Gender differences in early computing education

Which girls will become computer scientists?

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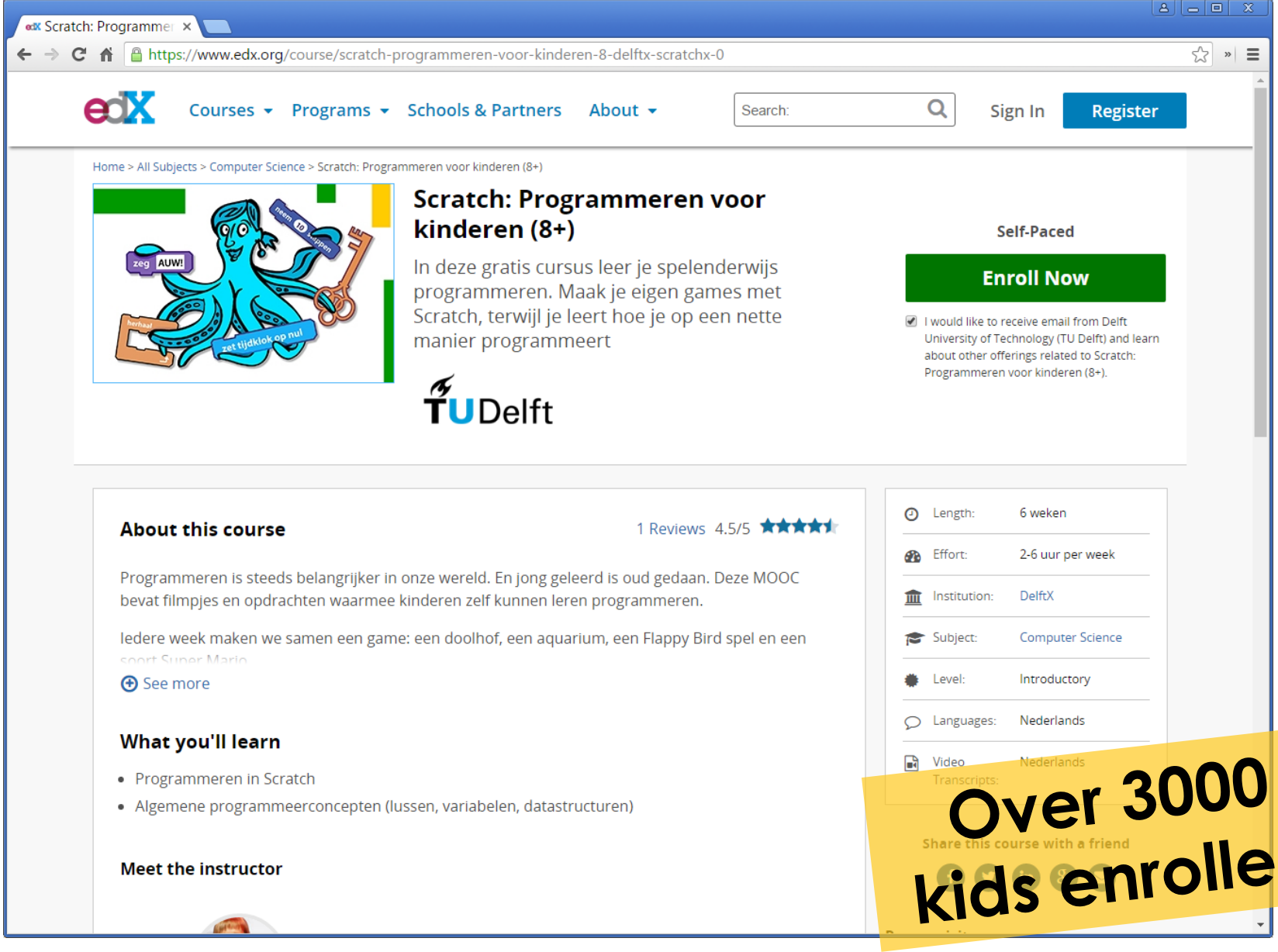

Felienne Hermans and Efthimia Aivaloglou. Teaching software engineering principles to k-12 students: A MOOC on scratch. *In Proceedings of the 39th International Conference on Software Engineering Companion, ICSE '17*, pages 13–22, 2017

student profile

8 years old

Male (65%)

No programming experience (60%)

With parent

student profile

8 years old

Male (65%)

No programming experience (60%)

With parent

student profile

8 years old

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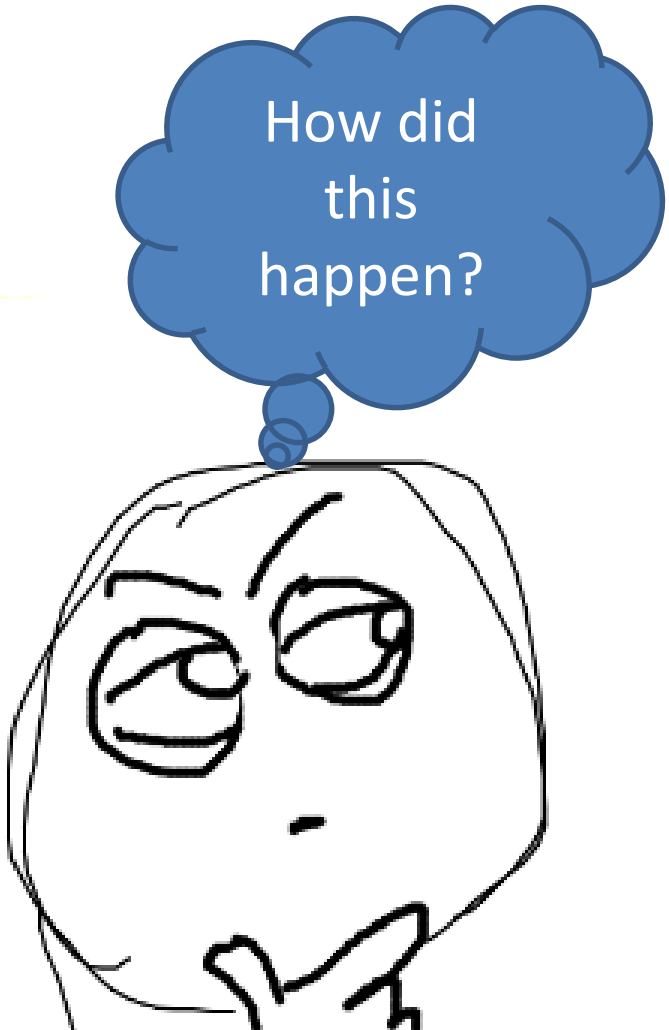
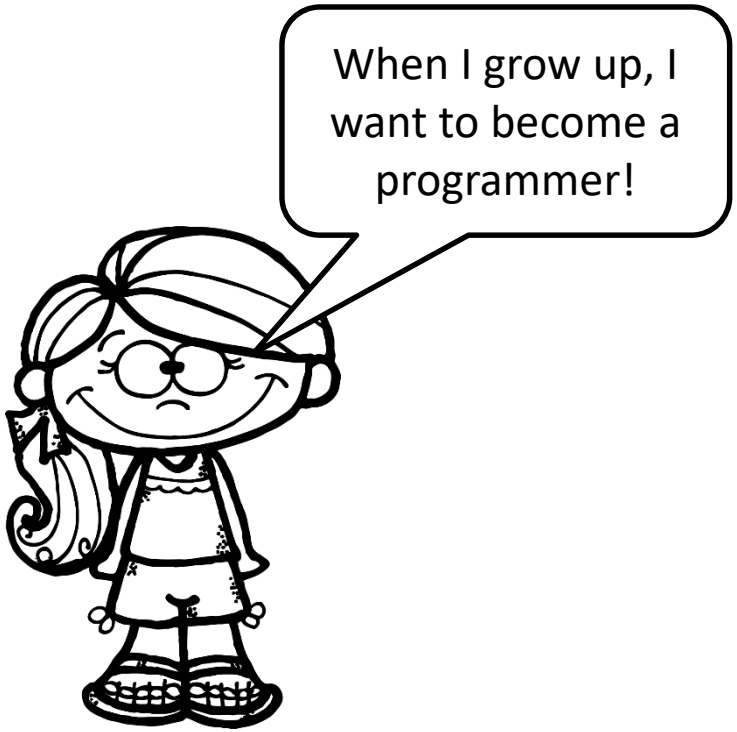
With parent


How did this happen?


When I grow up, I want to become a programmer!

Which elementary school students would consider a CS career?

Is it the stereotypes*?

Male
Singularly focused
Asocial
Competitive

… or something else?

Intrinsic motivation
Extrinsic motivation
Self-efficacy
Previous programming experience

*Colleen M. Lewis, Ruth E. Anderson, and Ken Yasuhara. 2016. "I Don’T Code All Day": Fitting in Computer Science When the Stereotypes Don’T Fit. In Proceedings of the 2016 ACM Conference on International Computing Education Research. ACM, 23–32

The field study

2 schools

4 groups

74 students

8 weeks

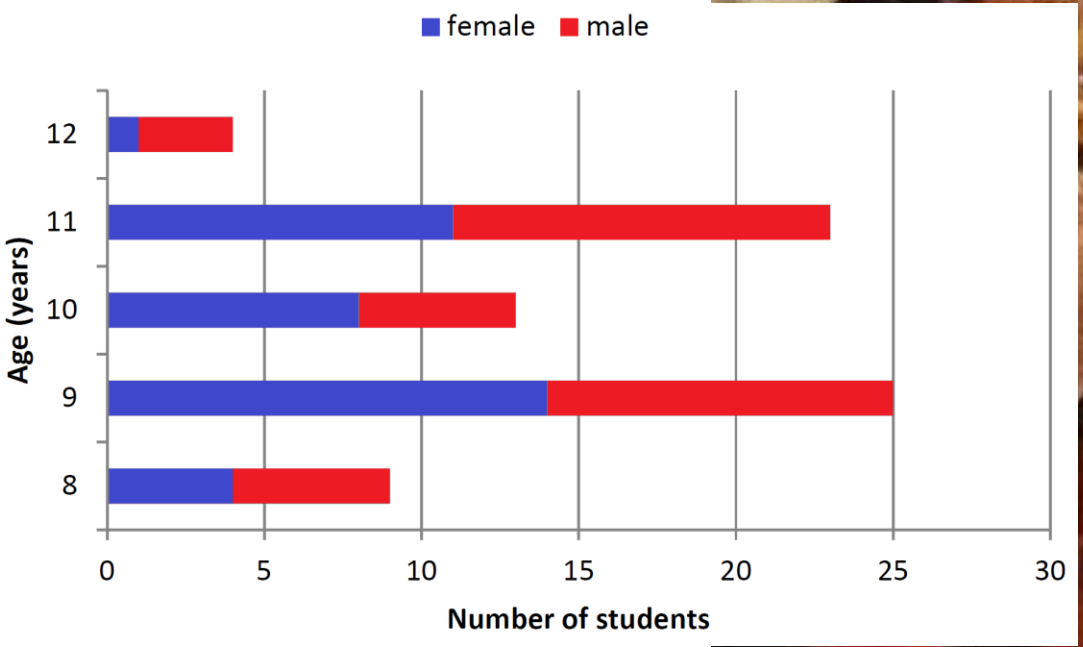
The field study

2 schools

4 groups

74 students (8 to 12 yo)

8 weeks



Materials and instruments

Lessons material

Scratch: Programmeren voor kinderen (8+)

In deze gratis cursus leer je spelenderwijs programmeren. Maak je eigen games met Scratch, terwijl je leert hoe je op een nette manier programmeert

Materials and instruments

Week 1	Setup & introductory lesson Student profile questionnaire
Week 2	Lesson 1
Week 3	Lesson 2
Week 4	Lesson 3
Week 5	Lesson 4
Week 6	Lesson 5
Week 7	Lesson 6
Week 8	Work on individual projects

Materials and instruments

Week 1	Setup & introductory lesson Student profile questionnaire
Week 2	Lesson 1
Week 3	Lesson 2
Week 4	Lesson 3
Week 5	Lesson 4 Interim test
Week 6	Lesson 5
Week 7	Lesson 6
Week 8	Work on individual projects Final test

Learning performance

Materials and instruments

Week 1	Setup & introductory lesson Student profile questionnaire
Week 2	Lesson 1 Self-efficacy Intrinsic & extrinsic goal orientation
Week 3	Lesson 2
Week 4	Lesson 3
Week 5	Lesson 4 Interim test Self-efficacy
Week 6	Lesson 5
Week 7	Lesson 6
Week 8	Work on individual projects Final test Self-efficacy

Learning performance

Self-efficacy and motivation

MSLQ subscales:
- self-efficacy
- extrinsic goal orientation
- intrinsic goal orientation

Materials and instruments

Week 1	Setup & introductory lesson Student profile questionnaire Stereotypes fit self-assessment Career orientation assessment
Week 2	Lesson 1 Self-efficacy Intrinsic & extrinsic goal orientation Stereotypes beliefs
Week 3	Lesson 2
Week 4	Lesson 3
Week 5	Lesson 4 Interim test Self-efficacy Career orientation assessment
Week 6	Lesson 5
Week 7	Lesson 6
Week 8	Work on individual projects Final test Self-efficacy Career orientation assessment

Learning performance

Self-efficacy and motivation

MSLQ subscales:
- self-efficacy
- extrinsic goal orientation
- intrinsic goal orientation

Stereotypes & career orientation

Results

RQ1 How is the learning performance of elementary school students affected by their self-efficacy and their intrinsic and extrinsic motivation within the context of a programming course?

RQ2 What is the effect of those factors, of the course, as well as of established stereotypes on CS scientists, on the selection of CS as a future career path?

RQ3 Does age, gender and previous programming experience affect those factors and relationships?

Results

RQ1 How is the learning performance of elementary school students affected by their self-efficacy and their intrinsic and extrinsic motivation within the context of a programming course?

→ No significant correlation between test performance and self-efficacy or motivation measurements

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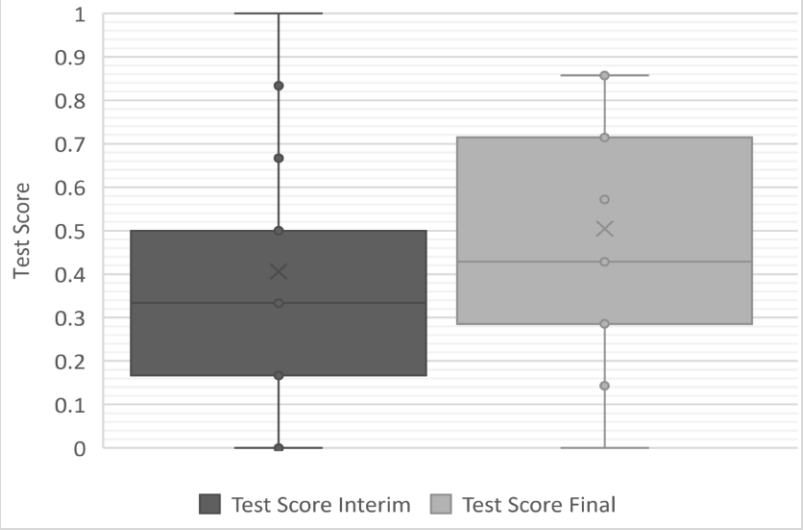

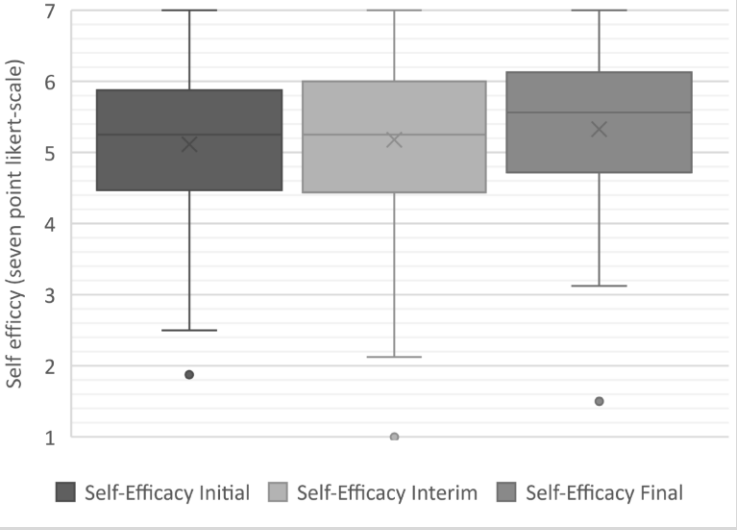

Results

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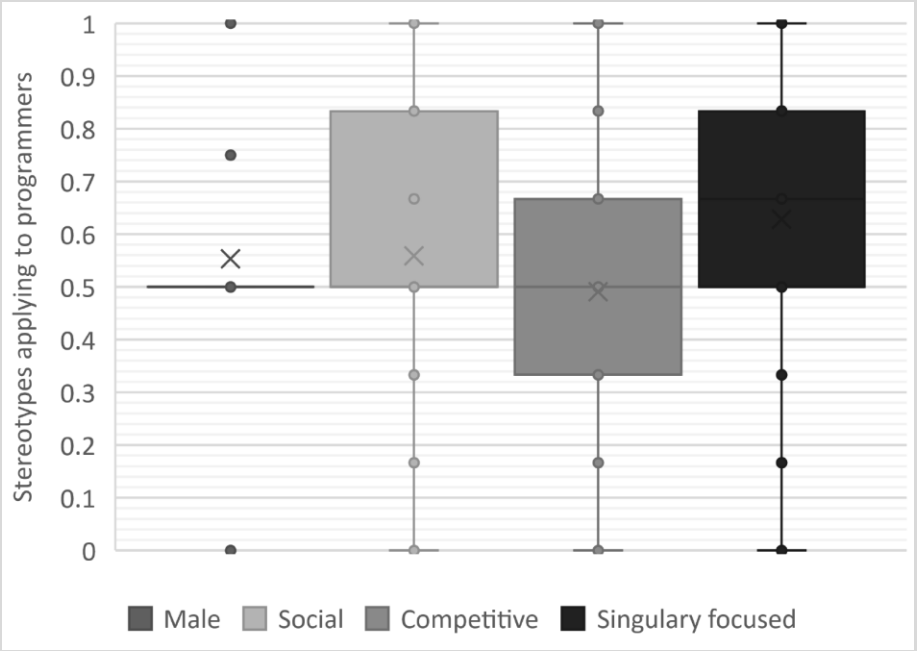
RQ3 Does age, gender and previous programming experience affect those factors and relationships?

Results

RQ2 What is the effect of those factors, of the course, as well as of established stereotypes on CS scientists, on the selection of CS as a future career path?

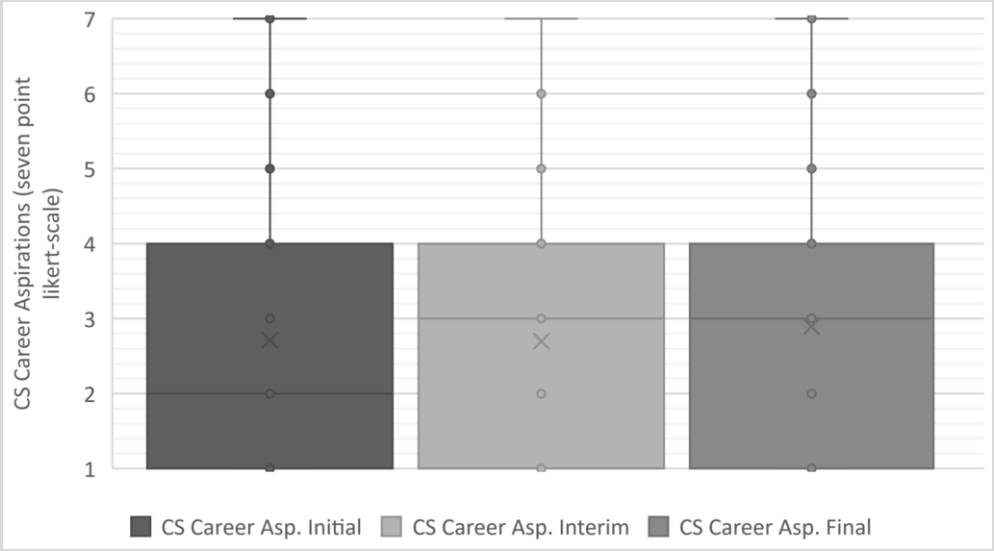
→ No inclinations towards any particular beliefs about computer scientists



Results

RQ2 What is the effect of those factors, of the course, as well as of established stereotypes on CS scientists, on the selection of CS as a future career path?

→ No effect of the course on CS career orientation: no significant difference between the repeated CS career orientation measurements during the course

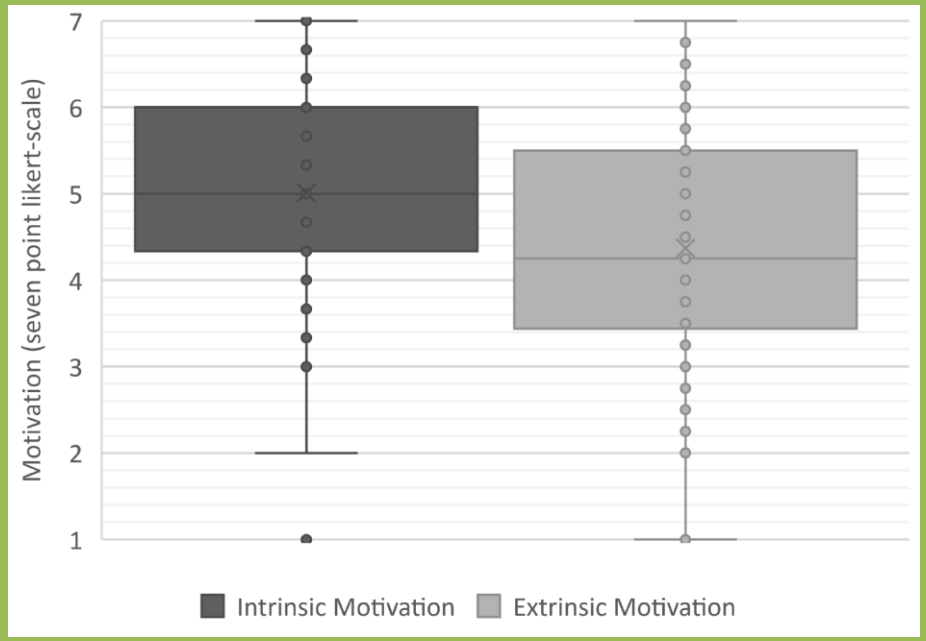


Results

RQ2 What is the effect of those factors, of the course, as well as of established stereotypes on CS scientists, on the selection of CS as a future career path?

Two factors significantly correlated with CS career orientation:

→ Intrinsic motivation



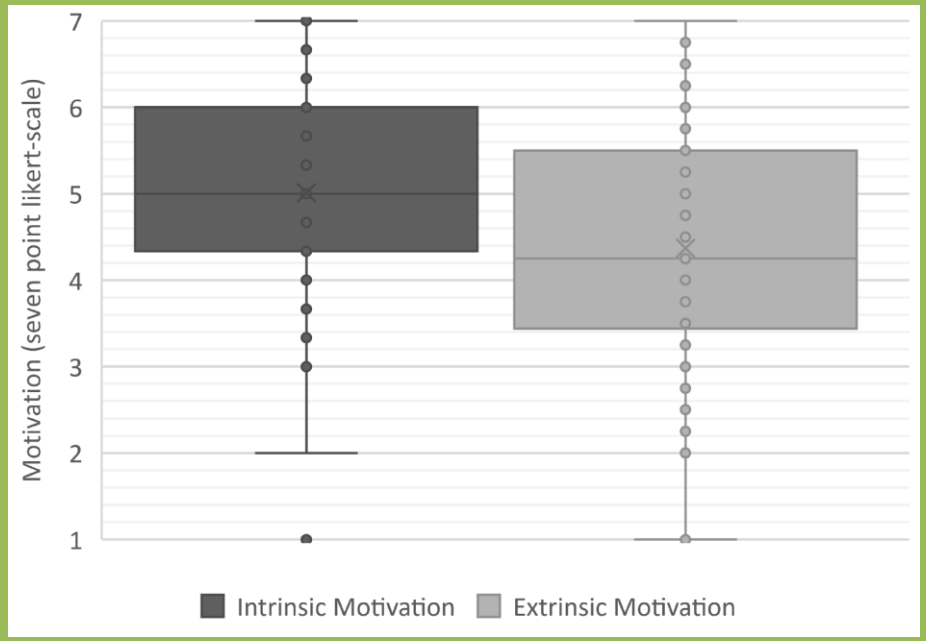
Results

RQ2 What is the effect of those factors, of the course, as well as of established stereotypes on CS scientists, on the selection of CS as a future career path?

Two factors significantly correlated with CS career orientation:

→ Intrinsic motivation

→ Self-efficacy *



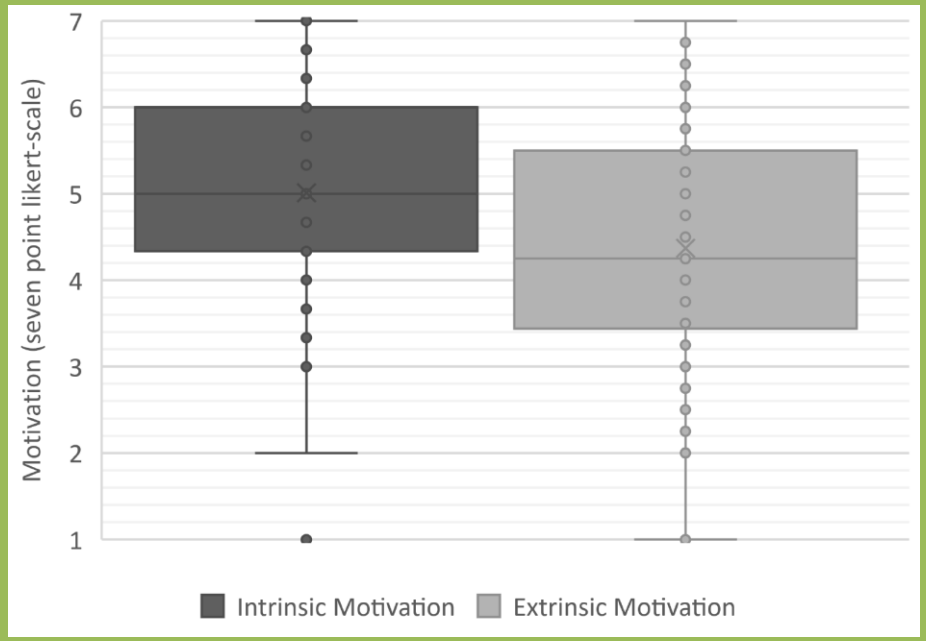
Results

RQ2 What is the effect of those factors, of the course, as well as of established stereotypes on CS scientists, on the selection of CS as a future career path?

Two factors significantly correlated with CS career orientation:

→ Intrinsic motivation

→ Self-efficacy (for females)



Results

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Results

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→ No effect of the age of the students on performance, career orientation, or any other of the examined variables

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→ For female students only, CS career orientation was significantly related to self-efficacy

Results

RQ3 Does age, gender and previous programming experience affect those factors and relationships?

→ No effect of the age of the students on performance, career orientation, or any other of the examined variables

→ For female students only, CS career orientation was significantly related to self-efficacy

→ Previous programming experience strongly correlated with extrinsic motivation, self-efficacy and CS career orientation

Which elementary school students would consider a CS career?

Is it the stereotypes?

Male
Singularly focused
Asocial
Competitive

… or something else?

Intrinsic motivation
Extrinsic motivation
Self-efficacy
Previous programming experience

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Is it the stereotypes?

~~Male~~
~~Singularly focused~~
~~Asocial~~
~~Competitive~~

… or something else?

Intrinsic motivation
~~Extrinsic motivation~~
Self-efficacy (for girls only!)
Previous programming experience

E. Aivaloglou and F. Hermans. 2019. Early Programming Education and Career Orientation: The Effects of Gender, Self-Efficacy, Motivation and Stereotypes. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (SIGCSE '19)

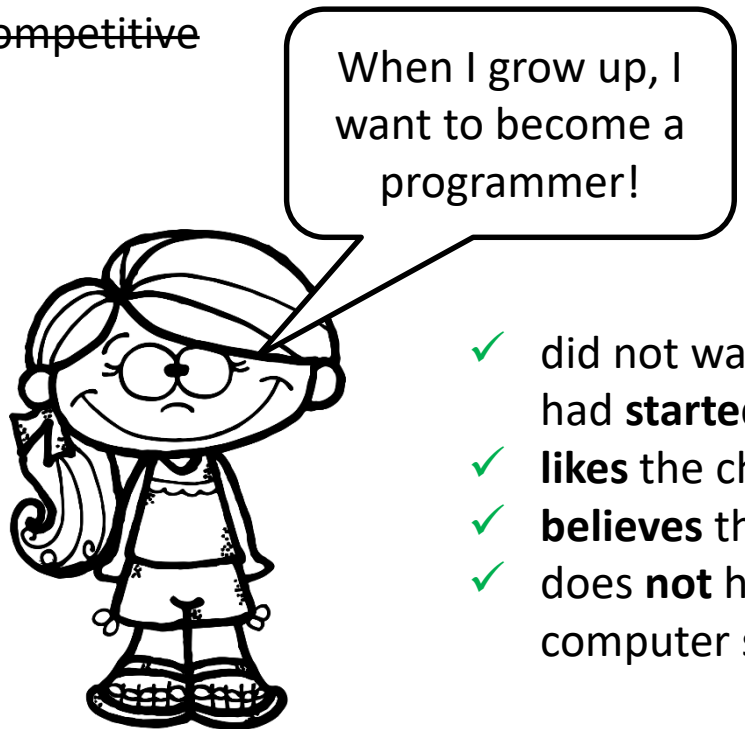
Which elementary school students would consider a CS career?

Is it the stereotypes?

~~Male~~
~~Singularly focused~~
~~Asocial~~
~~Competitive~~

… or something else?

Intrinsic motivation
~~Extrinsic motivation~~
Self-efficacy (for girls only!)
Previous programming experience



- ✓ did not wait for school to teach her programming, had **started already** by herself
- ✓ **likes** the challenges of programming
- ✓ **believes** that she is good at it
- ✓ does **not** hold any of the typical stereotypes of computer scientists

Which elementary school students would consider a CS career?

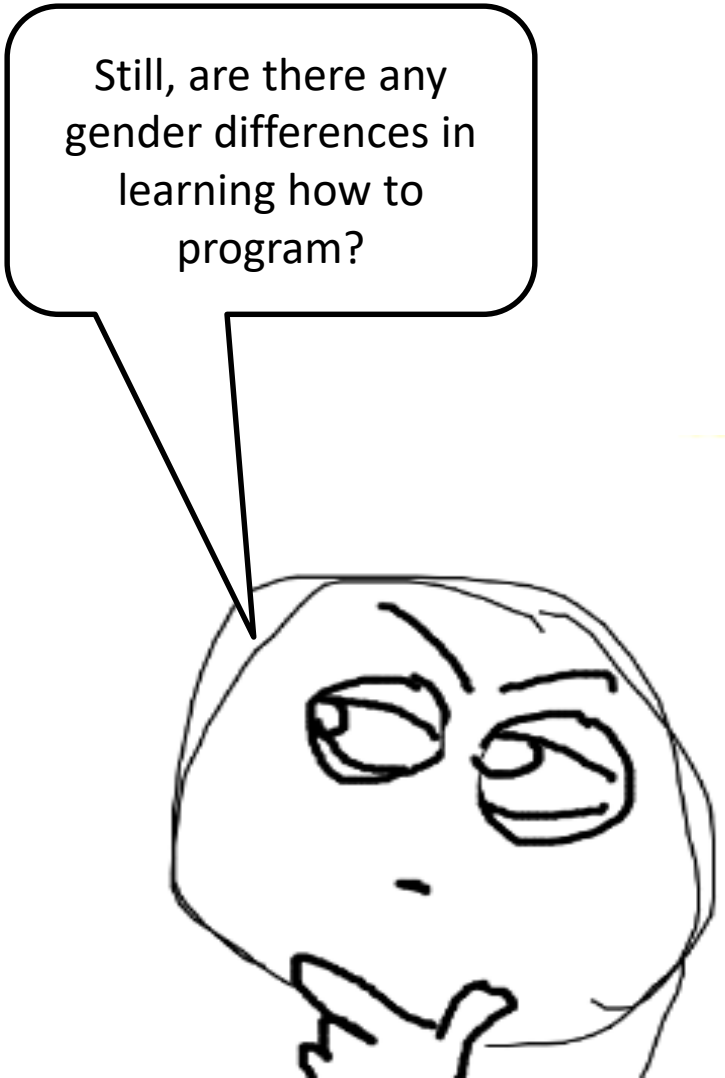
Is it the stereotypes?

~~Male~~
~~Singularly focused~~
~~Asocial~~
~~Competitive~~

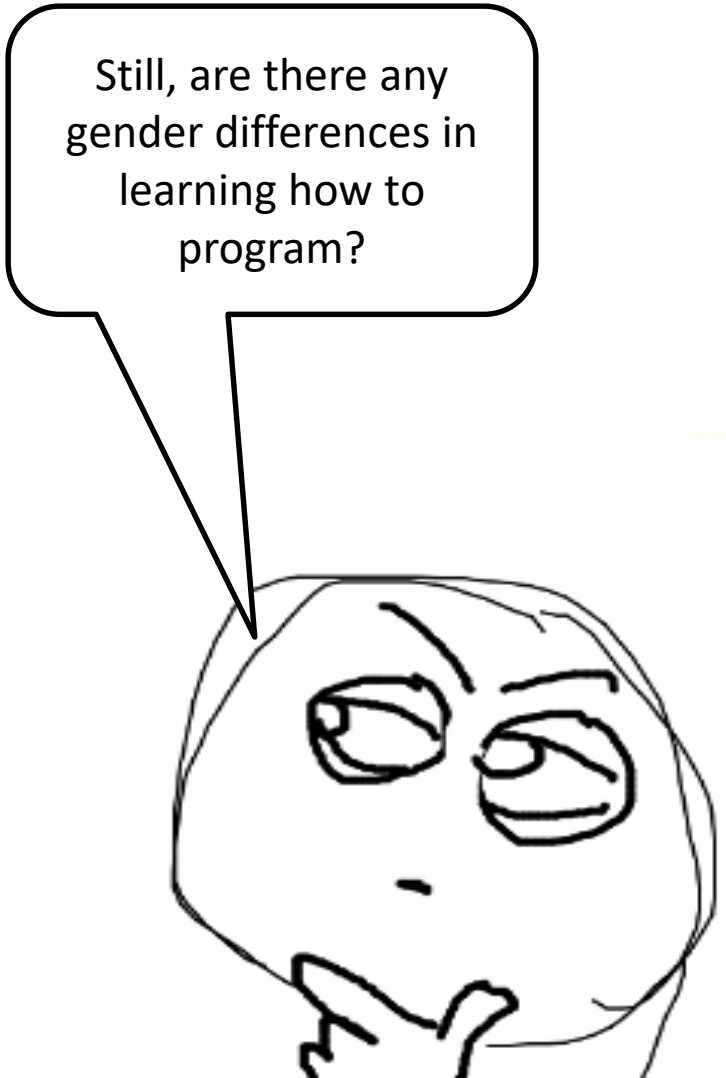
… or something else?

Intrinsic motivation
~~Extrinsic motivation~~
Self-efficacy (for girls only!)
Previous programming experience

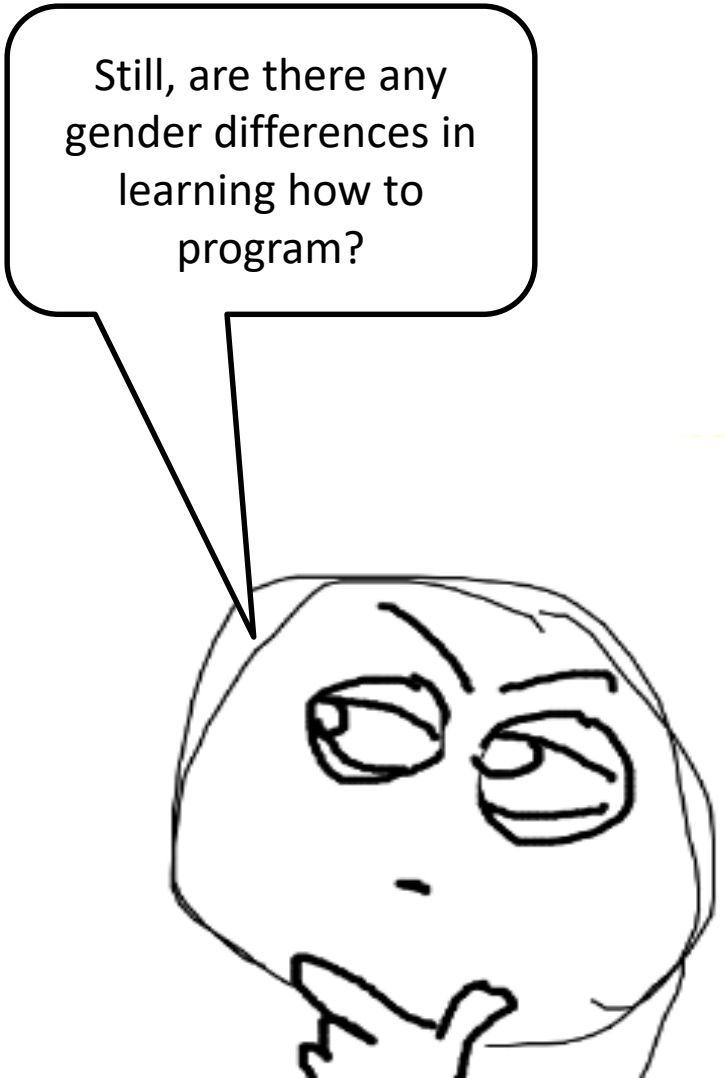
What does the future hold?


Still, are there any gender differences in learning how to program?

Are boys different than girls in programming?

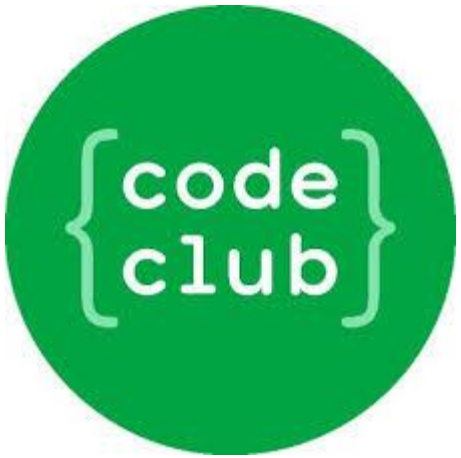


What are the teachers' perceptions of gender differences among their students?



What are the teachers' perceptions of gender differences among their students?

A survey for teachers at code clubs



11. **In what ways are boys different than girls in your classes?**

	Boys	Neutral, but maybe boys	Neutral	Neutral, but maybe girls	Girls
Who is more confident?	◯	◯	◯	◯	◯
Who is more motivated to learn programming?	◯	◯	◯	◯	◯
Who seems to like programming more?	◯	◯	◯	◯	◯
Who is more persistent when something does not work?	◯	◯	◯	◯	◯
Who seems to get it more easily?	◯	◯	◯	◯	◯
Who seems to concentrate better?	◯	◯	◯	◯	◯

12. **Which other differences have you noticed between how boys and girls learn programming?**

_____

_____

_____

11. **In what ways are boys different than girls in your classes?**

	Boys	Neutral, but maybe boys	Neutral	Neutral, but maybe girls	Girls
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Who is more persistent when something does not work?	◯	◯	◯	◯	◯
Who seems to get it more easily?	◯	◯	◯	◯	◯
Who seems to concentrate better?	◯	◯	◯	◯	◯

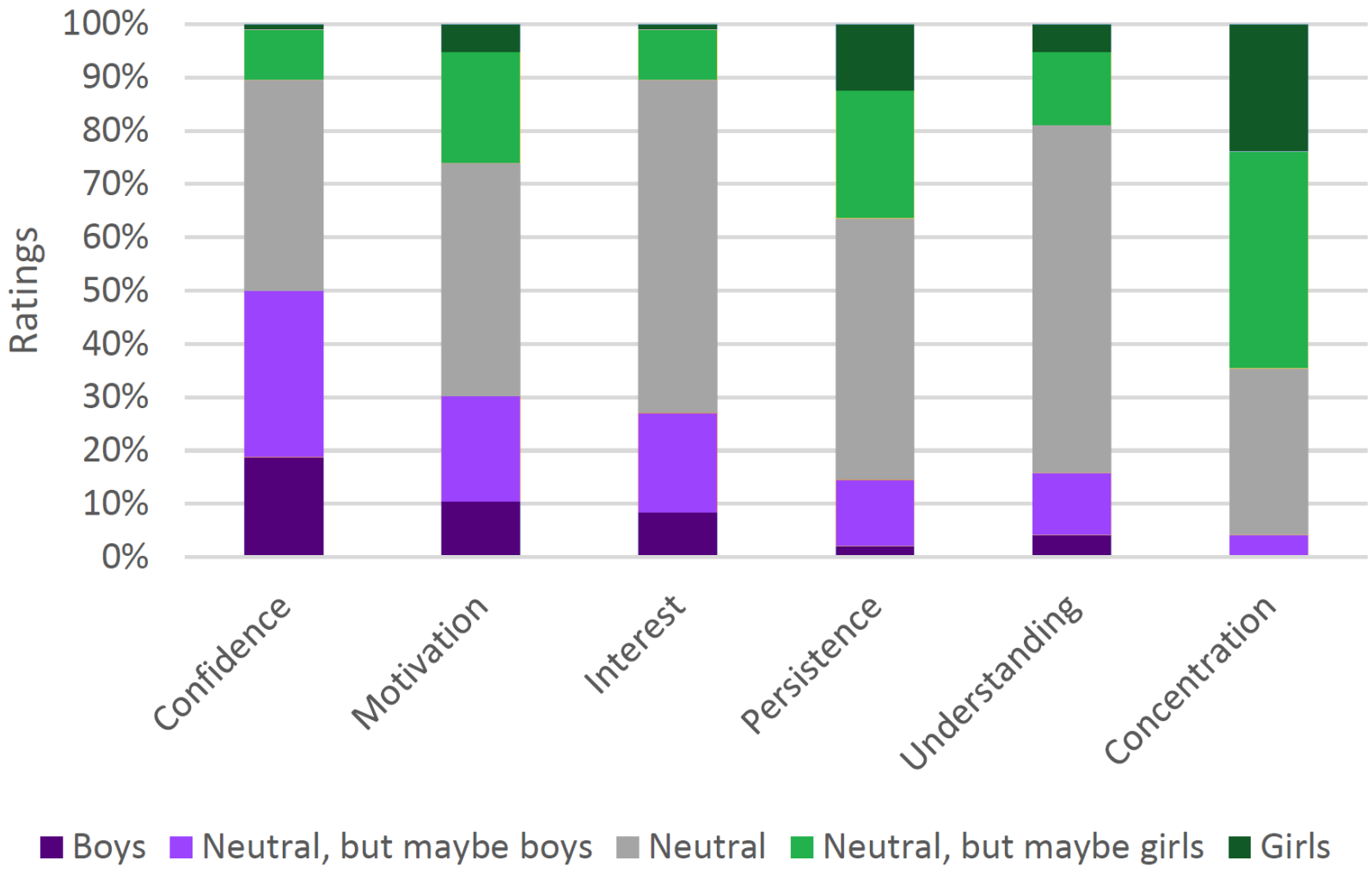
12. **Which other differences have you noticed between how boys and girls learn programming?**

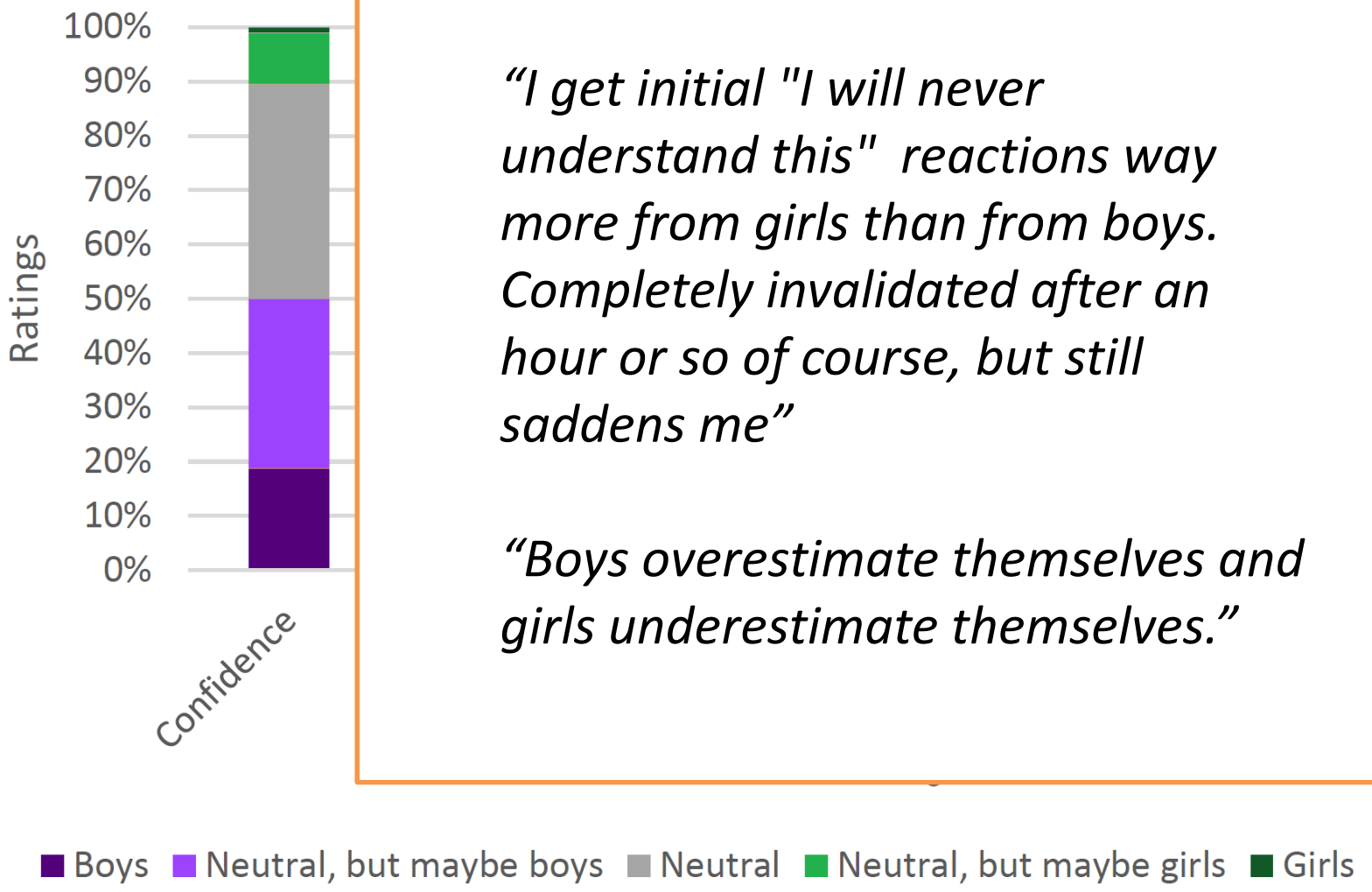
_____

_____

_____

98 responses
30% female students


Ratings
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Confidence
Motivation
Interest
Persistence
Understanding
Concentration
Boys
Neutral, but maybe boys
Neutral
Neutral, but maybe girls
Girls

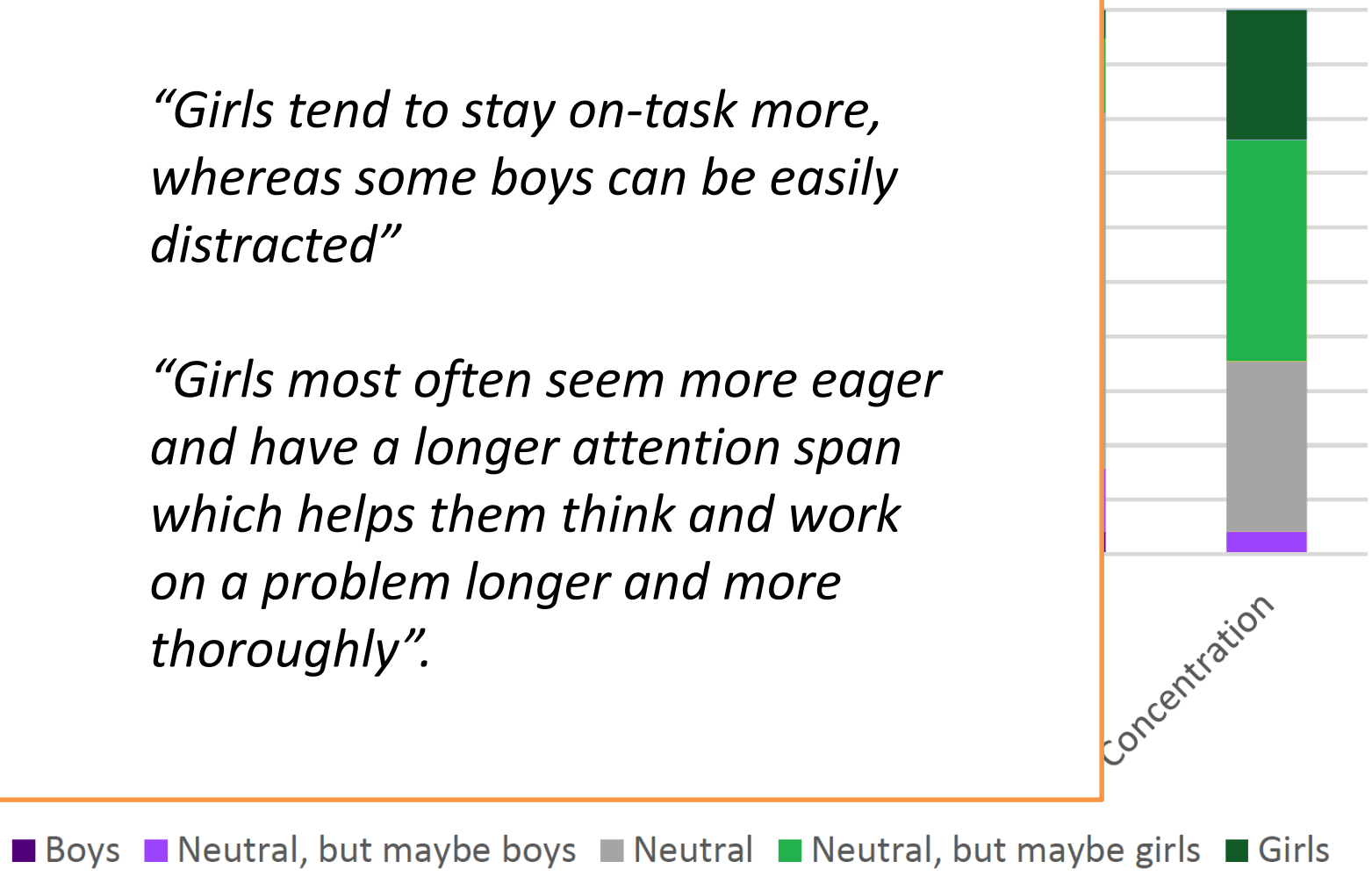


"I get initial "I will never understand this" reactions way more from girls than from boys. Completely invalidated after an hour or so of course, but still saddens me"

"Boys overestimate themselves and girls underestimate themselves."

“Girls tend to stay on-task more, whereas some boys can be easily distracted”

“Girls most often seem more eager and have a longer attention span which helps them think and work on a problem longer and more thoroughly”.



Some more differences…

Some more differences…

Preferred type of projects

“Girls seem to tend to like the more creative assignments, like computationally generated drawings whereas the boys tend to be more interested in the robots/less ‘drawing’-like exercises.”

Some more differences…

Preferred type of projects

Didactic preference and responsiveness to instruction

"Boys just start blindly without reading lessons and then run into trouble pretty quickly, then call for help. Girls tend to focus more, start reading and ask questions when they're really stuck."

Some more differences…

Preferred type of projects

Didactic preference and responsiveness to instruction

Collaboration skills

"Girls are more likely to help each other before asking me for help. Boys tend to ask for help from me first. Boys seem to work more independently where girls like group work."

Some more differences…

Preferred type of projects

Didactic preference and responsiveness to instruction

Collaboration skills

Grit and focus

“Girls have more grit to finish the puzzle and are more precise”

“[…] Some boys rush through without really understanding what they are doing. […] All of the girls in my club have always been more careful and methodical. They seem to want to understand what they are doing more and don’t mind taking their time.”.

Some more differences…

Preferred type of projects

Didactic preference and responsiveness to instruction

Collaboration skills

Grit and focus

Familiarity and prior knowledge

"Boys tend to have more experience/knowledge, so they meet fewer problems"

"Initially, girls are more hesitant to experiment and play around with the computers, and more scared of 'spoiling' them."

Some more differences…

Preferred type of projects

Didactic preference and responsiveness to instruction

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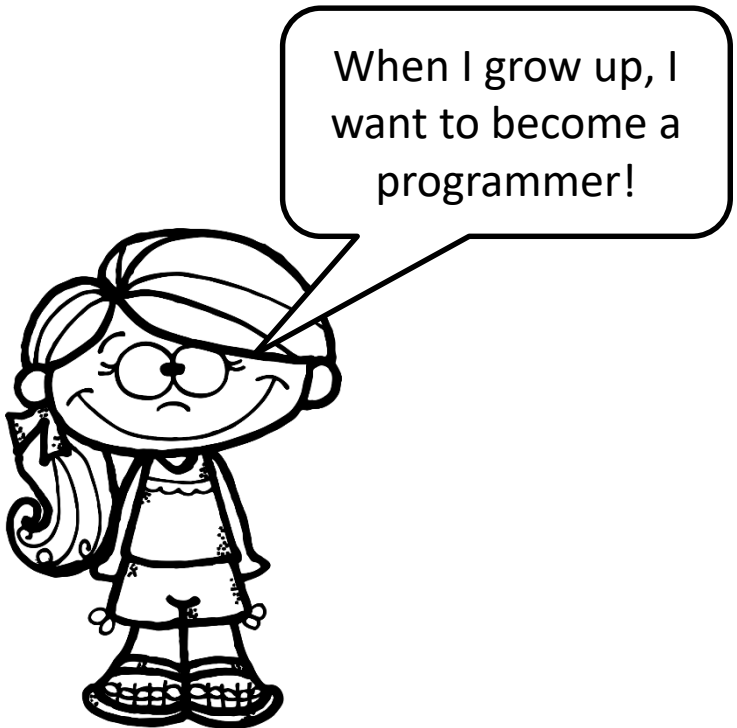
E. Aivaloglou and F. Hermans. 2019. How is programming taught in code clubs? Exploring the experiences and gender perceptions of code club teachers. In 19th Koli Calling International Conference on Computing Education Research (Koli Calling '19)

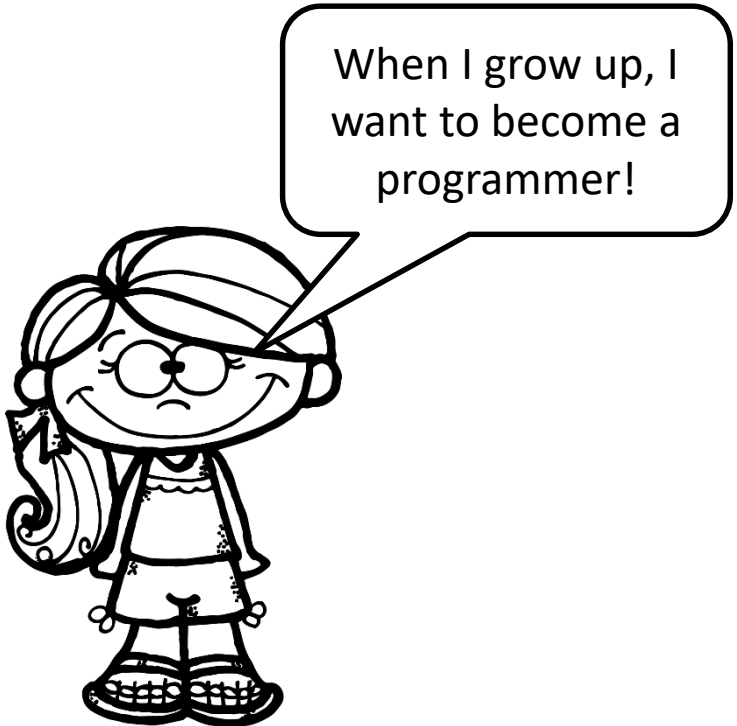
- ✓ Intrinsic motivation
- ✓ Self-efficacy
- ✓ Previous programming experience

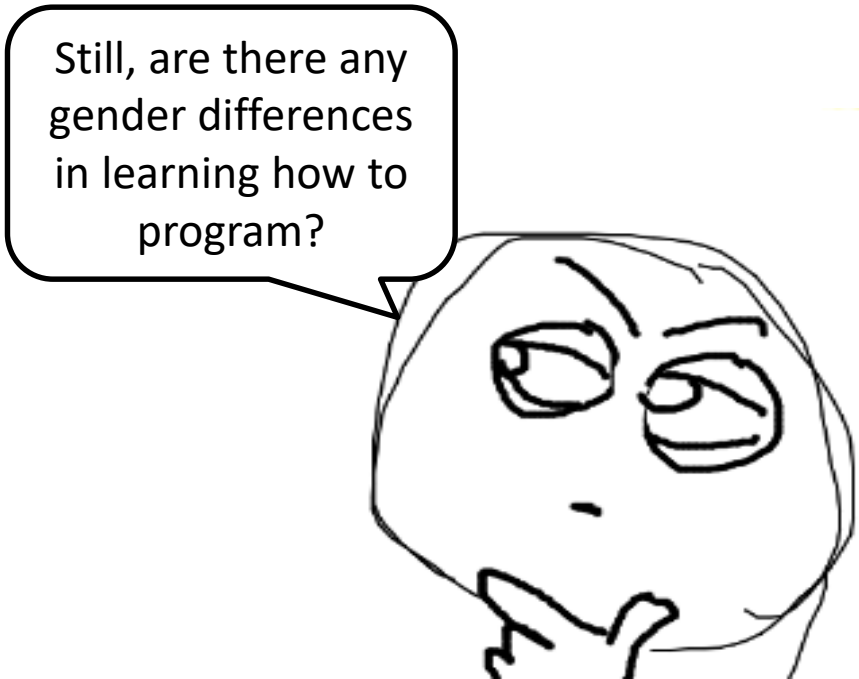


↓ Confidence
↓ Familiarity and prior knowledge

↑ Persistence
↑ Concentration
↑ Collaboration skills
↑ Grit and focus
↑ Responsiveness to instruction

✓ Intrinsic motivation
✓ Self-efficacy
✓ Previous programming experience





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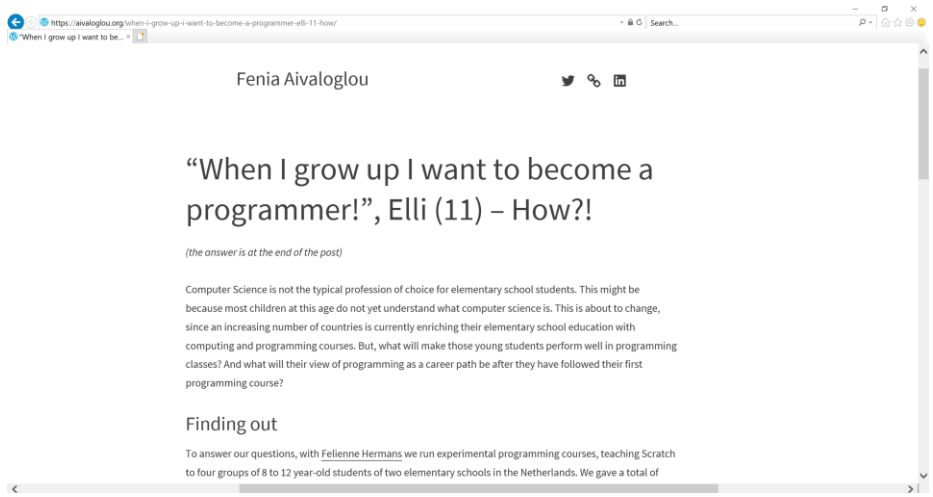

http://perl.liacs.nl/ http://aivaloglou.org/ @feniaiv