CS0 vs. CS1:
Understanding **Fears and Confidence amongst Non-majors** in Introductory CS Courses

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01.

Motivation

Computing Courses for Non-Majors: **Growing Demand**

1

Benefits

- Growing need for CS in **other fields**
- **Increasing participation** from students in URM groups

2

Course Requirements

- More majors **require** an introductory CS course
- CS0 is **not always an option**

Gaps in Prior Literature

Research Questions

❖ **Fears and concerns**

Gaps in Prior Literature

Research Questions

❖ Fears and concerns

❖ **Confidence in
CSO vs. CS1**

Gaps in Prior Literature	Research Questions

❖ Fears and concerns

❖ Confidence in
CS0 vs. CS1

❖ **Relationship between initial fears and confidence**

Gaps in Prior Literature

Research Questions

❖ Fears and concerns

❖ Confidence in
CS0 vs. CS1

❖ Relationship between
initial fears and
confidence

1. **What are the fears of non-majors taking introductory CS?**

Gaps in Prior Literature

❖ Fears and concerns

❖ Confidence in CS0 vs. CS1
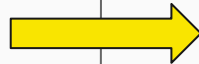
❖ Relationship between initial fears and confidence
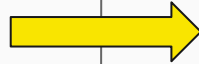
Research Questions
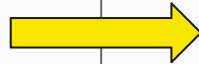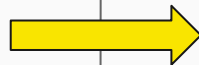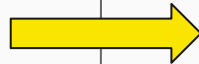
1. What are the fears of non-majors taking introductory CS?

2. **How does non-majors' confidence differ in CS0 vs. CS1 courses?**

Gaps in Prior Literature

Research Questions

❖ Fears and concerns

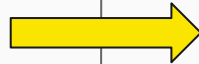❖ Confidence in CS0 vs. CS1

❖ Relationship between initial fears and confidence

1. What are the fears of non-majors taking introductory CS?
2. How does non-majors' confidence differ in CS0 vs. CS1 courses?
3. **Is there a connection between fears expressed and change in confidence?**

02.

Background

Prior Work: Concerns of Engineering Students

Zarb et al. (2018):
- International study (N = 351)
- Primary concerns of computing students

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The possibility of failing, and any repercussions

Workload expectation

Managing my time well

Feeling prepared

Being good at the course

Liking the course

Prior Work: Concerns of Engineering Students

Zarb et al. (2018):
- International study (N = 351)
- Primary concerns of computing students
- **6 of the top 10** fears were course related
- Fears **aligned with those found in our study**

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Other Related Works:

- Confidence and Self-Efficacy
- Introductory CS Courses for Non-CS Majors

03.

Methods

- Study population
- Survey Collection
- Data analysis

Study Population

- Two introductory CS courses at UC San Diego
  - CS0 (Spring 2021) and CS1 (Spring 2022)
- **No prior knowledge of programming** expected for **either course**
- **Fulfill the same requirement** for non-CS majors

<u>CS0</u>   <u>CS1</u>

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CS0	CS1
● **Intentionally for non-majors** ● Uses Snap! ● **Offered infrequently** (then non-CS majors need to enroll in CS1)	

Study Population

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CS0

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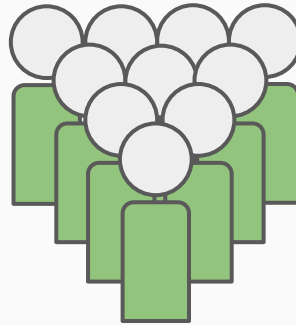- **Offered infrequently** (then non-CS majors need to enroll in CS1)

CS1

- Traditional
- Uses Python
- First of a two-part series for CS majors
- CS majors take CS1 in the Fall, **Spring offering is primarily non-majors**

Data Collection

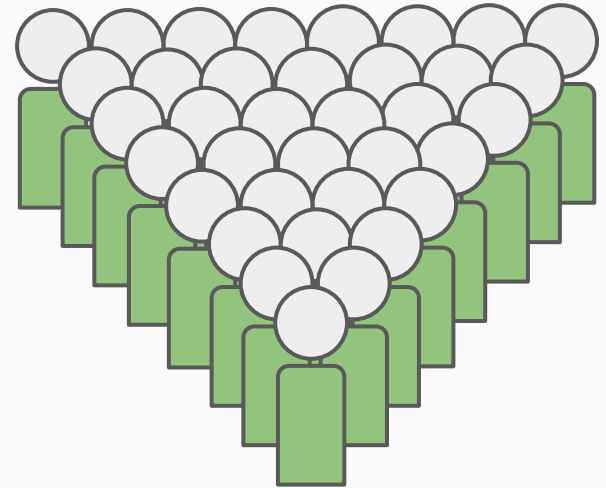**624 total student survey responses** from CS0 and CS1 courses

CS0

(N = 124)

CS1

(N = 502)

Data Collection

Weekly Surveys

- Pre-surveys and weekly surveys conducted in both courses
- Students received small amount of credit for completion
- Questions were identical for both courses

Data Collection

Survey Questions Used in Study

Fears   Confidence

Data Collection

Survey Questions Used in Study

Fears   Confidence

What do you fear the most about taking this class?

- Pre-survey only
- Open-ended with no length requirements

Data Collection

Survey Questions Used in Study

Fears

What do you fear the most about taking this class?

- Pre-survey only
- Open-ended with no length requirements

Confidence

On a scale of 1 to 5, how confident are you about your ability to do well in this course?

- Pre-survey & weekly survey
- Likert scale from 1 to 5

Data Analysis: Mixed-Methods

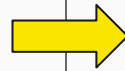| Research Questions	Methods
RQ1: What are the fears of non-majors taking introductory CS? **RQ2:** How does non-majors' confidence differ in CS0 vs. CS1 courses? **RQ3:** Is there a connection between fears expressed and change in confidence?	

Data Analysis: Mixed-Methods

Research Questions	Methods
RQ1: What are the fears of non-majors taking introductory CS? **RQ2:** How does non-majors' confidence differ in CS0 vs. CS1 courses? **RQ3:** Is there a connection between fears expressed and change in confidence?	**Qualitative Coding**

Qualitative Coding Process (RQ1)

❖ Two first authors performed open coding on CS0 data, then CS1

❖ Many responses included >1 concern (see Table 1)

❖ Labeled each response with *all labels that applied*

Student Response	Open Coding
"the coding as well as the work load with other out of class responsibilities"	coding; workload
"Falling behind because the material is too difficult for me"	fear of falling behind; concern about the difficulty of the class

Table 1: Examples of responses assigned multiple codes

Data Analysis: Mixed–Methods

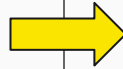| Research Questions	Methods
RQ1: What are the fears of non-majors taking introductory CS?	➡ **Qualitative Coding**
RQ2: How does non-majors' confidence differ in CS0 vs. CS1 courses?	➡ **Mann-Whitney U:** Mean initial, final, and change in confidence
RQ3: Is there a connection between fears expressed and change in confidence?	

Data Analysis: Mixed-Methods

Research Questions	Methods

RQ1: What are the fears of non-majors taking introductory CS? → **Qualitative Coding**

RQ2: How does non-majors' confidence differ in CS0 vs. CS1 courses? → **Mann-Whitney U:** Mean initial, final, and change in confidence

RQ3: Is there a connection between fears expressed and change in confidence? → **Mann-Whitney U:** Mean change in confidence for each fear category

04. Results

Results (RQ1): Fears of Non-majors taking Introductory CS

Categories	Open Codes	% of Total
coding	1. coding 2. not being able to code independently	19.65%
comprehension	1. not being able to understand the material	19.65%
being left behind	1. fear of falling behind 2. help	19.33%
perceiving STEM as difficult	1. concerns related to CS peers 2. CS in general 3. concern about the difficulty of the class	18.69%
managing workload	1. workload 2. concern about personal organization 3. fear of experiencing negative emotion	15.97%
grading	1. fear of poor outcome	13.90%
preparation	1. lack of technological fluency 2. not enough prior experience	14.06%
disappointment in course	1. not achieving desired learning goal 2. fear of loss of interest	4.95%
no fear	1. no concern	3.35%

Table 2 (Left): Individual codes included in each category, and percentage responses for each

- 15 individual codes emerged from CS0 data
- 2 additional codes emerged from CS1 data, totaling 17

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Table 2 (Left): Individual codes included in each category, and percentage responses for each

- 15 individual codes emerged from CS0 data
- 2 additional codes emerged from CS1 data, totaling 17
- Grouped 17 codes into 9 categories of fear

Figure 1 (Right): (a) initial and (b) final confidence for CS0 vs. CS1
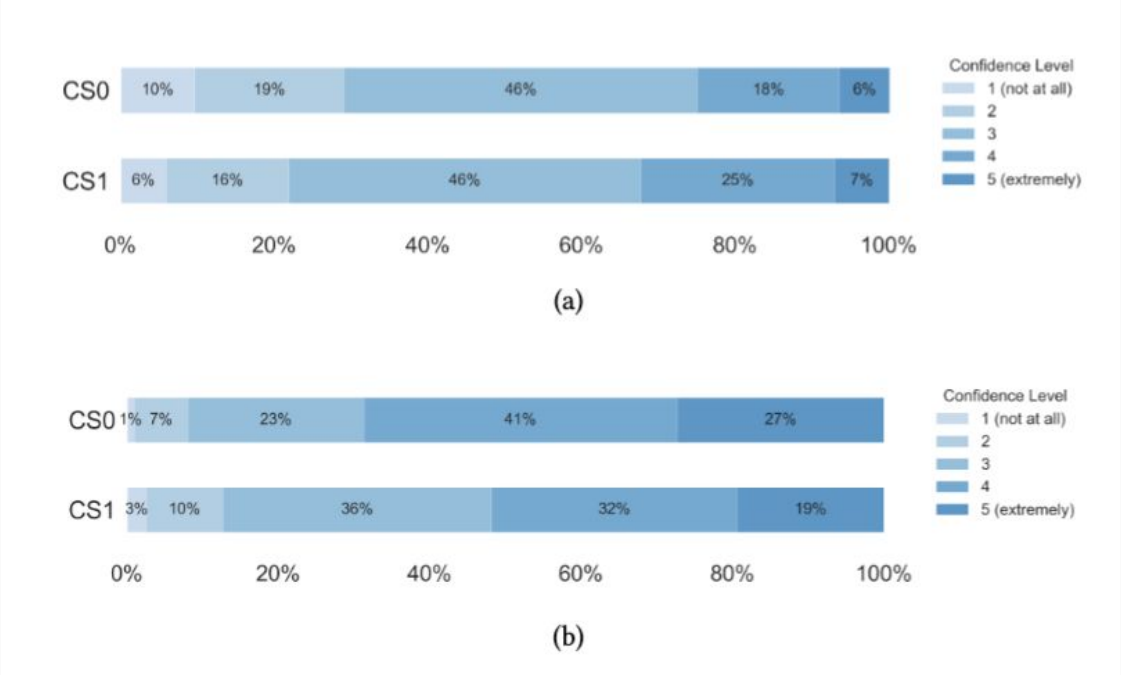
Results (RQ2): Confidence Levels in CS0 vs. CS1

Results of Mann-Whitney U tests comparing initial, final, and change in confidence in CS0 vs. CS1

Conf.	Pop.	N	M	Mdn	SD	U	p	r
initial	CS0	124	2.9	3.0	1.0	27841.5	.053	0.11
	CS1	502	3.1	3.0	1.0			
final	CS0	99	3.9	4.0	0.9	20197.0	<.01	-0.18
	CS1	346	3.6	4.0	1.0			
change	CS0	99	0.9	1.0	1.2	20878.5	<.001	-0.26
	CS1	335	0.4	0.0	1.1			

Table 3: Results of comparing initial, final, and change in confidence levels among CS0 and CS1 students
Conf. - Confidence; Pop. - Population; N - Number of students in each group; M - Mean; Mdn - Median; SD - Standard Deviation; U - Mann-Whitney U statistic; p - p-value; r - Rank-biserial correlation effect size

Results (RQ2): Confidence Levels in CS0 vs. CS1

Initial Confidence:
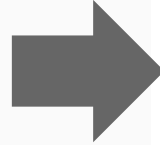- Lower mean in CS0
- not statistically significant

Conf.	Pop.	N	M	Mdn	SD	U	p	r
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Results (RQ2): Confidence Levels in CS0 vs. CS1

- **Higher final confidence in CS0 t**han CS1
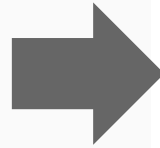- **Statistically significant** with a small effect size

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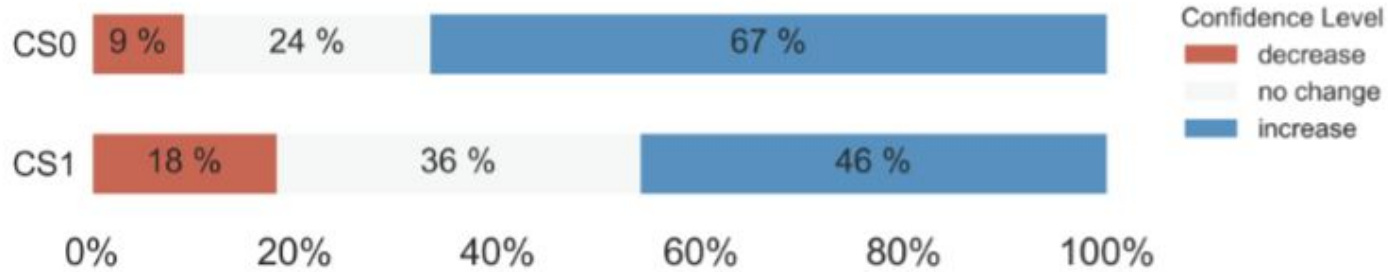# Results (RQ2): Confidence Levels in CS0 vs. CS1

- **Higher change in confidence for CS0** compared to CS1
- **Statistically significant** with a small effect size

Conf.	Pop.	N	M	Mdn	SD	U	p	r
initial	CS0	124	2.9	3.0	1.0	27841.5	.053	0.11
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Results (RQ2): Confidence Levels in CS0 vs. CS1

Figure 2: The stacked bar chart shows the distributions of the change in confidence level among CS0 and CS1 students.

67% of CS0 students reported an **increase in confidence,** compared to **46** **in CS1**

Results (RQ3): Connections between Fears and Change in Confidence in CS0 vs. CS1

Using the **9 fear categories** :
- Computed average **change in confidence** for all **students with responses included in that category**

Four intervals for change in confidence, (shown in Table 4)

Table 4: Confidence Change Intervals

Change in Confidence	Confidence Change Interval
< 0	decrease
0 - 0.5	low increase
0.5 - 1	moderate increase
1 - 1.5	high increase

Results (RQ3): CS0 Average Change in Confidence by Fear Category
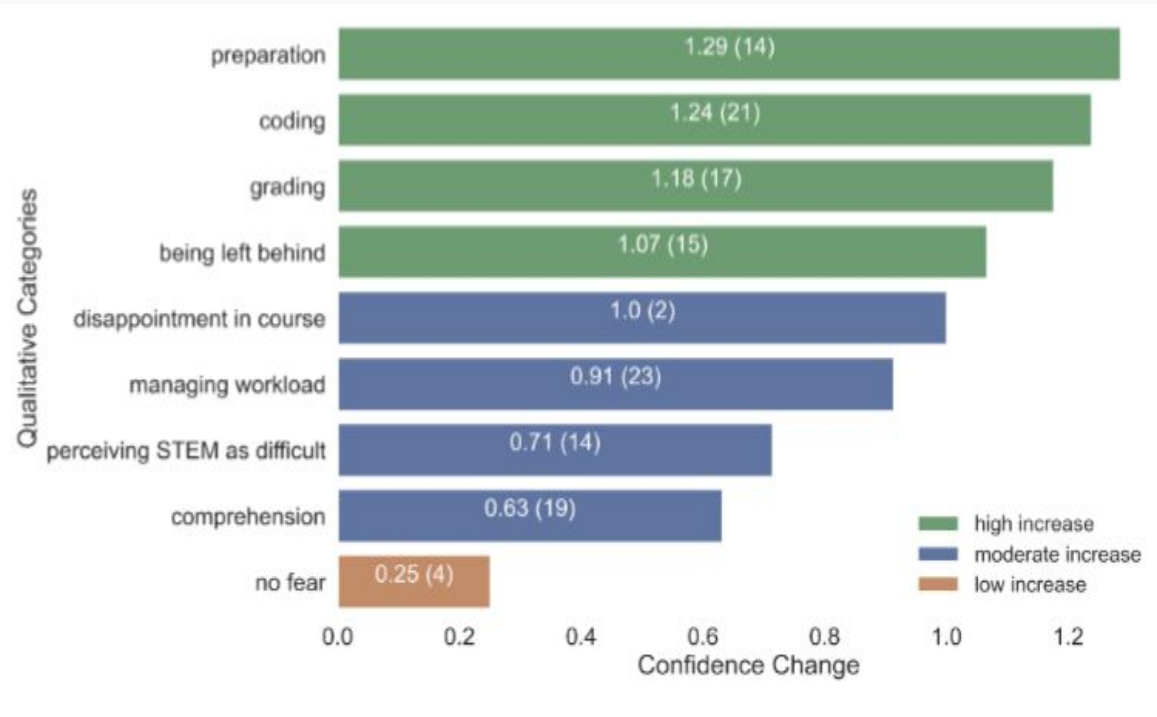
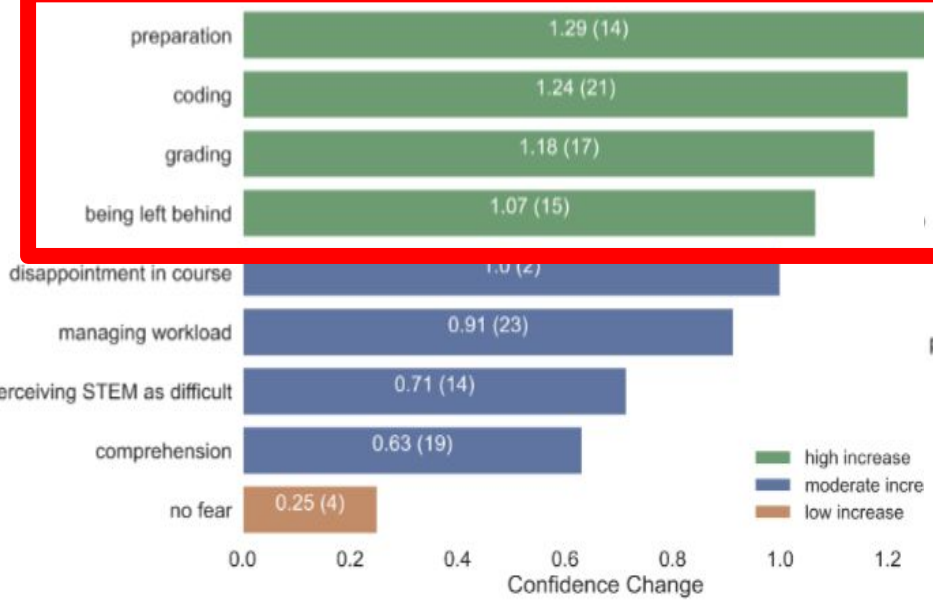# Results (RQ3): CS1 Average Change in Confidence by Fear Category
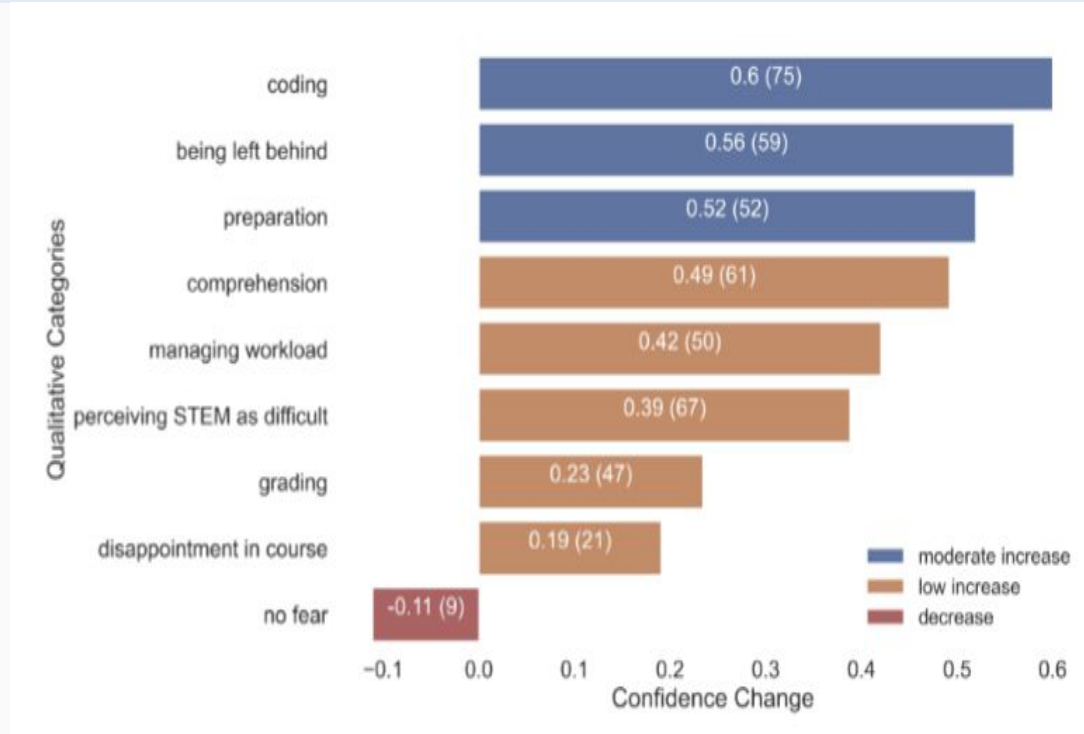
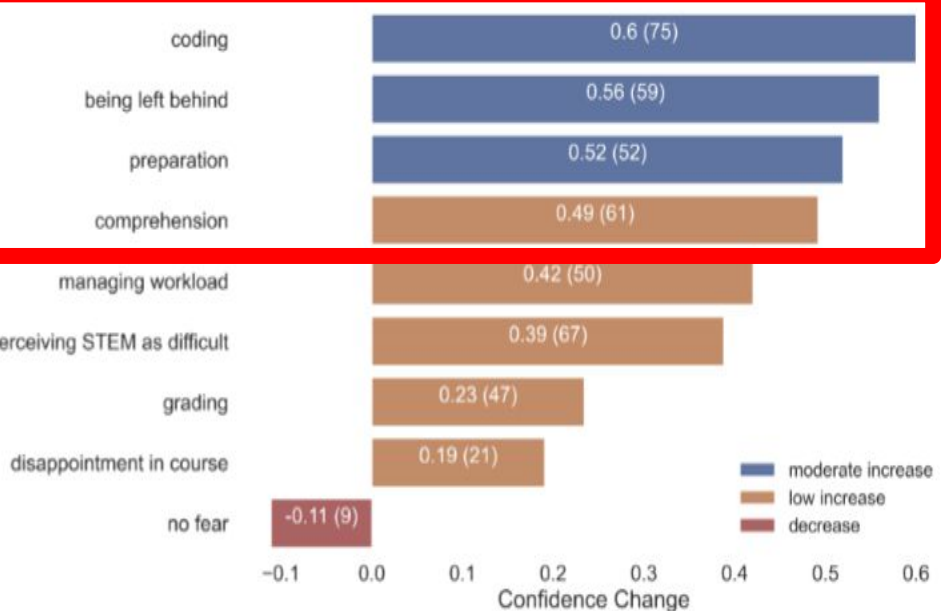# Results (RQ3): Connections between Fears and Change in Confidence in CS0 vs. CS1
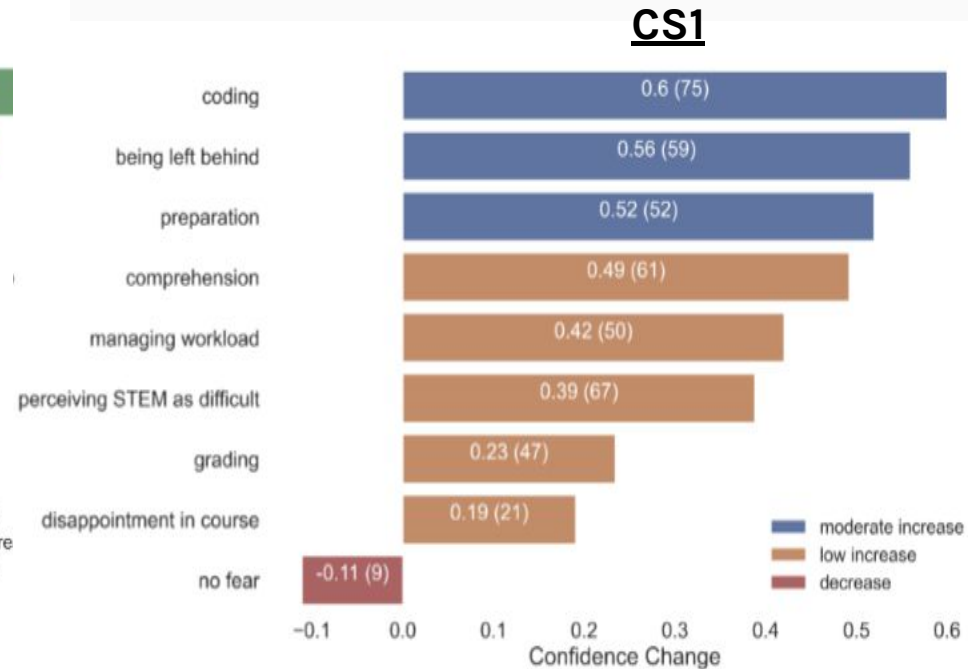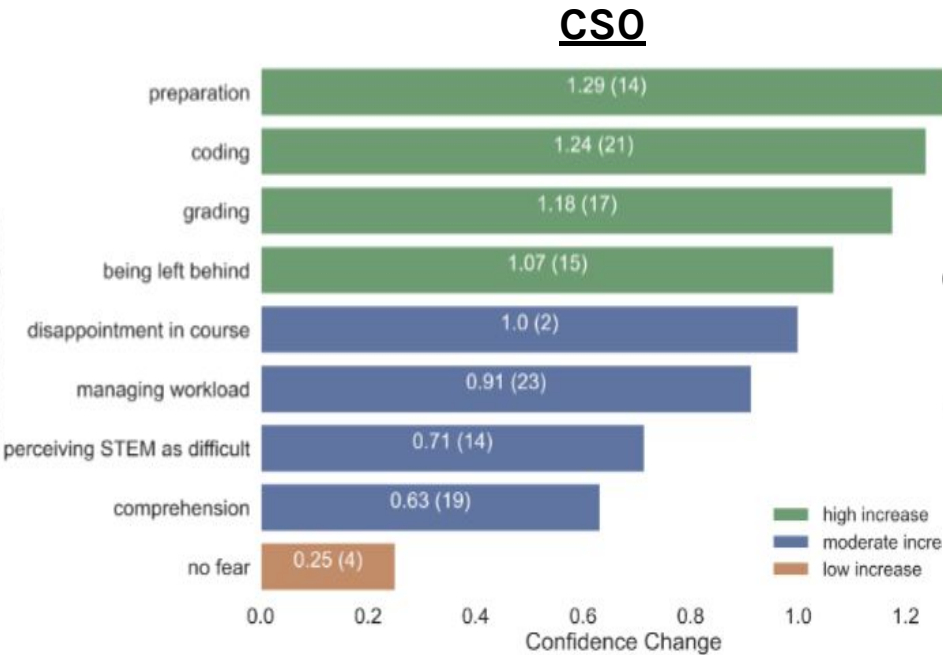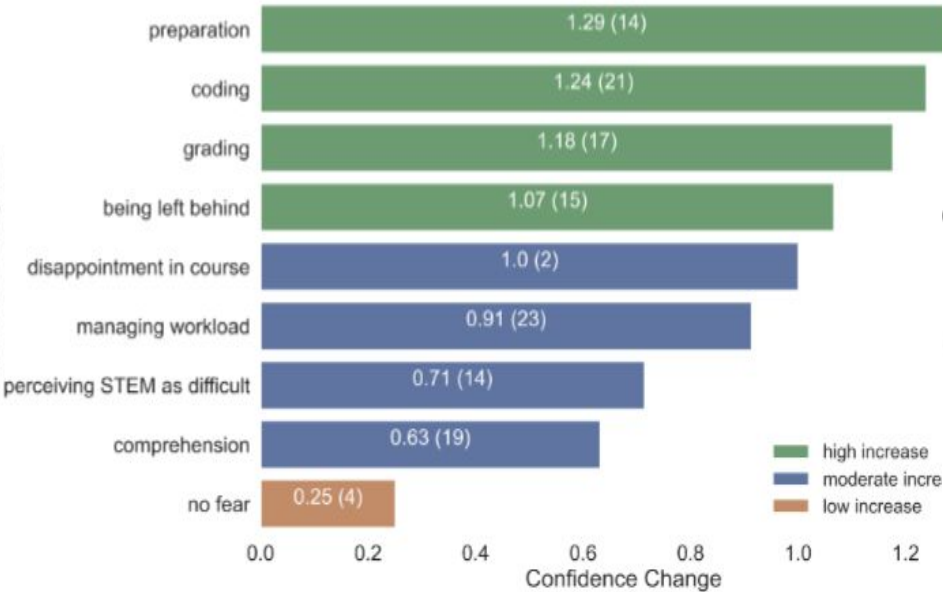
Results (RQ3)

Results (RQ3)

CS0

preparation	1.29 (14)
coding	1.24 (21)
grading	1.18 (17)
being left behind	1.07 (15)
disappointment in course	1.0 (2)
managing workload	0.91 (23)
perceiving STEM as difficult	0.71 (14)
comprehension	0.63 (19)
no fear	0.25 (4)

Confidence Change (0.0 to 1.2)

Legend:
- high increase
- moderate incre
- low increase

CS1

coding	0.6 (75)
being left behind	0.56 (59)
preparation	0.52 (52)
comprehension	0.49 (61)
managing workload	0.42 (50)
perceiving STEM as difficult	0.39 (67)
grading	0.23 (47)
disappointment in course	0.19 (21)
no fear	-0.11 (9)

Confidence Change (-0.1 to 0.6)

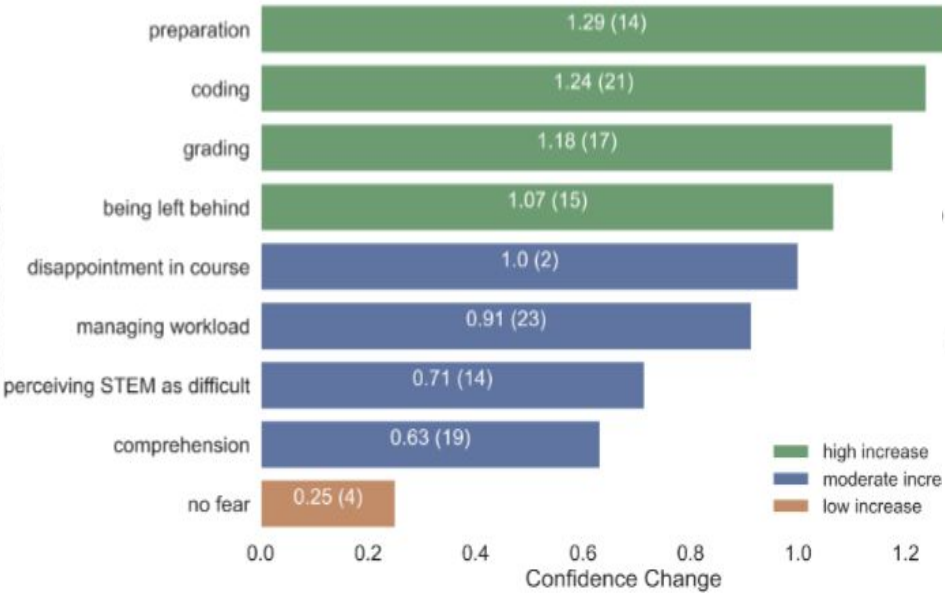Legend:
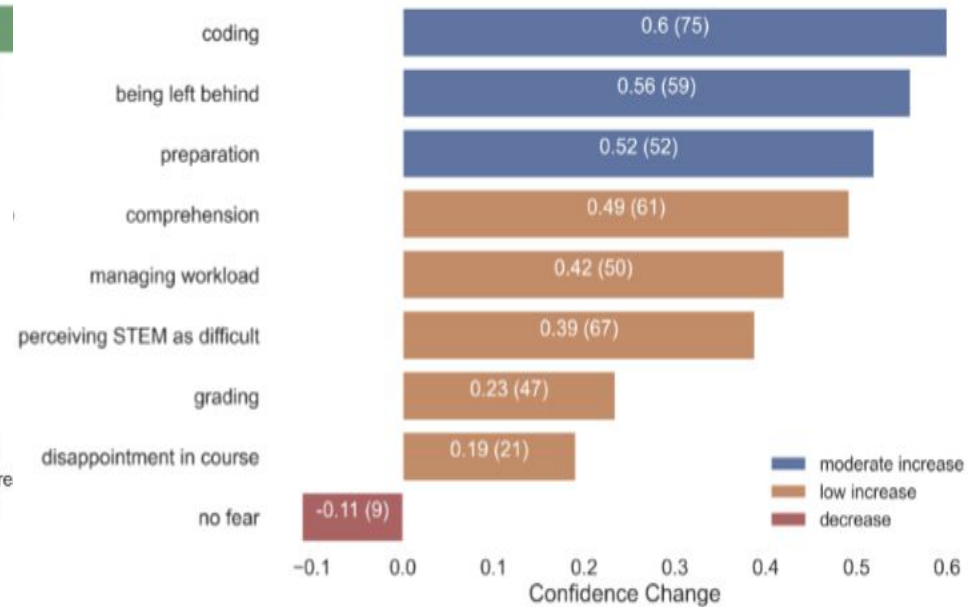- moderate increase
- low increase
- decrease

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Results (RQ3)

Results (RQ3): Connections between Fears and Change in Confidence in CS0 vs. CS1

	Low Increase	Moderate Increase	High Increase
CS0	1. no fear	1. disappointment in course 2. managing workload 3. perceiving STEM as difficult 4. comprehension	1. preparation 2. coding 3. grading 4. being left behind
CS1	1. comprehension 2. managing workload 3. perceiving STEM as difficult 4. grading 5. disappointment in course	1. coding 2. being left behind 3. preparation	N/A

Table 5: Distribution of category-based groups in CS0 and CS1 among the four confidence change intervals (the 'decrease' interval was not included as only one group from CS1 showed a decrease in confidence)

05. Discussion

Discussion: Fear Categories Aligned with Prior Work

| Zarb et al.	Hogan, Li, and Soosai Raj
The possibility of failing, and any repercussions	Fear of poor outcome / grading
Workload expectation	Workload
Managing my time well	Concern about personal organization
Feeling prepared	Preparation / Not enough prior experience
Being good at the course	Being left behind
Liking the course	Disappointment in course

Discussion: Fears Potentially Rooted in Self-Efficacy

Several of our identified **categories of fear** could be rooted in **self-efficacy** beliefs:

- 'coding'
- 'comprehension'
- 'preparation'
- 'perceiving STEM as difficult'

Discussion: Fears Potentially Rooted in Self-Efficacy
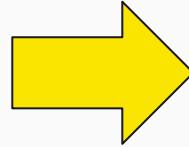
Several of our identified **categories of fear** could be rooted in **self-efficacy** beliefs:
- 'coding'
- 'comprehension'
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- 'perceiving STEM as difficult'

'coding': fear specifically about the programming aspect of the course
- **1 in 5 of students reported fear related to coding**
- High increase in confidence by the end of the course
- Overestimating how difficult it is to learn programming

Lack of self-efficacy beliefs amongst non-majors in a pre-course survey

- Recent research shows self-efficacy beliefs pre-course to impact:
    - Students' experience in CS courses
    - Course outcome for groups that are currently underrepresented in computing (e.g., women, Black, Latinx)

Discussion: Non-majors experience a greater increase in confidence in CS0 than in CS1

- Controlling for variables:
  - Instructor
  - University
  - Time period
- Most likely because **CS0 is specifically designed for non-majors**

Discussion: Fear Categories with Highest Increase in Confidence

- Preparation, coding, and being left behind experienced the highest increases in confidence in both courses
- Higher in CS0 than CS1
- CS0 may better address concerns of non-majors than CS1

06. Limitations & Future Work

Limitations

Future Work

❖ Lack of specificity
❖ Unable to confirm relationship between confidence & fears

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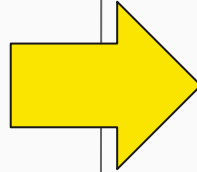
Future Work

● Interview students

Limitations

- ❖ Lack of specificity
- ❖ Unable to confirm relationship between confidence & fears
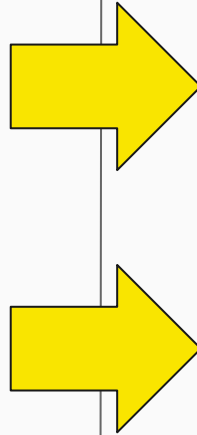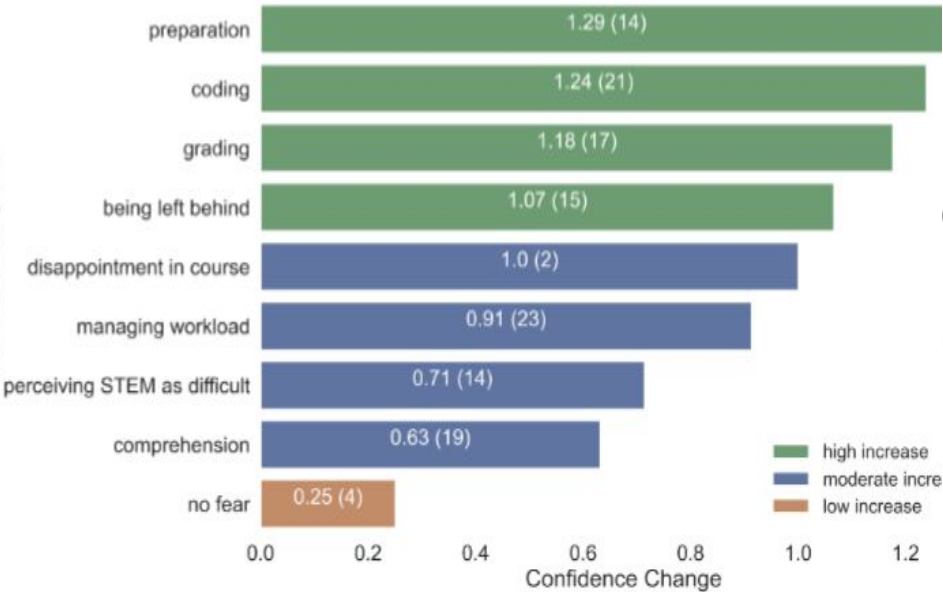- ❖ Confidence level reporting
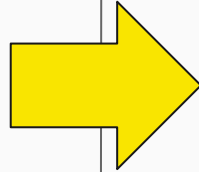
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Future Work

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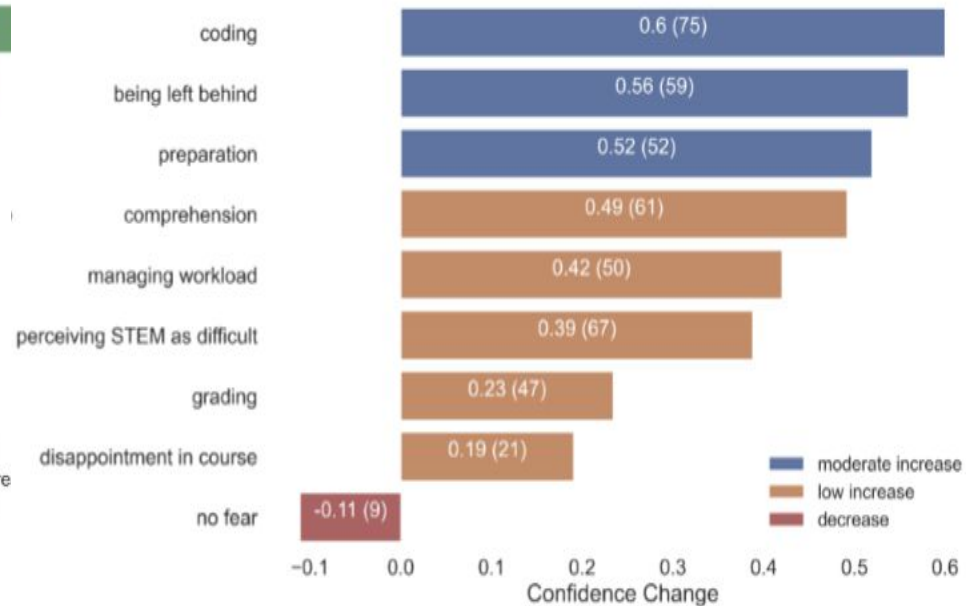● Other methods to measure success in addressing fears

Thank You!

Contact: Emma Hogan; emhogan@ucsd.edu; UC San Diego