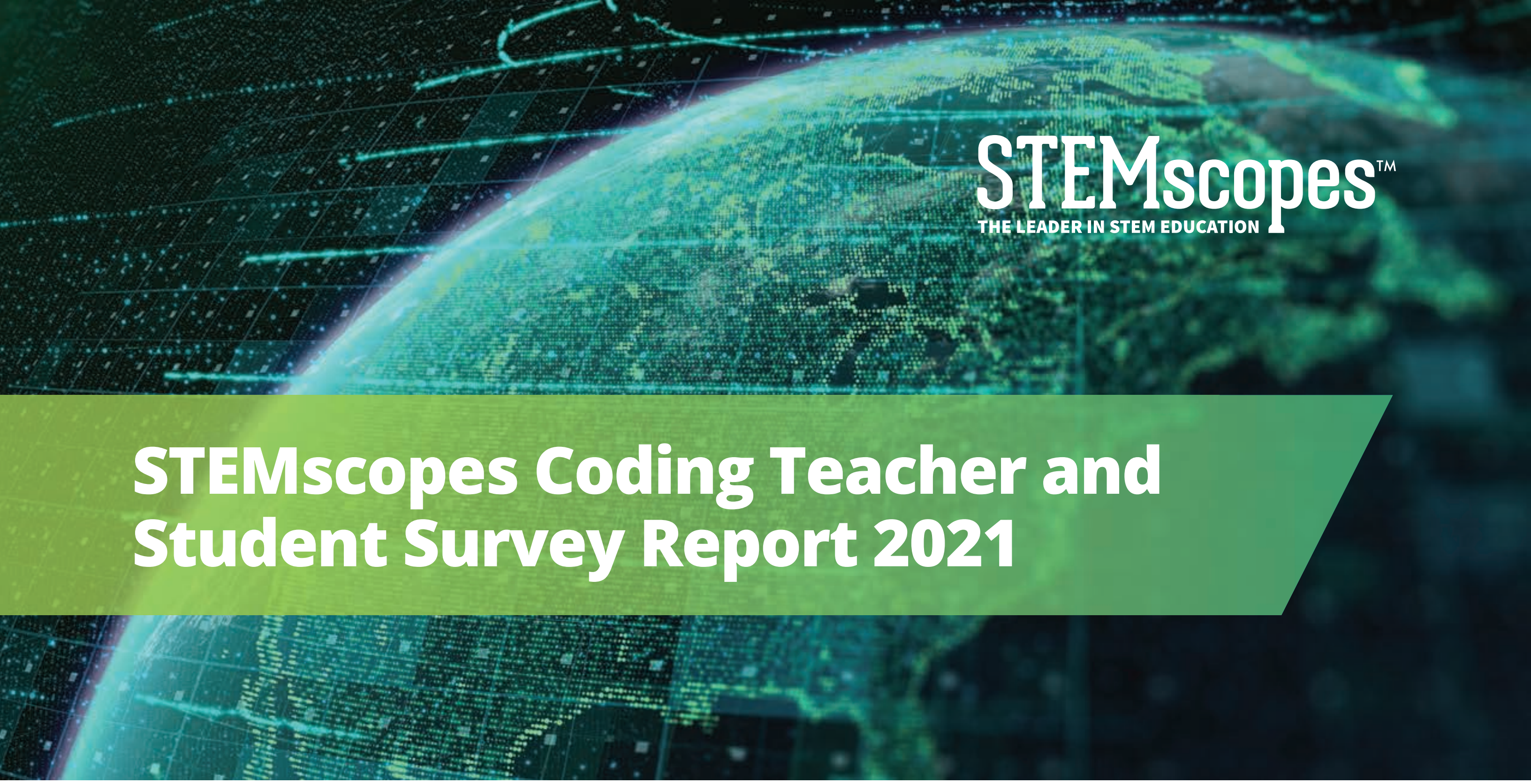


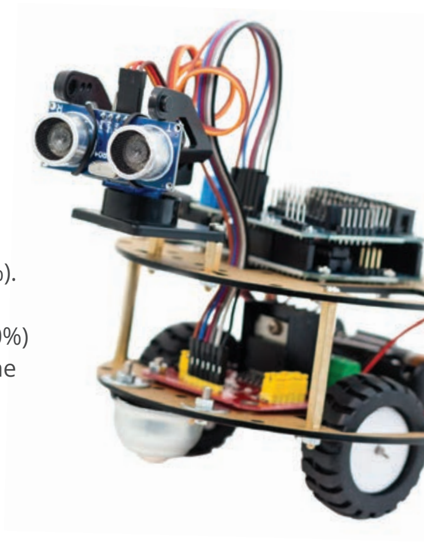
STEMscopes Coding Teacher and Student Survey Report 2021

EXECUTIVE SUMMARY

At the end of the 2020-2021 school year (from May 26 - June 18), we surveyed teachers and students who used STEMscopes Coding during the school year. We asked teachers and students how they liked STEMscopes Coding, how much they were using the program, what elements were their favorites, what skills STEMscopes Coding may improve and how it may relate to future career aspirations. We often asked teachers and students the same question. This helps us to see if there is concordance between responses which helps to validate the student responses in particular. It also provides a snapshot into differences in responses that may be meaningful. Importantly, we also asked teachers and students about their perceived motivation related to coding defined as efficacy, values, and motivational cost and gave them a very brief knowledge check. We were interested to see whether teacher and students' perceptions predicted teacher time using the program, teacher recommendations for further use, student liking and coding knowledge.

Results indicated that teachers and students felt similarly positive about STEMscopes Coding and are using coding fairly regularly (at least once a week) on average, and that students using STEMscopes Coding tended to be interested in STEM-related careers. We found many predictive relationships with teacher and student reported outcomes. Specifically, we found that teacher reported value regarding the importance of coding significantly predicted how much they use STEMscopes in the classroom, and teacher efficacy using STEMscopes Coding predicted teacher reported student enjoyment of the program. There were trend level findings with teacher perceived motivational cost potentially negatively affecting teacher recommendations for use and teacher perceived value potentially increasing student enjoyment. For students: perceived motivational cost was negatively associated with how much they liked to learn about coding and their knowledge of coding; student efficacy increased student liking; and student perceptions of the value of coding increased their liking and coding knowledge. Finally, student reported efficacy was indirectly associated with student coding knowledge through its positive effect on student enjoyment, which in turn, increased student knowledge.

Participants. Data includes 52 teachers and 274 students from 22 states and 4 countries (USA, Canada, Mexico, and United Arab Emirates). Kindergarten - 8th grade teachers and 1st - 12th students responded. Teachers who taught 7th graders (29.4%) and 5th graders (20.9%) were the most common respondents. Among teachers, the majority were math and science teachers (60.8%). Among the students, girls (49.8%) were slightly more common responders than boys (40.2%) while 10% preferred not to report their sex. Curiously, a high number of teachers (45%) and students (60%) did not complete the survey. This resulted in 108 students completing the whole survey through the knowledge check, and 20 teachers completing the survey.



STEMSCOPES USAGE, LIKING, & PERCEIVED RELATIONS

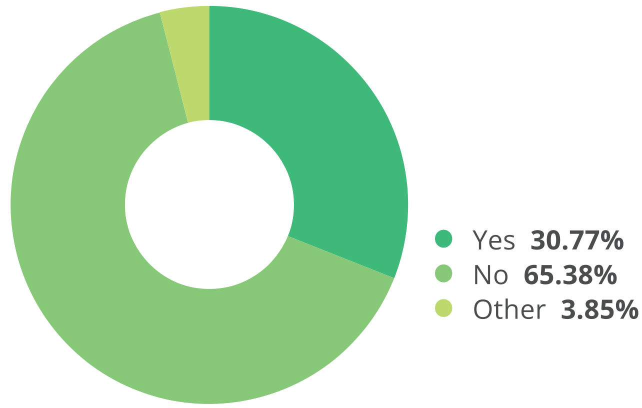
1. ***STEMscopes Coding Usage***

- Over 65% of teachers reported that using STEMscopes Coding is their first experience with coding, 78.9% reported it is their first time teaching coding and 75% noted they had *not* received PD related to coding before.
- In contrast, just under half (48%) of students had some exposure to coding before STEMscopes. This suggests a key gap in teacher skills that STEMscopes Coding meets.
- 60% of teachers noted they use STEMscopes Coding at least once a week, with 15% using it everyday, although 25% used it less than once a month.
- Similarly about half of students (49.4%) noted the use of STEMscopes Coding at least once a week, however only 4% reported daily usage.
- Teachers (only) reported the most common block of time spent coding was 30-45 minutes.
- We asked teachers to 'click on all that apply' related to problems that they themselves or students may have faced. The most common choice was "Students struggle because they're not good at typing (28.6%), followed closely by "There was/is not sufficient time in our schedule" (23.8%).

2. ***Do you like STEMscopes Coding?***

- We asked teachers to report how much they felt students enjoyed STEMscopes Coding on a 100 point scale. Teachers reported an average of 67.21 (Min: 12, Max: 100) for student liking.
- We also asked students on the same scale how much they liked to learn about coding: Student actual responses were nearly identical to what teachers reported, with an average liking of 68 (Min: 0, Max: 100; with younger students tending to report higher liking). This suggests a strong correspondence between teacher and student perceptions (note higher correspondence can be taken as an indicator of validity of the responses).
- Favorite elements for teachers included: a wide selection of products (45.5%), and 'How do I' projects (22.7%), followed by "Challenge" projects (18.2%).
- Student likes were similar but with the most popular element being "Coding their own apps" (49.1%), then "challenge projects'' (39.9%), and then "wide selection of products" (36.8%).
- We also asked teachers what elements they would like to improve: 61% responded "nothing, n/a, not sure, or I don't know," and 11% mentioned a need for more training.

HAVE YOU HAD ANY PRIOR CODING EXPERIENCE?



- A key indicator of whether teachers really like a program and will continue usage is whether they would recommend continued usage within their districts. Teachers like STEMscopes Coding because 72.7% agreed or strongly agreed that they would recommend continued usage by their school and district. All other responses were neutral ("neither agree nor disagree); not a single teacher reported disagreement.

3. ***STEMscopes Coding relates to...***

- Teachers felt that STEMscopes Coding not only improved students' coding but also their problem solving skills (72.7% of teachers), and logical thinking (50%).
- Over half of teachers (54.6%) reported it helps students develop an interest in STEM-related careers.
- Indeed, when students were asked what they would "like to be when they grow-up," the most common responses were doctor (16.9%), 'you-tuber/ tik-toker' (16.9%), scientist (9.6%), game coder (6.6%), and engineer (6.6%). Just as teachers suggested: STEM-related career aspirations accounted for 53% of student responses overall, again showing high correspondence between teacher and student reports.
- Students also reported what they would like to study in college, and, again, choices were STEM-related with computers (25.9%), math (17.5%), and science (14.5%) as the top three choices.
- Currently, students' favorite school subjects are math (29%), science (15.4%), and reading (11.1%). Asking about college and current preferences help us to see that student interest in STEM is consistent.

THE EFFECTS OF TEACHER AND STUDENT MOTIVATIONAL PERCEPTIONS

To really dig into teacher and student responses related to using STEMscopes Coding, we took an expectancy-value motivation theory approach (Wigfield & Eccles, 2000). Research suggests that learning new technological, STEM-based skills may be affected by motivation such as perceived efficacy (I do this well), "motivational cost" when faced with a new task (this takes so much effort) and value (this is important).

With this in mind, we asked teachers to rate statements on a 7 point scale (strongly disagree, disagree, somewhat disagree, neither agree or disagree, somewhat agree, agree, and strongly agree) about their efficacy (I am comfortable teaching STEMScopes Coding), cost (teaching with STEMscopes Coding stresses me out), and values around coding (it is important to have good computer coding knowledge). We asked students to rate statements about their efficacy (I am good at coding), cost (coding stresses me out), and values (It is important to have good computer coding skills). With students we used a simplified 5 point rating scale with the responses "very false," "false," "maybe," "true," and "very true." Please note that for teachers, we mostly focused on perceptions related specifically to STEMscopes Coding. However, with students we focused the questions on coding in general (as we have received past feedback that students are not always aware of what curricula/ program they are using; their awareness is focused on what they are learning about).

We then looked at how well the items grouped together (how highly correlated they were), and averaged items that were efficacy items, or cost items, or value items, in order to create a summary score for each type of motivation perception. Below, we first describe teacher and student responses. We then used responses to predict outcomes related to coding. For teachers, we predicted: 1) teachers' reporting of how much they used STEMscopes Coding, 2) how much students enjoyed STEMscopes Coding, and 3) whether they would recommend to their district that STEMscopes Coding continue to be used. For students, we predicted: 1) how much they like to learn about coding and 2) their knowledge of coding concepts via a brief knowledge check (note in this case we cannot look at teachers and students together because teachers and students who reported are not in the same classrooms). The knowledge check initially included eight questions, but one of the questions did not correlate well with the other items, and had a strange response pattern so it was dropped. The final seven items included a range of difficulties from easy ("can code tell the computer sounds to play," with 84% of students responding correctly) to difficult ("How do capital letters affect how code works," with only 39% responding correctly). We had to include a big range of item difficulty because we were asking students from many different grade levels to respond (thus we expected some items would be very hard for younger students, but we needed to be able to have some harder items for older students). Indeed, in all student analyses grade (1-12) was a significant predictor of outcomes and was included as a covariate (to ensure we are not just capturing grade level effects).

DESCRIPTIVE FINDINGS RELATED TO MOTIVATION

- On average, teachers 'somewhat disagree' regarding the motivational cost of using STEMscopes Coding. That is, they tend to somewhat disagree with statements such as "It is stressful to teach STEMscopes Coding," or "It takes too much effort for me to teach STEMscopes Coding."
- As a group, teachers tended to be neutral, on average, regarding their own feeling of efficacy.
- Teachers "somewhat agreed" regarding the general value of learning coding. This suggests some room for improvement for teachers feeling efficacious and valuing coding skills.
- On average, students responded neutrally ("maybe") regarding the motivational cost of coding.
- Students as a group tended to report statements about their efficacy (such as I am a good coder) were "true."
- Likewise students tended, on average, to report that statements about the value of coding were "true."

INFERENTIAL FINDINGS

TABLE 1 SUMMARY OF INFERENTIAL FINDINGS WITH MOTIVATION AND LIKING PREDICTING OUTCOMES

Predictors	Teacher Outcomes			Student Outcomes	
Teacher Predictors	**STEMscopes Usage**	**Teacher Reported Student Enjoyment**	**Recommend Continued Use**	**Perceived Liking**	**Knowledge**
1. Motivational cost	□	□	↓ (orange)	—	—
2. Efficacy	□	↑ (green)	□	—	—
3. Value	↑ (green)	↑ (orange)	□	—	—
Student Predictors					
1. Motivational cost	—	—	—	↓ (green)	↓ (green)
2. Efficacy	—	—	—	↑ (green)	□
3. Value	—	—	—	↑ (green)	↑ (green)
3. Student liking	—	—	—	—	↑ (green)

Note: Empty boxes indicate non-significant associations, green arrows indicate significant associations with arrow direction indicating if the relationship was positive or negative, orange arrows indicate trend level associations, dashes indicate the outcome does not match the predictor and could not be tested.

1. Teacher reported time spent coding

- Results indicated no significant predictive associations between teacher reported cost (b = -0.89, $p = 0.19$), or efficacy (b = 0.96 , $p = 0.17$) and the amount of class time spent using STEMscopes Coding.
- Results indicated a positive significant association between teacher reported value (b = 1.12, $p < .05$) and class time spent using STEMscopes Coding with teachers who valued coding skills more using STEMscopes coding more in their classrooms.

2. Teacher reported student enjoyment

- Results indicated no significant predictive associations between teacher reported cost (b = -3.28, $p = 0.62$) and student enjoyment.
- Results indicated a "trend" predictive relationship between teacher reported value (b = 9.16, $p = 0.07$) and student enjoyment. The "p-value" in the parenthetical statistical statement tells us how confident we feel about whether an association is true and trustworthy versus possibly occurring by chance. The typical p-value used by researchers is $p < .05$ which means we are 95% confident that the association is not by chance. In this case, we are only 93% confident that the association is not by chance. Given our small sample size, the positive association between teachers' value and student enjoyment is promising, but may need more evaluation.
- Results indicated that teacher reported efficacy was a positive significant predictor of student enjoyment (14.94, $p < .05$), such that for a one point increase in teacher efficacy with STEMscopes Coding (equivalent to a category shift on the 7 point likert scale above), there is a nearly 15 point increase in student enjoyment (please recall enjoyment was rated on a 100 point scale).

3. Teacher reported recommendation for continued use

- We did not see any significant predictors regarding the recommendation for continued use, although please note from above that no teacher disagreed with the statement that they would recommend STEMscopes Coding, rather, some teachers were neutral. With this in mind, we did see another trend level finding related to motivational cost (b = -0.34, *p* = 0.06) that suggest a potential association where teachers who reported increased motivational cost tended to be more ambivalent about recommendations. that the association is not by chance.

4. Student reported "Do you like to learn about coding"

- Results indicated that student perceived motivational cost was a significant negative predictor of whether students reported that they liked to learn about coding (b = -11.57, $p < .01$). For every one unit increase (in other words: as students began to endorse as "true" statements about coding as stressful or hard) their liking about learning to code decreased ~11.5 points.
- On the flipside, student perceived coding efficacy positively predicted whether students liked to learn about coding (b = 21.54, $p < .001$) such that for a one unit increase in efficacy, student liking jumped ~21.5 points.
- Similarly, student perceived value also positively predicted whether students liked to learn about coding (b = 15.99, $p < .001$), such that for a one unit increase in student values, there was a nearly 16 point increase in student liking.

5. Student knowledge

- Results indicated that efficacy was not a significant predictor of student knowledge (b = 0.25, *p* = 0.18).
- However, motivation cost was a significant negative predictor of student knowledge (b = -0.41, $p < .01$). This means that for a one unit increase in motivational cost, student scores decreased just under half a point, or put another way, student "percent correct scores" dropped about 6% per unit change in cost.
- Student perceived value, on the other hand, positively predicted student knowledge (b = 0.41, $p < .05$), such that a one unit increase in value increased student scores about half a point (or percent correct increased about 6%).
- Thus value and cost had a similar magnitude of effect on student knowledge, but in opposite directions, and while efficacy was the strongest predictor of student liking, it was not predictive of knowledge.
- Given this pattern, we ran two more follow-up analyses. Specifically, we anticipated that whether students liked to learn about coding may also affect their coding knowledge. Indeed, student reported liking predicted knowledge (b = 0.11, $p < .05$). In this case, for every 10 point increase in student reported liking to learn about coding, there was a ~1/10 of a point increase in student knowledge (1% score increase in percent score for every additional 10 points of liking). This is small but important as there may be an underlying process that unfolds over time such that student perceived efficacy may increase knowledge indirectly *through* increasing student liking (versus directly). This is testable via a mediation model and is exactly what we see: student perceived efficacy significantly and positively predicts student knowledge *through* first increasing student liking (indirect b = 0.33, *p* = 0.05), see figure below for a graphical display.

FIGURE: **EFFECT OF STUDENT EFFICACY ON STUDENT CODING KNOWLEDGE THROUGH STUDENT LIKING**

Indirect effect (efficacy * liking): b = 0.33, *p* = 0.05

CONCLUSION

Overall results can be interpreted positively, with the teachers and students reporting, on average, positive feelings regarding STEMscopes Coding, and that they are using the program at least weekly, although there was certainly a range of usage. Teachers had very little experience and training before STEMscopes Coding whereas students, comparatively, had more prior exposure. This is an important gap that STEMscopes Coding is addressing, and some teachers noted training as a need. With STEMscopes Coding, teachers felt students not only improved in their coding skills but a host of other skills as well, especially logical thinking and problem solving. Teachers and students also reported that students were more interested in STEM careers. Teachers and students' responses had a remarkably high correspondence adding to the validity of the findings.

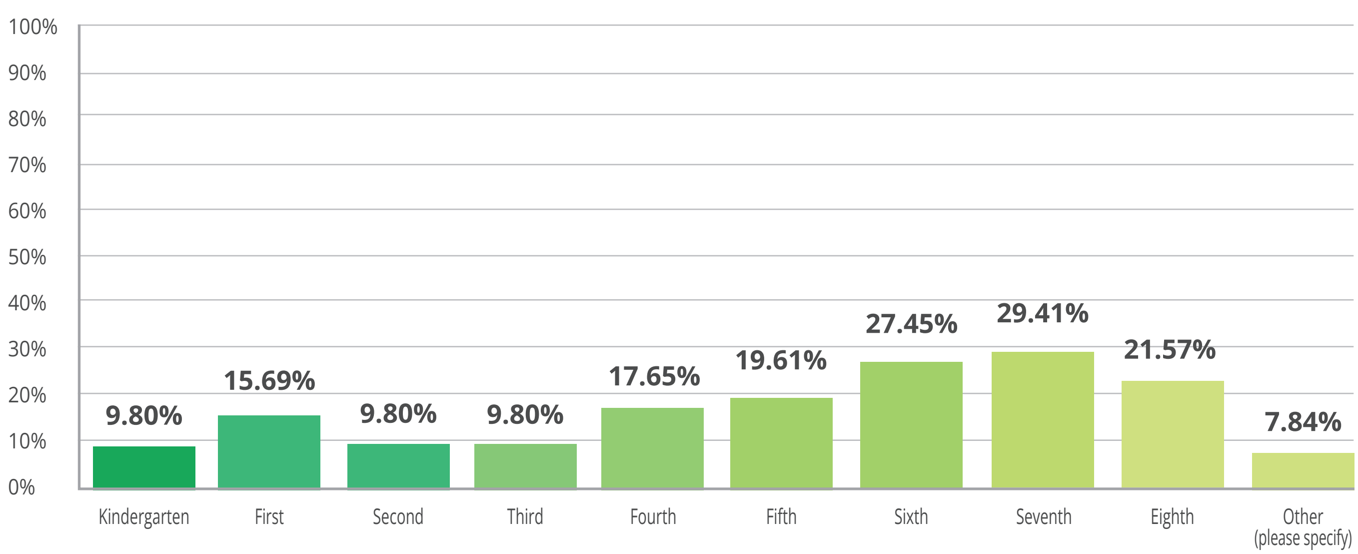
Both teacher and student motivations, including their efficacy, cost, and value of coding were associated with coding outcomes. We found that teacher coding value significantly predicted how much they use STEMscopes Coding, and teacher efficacy using STEMscopes Coding predicted teacher reported student enjoyment of STEMScopes Coding. There were trend level findings with teacher motivational cost potentially negatively affecting teacher recommendations for use, and teacher value potentially increasing student enjoyment. For students: motivational cost was negatively associated with how much they liked to learn about coding and their coding knowledge; student efficacy increased student liking; and student perceptions of value increased their liking and coding knowledge. Finally, student efficacy was indirectly associated with student coding knowledge through its positive effect on student liking, which in turn, increased student knowledge. These findings demonstrate that *how* teachers and students feel about STEMscopes Coding and coding in general affects their usage and liking of the program and student coding knowledge. Overall, the findings suggest that STEMscopes Coding fills an important gap in prior teacher training and experience, and the more we can support teachers and students to feel efficacious, less stressed, and increased value for these new STEM-related skills, the more they, in turn, use, like, and learn about coding.

DETAILED APPENDIX

The detailed appendix includes three sections. In the first two sections: figures and tables are presented for individual **1) teacher items** and **2) student items**. In the third section, data cleaning processes and descriptions of how items were combined as well as related statistics (e.g., correlations) are described.

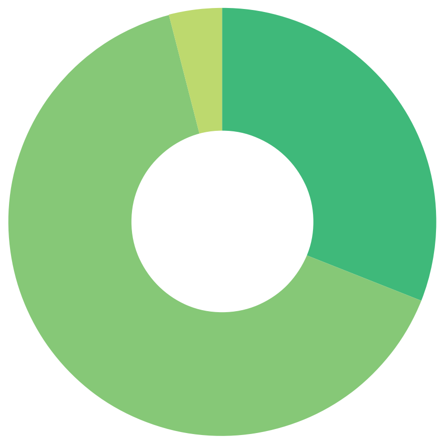
1. TEACHER ITEMS

Q1 WHAT GRADE LEVEL DO YOU TEACH?



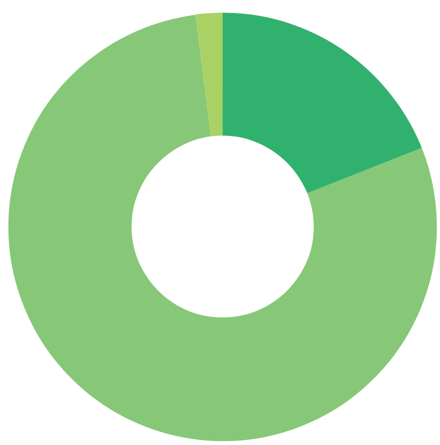
Other responses: Included "admin" or teachers specified multiple grades (e.g., K-5) instead of clicking multiple grades

Q2 HAVE YOU HAD ANY PRIOR CODING EXPERIENCE?



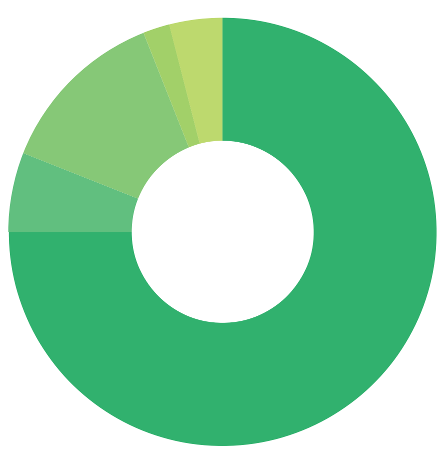
- Yes **30.77%**
- No **65.38%**
- Other (please specify) **3.85%**

Q3 HAVE YOU EVER TAUGHT CODING BEFORE?



- Yes **19.23%**
- No **78.85%**
- Other (please specify) **1.92%**

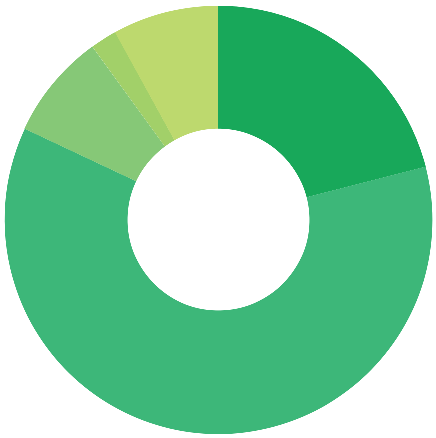
Q4 PRIOR TO THIS SCHOOL YEAR, HAVE YOU HAD ANY TRAINING / PROFESSIONAL DEVELOPMENT RELATED TO CODING?



- No **75.00%**
- Yes, last year **5.77%**
- Yes, over two years ago **13.46%**
- Yes, in college **1.92%**
- Other (please specify) **3.85%**

Other responses: included items such as "years ago"

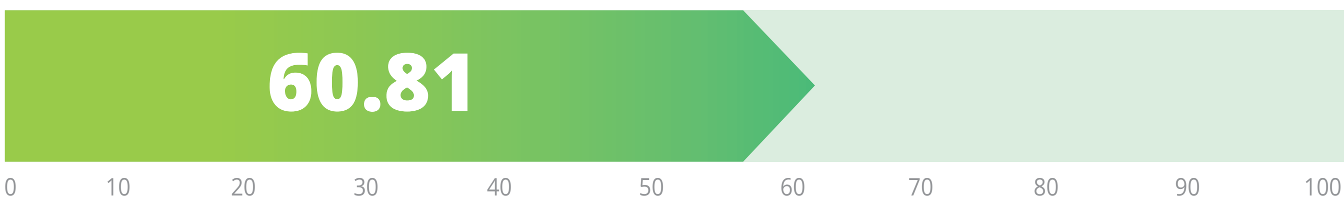
Q5 WHAT DO YOU PRIMARILY TEACH?



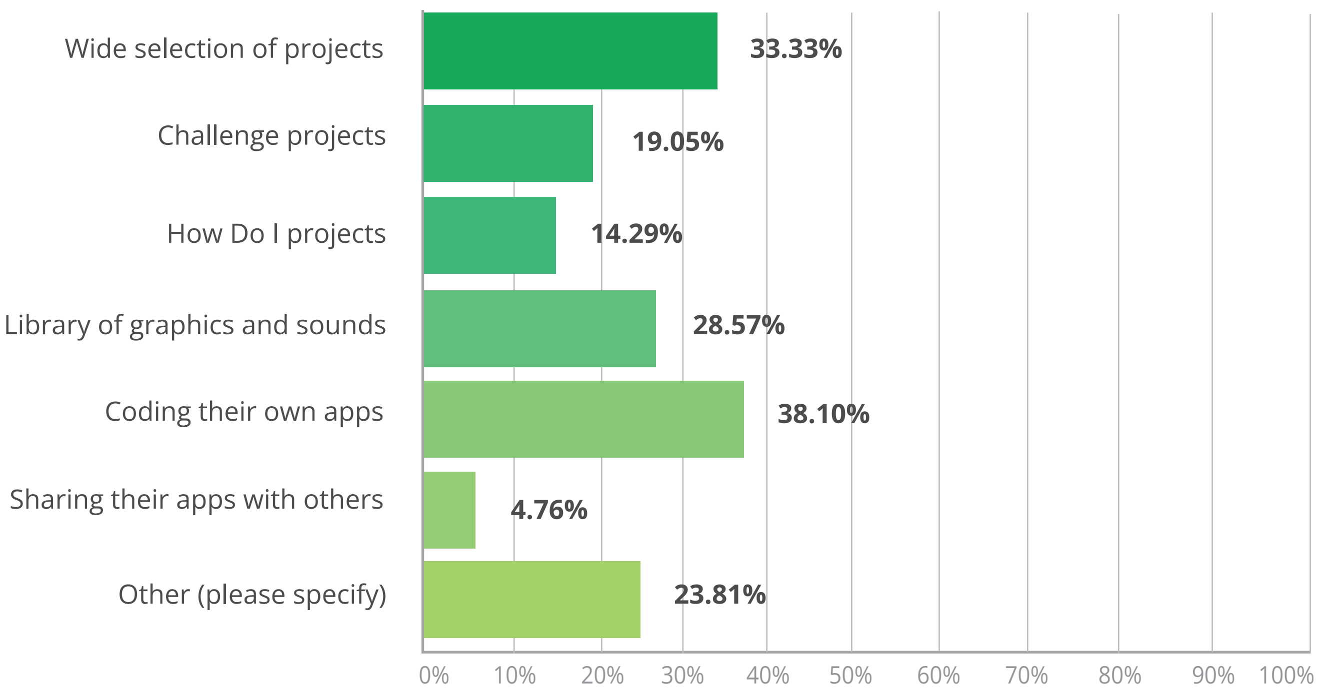
- Self contained (I teach all subjects for a grade level) **21.57%**
- Math/Science **60.78%**
- Reading/Writing/ELA **7.84%**
- Technology **1.96%**
- Extra-curriculars (I teach several extra curricular subjects and/or clubs) **0.00%**
- Computers **0.00%**
- Other (please specify) **7.84%**

Other responses: included "admin," "language," and "social studies/science"

Q6 HOW MUCH DO STUDENTS ENJOY STEMSCOPES CODING?

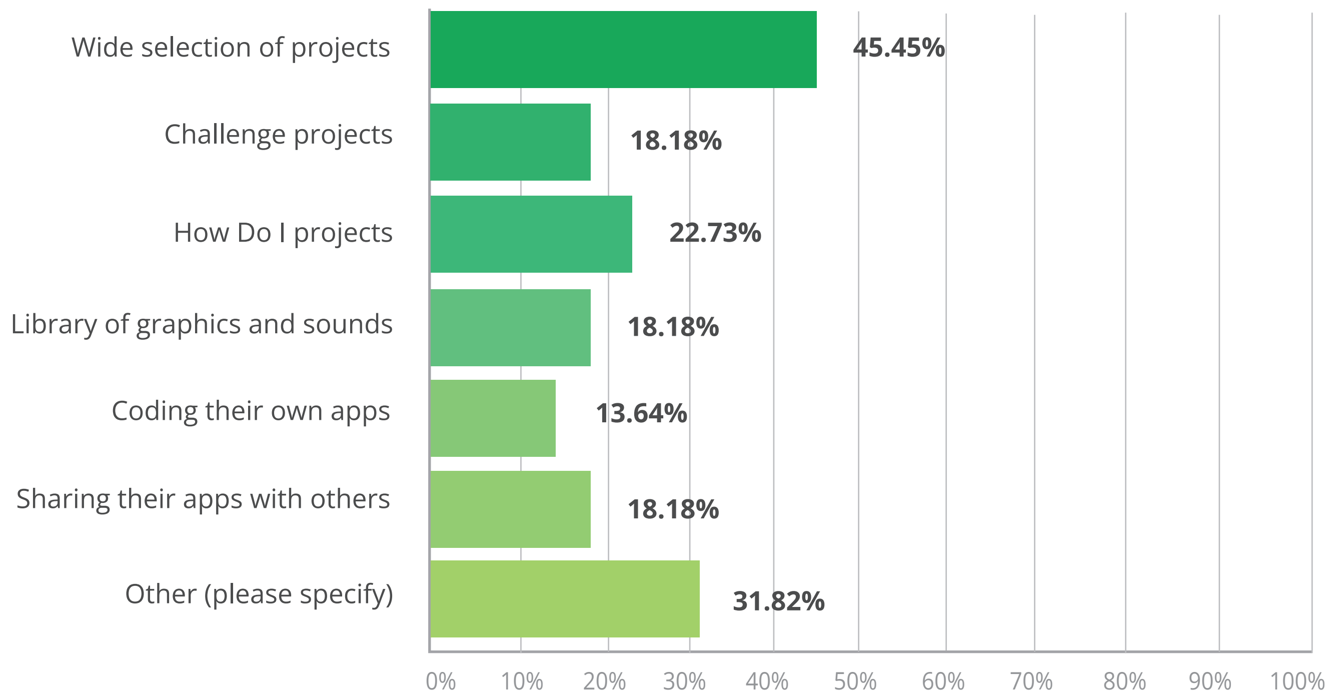


Q7 WHAT DO YOU FEEL IS STUDENTS' FAVORITE FEATURE OF STEMSCOPES CODING?



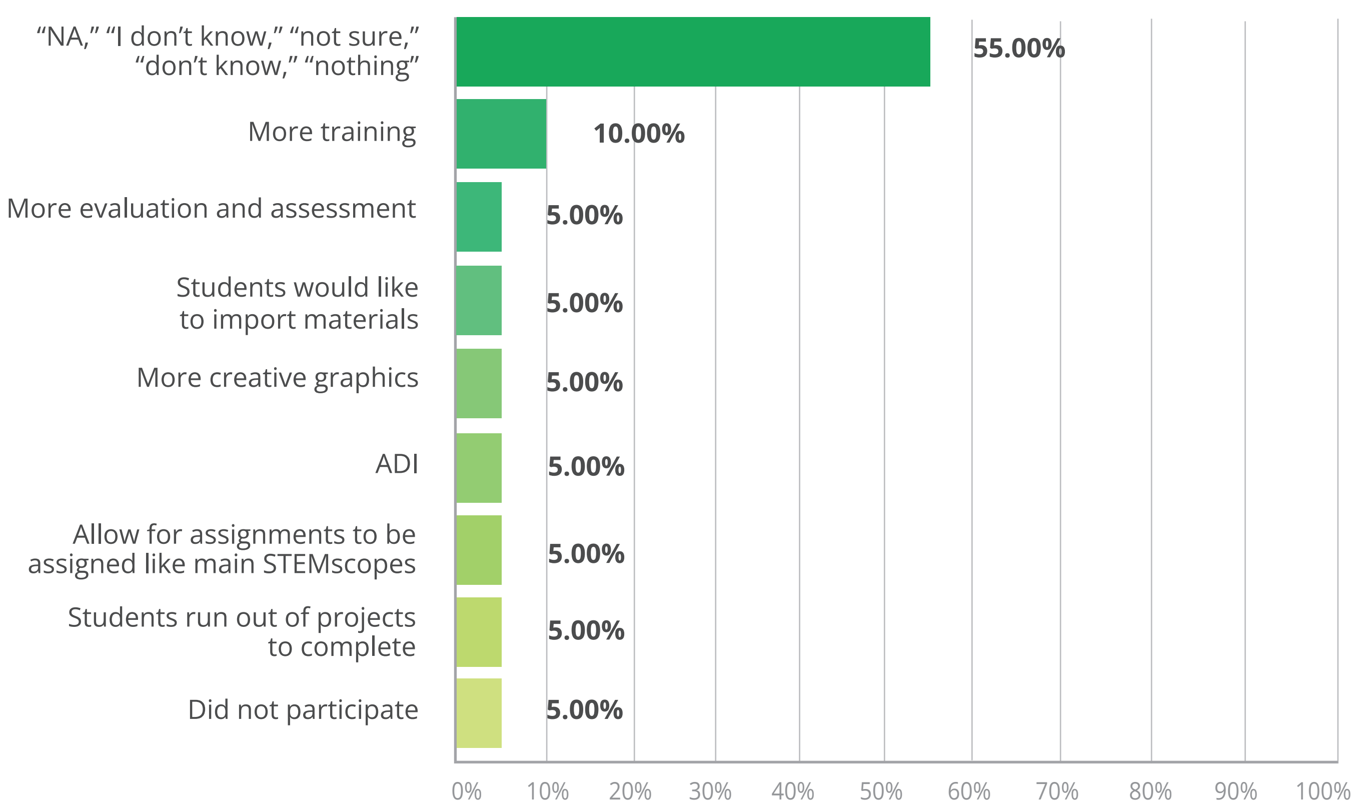
Other responses: included "did not participate" or "unsure."

Q8 WHAT ELEMENTS OF STEMSCOPES CODING DO YOU LIKE?



Other responses: included "teacher materials make it easy to teach" "not sure" and "have not tried"

Q9 WHAT ELEMENTS OF STEMSCOPES CODING WOULD YOU LIKE TO SEE IMPROVED? (OPEN-ENDED)



Q10 APPROXIMATELY HOW OFTEN DO YOU INCLUDE STEMSCOPES CODING IN YOUR CURRICULA?

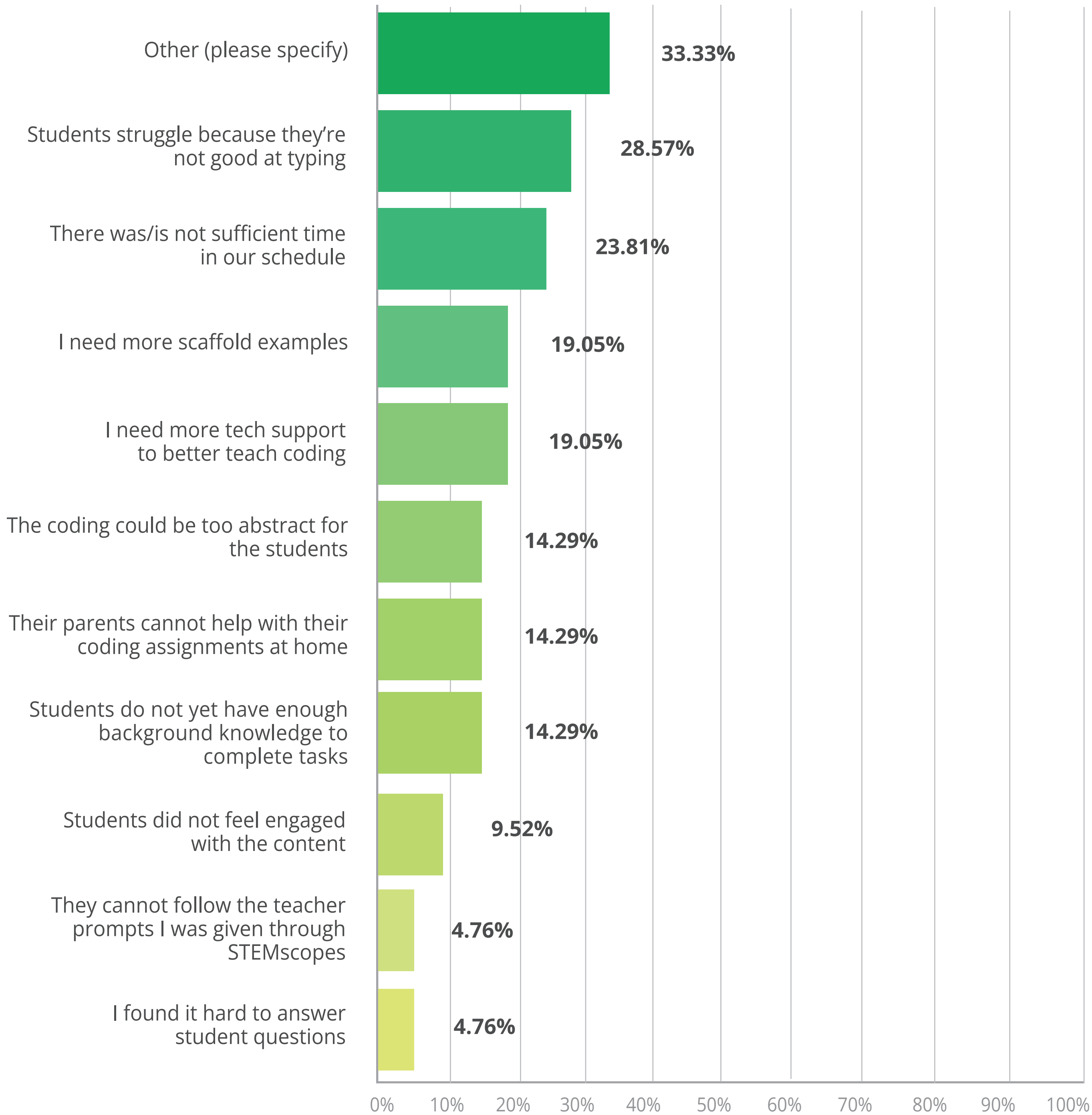
- Every day **15.00%**
- A few times a week **35.00%**
- About once a week **10.00%**
- A few times a month **5.00%**
- Once a month **10.00%**
- Less than once a month **25.00%**

Q11 WHEN TEACHING CODING, APPROXIMATELY HOW MUCH TIME DO YOU ALLOCATE TO STEMSCOPES CODING?

- Less than 15 minutes **22.73%**
- 15 - 30 minutes **9.09%**
- 30 - 45 minutes **31.82%**
- 45 - 60 minutes **13.64%**
- More than 60 minutes **0.00%**
- Other (please specify) **22.73%**

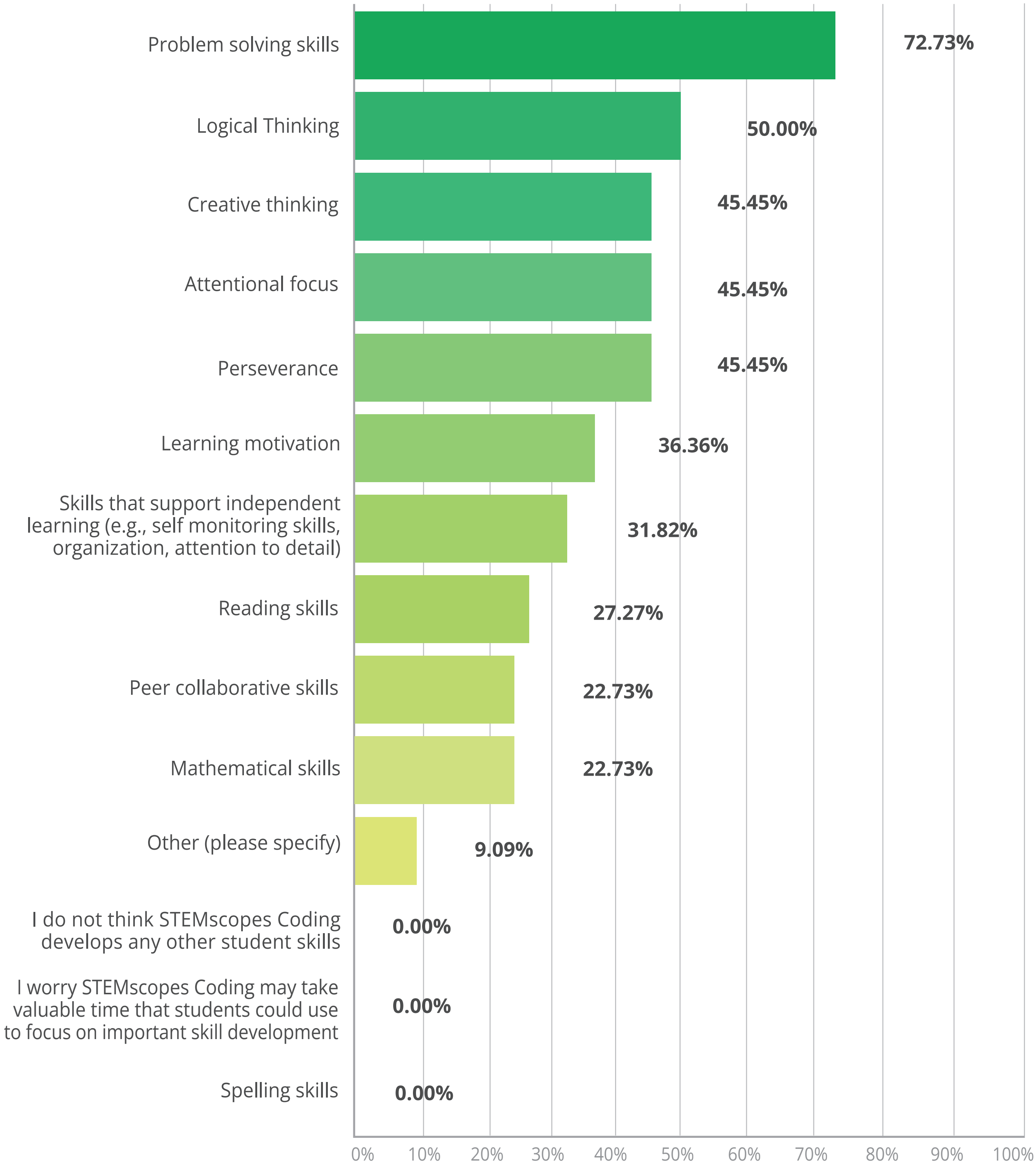
Other responses: included "NA," "not sure," and "did not participate."

Q12 WHAT ARE SOME DIFFICULTIES YOU OR YOUR STUDENTS ENCOUNTERED?



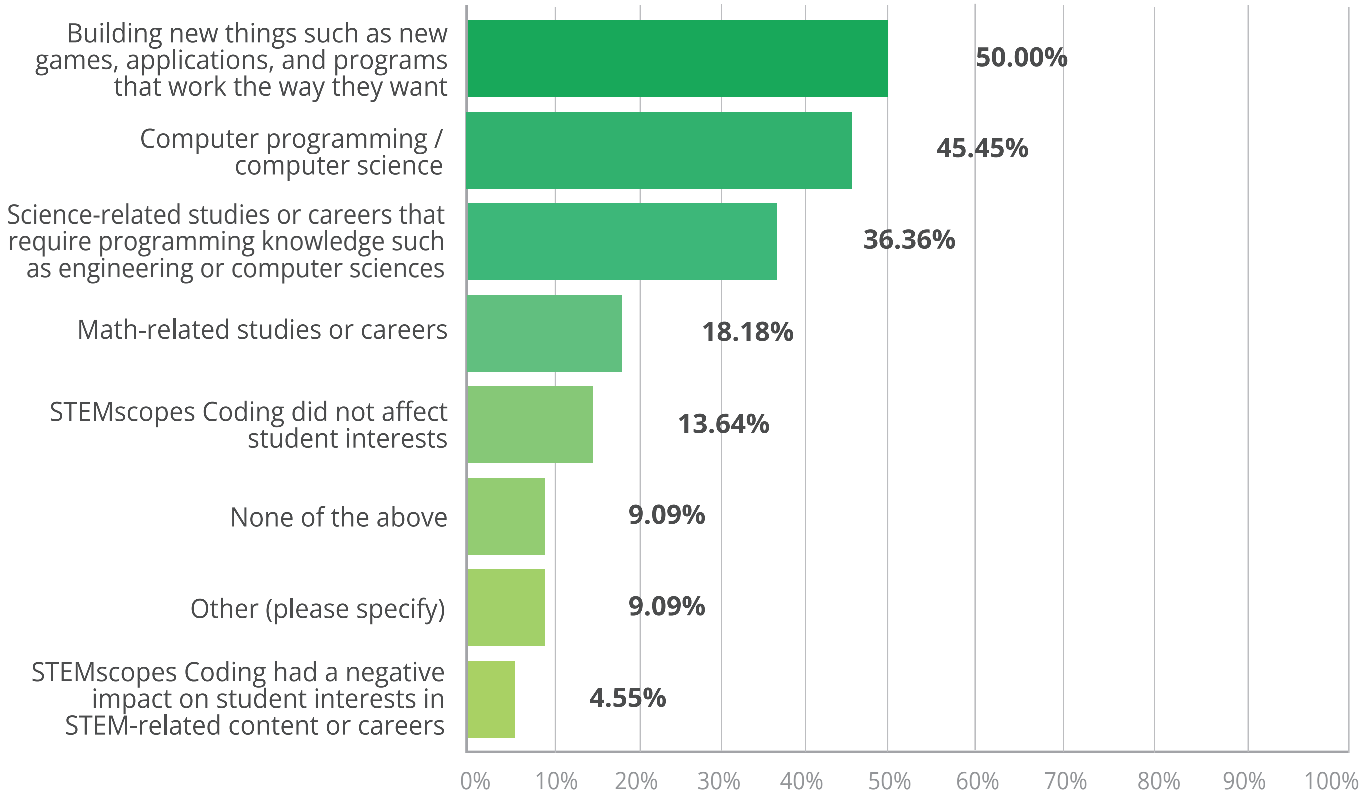
Other responses: included "NA," "not sure," "challenges were hard for some students (but that is ok!)," "have tried it just doing scopes," and "cannot assign the activities to students"

Q13 ARE THERE ADDITIONAL SKILLS (APART FROM CODING SKILLS) OR STUDENT QUALITIES THAT YOU FEEL STEMSCOPES CODING MAY HELP STUDENTS DEVELOP? PLEASE CHECK ALL THAT APPLY.



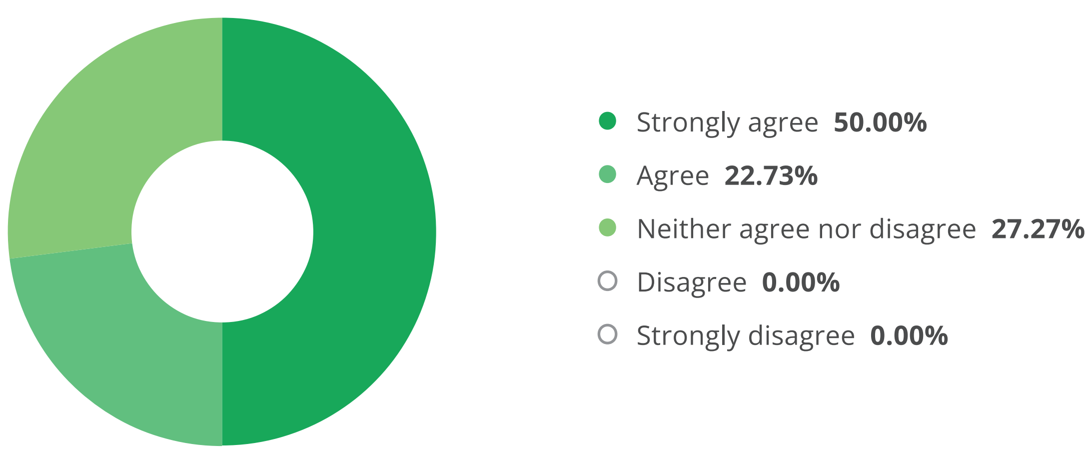
Other responses: included "NA" and "I don't know"

Q14 STEMSCOPES CODING HELPS STUDENTS DEVELOP AN INTEREST IN ... ? CHECK ALL THAT APPLY.

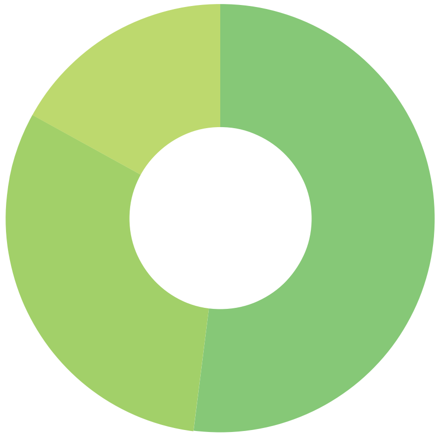


Other responses: include "NA"

Q15 I WOULD RECOMMEND STEMSCOPES CODING CONTINUE TO BE USED BY MY SCHOOL AND/OR DISTRICT.

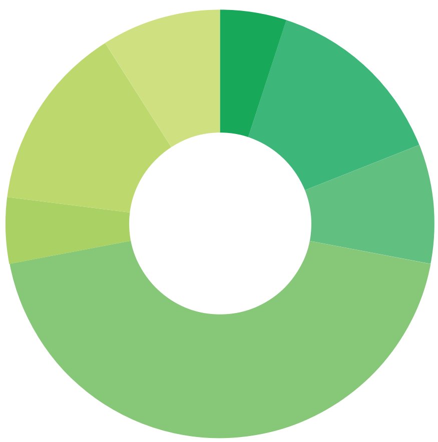


Q16 IT TAKES TOO MUCH EFFORT FOR ME TO TEACH STEMSCOPES CODING.



- Strongly agree **0.00%**
- Agree **0.00%**
- Neither agree nor disagree **52.17%**
- Disagree **30.43%**
- Strongly disagree **17.39%**

Q17 I HAVE ALL THE MATERIALS AND SUPPORT I NEED TO SUPPORT STUDENT LEARNING OF STEMSCOPES CODING.

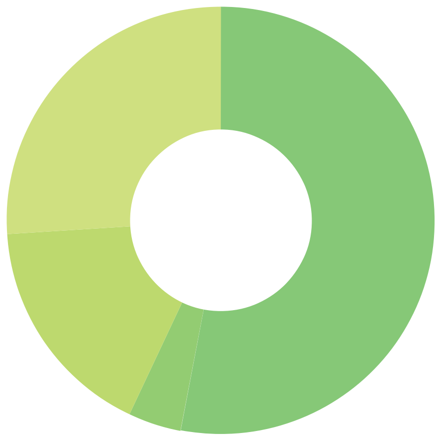


- Strongly agree **4.55%**
- Agree **13.64%**
- Somewhat agree **9.09%**
- Neither agree nor disagree **45.45%**
- Somewhat disagree **4.55%**
- Disagree **13.64%**
- Strongly disagree **9.09%**

Q18 IT IS IMPORTANT TO HAVE GOOD COMPUTER CODING KNOWLEDGE AND SKILLS TO GET A JOB IN TODAY'S WORLD.

- Strongly agree **13.04%**
- Agree **26.09%**
- Somewhat agree **13.04%**
- Neither agree nor disagree **30.43%**
- Somewhat disagree **8.70%**
- Disagree **0.00%**
- Strongly disagree **8.70%**

Q19 HELPING MY STUDENTS WITH STEMSCOPES CODING ACTIVITIES MAKES ME FEEL STRESSED.

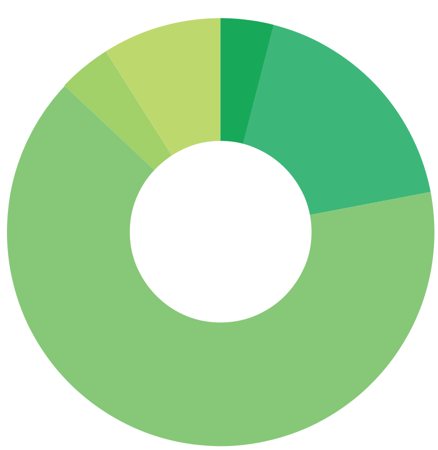


- Strongly agree **0.00%**
- Agree **0.00%**
- Somewhat agree **0.00%**
- Neither agree nor disagree **52.17%**
- Somewhat disagree **4.35%**
- Disagree **17.39%**
- Strongly disagree **26.09%**

Q20 I AM INTERESTED IN COMPUTER PROGRAMMING AND/OR CODING-RELATED SKILLS.

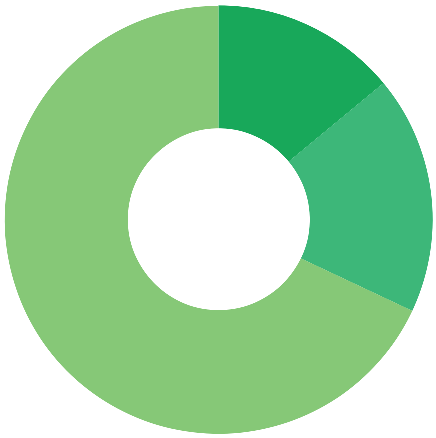
- Strongly agree **13.04%**
- Agree **26.09%**
- Neither agree nor disagree **43.48%**
- Disagree **4.35%**
- Strongly disagree **13.04%**

Q21 AT THE BEGINNING OF THE YEAR, I EXPECTED MY STUDENTS WOULD DO VERY WELL IN THE STEMSCOPES CODING PROGRAM.



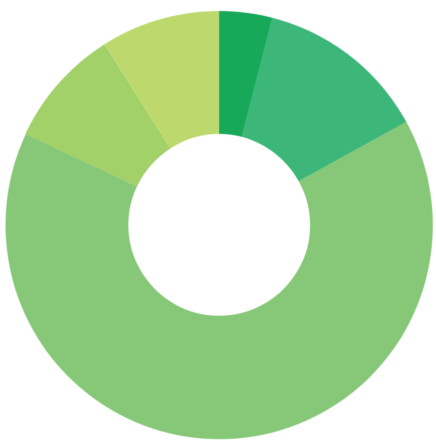
- Strongly agree **4.35%**
- Agree **17.39%**
- Neither agree nor disagree **65.22%**
- Disagree **4.35%**
- Strongly disagree **8.70%**

Q22 STUDENTS HAVE MET MY EXPECTATIONS THIS YEAR IN REGARDS TO STEMSCOPES CODING.



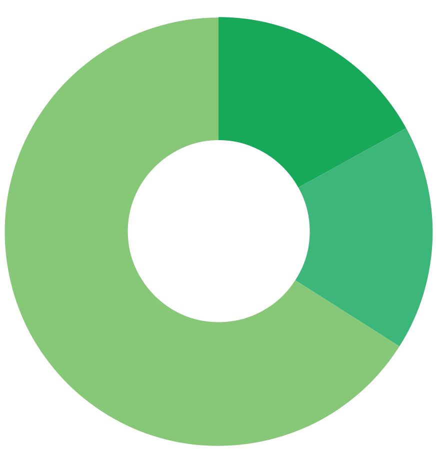
- Strongly agree **13.64%**
- Agree **18.18%**
- Neither agree nor disagree **68.18%**
- Disagree **0.00%**
- Strongly disagree **0.00%**

Q23 AT THE BEGINNING OF THE SCHOOL YEAR, I FELT CONFIDENT THAT I COULD SUPPORT STUDENT LEARNING OF CODING.



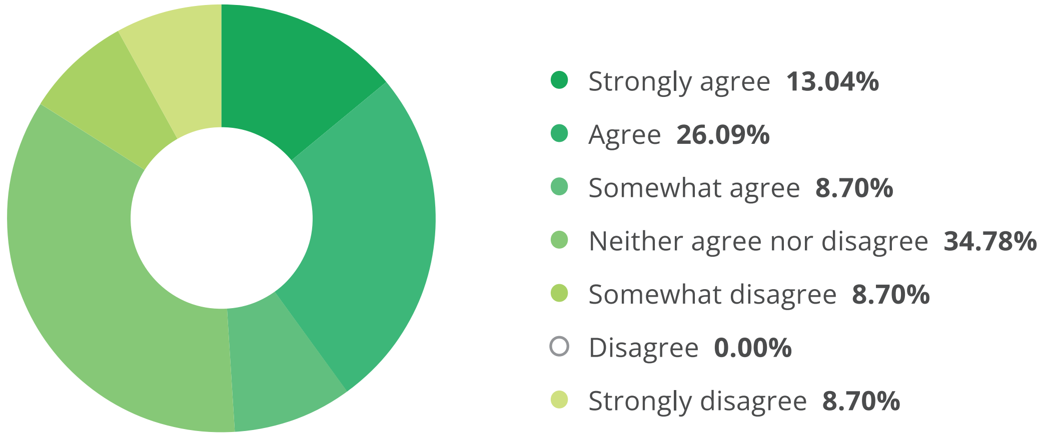
- Strongly agree **4.35%**
- Agree **13.04%**
- Neither agree nor disagree **65.22%**
- Disagree **8.70%**
- Strongly disagree **8.70%**

Q24 NOW (AT THE END OF THE YEAR): I FEEL CONFIDENT THAT I AM SUPPORTING MY STUDENTS' LEARNING OF CODING.

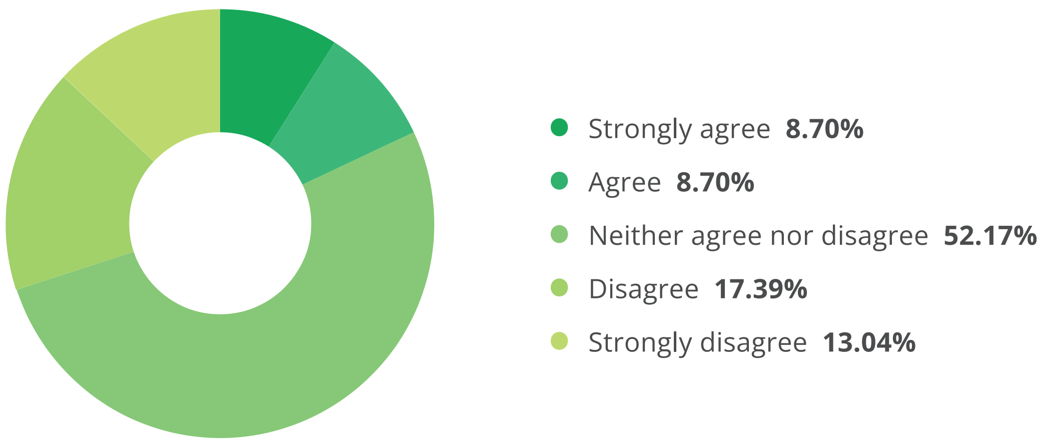


- Strongly agree **17.39%**
- Agree **17.39%**
- Neither agree nor disagree **65.22%**
- Disagree **0.00%**
- Strongly disagree **0.00%**

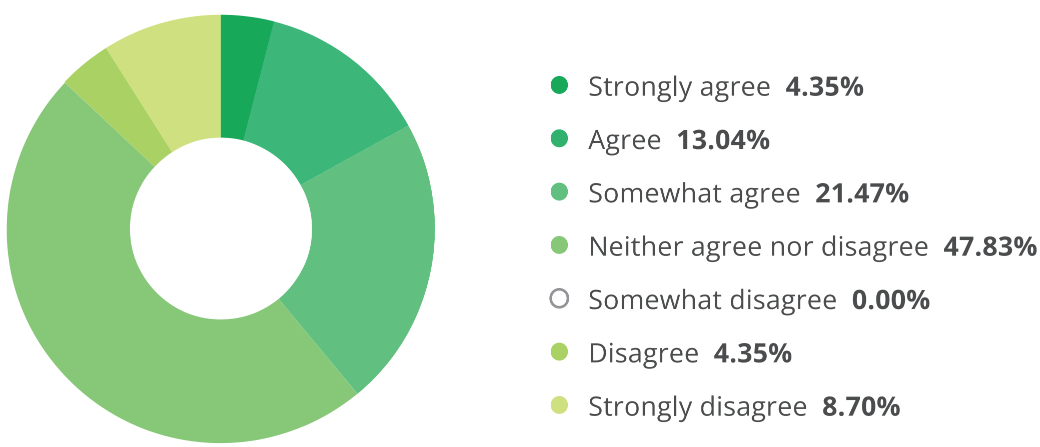
Q25 IT IS IMPORTANT FOR MY STUDENTS TO LEARN ABOUT CODING.



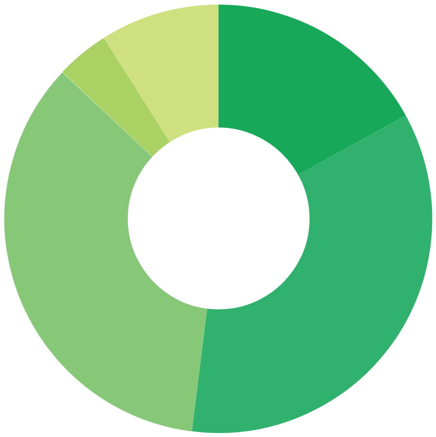
Q26 BECAUSE OF OTHER SUBJECTS I NEED TO TEACH, I DID NOT/DO NOT HAVE ENOUGH TIME FOR DOING STEMSCOPES CODING WITH STUDENTS.



Q27 I FEEL COMFORTABLE HELPING MY STUDENTS WITH STEMSCOPES CODING.

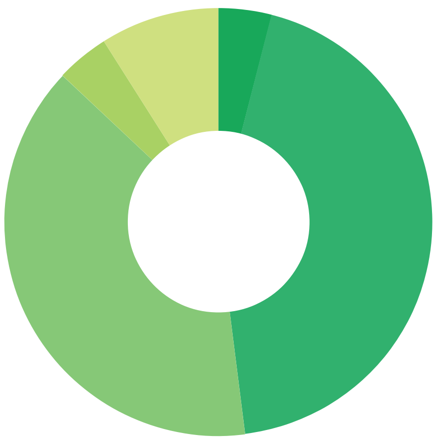


Q28 ON THE JOB MARKET, IT HELPS TO HAVE GOOD COMPUTER CODING KNOWLEDGE AND SKILLS.



- Strongly agree **17.39%**
- Agree **34.78%**
- Neither agree nor disagree **34.78%**
- Disagree **4.35%**
- Strongly disagree **8.70%**

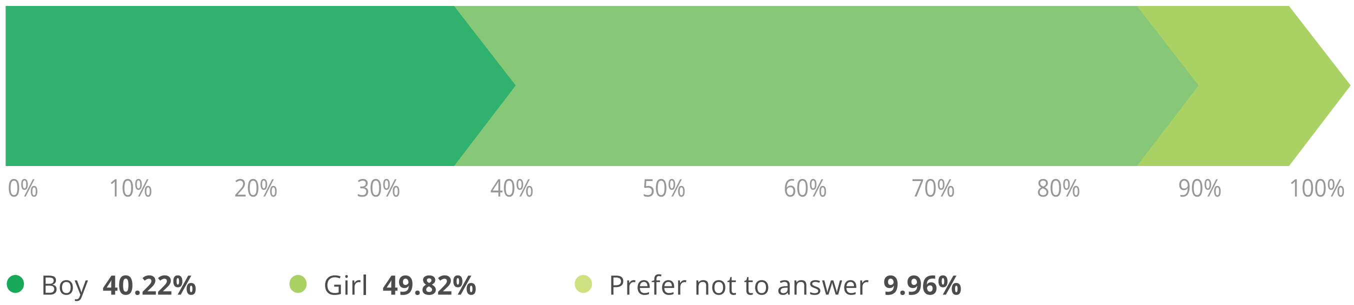
Q29 ANYBODY CAN LEARN CODING SKILLS.



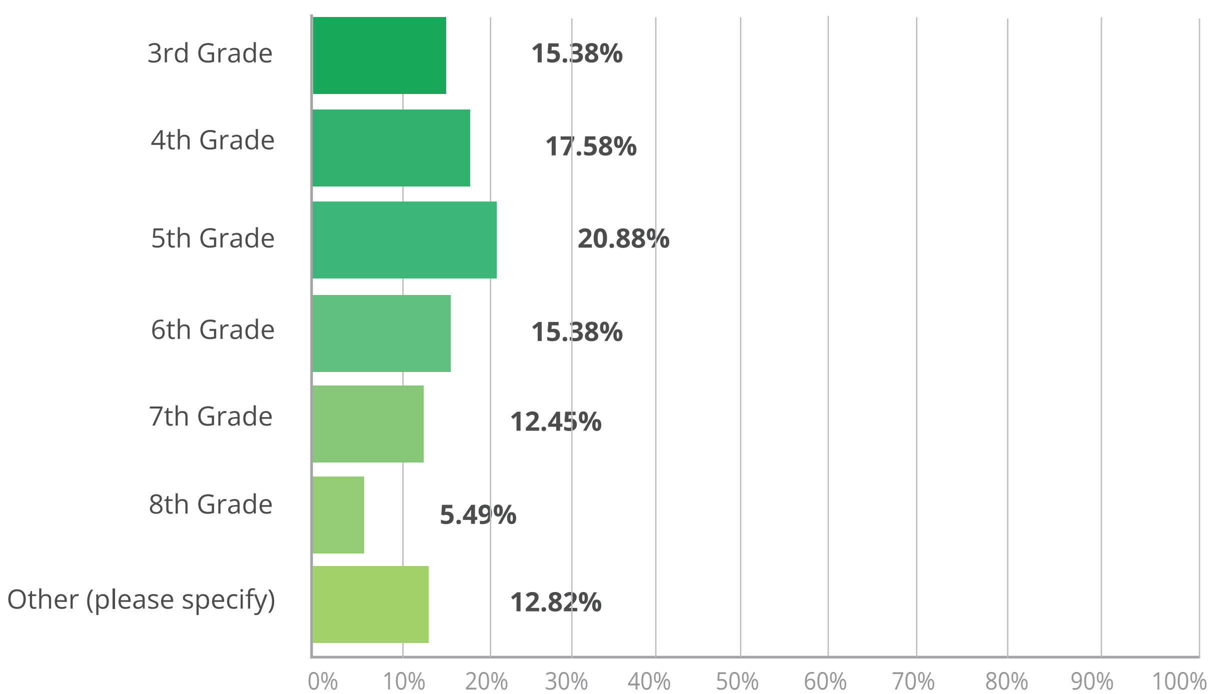
- Strongly agree **4.35%**
- Agree **43.48%**
- Neither agree nor disagree **39.13%**
- Disagree **4.35%**
- Strongly disagree **8.70%**

2. STUDENT ITEMS

Q1 ARE YOU A BOY OR A GIRL?

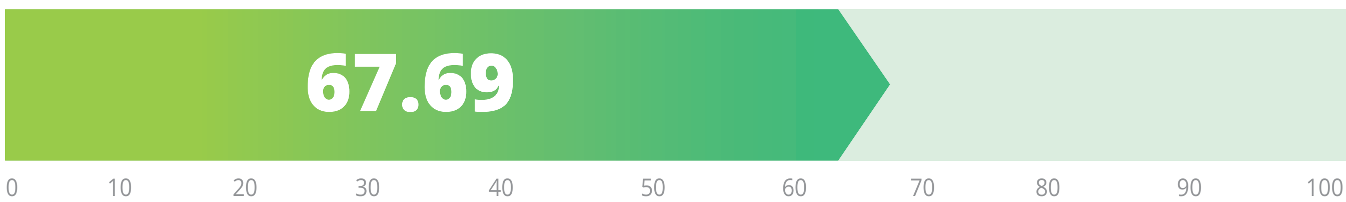


Q2 WHAT GRADE ARE YOU IN?

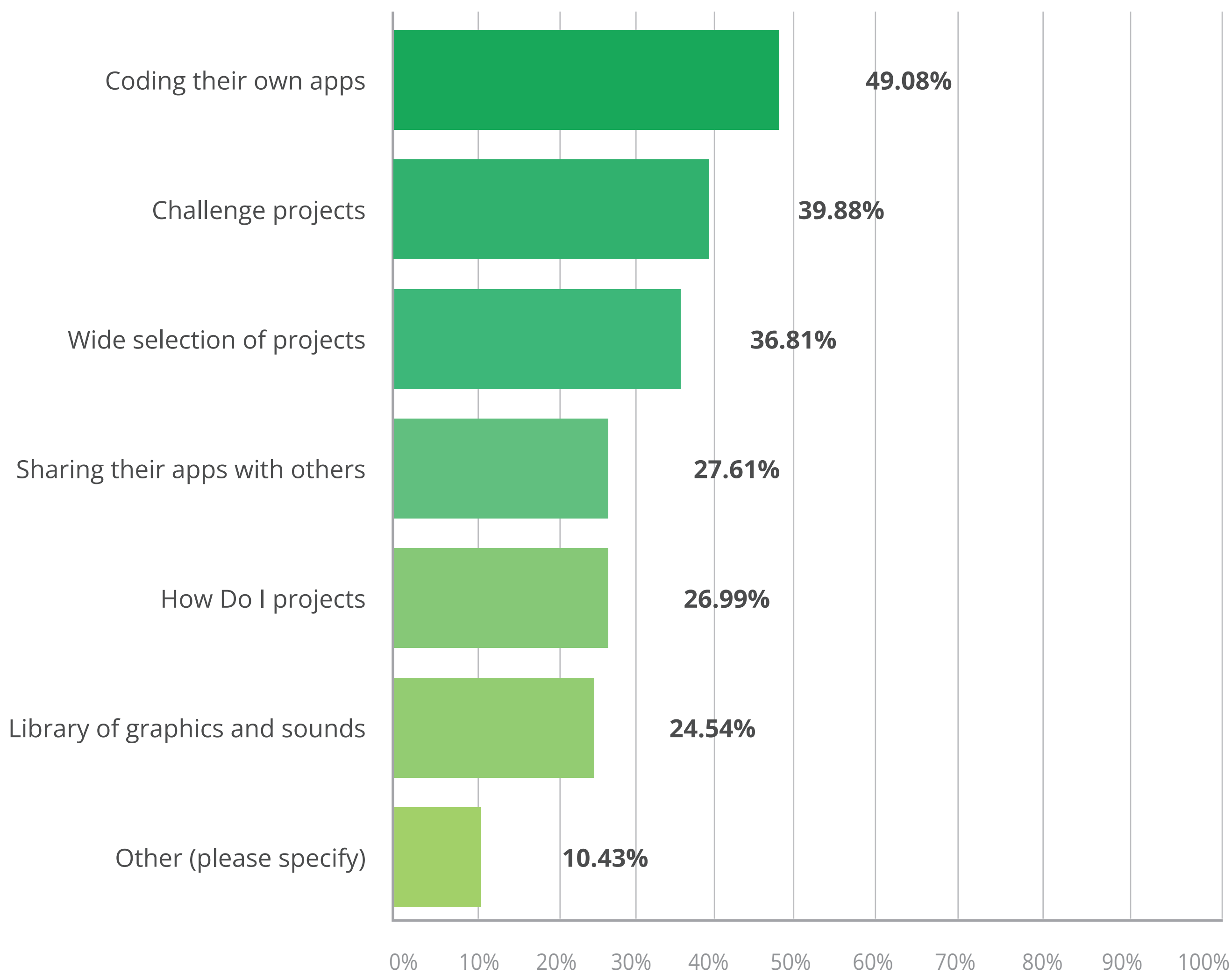


Other responses: included 1st and 2nd grade, 9th - 12th grade

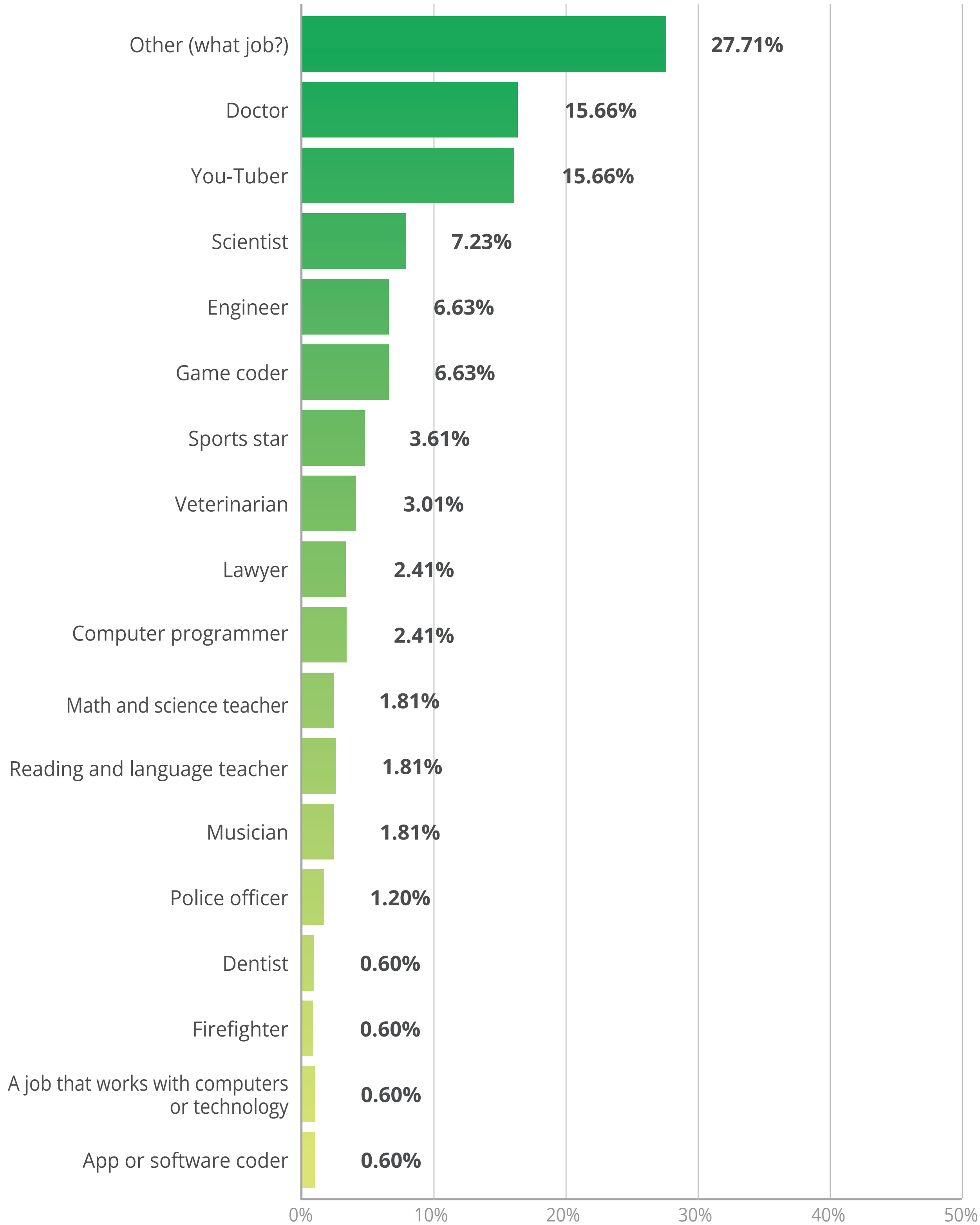
Q3 DO YOU LIKE LEARNING ABOUT CODING?



Q4 WHAT ARE YOUR FAVORITE THINGS ABOUT CODING SO FAR?



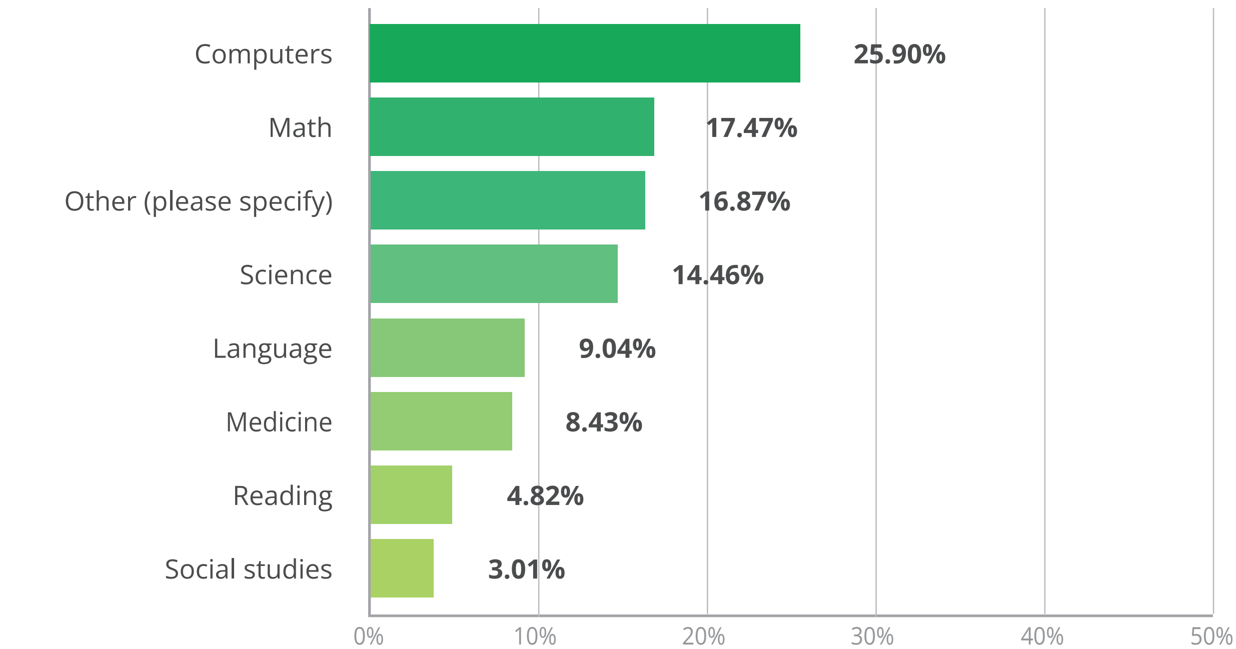
Q5 WHAT WOULD YOU LIKE TO BE WHEN YOU GROW UP?



Other responses: included artist (6), I don't know (3), chef (2), astronaut (2), army (2), architect (2), author, orthodontist, anime creator/astronomer, actor & animator, dancer, doctor, nanotechnology, teacher, vet or you-tuber, psychologist, pilot, 5th grade teacher, marine biologist, CEO of my own company, chicken nugget tester, dance teacher, NICU nurse, hunter, chief, basketball player, sports star or tik toker, FBI, paleontologist, surgeon or serve in the military, a music producer/music engineer, producer, and a speech therapist.

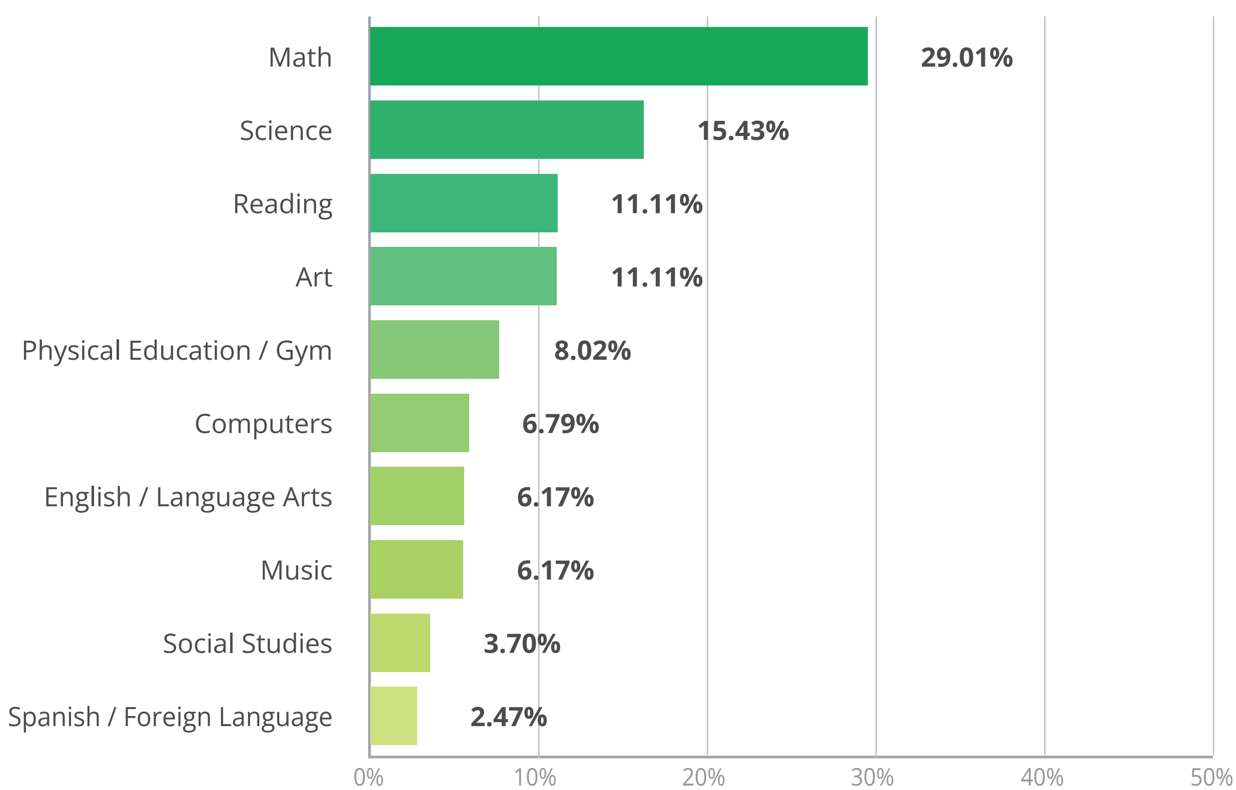
Note: Other responses that could be categorize (e.g., doctor, vet, paleontologist as a type of scientist etc.) were included in the percentages presented in the main report.

Q6 IF YOU GO TO COLLEGE, WHAT SUBJECT WOULD YOU LIKE TO STUDY?

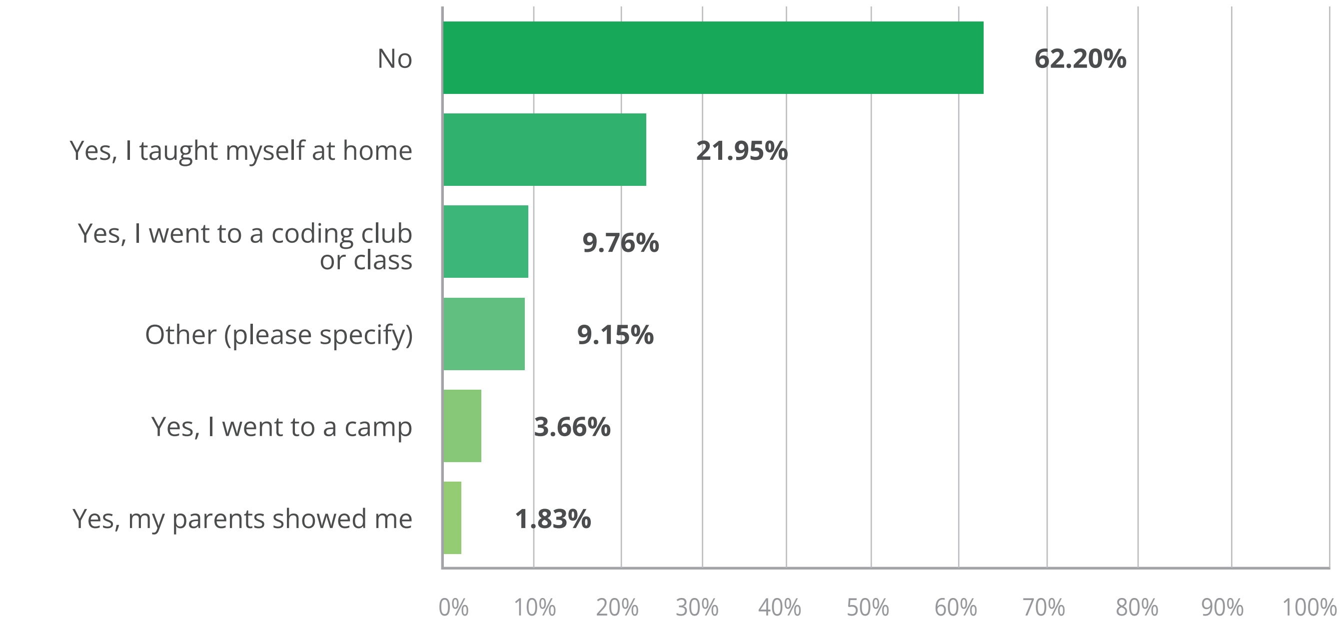


Other responses: included art (5), music (3), I don't know (2), law, coding, sports, acting, animal studies, all of them, teacher, coder, engineering, football, basketball, architecture, choir, psychology, poetry, and speech therapy.

Q7 WHAT IS YOUR FAVORITE SUBJECT RIGHT NOW?

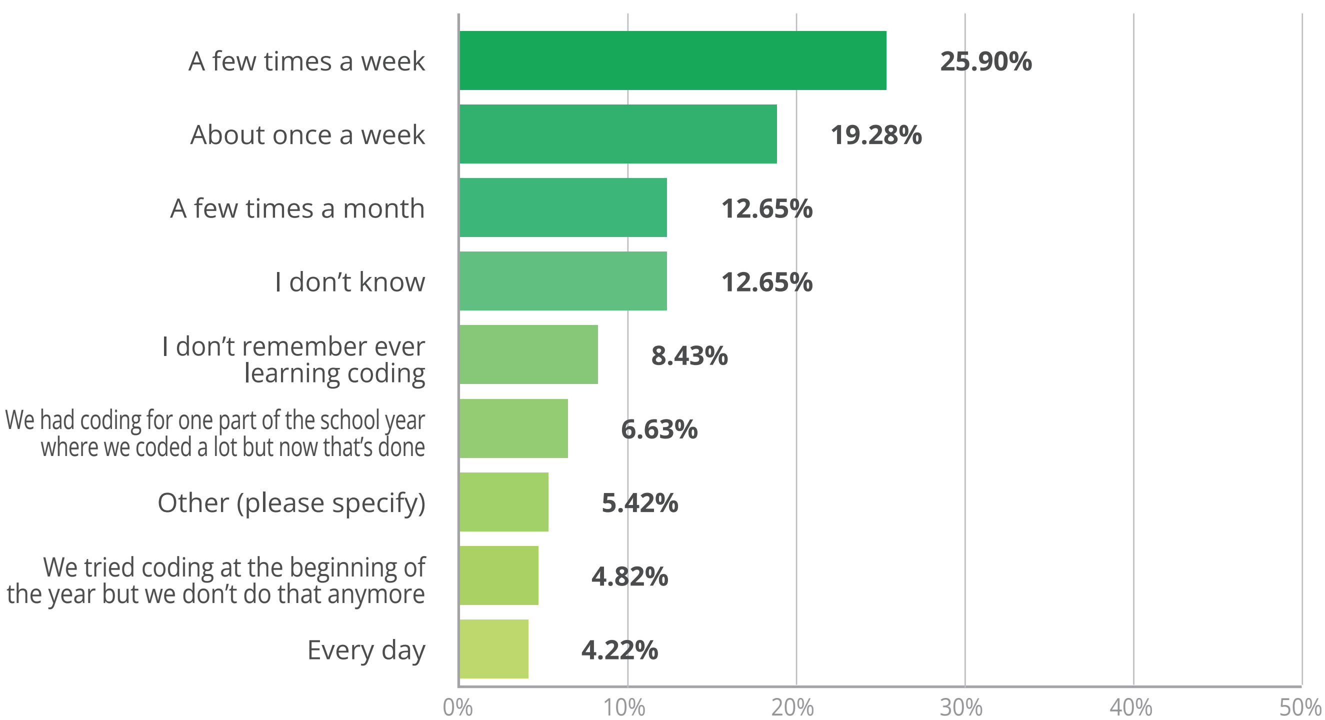


Q8 HAVE YOU EVER DONE CODING OUTSIDE OF SCHOOL?



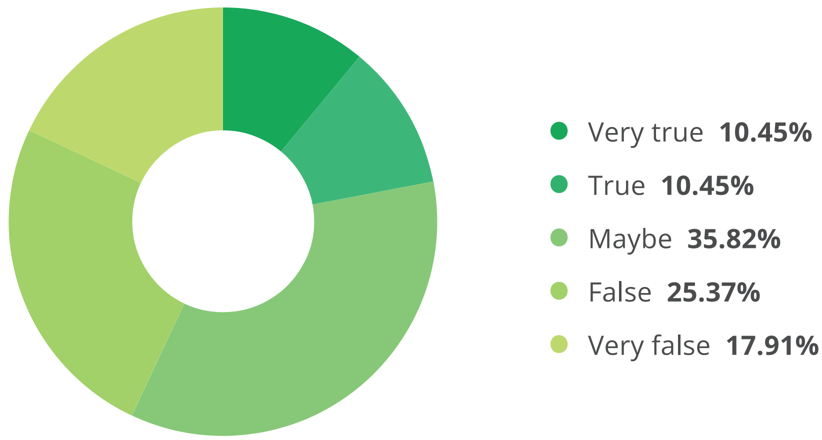
Other responses: included Yes: went to take your kids to work day, Yes: hower of code and this coding app, Yes: my dad showed me a basic coding thing, I figure out how to make small things on my own but I learn more in school, Yes (2), I don't think so, Yes: sometimes by myself, Yes: a little bit, I don't really know, Yes: code.org, Yes: I just do it for fun.

Q9 HOW MUCH TIME AT SCHOOL DID YOU SPEND CODING?

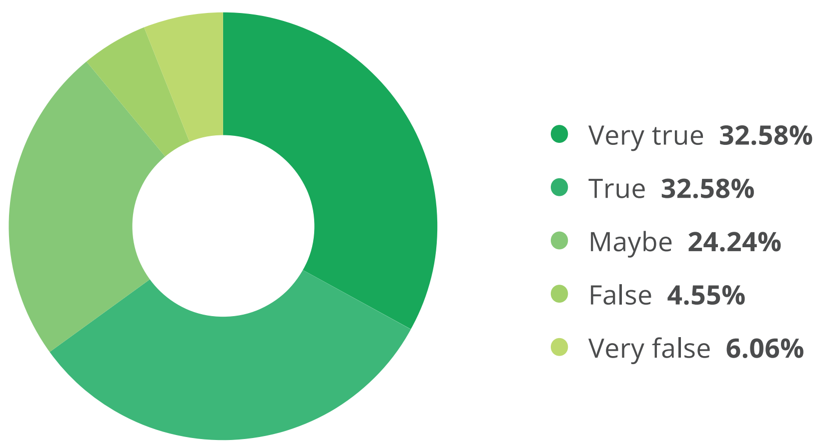


Other responses: include "it depends," not a lot, sometimes, none, I don't do coding anywhere, friday 30 minutes, a few times a week on my own, once every 4 months.

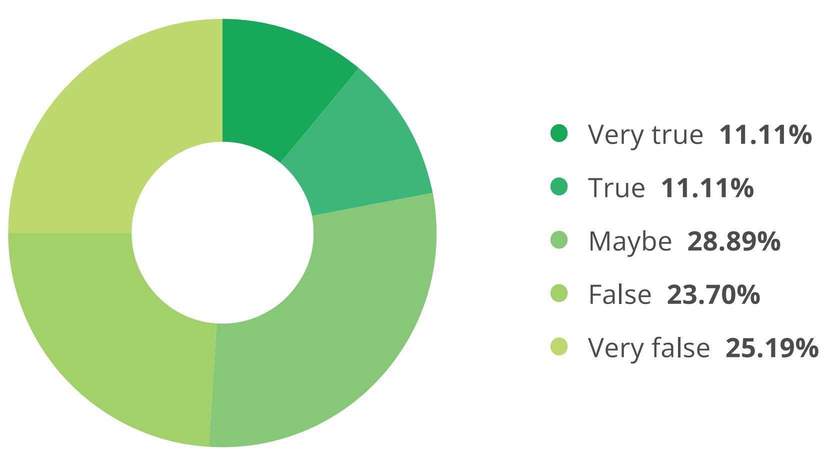
Q10 IT IS TOO HARD FOR ME TO LEARN ABOUT CODING.



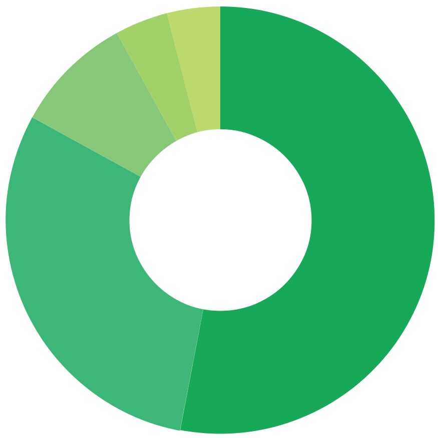
Q11 IT IS IMPORTANT TO HAVE GOOD COMPUTER CODING SKILLS.



Q12 CODING STRESSES ME OUT.

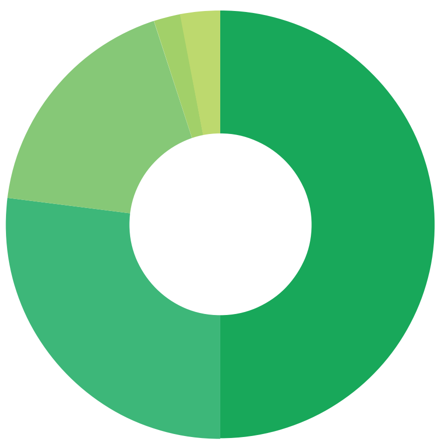


Q13 IF I TRY HARD ENOUGH, I CAN LEARN TO CODE.



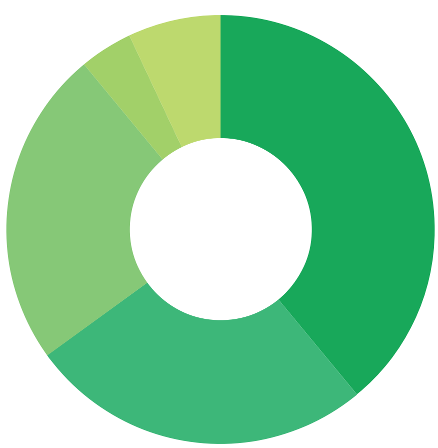
- Very true **52.99%**
- True **29.85%**
- Maybe **9.70%**
- False **3.73%**
- Very false **3.73%**

Q14 ANYBODY CAN LEARN TO CODE.



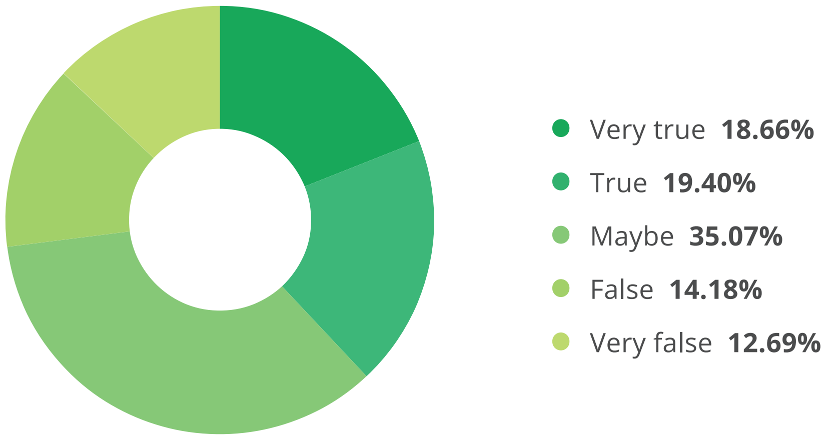
- Very true **50.00%**
- True **26.87%**
- Maybe **18.66%**
- False **1.49%**
- Very false **2.99%**

Q15 I LIKE CODING.

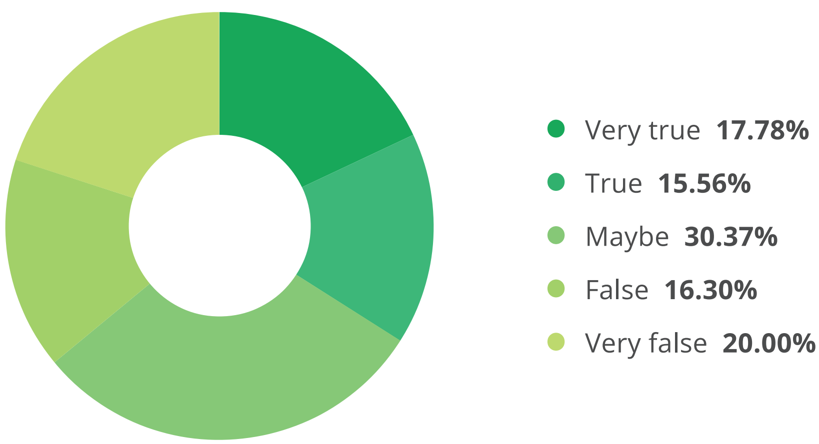


- Very true **39.10%**
- True **25.56%**
- Maybe **24.06%**
- False **3.76%**
- Very false **7.52%**

Q16 I AM GOOD AT CODING.



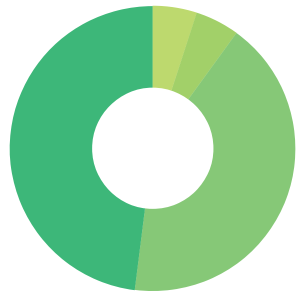
Q17 MY PARENTS WANT ME TO LEARN CODING.



Q18 HOW DO CAPITAL LETTERS AFFECT HOW CODE WORKS?

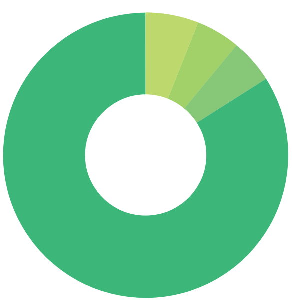
- No effect at all **35.19%**
- Using capital letters will make the code not work **16.67%**
- Using capital letters will slow down the running of the code **9.26%**
- √ In code, capital letters have a different meaning than lowercase letters **38.89%**

Q19 WHAT IS ONE OF THE LANGUAGES OF CODING?



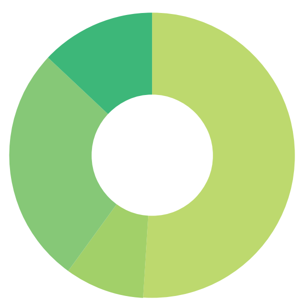
- Jaba **4.59%**
- Binary **4.59%**
- English **42.20%**
- √ JavaScript **48.62%**

Q20 CAN CODE TELL THE COMPUTER SOUNDS TO PLAY?



- No **6.48%**
- Only one sound **4.63%**
- Buttons do that **4.63%**
- √ Yes **84.26%**

Q21 WHAT WILL HAPPEN IF AN ENTIRE LINE OF CODE IS LEFT BLANK?



- The whole code will not work **51.38%**
- The code will work but run slower **9.17%**
- It depends on which line is left blank as to if it will work or not **26.61%**
- √ Nothing will happen, the code will still work **12.84%**

Note: This item was ultimately dropped, see section 3

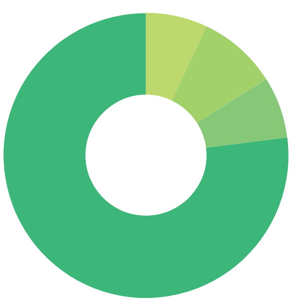
Q22 WHAT IS CODE?

- Code is groups of random letters and numbers **19.27%**
- Code is a collection of 0s and 1s that turn a computer on **11.01%**
- Code is pieces of information that are automatically loaded onto computers so they will run correctly **20.18%**
- √ Code is written instructions that tell the computer what to do **49.54%**

Q23 WHAT LINE OF CODE WOULD SUCCESSFULLY TURN THE BACKGROUND OF A SCREEN ORANGE?

- Color orange = background **22.94%**
- Fill background (orange) **32.11%**
- Orange **3.67%**
- √ Fill ('orange') **41.28%**

Q24 A BUG IN YOUR CODE MEANS THAT?



- It's too long **6.48%**
- It's missing an antenna mark **9.26%**
- It runs too slowly **7.41%**
- √ It has an error **76.85%**

Q25 WHAT LINE OF CODE BELOW **DOES NOT** HAVE A MISTAKE?

- stamp('pizza) **18.52%**
- stamp('pizza,' 400, 45 4500) **13.89%**
- stamp('pizza' 400 45 450) **11.11%**
- √ stamp('pizza,' 400, 45, 450) **56.48%**

3. DATA CLEANING, SCORING, AND INFERENTIAL STATISTICS

Teacher data. Of the initial 52 teachers, 3 were removed before analyses because they indicated in the open ended question that they had not taught using STEMscopes Coding. There was also extensive missingness with 29 teachers attriting after they filled out initial background information (e.g., grade taught, experience, and what they primarily taught). These, too, were not included in analyses (listwise deletion). Of the remaining 20 teachers, one teacher's responses followed an unusual pattern such that on the motivational questions (efficacy, cost, and value), the pattern of responses represented an outlier for efficacy and cost, relative to value with the teacher clicking the lowest possible value on any question related to themselves (efficacy and cost), and the highest possible value on any question related to students. This did not match well with other survey responses given by the teacher. We ran analyses with and without this individual included. The pattern of results were similar; we reported the results that do *not* include this individual.

We combined two questions regarding time spent with STEMscopes Coding: "Approximately how often do you include STEMscopes Coding" and "Approximately how much time do you allocate to STEMscopes Coding." For 'how often,' we converted the rating scale to numeric values (0 = less than once a month, 1 = once a month, 2 = a few times a month, 3 = once a week, 4 = a few times a week, and 5 = everyday). For how much time, we converted the scale to numeric values with 0 = less than 15 minutes, 1 = 15 - 30 minutes, 2 = 30 - 45 minutes, and 3 = 45 - 60 minutes. We added responses together. For example, if a teacher taught everyday (5) for 15-30 minutes (1), then their score was a six (5 + 1), with combined scores possibly ranging from 0–8.

We also combined responses for motivation questions (see teacher motivation questions table). Initially the survey had 14 motivation questions. We dropped 2 questions. Specifically, "Students have met my expectations this year in regards to STEMscopes Coding." We anticipated this question would be positively correlated with value questions (see correlation table below). However, it did not, and it had a very strong correlation with "At the beginning of the year (BOY), I felt confident that I could support student learning of coding" ($r = 0.98$). When a correlation is this high, it means that the 'met expectations' question is not telling us anything more than the BOY question, and the BOY question had better associations with other questions. We dropped 'met expectations.' We also dropped "anybody can learn coding skills." Initially we expected this question to correlate with efficacy questions, but it fit equally well with value questions, making it difficult to include on either scale. Finally, after looking at the correlations, the question "NOW I feel confident that I am supporting my students' learning of coding" was most strongly (negatively) associated with the cost questions. With this in mind, we reverse coded the question. Reverse coding means that, conceptually, the question now should be read "Now I *do not* feel confident that I am supporting my students' learning of coding"

Among the final 12 questions: 4 were averaged as the Cost subscale (questions 1, 4, 9, and 11 in the table below), 4 were averaged as the Value subscale (questions 3, 5, 10, 13), and 4 as the Efficacy subscale (questions 2, 6, 8, 12). We calculated means and alpha reliability for each scale, and the correlations between scales (see subscale properties table below). Means indicated that as a group teachers 'somewhat disagree' regarding the cost of using STEMscopes Coding. They tended to be neutral regarding their own feeling of efficacy, and they "somewhat agreed" regarding the general value of learning coding. Reliabilities were above 0.80 suggesting good subscale reliability (the questions are measuring the same thing), and correlations indicated that each scale is measuring something different as scales were either not significantly correlated or were only moderately (versus strongly) correlated.

TABLE **TEACHER MOTIVATION QUESTIONS ACHIEVEMENT?**

1.	It takes too much effort for me to teach STEMscopes Coding. (effort) C
2.	I have all the materials and support I need to support student learning of STEMscopes Coding. (materials) E
3.	It is important to have good computer coding knowledge and skills to get a job in today's world. (important1) V
4.	Helping my students with STEMscopes Coding activities makes me feel stressed. (stressed) C
5.	I am interested in computer programming and/or coding-related skills. (interested)
6.	At the beginning of the year, I expected my students would do very well in the STEMscopes Coding program. (boy_expect) E
7.	Students have met my expectations this year in regards to STEMscopes Coding. (met_exp)
8.	At the beginning of the school year, I felt confident that I could support student learning of coding. (boy_confident) E
9.	NOW I (do not) feel confident that I am supporting my students' learning of coding. (now_confidentR) C
10.	It is important for my students to learn about coding. (important2) V
11.	Because of other subjects I need to teach, I did not/do not have enough time for doing STEMscopes Coding with students. (no_time) C
12.	I feel comfortable helping my students with STEMscopes Coding. (comfortable) E
13.	On the job market, it helps to have good computer coding knowledge and skills. (important3) V
14.	Anybody can learn coding skills. (anybody_code)

Note: The parenthetical nickname is used in the correlation table. **C = cost, V= value, E = efficacy**

TABLE **CORRELATIONS BETWEEN TEACHER MOTIVATION QUESTIONS.**

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. too_effort C	1.00													
2. materials E	-0.31	1.00												
3. important1 V	-0.18	0.12	1.00											
4. stressed C	0.83	-0.37	-0.23	1.00										
5. interested V	-0.39	0.09	**0.67**	-0.37	1.00									
6. boy_expect E	-0.17	**0.62**	0.44	-0.4	0.32	1.00								
7. met_exp	**-0.66**	**0.48**	0.1	**-0.82**	0.08	0.28	1.00							
8. boy_confident E	-0.19	**0.61**	0.32	-0.21	0.34	**0.47**	0.47	1.00						
9. now_confidentR C	**-0.66**	0.46	0.17	**-0.84**	0.15	0.42	**0.98**	0.36	1.00					
10. important2 V	**-0.46**	0.33	**0.71**	**-0.52**	**0.85**	**0.61**	0.27	0.42	0.35	1.00				
11. no_time C	**0.47**	-0.26	0.24	0.36	0.02	0.32	**-0.53**	0.02	-0.39	0.07	1.00			
12. comfortable E	**-0.47**	**0.58**	**0.57**	**-0.56**	**0.66**	**0.6**	0.45	**0.6**	**0.52**	**0.71**	-0.14	1.00		
13. important3 V	-0.18	0.25	**0.93**	-0.28	**0.75**	**0.57**	0.07	0.44	0.15	**0.81**	0.24	**0.64**	1.00	
14. anybody_code	-0.38	0.46	**0.68**	-0.41	**0.80**	**0.62**	0.13	0.41	0.20	**0.92**	0.06	**0.73**	**0.83**	1.00

Note: Cells are color coded with reds indicating increasingly negative correlations, yellow indicating weak correlations, and greens indicating increasingly stronger correlations. Bold values are significant at $p < .05$. Full question names are in the table above. C = cost, V = value, and E = efficacy.

TABLE **SUBSCALE PROPERTIES**

	Cost	Efficacy	Value
Means (SD)	2.18 (1.1)	3.37 (1.0)	4.08 (1.3)
Alpha reliability	0.85	0.84	0.94
Correlations			
Cost	1.00		
Efficacy	-0.43	1.00	
Value	-0.23	0.53	1.00

Once cleaning and scoring were completed, we ran several analyses with cost, efficacy and value separately predicting (combined) time spent using STEMscopes Coding, teacher reported student enjoyment, and teacher's recommendations that districts continue to use STEMscopes. The tables below include information from each of these analyses.

TABLE **TEACHER REGRESSION ANALYSES**

variable	b estimate	std. err	p-value
Regression predicting time spent by cost			
Cost	-0.89	0.64	0.19
Regression predicting time by efficacy			
Efficacy	0.96	0.67	0.17
Regression predicting time by efficacy			
Value	1.12	0.47	**0.03***

variable	b estimate	std. err	p-value
Regression predicting student enjoyment spent by cost			
Cost	-3.28	6.43	0.62
Regression predicting student enjoyment by efficacy			
Efficacy	14.94	5.51	**0.02***
Regression predicting student enjoyment by value			
Value	9.16	4.63	0.07^t

variable	b estimate	std. err	p-value
Regression predicting recommendation by cost			
Cost	-0.34	0.4	0.06^t
Regression predicting recommendation by efficacy			
Efficacy	1.12	0.7	0.67
Regression predicting recommendation by value			
Value	0.16	0.15	0.29

$p<.05$; $^t<.10$

Student data. Of the initial 274 students, 2 students were removed as open ended answers were nonsensical and indicated that the students were not being serious while filling out the survey (e.g., responses were all about Fortnite wins). There was also extensive missingness with 165 students providing at least some data that was used during the analyses while 108 completed the survey.

We combined the motivation questions for students. The student survey included 8 motivation questions that were all used in the analyses (see student motivation questions table below). Two questions were averaged to form the Cost subscale (questions 1 and 3 below), three questions formed the Efficacy subscale (questions 5, 6, and 7), and three questions to form the Value subscale (Questions 2, 4, and 8). We calculated means and alpha reliability for each scale, and the correlations between scales (see subscale properties table below). Means indicated that as a group students 'maybe' regarded that there was a motivational cost of coding. They tended to rate statements regarding their own feelings of efficacy as 'true', and statements regarding the general value of learning coding as true. Reliabilities were initially somewhat low. However, this may relate to the fact that younger children tend to be more inconsistent raters (and reliability is capturing consistency across questions). As a test, we re-ran reliability with 5th grade and above, and reliability levels were more acceptable (although still slightly low for cost). Correlations indicated that each scale is measuring something different as scales were either not significantly correlated or were only moderately (versus strongly) correlated.

We also combined data from the knowledge check by summing responses together into a total score. We did not include question 8 in the table below as this question had less than 25% correct ("at chance" response for a multiple choice question with 4 options). This means there was something confusing about this question that it did not include even "at chance" scoring. It was removed immediately. Among the remaining 7 items, correlations between items are presented in the table below, as well as the overall mean and alpha reliability. Between item correlations are small to moderate. Once again, this is somewhat expected on multiple choice items (where there is some level of guessing) and given the large range of students (grade levels) taking the knowledge check (e.g., we would expect a 1st grade to guess on all but ~2 easier questions: this adds noise to the correlations). This also adds noise to the reliability. Similar to the motivation questions, we calculated alpha reliability for students in 5th grade and above and, again, this improved reliability.

TABLE **STUDENT MOTIVATION QUESTIONS.**

1.	It is too hard for me to learn about coding. (coding_hard) C
2.	It is important to have good computer coding skills. (coding_important) V
3.	Coding stresses me out. (coding_stress) C
4.	If I try hard enough, I can learn to code. (try_hard) V
5.	Anybody can learn to code. (anybody_code) E
6.	I like coding. (like_coding) E
7.	I am good at coding. (good_coder) E
8.	My parents want me to learn coding. (parent_exp) V

TABLE **CORRELATIONS BETWEEN STUDENT MOTIVATION QUESTIONS**

	1.	2.	3.	4.	5.	6.	7.	8.
1. coding_hard C	1.00							
2. coding_important V	0.07	1.00						
3. coding_stress C	**0.49**	-0.02	1.00					
4. try_hard_good_code V	-0.17	**0.44**	-0.16	1.00				
5. Anybody_code E	**-0.21**	**0.27**	**-0.16**	**0.55**	1.00			
6. like_coding E	**-0.28**	**0.45**	**-0.37**	**0.43**	**0.33**	1.00		
7. good_coder E	**-0.43**	**0.22**	**-0.39**	**0.32**	**0.36**	**0.50**	1.00	
8. parent_exp V	0.03	**0.32**	-0.12	**0.23**	0.16	**0.31**	**0.30**	1.00

Note. Cells are color coded with reds indicating increasingly negative correlations, yellow indicating weak correlations, and greens indicating increasingly stronger correlations. Bold values are significant at p < .05. Full question names are in the table above. C = cost, V = value, and E = efficacy.

TABLE **STUDENT SUBSCALE PROPERTIES**

	Cost	Efficacy	Value
Means (SD)	1.66 (1.1)	2.76 (0.87)	2.69 (0.85)
Alpha reliability	0.66	0.66	0.60
Alpha reliability 5th grade and up	0.69	0.75	0.77
Correlations			
	Efficacy	Value	Cost
Efficacy	1.00		
Value	**0.57**	1.00	
Cost	**-0.46**	-0.08	1.00

TABLE **STUDENT KNOWLEDGE CHECK ITEMS**

Question		% Correct
1.	How do capital letters affect how code works? (code_work)	39%
2.	What is one of the languages of coding? (language)	49%
3.	Can code tell the computer sounds to play? (sound_play)	84%
4.	What line of code below DOES NOT have a mistake? (no_mistake)	56%
5.	What is code? (code?)	50%
6.	What line of code would successfully turn the background of a screen orange? (background)	41%
7.	A bug in your code means that: (bug)	77%
8.	What will happen if an entire line of code is left blank? DROPPED	13%

TABLE **CORRELATIONS BETWEEN CODING KNOWLEDGE QUESTIONS**

	1.	2.	3.	4.	5.	6.	7.
1. code_work	1.00						
2. language	**0.35**	1.00					
3. sound_play	0.14	0.06	1.00				
4. no_mistake	**0.24**	**0.28**	0.18	1.00			
5. code?	0.18	**0.22**	0.10	**0.21**	1.00		
6. background	**0.20**	**0.21**	**0.21**	**0.26**	0.18	1.00	
7. bug	0.09	0.16	**0.22**	0.11	0.00	0.12	1.00

Note: Cells are color coded with reds indicating increasingly negative correlations, yellow indicating weak correlations, and greens indicating increasingly stronger correlations. Bold values are significant at $p < .05$. Full question names are in the table above. C = cost, V = value, and E = efficacy.

TABLE **CORRELATIONS BETWEEN CODING KNOWLEDGE QUESTIONS**

	1	2	3	4	5	6	7	Total
Means	0.39	0.49	0.84	0.50	0.42	0.78	0.57	3.96
1. code_work	1.00						Alpha	0.60
2. language	**0.35**	1.00					Alpha 5th and up	0.65
3. sound_play	0.14	0.06	1.00					
4. no_mistake	**0.24**	**0.28**	0.18	1.00				
5. code?	0.18	**0.22**	0.10	**0.21**	1.00			
6. background	**0.20**	**0.21**	**0.21**	**0.26**	0.18	1.00		
7. bug	**0.09**	0.16	**0.22**	0.11	0.00	0.12	1.00	

Note: Cells are color coded with reds indicating increasingly negative correlations, yellow indicating weak correlations, and greens indicating increasingly stronger correlations. Bold values are significant at p < .05. Full question names are in the table above. C = cost, V = value, and E = efficacy.

TABLE **STUDENT REGRESSION ANALYSES**

Once cleaning and scoring were completed, we ran several analyses with cost, efficacy and value separately predicting reported "how much do you like to learn about coding," and student knowledge. The tables below include information from each of these analyses. Grade (1-12) is included as a predictor in all analyses given that student grade (age) was associated with all of their survey responses.

variable	b estimate	std. err	p-value
Regression predicting student liking by cost and grade			
Cost	-11.57	2.59	**<.001**
Grade	-2.44	1.42	0.09^{t}
Regression predicting student liking by efficacy and grade			
Efficacy	21.54	2.83	**<.001***
Grade	-0.75	1.28	0.56
Regression predicting student liking by value and grade			
Value	15.99	3.2	**<.001***
Grade	-0.73	1.43	0.61

variable	b estimate	std. err	p-value
Regression predicting student knowledge spent by cost and grade			
Cost	-0.41	0.15	**<.01***
Grade	0.21	0.09	**0.02***
Regression predicting student knowledge by efficacy and grade			
Efficacy	0.25	0.19	0.18
Grade	0.25	0.09	**<.01***
Regression predicting student knowledge by value and grade			
Value	0.41	0.2	**0.04***
Grade	0.28	0.09	**<.01***

**p<.05; ^{t}<.10*

We were surprised that efficacy did not predict student knowledge. However, given its association with student liking, we theorized a process whereby efficacy predicts student liking which, in turn, predicts student knowledge. We tested this process via a mediation model and our hypothesis was confirmed such that for every one unit increase in student efficacy there was a 2.38 increase in student liking ($p < .001$). In turn, a 10 unit increase in student liking, was associated with 0.14 increase in student knowledge ($p < .05$). This "indirect pathway" that considers the omnibus effect of student efficacy to student knowledge *through* student liking was significant (b = 0.33, $p = .05$), please see the figure below for a graphical display.

FIGURE: **EFFECT OF STUDENT EFFICACY ON STUDENT CODING KNOWLEDGE THROUGH STUDENT LIKING**

Indirect effect (efficacy * liking): b = 0.33, $p = 0.05$