Introduction

Increasing women's representation in computer science (CS) has become a national priority. One of the many reasons female students nationwide choose not to finish their study in CS is that they do not feel a deep sense of belonging in the major. To foster the sense of belonging among female CS students, the affective learning outcomes are integrated into the context of peer tutoring as five successive stages adopted from Bloom's Taxonomy on human learning. Through the stages of Affective Peer Tutoring (APT), students gradually deepen their sense of belonging in CS.

Our empirical data indicate that APT has resulted in an increased level of peer-to-peer interaction outside of the classrooms, significantly better grade performance in introductory programming courses, and improved retention rate among female CS students. Therefore, this study may be of interest to any CS educator who wishes to improve the interaction, performance, and retention among female CS students while sustaining a peer-led learning program at their institution.

Overview

Methods

Progression into a higher stage depends on the outcome of prior stages

1. Receiving Stage: Visiting classes to Raise Awareness of Service
2. Responding Stage: Making a Tutoring Appointment
3. Valuing Stage: Promoting Self-efficacy in Tutoring
4. Organization Stage: Building a Support System
5. Internalization Stage: Joining a Team of Peer Tutors

Results

Measuring how much female students felt like they belong:

1. Student-Tutor Engagement

Contribution

1. Receiving Stage: Visiting classes to Raise Awareness of Service
2. Responding Stage: Making a Tutoring Appointment
3. Valuing Stage: Promoting Self-efficacy in Tutoring
4. Organization Stage: Building a Support System
5. Internalization Stage: Joining a Team of Peer Tutors

This study contributes to the broadening of female participation and retention in CS by proposing the Affective Peer Tutoring model inspired by Bloom's Taxonomy on human learning. The sense of belonging is evaluated in this paper using three main indicators:

1. More peer engagement as the level of interaction.
2. Higher grade of the female students participated in ATP
3. Greater correlation between APT hours and retention rate.

Fostering a Sense of Belonging among Female CS Students with Affective Peer Tutoring

N. Rich Nguyen, Department of Computer Science, UNC Charlotte

2nd week of CS1: 68% of students frustrated with syntax problem
42% of students had difficulty with solving programming assignment

2. Student Performance in CS2

3. Student Perception and Retention Rate

It may be inferred that through the stages of Affective Peer Tutoring (APT), students gradually deepen their sense of belonging in CS.

More importantly, serving as a peer leader gives the female tutors opportunities to reinforce their own understanding of CS, rewards them with satisfaction of stimulating other student learning, and cultivates their friendship with other tutors. After all, what else would be the long-lasting values that most educators wish for their students?
Introduction

Increasing women’s representation in computer science (CS) has become a national priority. One of the many reasons female students nationwide choose not to finish their study in CS is that they do not feel a deep sense of belonging in the major. To foster the sense of belonging among female CS students, the affective learning outcomes are integrated into the context of peer tutoring as five successive stages adopted from Bloom’s Taxonomy on human learning. Through the stages of Affective Peer Tutoring (APT), students gradually deepen their sense of belonging in CS.

Our empirical data indicate that APT has resulted in an increased level of peer-to-peer interaction outside of the classrooms, significantly better grade performance in introductory programming courses, and improved retention rate among female CS students. Therefore, this study may be of interest to any CS educator who wishes to improve the interaction, performance, and retention among female CS students while sustaining a peer-led learning program at their institution.

Overview

![Overview Diagram]

Contribution

This study contributes to the broadening of female participation and retention in CS by proposing the Affective Peer Tutoring model inspired by Bloom’s Taxonomy on human learning. The sense of belonging is evaluated in this paper using three main indicators:

1. More peer engagement as the level of interaction.
2. Higher grade of the female students participated in ATP
3. Greater correlation between APT hours and retention rate.

Methods

Progression into a higher stage depends on the outcome of prior stages

1. Receiving Stage: Visiting classes to Raise Awareness of Service
   2nd week of CS1: 68% of students frustrated with syntax problem
   42% of students had difficulty with solving programming assignment

2. Responding Stage: Making a Tutoring Appointment

3. Valuing Stage: Promoting Self-efficacy in Tutoring

4. Organization Stage: Building a Support System

5. Internalization Stage: Joining a Team of Peer Tutors
   Almost all new female tutors have previously received support from the tutoring services. Their attitude changed through the stages of APT from getting tutoring to believing in a peer-led learning.

Results

Measuring how much female students felt like they belong:

1. Student-Tutor Engagement

<table>
<thead>
<tr>
<th></th>
<th>Without APT (Fall 2013)</th>
<th>With APT (Fall 2016)</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female CS Enrollment</td>
<td>364 (100%)</td>
<td>289 (100%)</td>
<td>+19%</td>
</tr>
<tr>
<td>Female Participants</td>
<td>37 (27%)</td>
<td>57 (32%)</td>
<td>+54%</td>
</tr>
<tr>
<td>Female Contact Hours</td>
<td>182 (28%)</td>
<td>386 (36%)</td>
<td>+112%</td>
</tr>
</tbody>
</table>

2. Student Performance in CS2

3. Student Perception and Retention Rate

I could not thank (the tutors) enough, they are the most helpful, smart, and went into the most detail giving me assignments, tutorials, and problem sets. After all, what else would be the long-lasting values that most educators wish for their students?

Table: Reviews Received, 93% at the highest rating!

Table: Female students who used more APT had higher retention.

Discussions

It may be inferred that through the stages of Affective Peer Tutoring (APT), students gradually deepen their sense of belonging in CS.

More importantly, serving as a peer leader gives the female tutors opportunities to reinforce their own understanding of CS, rewards them with satisfaction of stimulating other student learning, and cultivates their friendship with other tutors. After all, what else would be the long-lasting values that most educators wish for their students?