Predicting Middle School Students’ Self-Efficacy in Computer Programming Using Linear Mixed Models

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Introduction

- Self-efficacy (SE): individual’s beliefs regarding their performance and capacity in a particular domain
  - According to Social Cognitive Career Theory (SCCT), SE promotes career interests and goals¹
- Curated Pathways to Innovation (CPI): web app providing a collection of STEM and computer science (STEM+C) activities for middle school students³
  - Aims to boost self-efficacy and career aspirations in STEM+C, particularly among female and URM students (Black/African-American, Hispanic/Latino, American Indian, Asian Native)²
  - Ultimate goal is to expand diversity in STEM+C education and employment
  - Students complete activities to earn badges; after each badge they fill out a survey asking about task-specific self-efficacy (specific to badge) and global self-efficacy (computer programming in general)

Research Questions

- RQ1: Does task-specific SE predict global SE?
- RQ2: Are there differences in students’ task-specific and global SE on the basis of gender, URM-status, or the interaction of these two demographic variables?
- RQ3: Does gender, URM-status, or the interaction of these two variables predict global SE after accounting for variation explained by task-specific SE?

Sample

- 869 middle school students (mean age = 11.2, 42.8% female, 55.9% URM)
- 6082 survey responses
- 122 badges total

Materials

- Self-efficacy survey items are answered using a 5-point Likert scale (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree)
- Only including responses in which both self-efficacy items were answered

<table>
<thead>
<tr>
<th>Task-specific SE</th>
<th>Global SE</th>
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</thead>
<tbody>
<tr>
<td>“I am good at the kinds of activities that were in this badge”</td>
<td>“I am good at computer programming”</td>
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<table>
<thead>
<tr>
<th>Task-Specific SE</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global SE</td>
<td></td>
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Table 1: Items corresponding to task-specific and global SE

Table 2: Descriptive statistics for task-specific and global SE

Analysis

- Survey responses are nested under both student and badge → non-independence within clusters
  - Responses completed by the same student are non-independent
  - Responses corresponding to the same badge are non-independent

<table>
<thead>
<tr>
<th>Task-specific SE</th>
<th>Specific SE</th>
<th>Global SE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Specific SE Model</th>
<th>Formula</th>
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<tbody>
<tr>
<td>Task1</td>
<td>gse ~ tse + (1</td>
</tr>
<tr>
<td>Task2</td>
<td>tse ~ female1*urm1 + (1</td>
</tr>
<tr>
<td>Task3</td>
<td>gse ~ tse + female1*urm1 + (1</td>
</tr>
</tbody>
</table>

Table 3: Linear mixed-effects models of task-specific self-efficacy (tse) and global self-efficacy (gse)

Results

- RQ1: Task-specific SE was significantly and positively predictive of global SE (β = 0.49, p < 0.001)
- RQ2: Gender was a significant predictor of task-specific SE, but not global SE
  - Female students had lower task-specific self-efficacy (β = -0.20, p = 0.048)
  - Neither URM-status nor the gender-URM interaction were significant predictors of task-specific or global SE
- RQ3: After accounting for variation due to task-specific SE, neither gender, URM-status, nor the interaction of the two were significantly associated with global SE
  - Task-specific SE was the only significant predictor (β = 0.49, p < 0.001)

Discussion

- Limitations
  - Dichotomous coding of gender
  - Homogeneous term “URM” to categorize a heterogeneous group
  - Findings are all correlational
- Student and badge random effects both significantly explain variation in self-efficacy ratings
  - Individual differences in self-efficacy
  - Perhaps harder badges lead to diminished self-efficacy (area for future research)
- Boosting confidence through specific activities corresponds to higher general self-efficacy in STEM+C
- Reinforces importance of CPI and other resources to encourage students to pursue STEM+C and combat gendered and racialized stereotypes, in line with Social Cognitive Career Theory²

References


Acknowledgements

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Table 3: Linear mixed-effects models of task-specific self-efficacy (tse) and global self-efficacy (gse)

Figure 1: Student demographics by gender and URM-status

Figure 2: Nested data structure with clusters of survey responses at the student and badge level

Figure 3: Survey Responses