items that load significantly on factor 2 are color-coded light green. Items that load significantly on factor 3 are color-coded light purple. Items that load significantly on factor 4 are color-coded light blue.

Table 26. Exploratory Factor Analysis Results Based on Varimax Rotation, Coding Self-Efficacy

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
1.	I am able to do well in activities that involve coding.	0.54*	0.15	0.39	0.08
2.	I am good at coding.	0.57*	0.18	0.41*	0.10
3.	Even if coding is hard, I can learn it.	0.26	0.17	0.49*	0.13
4.	I could perform well in a difficult coding class.	0.49*	0.14	0.41*	0.03

Note. Items 1, 2, and 4 load significantly on factor 1. Items 2, 3, and 4 load significantly on factor 3.

Table 27. Exploratory Factor Analysis Results Based on Varimax Rotation, Coding Self-Efficacy (Barrier Coping)

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
5.	I know how to prepare for a job interview that assesses my coding skills.	0.47*	0.30	0.08	0.17
6.	Someone who has been coding longer than me has told me I am good at coding.	0.50*	0.08	0.20	0.16

Note. Items 5 and 6 load significantly on factor 1.

Table 28. Exploratory Factor Analysis Results Based on Varimax Rotation, Interest in Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
7.	I want to keep coding.	0.14	0.56*	0.56*	0.14
8.	I like coding.	0.17	0.41*	0.74*	0.09
9.	I find coding to be interesting.	0.09	0.43*	0.69*	0.08
10.	Coding will help me reach my career goals.	0.19	0.73*	0.18	0.22
11.	It is important to me that I keep coding.	0.20	0.73*	0.23	0.19

Note. Items 7, 8, 9, 10, and 11 load significantly on factor 2. Items 7, 8, and 9 load significantly on factor 3.

Table 29. Exploratory Factor Analysis Results Based on Varimax Rotation, Intention to Pursue a Career That Involves Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
12.	I am considering a career that uses coding.	0.22	0.74*	0.17	0.22
13.	I want a career where I code every day.	0.25	0.74*	0.21	0.06
14.	A career where I code every day would be interesting.	0.23	0.68*	0.25	−0.05
15.	Having a coding career would help me live the kind of life I want to live.	0.20	0.76*	0.13	0.08
16.	It is important to me to have a career that uses coding.	0.30	0.76*	0.12	0.02

Note. Items 12, 13, 14, 15, and 16 load significantly on factor 2.

Table 30. Exploratory Factor Analysis Results Based on Varimax Rotation, Practical Support for Pursuing a Career That Involves Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
17.	I have regular access to a computer so I can practice coding on my own.	0.10	0.18	0.19	0.72*
18.	I have regular access to high-speed internet so I can learn about coding on my own (i.e., from web sites or videos).	0.11	0.13	0.12	0.76*
19.	I have the financial resources to get the technology and other supplies I need to study and practice coding (e.g., textbooks and other instructional materials, devices, programming tools).	0.28	0.05	0.00	0.55*
20.	When I have the time to code, I feel mentally and physically able to do so.	0.45*	0.21	0.29	0.22
21.	I know who to ask or where to go for help if I have a question about coding.	0.50*	0.09	0.11	0.38

Note. Items 17, 18, and 19 load significantly on factor 4. Items 20 and 21 load significantly on factor 1.

Table 31. Exploratory Factor Analysis Results Based on Varimax Rotation, Social Support for Pursuing a Career That Involves Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
22.	There is a person in my life who uses coding in their career (online or face-to-face).	0.34	−0.03	−0.22	0.29
23.	I follow coders on social media.	0.41*	0.21	0.06	−0.02
24.	I chat with people online about coding (e.g., through social media or a chat server like Discord or Slack).	0.59*	0.24	−0.03	0.09
25.	People who know me think that I should become a coder.	0.55*	0.41*	0.10	0.04
26.	I know who to ask or where to go for advice on pursuing a coding career.	0.58*	0.09	−0.11	0.27

Note. Items 23, 24, 25, and 26 load significantly on factor 1. Item 25 loads significantly on factor 2.

Table 32. Exploratory Factor Analysis Results Based on Varimax Rotation, Sense of Belonging in Computing

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
27.	I feel comfortable talking to coders about coding.	0.71*	0.16	0.21	0.22
28.	I feel comfortable asking other coders for help with my coding.	0.60*	0.15	0.22	0.14
29.	I feel like I belong to a community of coders (online or face-to-face).	0.68*	0.27	0.10	0.14
30.	Someone like me could do well in a coding career.	0.53*	0.29	0.34	0.07
31.	I feel I would belong in a coding career.	0.56*	0.47*	0.28	0.04
32.	I think of myself as a coder.	0.62*	0.46*	0.23	0.01

Note. Items 27, 28, 29, 30, 31, and 32 load significantly on factor 1. Items 31 and 32 load significantly on factor 2.

This structure of the four-factor solution can be seen more clearly within the oblimin oblique rotation solution presented in Tables 33 through 39. Factor 1 consists of items intended to measure self-efficacy, social support, and sense of belonging in computing; factor 2 consists of items intended to measure interest and intention to pursue a career that involves coding; factor 3 consists of items intended to measure interest and motivation in coding; and factor 4 consists of items intended to measure practical support for pursuing a career in coding.

Table 33. Exploratory Factor Analysis Results Based on Oblimin Rotation, Coding Self-Efficacy

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
1.	I am able to do well in activities that involve coding.	0.69*	−0.04	0.16	0.01
2.	I am good at coding.	0.71*	−0.02	0.16	0.02
3.	Even if coding is hard, I can learn it.	0.41*	0.02	0.35	0.11
4.	I could perform well in a difficult coding class.	0.66*	−0.04	0.20	−0.04

Note. Items 1, 2, 3, and 4 load significantly on factor 1.

Table 34. Exploratory Factor Analysis Results Based on Oblimin Rotation, Coding Self-Efficacy (Barrier Coping)

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
5.	I know how to prepare for a job interview that assesses my coding skills.	0.38	0.23	−0.13	0.09
6.	Someone who has been coding longer than me has told me I am good at coding.	0.57*	−0.07	−0.01	0.09

Note. Item 6 loads significantly on factor 1.

Table 35. Exploratory Factor Analysis Results Based on Oblimin Rotation, Interest in Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
7.	I want to keep coding.	0.16	0.50*	0.43*	0.12
8.	I like coding.	0.36	0.27	0.60*	0.07
9.	I find coding to be interesting.	0.24	0.32	0.58*	0.07
10.	Coding will help me reach my career goals.	−0.06	0.78*	0.03	0.17
11.	It is important to me that I keep coding.	−0.01	0.77*	0.07	0.13

Note. Items 7, 10, and 11 load significantly on factor 2. Items 7, 8, and 9 load significantly on factor 3.

Table 36. Exploratory Factor Analysis Results Based on Oblimin Rotation, Intention to Pursue a Career That Involves Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
12.	I am considering a career that uses coding.	−0.04	0.78*	0.01	0.17
13.	I want a career where I code every day.	0.06	0.77*	0.04	−0.01
14.	A career where I code every day would be interesting.	0.11	0.70*	0.09	−0.12
15.	Having a coding career would help me live the kind of life I want to live.	−0.05	0.82*	−0.02	0.01
16.	It is important to me to have a career that uses coding.	0.06	0.82*	−0.07	−0.06

Note. Items 12, 13, 14, 15, and 16 load significantly on factor 2.

Table 37. Exploratory Factor Analysis Results Based on Oblimin Rotation, Practical Support for Pursuing a Career That Involves Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
17.	I have regular access to a computer so I can practice coding on my own.	−0.06	0.14	0.11	0.75*
18.	I have regular access to high-speed internet so I can learn about coding on my own (i.e., from web sites or videos).	−0.07	0.09	0.04	0.79*
19.	I have the financial resources to get the technology and other supplies I need to study and practice coding (e.g., textbooks and other instructional materials, devices, programming tools).	0.14	−0.01	−0.12	0.53*
20.	When I have the time to code, I feel mentally and physically able to do so.	0.48*	0.08	0.08	0.16
21.	I know who to ask or where to go for help if I have a question about coding.	0.45*	−0.03	−0.10	0.33

Note. Items 17, 18, and 19 load significantly on factor 4. Items 20 and 21 load significantly on factor 1.

Table 38. Exploratory Factor Analysis Results Based on Oblimin Rotation, Social Support for Pursuing a Career That Involves Coding

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
22.	There is a person in my life who uses coding in their career (online or face-to-face).	0.20	−0.05	−0.34	0.25
23.	I follow coders on social media.	0.39	0.15	−0.11	−0.10
24.	I chat with people online about coding (e.g., through social media or a chat server like Discord or Slack).	0.50*	0.16	−0.27	−0.02
25.	People who know me think that I should become a coder.	0.46*	0.35	−0.14	−0.07
26.	I know who to ask or where to go for advice on pursuing a coding career.	0.47*	0.00	−0.34	0.18

Note. Items 24, 25, and 26 load significantly on factor 1.

Table 39. Exploratory Factor Analysis Results Based on Oblimin Rotation, Sense of Belonging in Computing

#	Item	Factor 1	Factor 2	Factor 3	Factor 4
27.	I feel comfortable talking to coders about coding.	0.75*	−0.02	−0.08	0.12
28.	I feel comfortable asking other coders for help with my coding.	0.66*	−0.01	−0.03	0.05
29.	I feel like I belong to a community of coders (online or face-to-face).	0.63*	0.15	−0.18	0.02
30.	Someone like me could do well in a coding career.	0.60*	0.14	0.10	−0.01
31.	I feel I would belong in a coding career.	0.53*	0.37	0.02	−0.07
32.	I think of myself as a coder.	0.59*	0.35	−0.05	−0.11

Note. Items 27, 28, 29, 30, 31, and 32 load significantly on factor 1.

Taken as a whole, the preponderance of the evidence from the results of the EFA indicated that a four-factor solution provided the best fit to the survey data. Within the four-factor solution, each factor accounted for at least 5 percent of the variance, at least three items loaded on all factors, and subscales intending to measure the same construct tended to group within the same factor and did not split among multiple factors. The four-factor solution also showed simple structure under oblimin rotation and had the fewest items that did not load on any factor.

Study 2: Test–Retest Reliability

We administered the survey twice to a selected sample of participants to evaluate the test–retest reliability, or stability, of the survey. The design of our test–retest reliability study assumed respondents' coding career intentions would be stable in the short term and therefore used participants' performance at two different time points to estimate how well the survey provides an accurate measurement of the construct. Poor test–retest reliability would imply that factors outside the construct of interest are influencing the survey's results.

Test–Retest Participants

Participants for the test–retest study were recruited in two phases. Adult (age 18+) participants were recruited from a pool of large-scale survey respondents who agreed to be contacted again for additional survey opportunities. WestEd stratified these respondents by race/ethnicity, gender, and age group, and randomly selected individuals were invited to complete the retest. Minor participants were invited to participate by the leader of a high school–focused Google program that had a high response rate during the large-scale field test.

The sample design aimed to have equal proportions of participants in each cell. However, as noted in Tables 1 through 3, the original sample was skewed with an overrepresentation of Asian participants and those in the group aged 18 to 24. Therefore, our goal of having equal proportions of participants in each cell for the retest sample was not fully achieved. Demographics for the final test–retest sample appear in Tables 40 through 42.

Table 40. Test–Retest Sample Demographics, Men and Women in All Age Groups

Race/ethnicity	Men and women in all age groups
Asian	32 (29%)
Black or African American	25 (23%)
Hispanic, Latino, or Spanish	31 (28%)
White	19 (17%)
All other races/ethnicities	3 (2%)
Total	**110 (100%)**

Note. The percentage in each cell represents the percentage of each age/gender group represented by the racial/ethnic subgroup (e.g., of the 9 participants overall who were men under the age of 18, 2 of them [22%] were Asian). Totals may not sum to 100 because of rounding.

Table 41. Test–Retest Sample Demographics, Men in All Age Groups

Race/ethnicity	Men <18	Men 18–24	Men 25–34	Men >35
Asian	2 (22%)	14 (40%)	0 (0%)	0 (0%)
Black or African American	2 (22%)	9 (26%)	4 (67%)	1 (14%)
Hispanic, Latino, or Spanish	4 (44%)	11 (31%)	1 (17%)	1 (14%)
White	0 (0%)	1 (3%)	1 (17%)	4 (57%)
All other races/ethnicities	1 (11%)	0 (0%)	0 (0%)	1 (14%)
Total	**9 (9%)**	**35 (32%)**	**6 (5%)**	**7 (6%)**

Note. The percentage in each cell represents the percentage of each age/gender group represented by the racial/ethnic subgroup (e.g., of the 9 participants overall who were men under the age of 18, 2 of them [22%] were Asian). Totals may not sum to 100 because of rounding.

Table 42. Test–Retest Sample Demographics, Women in All Age Groups

Race/ethnicity	Women <18	Women 18–24	Women 25–34	Women >35
Asian	0 (0%)	14 (36%)	2 (33%)	0 (0%)
Black or African American	2 (100%)	6 (15%)	0 (0%)	1 (17%)
Hispanic, Latino, or Spanish	0 (0%)	14 (36%)	0 (0%)	0 (0%)
White	0 (0%)	4 (10%)	4 (67%)	5 (83%)
All other races/ethnicities	0 (0%)	1 (3%)	0 (0%)	0 (0%)
Total	**2 (2%)**	**39 (35%)**	**6 (5%)**	**6 (5%)**

Note. The percentage in each cell represents the percentage of each age/gender group represented by the racial/ethnic subgroup (e.g., of the 39 participants overall who were women between the ages of 18 and 24, 14 of them [36%] were Asian). Totals may not sum to 100 because of rounding.

Data Collection and Cleaning Procedure for Computing Test–Retest Reliability

To collect the test–retest sample, WestEd followed the same data collection and data cleaning procedures described earlier in the report in the section Study 1: Large-Scale Field Test. Retest participants were invited and responded to the retest survey invitation between October 17, 2022, and November 11, 2022, or 1 to 2 months after their initial survey response. Despite only inviting 135 adults to participate in the retest, WestEd unexpectedly received a total of 443 responses during this period. A large proportion of the excess responses were repeated low-quality submissions by a small set of respondents. We also received responses from email addresses that were not part of the stratified random subsample that had been invited to participate in the retest. WestEd applied to the retest survey data the same rigorous screening procedure described earlier to remove low-quality responses. A total of 112 responses remained in the analytic sample following data cleaning.

Results

The correlation between the participants' scores from both survey administrations is used as the estimate of test–retest reliability. A correlation coefficient greater than 0.9 represents excellent reliability, between 0.9 and 0.8 represents good reliability, and between 0.8 and 0.7 represents acceptable reliability. The full survey test–retest reliability coefficient is 0.79, which is considered acceptable bordering on good.

Reducing the Number of Survey Items

One of Google's primary goals for this project was to create a short, approximately 10-item survey that could be embedded into a longer program evaluation survey without being burdensome for participants. To that end, WestEd and the Google team selected 12 out of 32 items for the short version of the survey. We chose two items measuring self-efficacy and two items from each of the other constructs that were originally identified for the survey. Items were initially chosen based on the content of the question to ensure that the survey still addressed the individual, situational, and social factors in the original survey design. We also considered the readability of the question and then evaluated each item psychometrically by examining their factor loadings (preferably >0.40) within the reduced four-factor EFA solution, their DIF categories (preferably "A" or "B"), and their classical statistics (preferably item–total correlation >0.40). For example, the item "There is a person in my life who uses coding in their career (online face-to-face)" may have been desirable from a content perspective, but it did not have a factor loading >0.40 on any of the four EFA factors and had an item–total correlation of <0.40, which ultimately made it an unattractive candidate for the final reduced survey. When possible, we also selected items with lower mean responses to minimize potential ceiling effects and allow the survey to measure increases in coding career intentions over time. Table 43 presents the 12 items selected for the short survey.

Table 43. Items Selected for the 12-Item Short Survey

#	Factor	Original construct	Item text
2.	Factor 1	Self-efficacy	I am good at coding.
4.	Factor 1	Self-efficacy	I could perform well in a difficult coding class.
25.	Factor 1	Social support	People who know me think that I should become a coder.
26.	Factor 1	Social support	I know who to ask or where to go for advice on pursuing a coding career.
28.	Factor 1	Sense of belonging	I feel comfortable asking other coders for help with my coding.
29.	Factor 1	Sense of belonging	I feel like I belong to a community of coders (online or face-to-face).
13.	Factor 2	Intention to pursue coding career	I want a career where I code every day.
16.	Factor 2	Intention to pursue coding career	It is important to me to have a career that uses coding.
7.	Factor 3	Interest	I want to keep coding.
8.	Factor 3	Interest	I like coding.
17.	Factor 4	Practical support	I have regular access to a computer so I can practice coding on my own.
18.	Factor 4	Practical support	I have regular access to high-speed internet so I can learn about coding on my own (e.g., from web sites or videos).

We computed the reliability for the final 12-item survey. It remains in the acceptable-to-good range. Coefficient alpha for the reduced survey is 0.85, and remains in the good-to-adequate range as well. Because the calculation for coefficient alpha is dependent on the number of items, an alpha value of 0.85 with only 12 items is unexpectedly high. The test–retest reliability for the 12-item survey is 0.75. In addition, all but two items on the final survey had item–total correlations greater than 0.40, and therefore good discrimination properties, and none of these 12 items were found to detract from internal consistency (see Table 44).

Table 44. Classical Statistics for Final Survey Items

#	Item	Mean	SD	*N*	Item–total corr	α with item deleted
2.	I am good at coding.	3.59	0.90	550	0.60	0.83
4.	I could perform well in a difficult coding class.	3.73	0.89	551	0.51	0.84
7.	I want to keep coding.	4.47	0.73	546	0.57	0.84
8.	I like coding.	4.35	0.74	546	0.56	0.84
13.	I want a career where I code every day.	3.80	1.05	541	0.60	0.83
16.	It is important to me to have a career that uses coding.	4.00	0.98	542	0.60	0.83
17.	I have regular access to a computer so I can practice coding on my own.	4.57	0.70	537	0.38	0.85
19.	I have the financial resources to get the technology and other supplies I need to study and practice coding.	3.73	1.14	535	0.33	0.86
25.	People who know me think that I should become a coder.	3.66	1.01	531	0.58	0.83
26.	I know who to ask or where to go for advice on pursuing a coding career.	3.67	1.10	530	0.42	0.85
28.	I feel comfortable asking other coders for help with my coding.	3.85	0.98	526	0.57	0.84
29.	I feel like I belong to a community of coders (online or face-to-face).	3.48	1.14	525	0.63	0.83

Conclusions, Limitations, and Future Work

This project was successful in developing a valid and reliable survey to measure students' coding career intentions. Both the full 32-item survey and the 12-item short survey demonstrated acceptable-to-good psychometric properties. We summarize survey-level statistics for the long and short versions of the survey in Table 45. Although the 32-item version of the survey will have greater precision of measurement, the psychometric properties of the 12-item version are good enough that we can recommend using it for program evaluation.

However, there are two limitations of the current survey work. First, the current project did not measure students' coding career intentions at the beginning and the end of a coding education program. Most of our participants completed the survey only at one time point. Of the participants who completed the survey twice, we do not know whether those responses coincided with the beginning or end of any program participation. As a result, we do not know whether the survey will be sensitive to changes in computing career intentions that take place over the course of a coding education program, and would therefore caution against the evaluation of change based on this survey. Second, the duration of the current project did not allow for longitudinal follow-up with respondents to collect evidence of the survey's predictive validity—that is, to evaluate if students who indicated strong computing career intentions in the survey did in fact choose a computing career. Future work on this survey should include studies to address both of these limitations.

Table 45. Comparison of Survey-Level Statistics for the Full and Short Versions

Survey version	# of items	Cronbach's α	Test–retest reliability
Full	32	0.94	0.79
Short	12	0.85	0.75

Acknowledgments

We would like to thank Fernando Echeverria and Sonya Powers for their contributions throughout this project.

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Appendix A: Computing Survey Items

An asterisk (*) indicates the item appeared in the short survey.

Coding self-efficacy

1. I am able to do well in activities that involve coding.
2. I am good at coding.*
3. Even if coding is hard, I can learn it.
4. I could perform well in a difficult coding class.*

Coding self-efficacy (barrier coping)

5. I know how to prepare for a job interview that assesses my coding skills.
6. Someone who has been coding longer than me has told me I am good at coding.

Interest in coding

7. I want to keep coding.*
8. I like coding.*
9. I find coding to be interesting.
10. Coding will help me reach my career goals.
11. It is important to me that I keep coding.

Intention to pursue a career that involves coding

12. I am considering a career that uses coding.
13. I want a career where I code every day.*
14. A career where I code every day would be interesting.
15. Having a coding career would help me live the kind of life I want to live.
16. It is important to me to have a career that uses coding.*

Practical support for pursuing a career that involves coding

17. I have regular access to a computer so I can practice coding on my own.*
18. I have regular access to high-speed internet so I can learn about coding on my own (e.g., from web sites or videos).*
19. I have the financial resources to get the technology and other supplies I need to study and practice coding (e.g., textbooks and other instructional materials, devices, programming tools).
20. When I have the time to code, I feel mentally and physically able to do so.
21. I know who to ask or where to go for help if I have a question about coding.

Social support for pursuing a career that involves coding

22. There is a person in my life who uses coding in their career (online or face-to-face).
23. I follow coders on social media.
24. I chat with people online about coding (e.g., through social media or a chat server like Discord or Slack).
25. People who know me think that I should become a coder.*
26. I know who to ask or where to go for advice on pursuing a coding career.*

Sense of belonging in computing

27. I feel comfortable talking to coders about coding.
28. I feel comfortable asking other coders for help with my coding.*
29. I feel like I belong to a community of coders (online or face-to-face).*
30. Someone like me could do well in a coding career.
31. I feel I would belong in a coding career.
32. I think of myself as a coder.

Appendix B: Demographic Survey Questions

Answering the questions below will help us understand how much someone's background influences their answers to the coding and career questions.

Which computer science and science/engineering education program(s) have you participated in? Select all that apply.

- All Star Code
- American Indian Science and Engineering Society
- Black Girls Code
- CodeNext
- CodePath
- Coding boot camp (e.g., Coding Dojo, Hack Reactor, Ada Developers Academy)
- Girls Who Code
- Google Computer Science Summer Institute
- Google Software Product Sprint
- Grasshopper
- National Society of Black Engineers
- Society of Asian Scientists and Engineers
- Society of Hispanic Professional Engineers
- Society of Women Engineers
- Technovation
- Women in Science and Engineering
- Other (please specify)

What is your gender identity?

- Woman
- Man
- Transgender/trans woman
- Transgender/trans man
- Nonbinary
- Prefer to self-identify: ______________________________
- Prefer not to reply

What is your race or ethnicity? Select all that apply.

- American Indian or Alaska Native
- Asian
- Black or African American
- Hispanic, Latino, or Spanish
- Middle Eastern or North African
- Native Hawaiian or Other Pacific Islander
- White
- Some other race or ethnicity (please specify)
- Prefer not to reply

In what country were you born?

- United States
- Other country

In what country were your parents born?

- Parent 1: United States
- Parent 1: Other country
- Parent 1: N/A
- Parent 2: United States
- Parent 2: Other country
- Parent 2: N/A

How would you classify your English fluency (proficiency)?

- Native speaker (English is my first/native language)
- Started learning/speaking English as a child
- English language learner with advanced fluency
- English language learner with intermediate fluency
- English language learner with basic fluency

What is your age group?

- Under 18
- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 or over

What is the highest degree or level of school you have completed?

- Some high school
- High school, GED, or equivalent
- Trade school
- Some college
- Associate's degree (e.g., AA, AS)
- Bachelor's degree (e.g., BA, BS)
- Master's degree (e.g., MA, MS, MEng, MSW, MBA, MFA)
- Doctorate (e.g., PhD, EdD, PsyD) or professional degree beyond a bachelor's degree (e.g., JD, MD, DDS)
- Other (please specify)

In what U.S. state or territory do you live?

- [Drop-down menu containing list of U.S. states and territories (Puerto Rico, U.S. Virgin Islands, Guam, American Samoa, and Northern Mariana Islands)]

Which of these best describes the area where you live?

- Urban
- Suburban
- Small town or rural

If you have any feedback about this survey, please enter it in the space below.

____

Thank you for completing the survey! Please select the type of e-gift card ($25) you would like to receive:

- Amazon.com
- Target

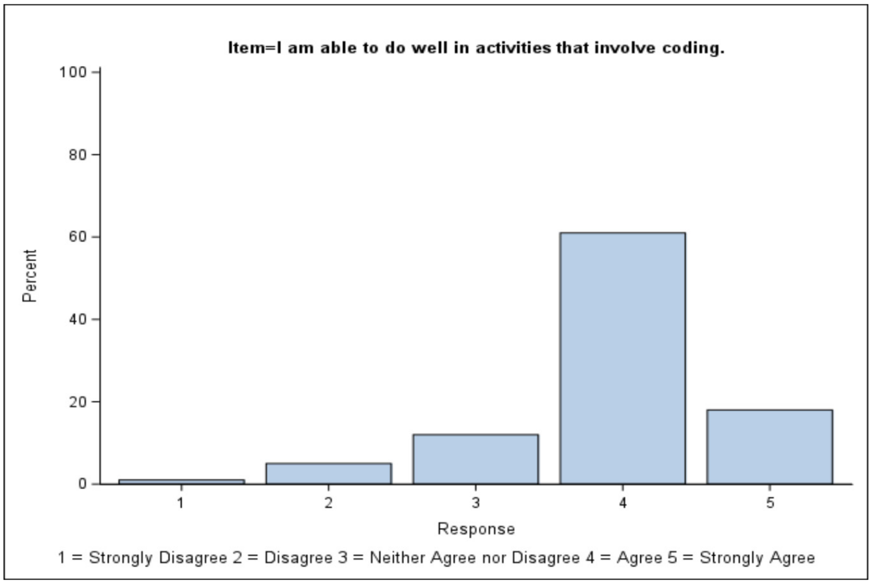
Please enter your email address. We will send the e-gift card to this address:

Please enter your email address again to confirm:

Appendix C: Response Distributions for All Survey Items

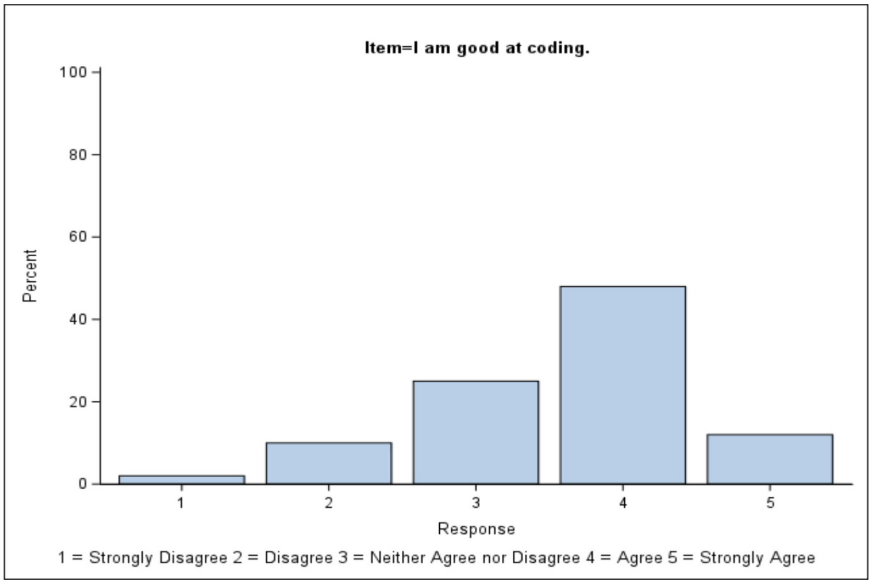
Coding Self-Efficacy

1. I am able to do well in activities that involve coding.



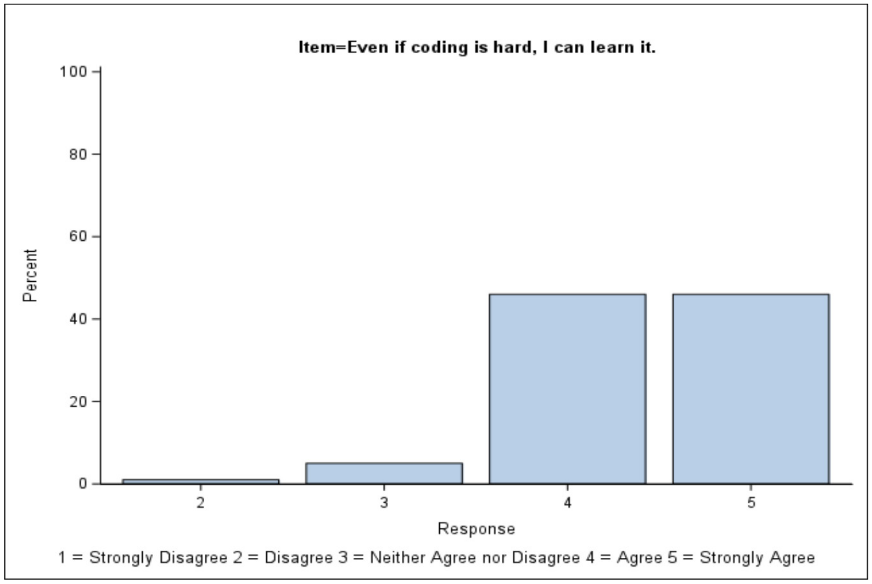
Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 5, neither agree nor disagree = 12, agree = 61, strongly agree = 18.

2. I am good at coding.



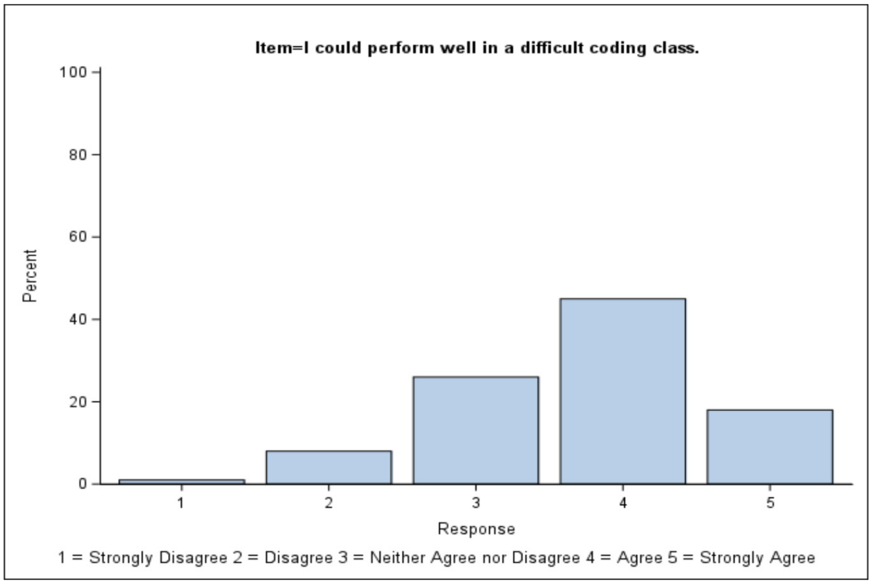
Note. The percentage of responses for each category were as follows: strongly disagree = 2, disagree = 10, neither agree nor disagree = 26, agree = 48, strongly agree = 12.

3. Even if coding is hard, I can learn it.



Note. The percentage of responses for each category were as follows: strongly disagree = 0, disagree = 1, neither agree nor disagree = 5, agree = 46, strongly agree = 46.

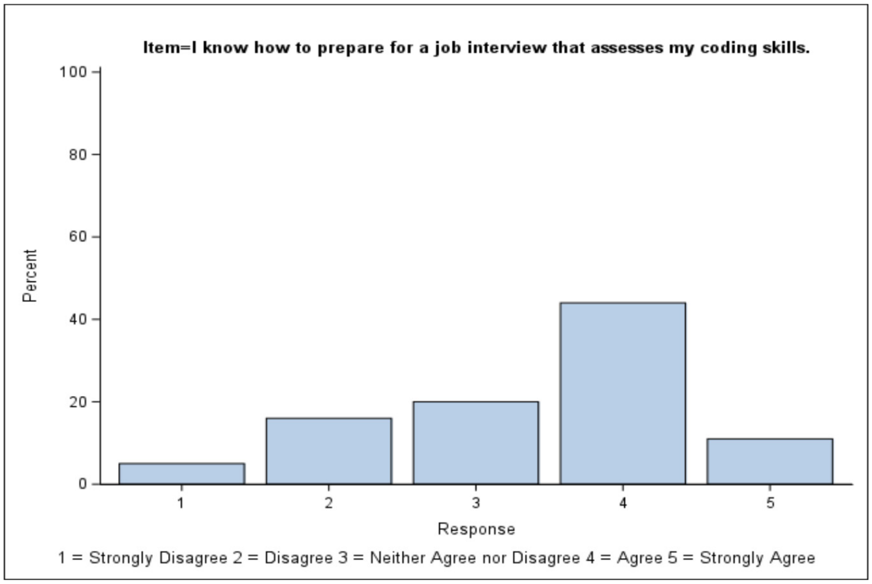
4. I could perform well in a difficult coding class.



Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 8, neither agree nor disagree = 26, agree = 45, strongly agree = 18.

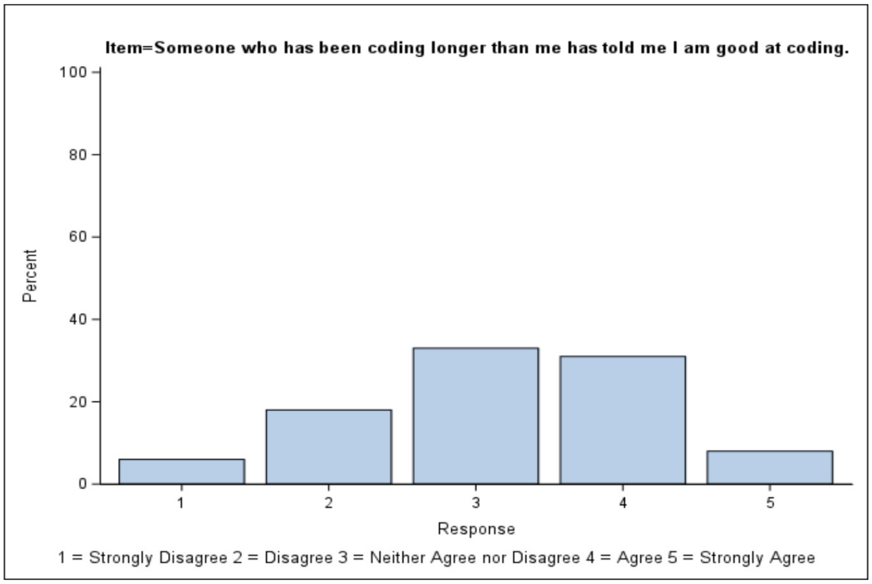
Coding Self-Efficacy (Barrier Coping)

5. I know how to prepare for a job interview that assesses my coding skills.



Note. The percentage of responses for each category were as follows: strongly disagree = 5, disagree = 16, neither agree nor disagree = 20, agree = 44, strongly agree = 11.

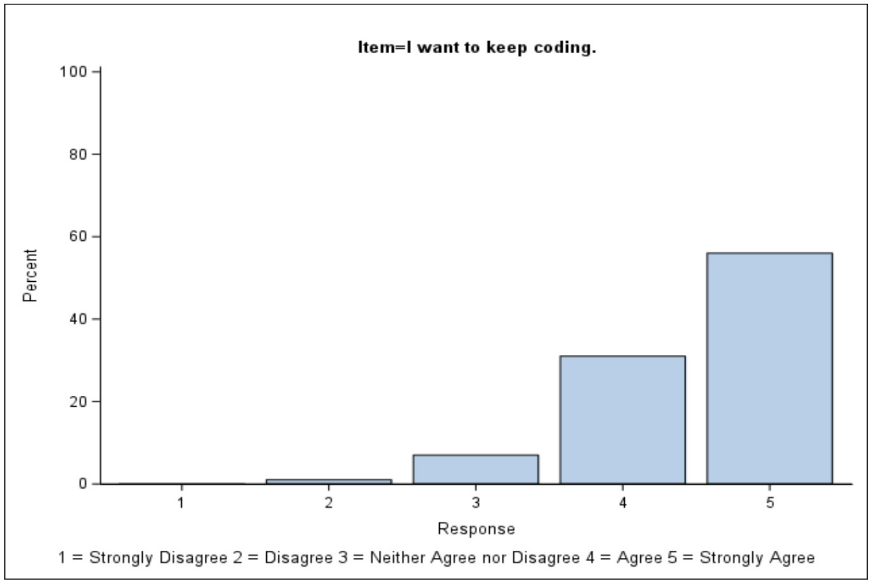
6. Someone who has been coding longer than me has told me I am good at coding.



Note. The percentage of responses for each category were as follows: strongly disagree = 6, disagree = 18, neither agree nor disagree = 33, agree = 31, strongly agree = 8.

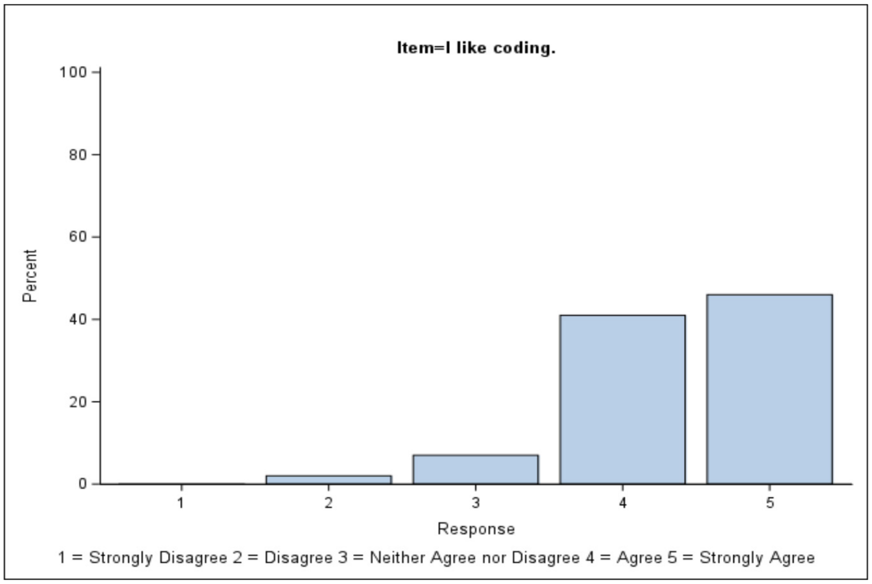
Interest in Coding

7. I want to keep coding.



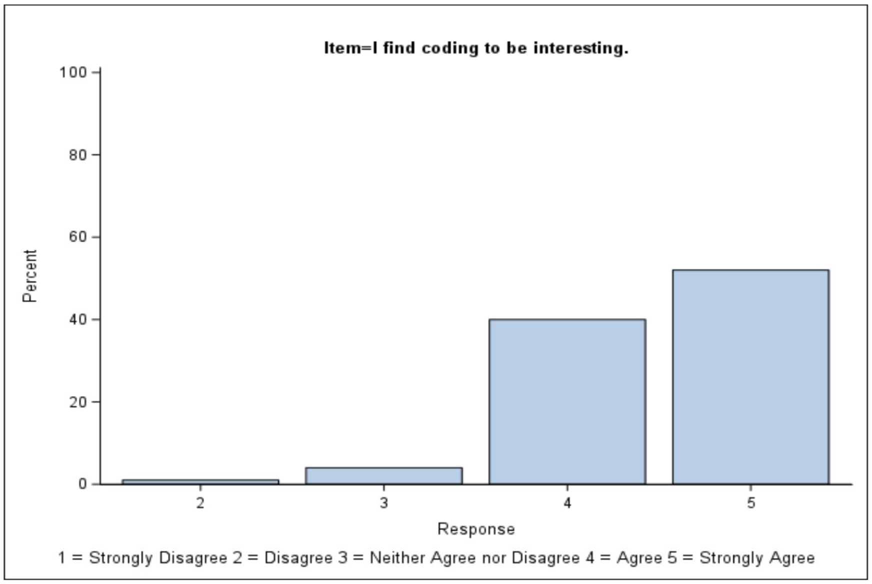
Note. The percentage of responses for each category were as follows: strongly disagree = 0, disagree = 1, neither agree nor disagree = 7, agree = 31, strongly agree = 56.

8. I like coding.



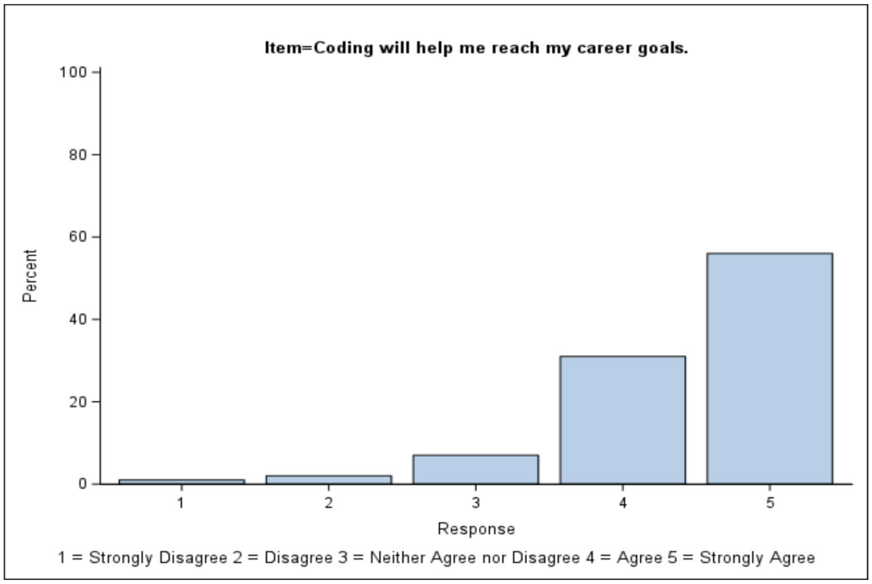
Note. The percentage of responses for each category were as follows: strongly disagree = 0, disagree = 2, neither agree nor disagree = 7, agree = 41, strongly agree = 46.

9. I find coding to be interesting.



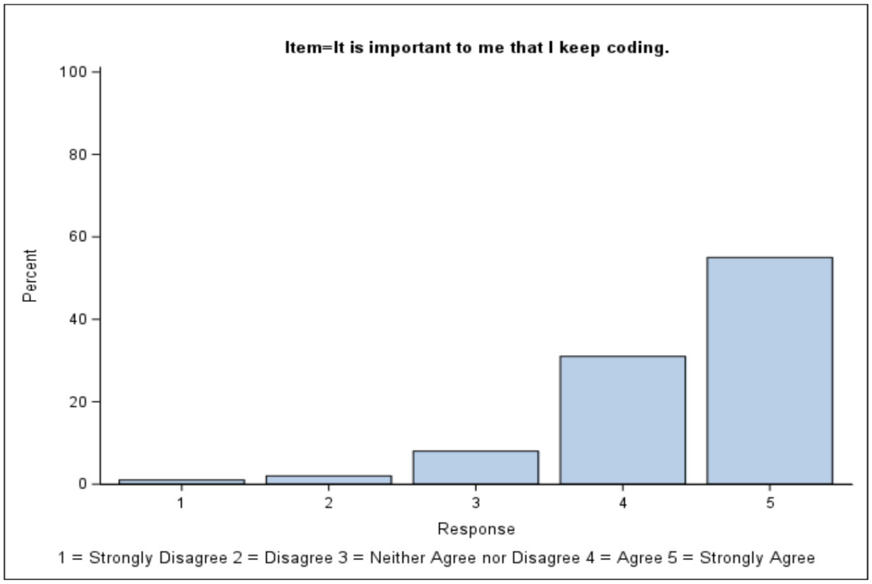
Note. The percentage of responses for each category were as follows: strongly disagree = 0, disagree = 1, neither agree nor disagree = 4, agree = 40, strongly agree = 52.

10. Coding will help me reach my career goals.



Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 2, neither agree nor disagree = 7, agree = 31, strongly agree = 56.

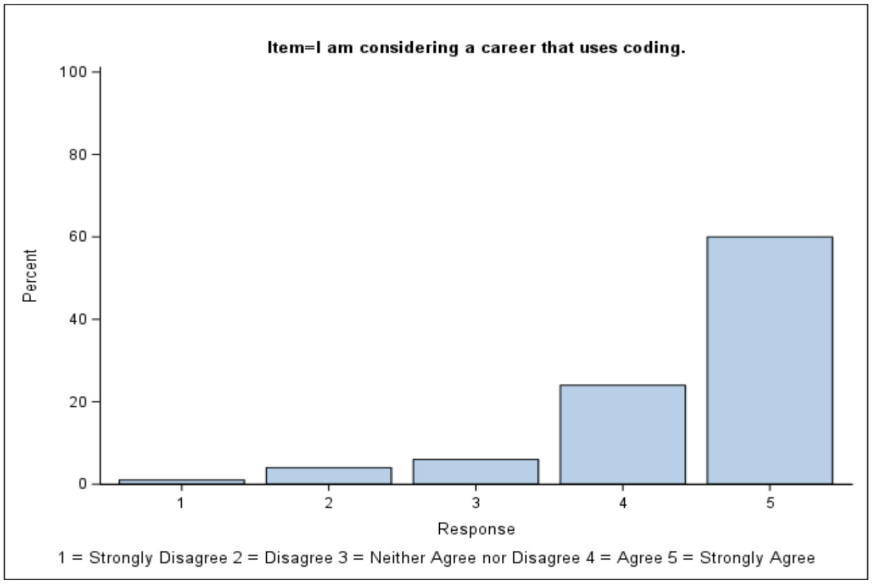
11. It is important to me that I keep coding.



Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 2, neither agree nor disagree = 8, agree = 31, strongly agree = 55.

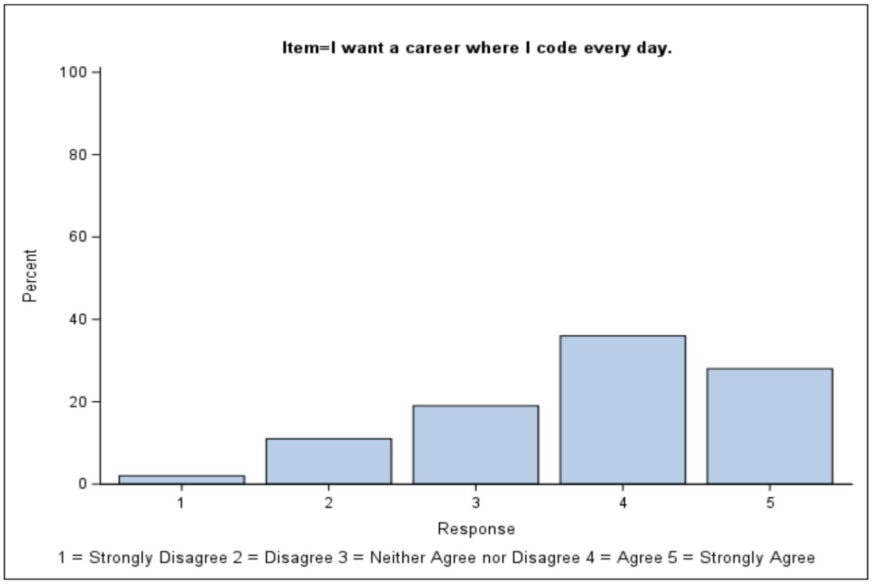
Intention to Pursue a Career That Involves Coding

12. I am considering a career that uses coding.



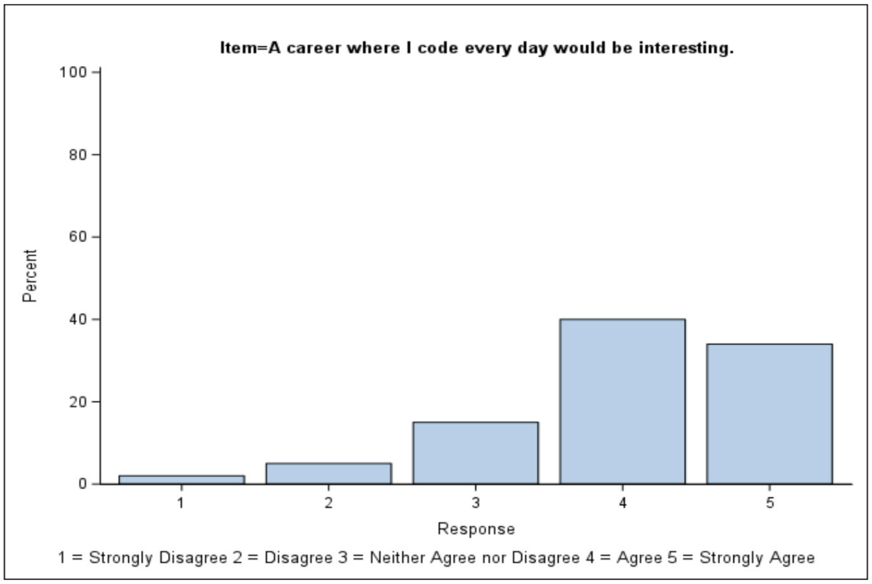
Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 4, neither agree nor disagree = 6, agree = 24, strongly agree = 60.

13. I want a career where I code every day.



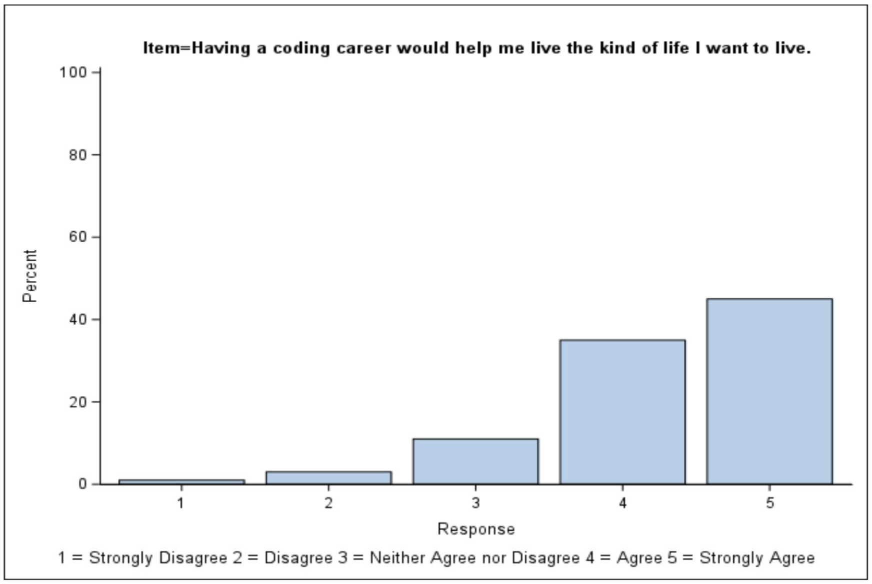
Note. The percentage of responses for each category were as follows: strongly disagree = 2, disagree = 11 neither agree nor disagree = 19, agree = 36, strongly agree = 28.

14. A career where I code every day would be interesting.



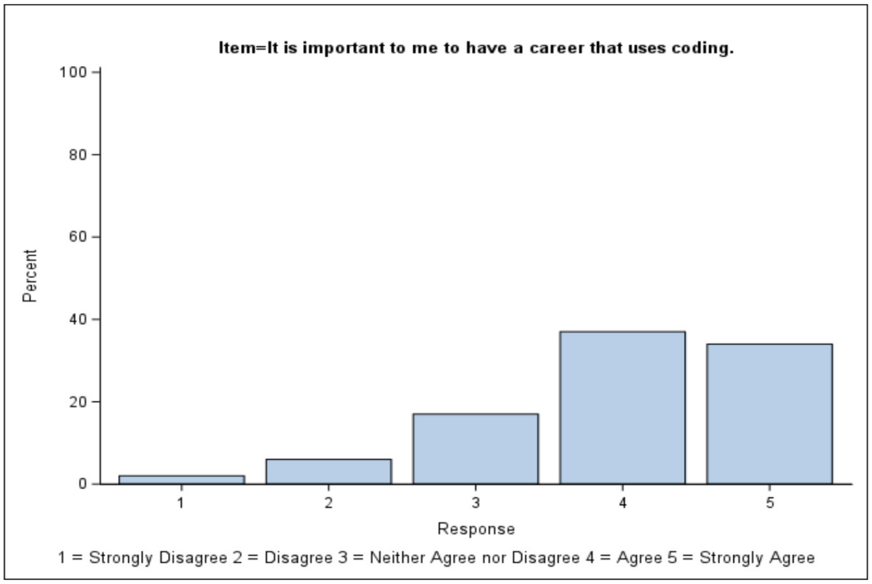
Note. The percentage of responses for each category were as follows: strongly disagree = 2, disagree = 5, neither agree nor disagree = 15, agree = 40, strongly agree = 34.

15. Having a coding career would help me live the kind of life I want to live.



Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 3, neither agree nor disagree = 11, agree = 35, strongly agree = 45.

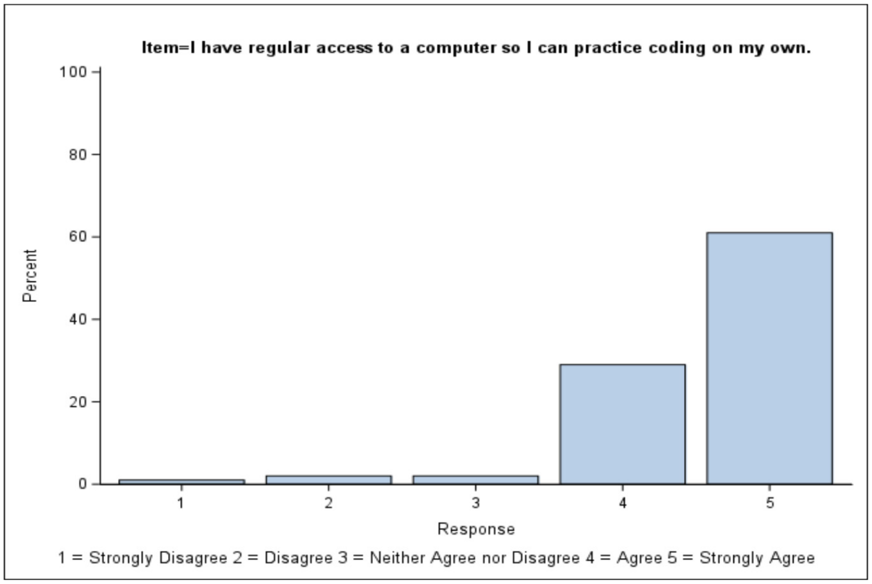
16. It is important to me to have a career that uses coding.



Note. The percent of responses for each category were as follows: strongly disagree = 2, disagree = 6, neither agree nor disagree = 17, agree = 37, strongly agree = 34.

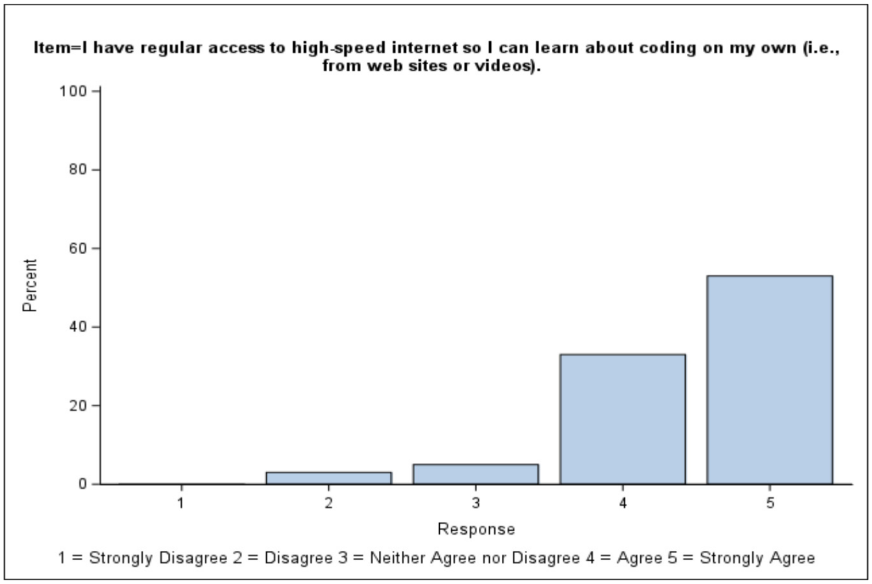
Practical Support for Pursuing a Career That Involves Coding

17. I have regular access to a computer so I can practice coding on my own.



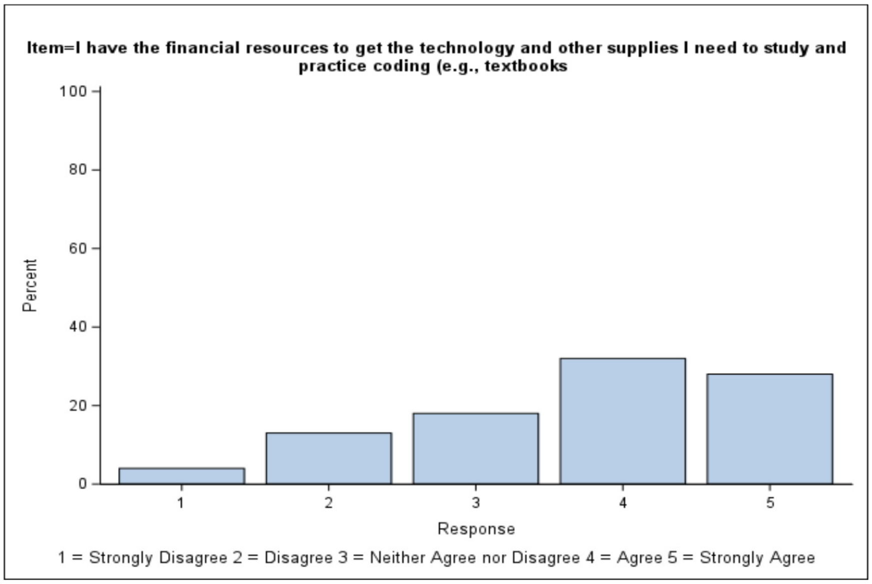
Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 2, neither agree nor disagree = 2, agree = 29, strongly agree = 61.

18. I have regular access to high-speed internet so I can learn about coding on my own (e.g., from web sites or videos).



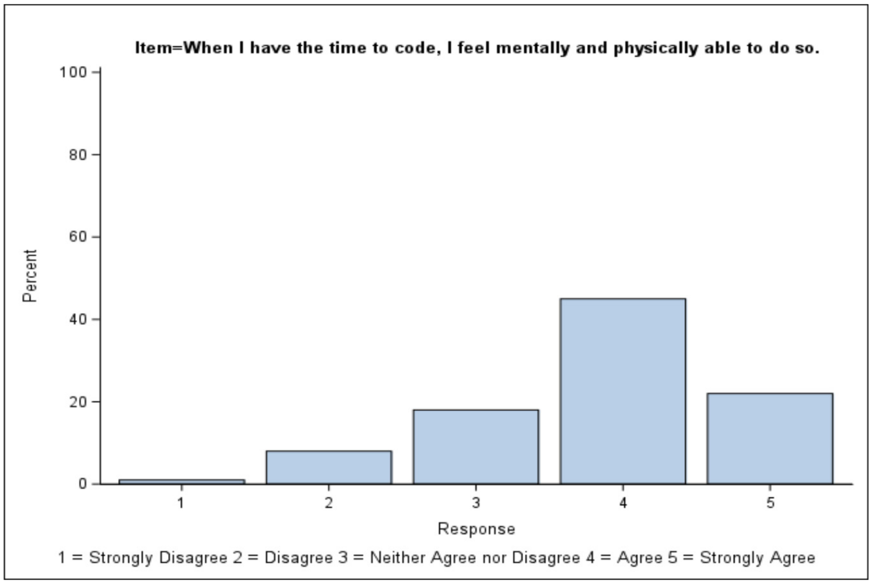
Note. The percentage of responses for each category were as follows: strongly disagree = 0, disagree = 3, neither agree nor disagree = 5, agree = 33, strongly agree = 53.

19. I have the financial resources to get the technology and other supplies I need to study and practice coding (e.g., textbooks and other instructional materials, devices, programming tools).



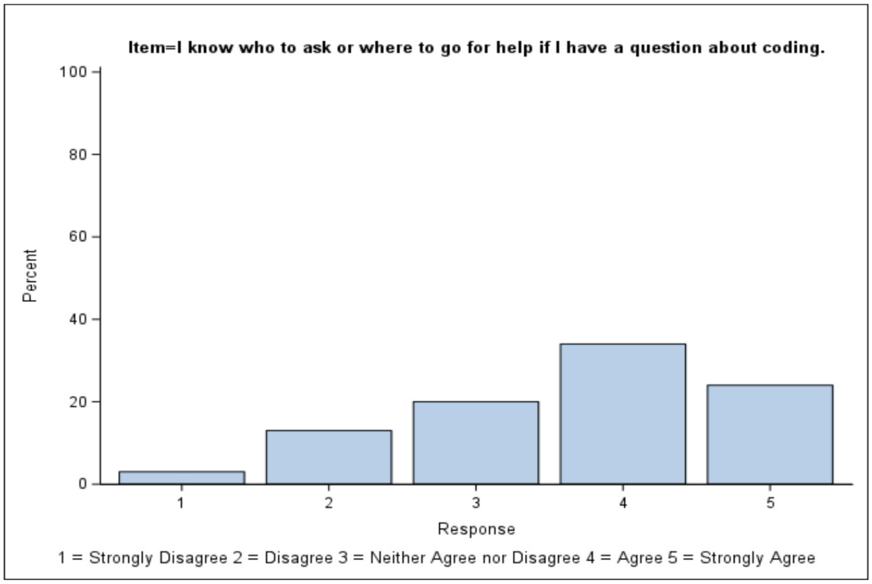
Note. The percentage of responses for each category were as follows: strongly disagree = 4, disagree = 13, neither agree nor disagree = 18, agree = 32, strongly agree = 28.

20. When I have the time to code, I feel mentally and physically able to do so.



Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 8, neither agree nor disagree = 18, agree = 45, strongly agree = 22.

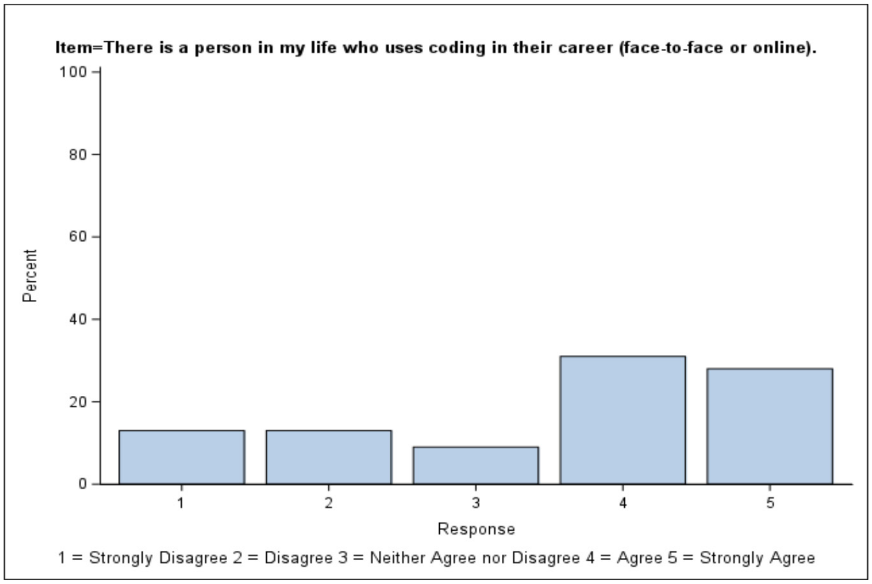
21. I know who to ask or where to go for help if I have a question about coding.



Note. The percentage of responses for each category were as follows: strongly disagree = 3, disagree = 13, neither agree nor disagree = 20, agree = 34, strongly agree = 24.

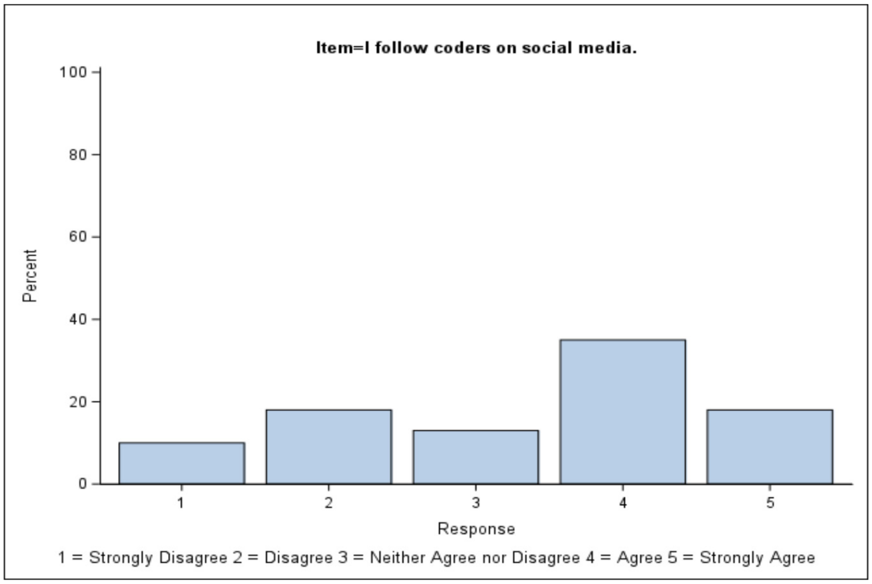
Social Support for Pursuing a Career That Involves Coding

22. There is a person in my life who uses coding in their career (online or face-to-face).



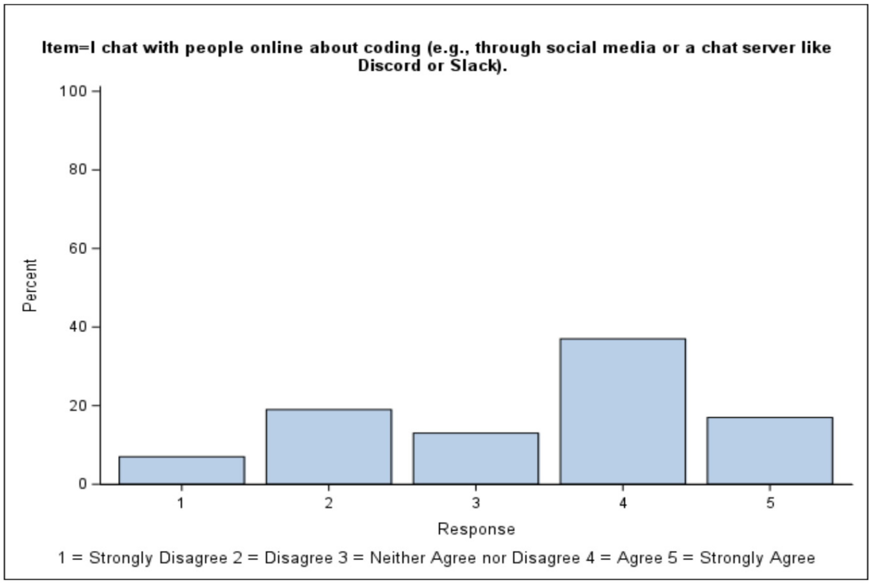
Note. The percentage of responses for each category were as follows: strongly disagree = 13, disagree = 13, neither agree nor disagree = 9, agree = 31, strongly agree = 28.

23. I follow coders on social media.



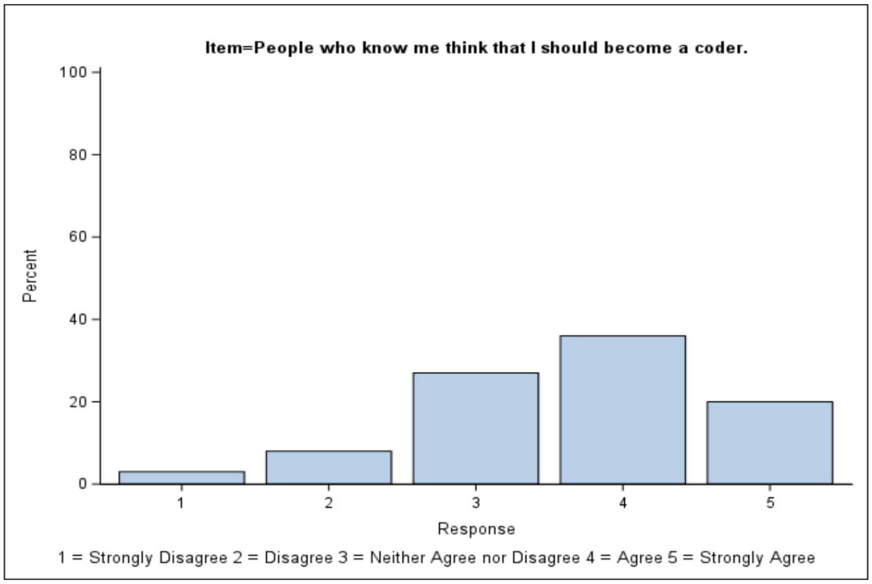
Note. The percentage of responses for each category were as follows: strongly disagree = 10, disagree = 18, neither agree nor disagree = 13, agree = 35, strongly agree = 18.

24. I chat with people online about coding (e.g., through social media or a chat server like Discord or Slack).



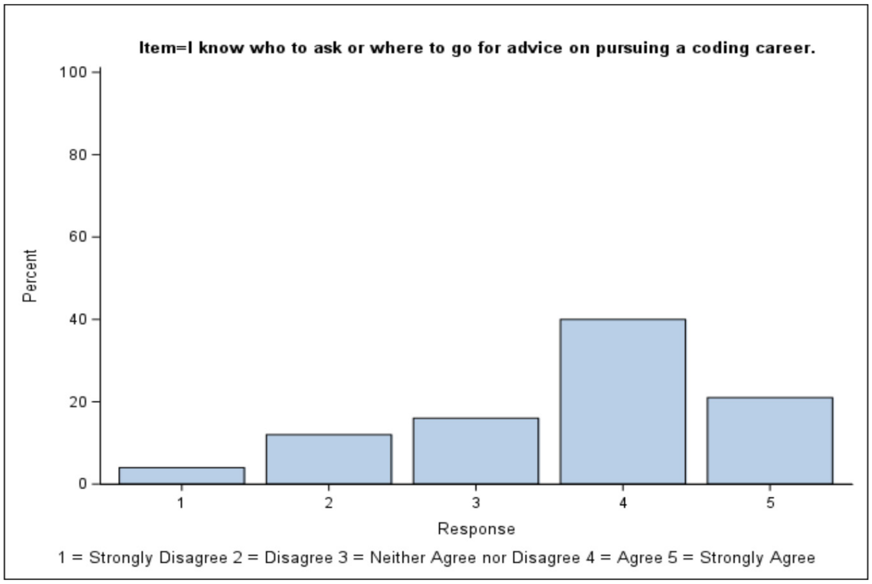
Note. The percentage of responses for each category were as follows: strongly disagree = 7, disagree = 19, neither agree nor disagree = 13, agree = 37, strongly agree = 17.

25. People who know me think that I should become a coder.



Note. The percentage of responses for each category were as follows: strongly disagree = 3, disagree = 8, neither agree nor disagree = 27, agree = 36, strongly agree = 20.

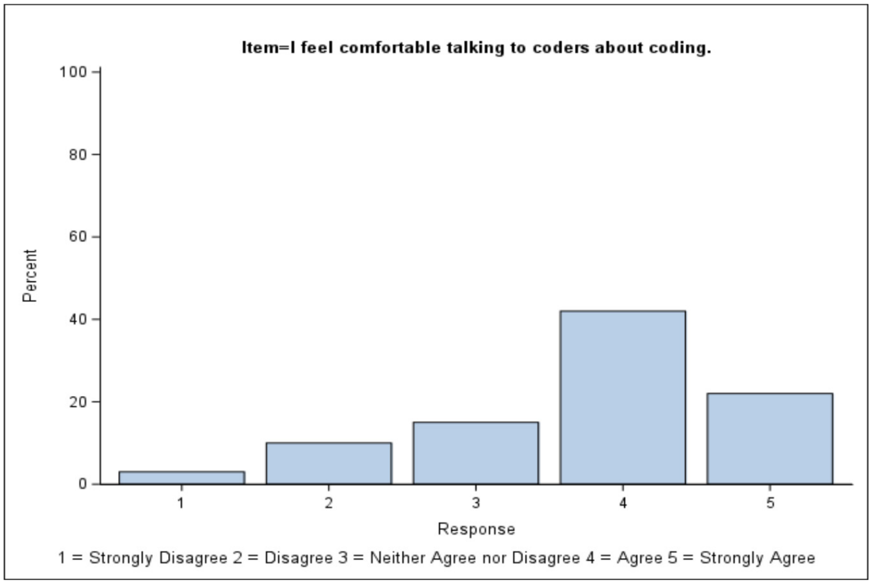
26. I know who to ask or where to go for advice on pursuing a coding career.



Note. The percentage of responses for each category were as follows: strongly disagree = 4, disagree = 12, neither agree nor disagree = 16, agree = 40, strongly agree = 21.

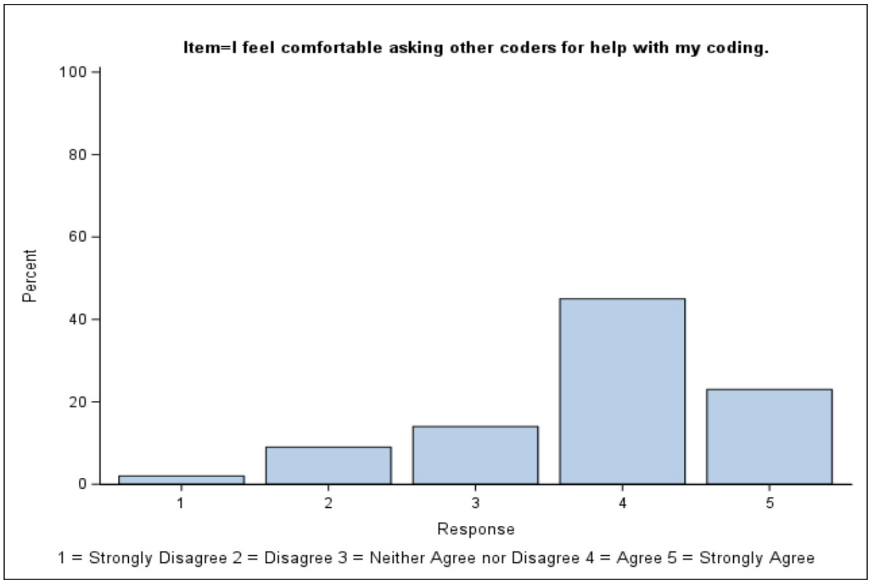
Sense of Belonging in Computing

27. I feel comfortable talking to coders about coding.



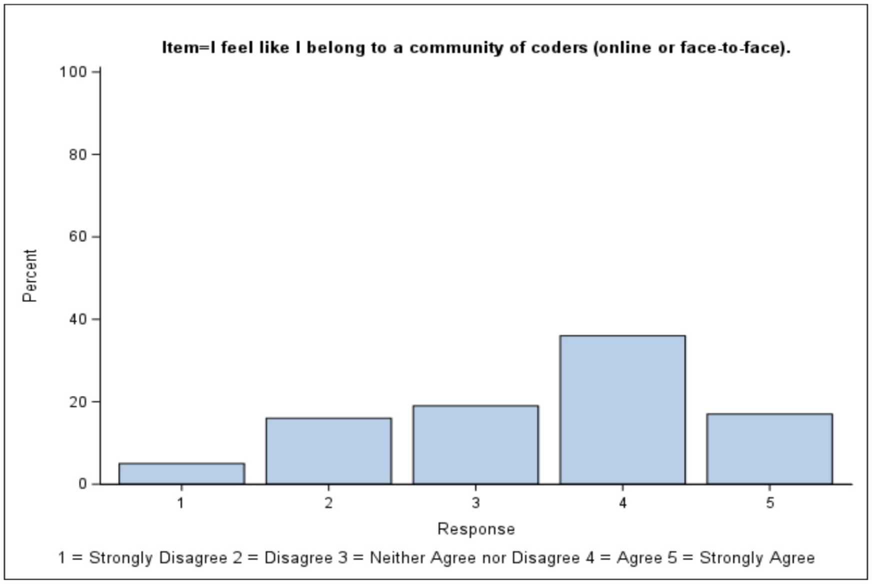
Note. The percentage of responses for each category were as follows: strongly disagree = 3, disagree = 10, neither agree nor disagree = 15, agree = 42, strongly agree = 22.

28. I feel comfortable asking other coders for help with my coding.



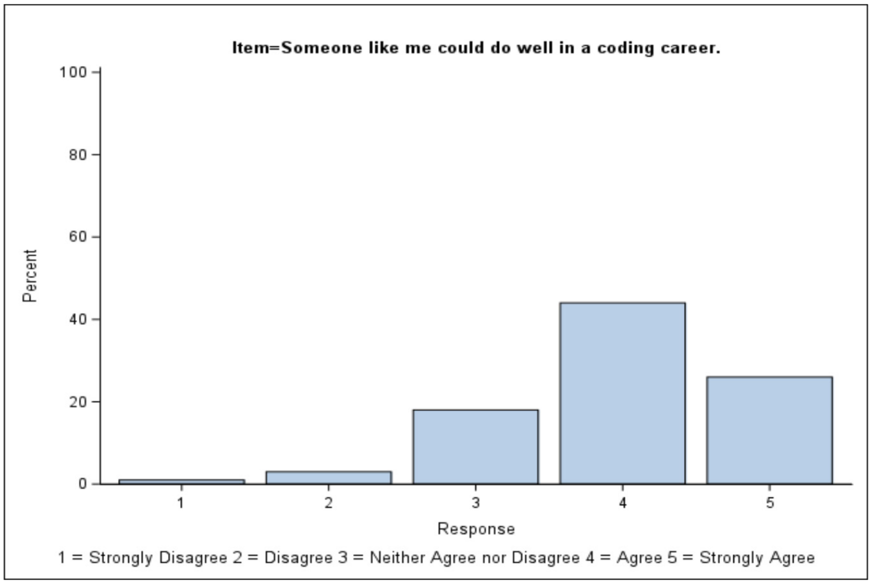
Note. The percentage of responses for each category were as follows: strongly disagree = 2, disagree = 9, neither agree nor disagree = 14, agree = 45, strongly agree = 23.

29. I feel like I belong to a community of coders (online or face-to-face).



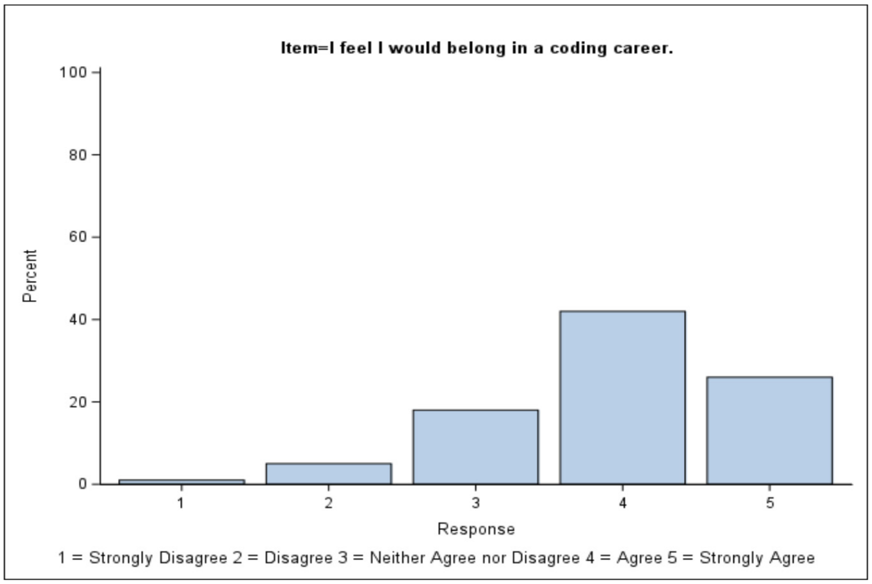
Note. The percentage of responses for each category were as follows: strongly disagree = 5, disagree = 16, neither agree nor disagree = 19, agree = 36, strongly agree = 17.

30. Someone like me could do well in a coding career.



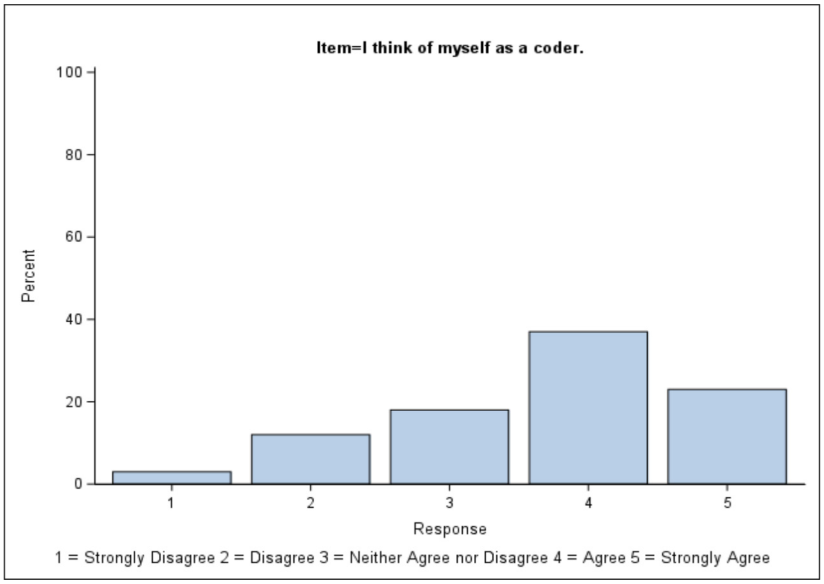
Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 3, neither agree nor disagree = 18, agree = 44, strongly agree = 26.

31. I feel I would belong in a coding career.



Note. The percentage of responses for each category were as follows: strongly disagree = 1, disagree = 5, neither agree nor disagree = 18, agree = 42, strongly agree = 26.

32. I think of myself as a coder.



Note. The percentage of responses for each category were as follows: strongly disagree = 3, disagree = 12, neither agree nor disagree = 18, agree = 37, strongly agree = 23.

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