The Impact of Undergraduate Research on Student Outcomes
Examining High Impact Practices in TBR community colleges
August 2021

Summary
This study examines the impact of participation in undergraduate research (UR), one of TBR’s high impact practices (HIP), on several student outcomes. It investigates whether UR experience affects 1) academic performance; 2) the probability of graduation, university transfer, and student departure; and 2) time to completion, transfer, and departure. It also analyzes whether these effects differ by UR frequency. Examining outcomes of comparable students, the study finds that UR participation is associated with a higher final GPA and higher probability of graduation and transfer. These results improve with an increase in UR frequency, and the effect sizes are substantial. On average, UR students progress to transfer slower than nonparticipants because the former earn more credits and get a credential prior to transferring in greater proportion. UR participants are also less likely to drop out in general and in any semester during the observation period.

Undergraduate Research at TBR
The study is part of the ongoing investigation of HIPs at TBR. Undergraduate research is one of twelve HIPs that TBR implements currently. TBR defines undergraduate research as “an inquiry or investigation conducted by an undergraduate student in collaboration with a faculty member that makes a unique intellectual, scholarly, or creative contribution to the discipline, and for which the student receives academic credit either through a course or independent study.” Although the TBR taxonomy differentiates between Undergraduate Research 1, 2, and 3, this study combines them in the overall UR experience to ensure larger sample sizes in all models.

Descriptive Outcomes by Undergraduate Research Participation
This study tracked a cohort of first-time freshmen students at TBR community college and examined their UR experiences and outcomes. Out of 21,578 students in the 2017 cohort, 3,197 (14.8%) experienced UR activities during the next 9 terms of observation. The table below shows that students participating in undergraduate research have higher shares of graduates, university transfers (overall and after earning a credential), and students still enrolled at the end of observation, and a lower share of students who dropped out or stopped out as compared to non-participants. This observation holds true for all UR students and each frequency level of UR participation (Once, Twice, and 3+ times) and supports the results of the quantitative analyses.

<table>
<thead>
<tr>
<th>Student Outcomes by Undergraduate Research Participation</th>
<th>Count</th>
<th>Graduated</th>
<th>Transferred at any time</th>
<th>Transferred after graduation</th>
<th>Still enrolled</th>
<th>Dropped out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Undergraduate Research</td>
<td>3,197</td>
<td>38.2%</td>
<td>28.3%</td>
<td>18.1%</td>
<td>1.5%</td>
<td>51.4%</td>
</tr>
<tr>
<td>UR - Once</td>
<td>1,843</td>
<td>35.5%</td>
<td>26.0%</td>
<td>16.0%</td>
<td>1.7%</td>
<td>54.3%</td>
</tr>
<tr>
<td>UR – Twice</td>
<td>727</td>
<td>37.3%</td>
<td>27.1%</td>
<td>16.9%</td>
<td>1.7%</td>
<td>51.6%</td>
</tr>
<tr>
<td>UR – 3+ times</td>
<td>627</td>
<td>46.9%</td>
<td>36.2%</td>
<td>25.5%</td>
<td>1.0%</td>
<td>42.7%</td>
</tr>
<tr>
<td>Non-participants</td>
<td>18,381</td>
<td>21.5%</td>
<td>17.7%</td>
<td>8.4%</td>
<td>1.1%</td>
<td>69.0%</td>
</tr>
<tr>
<td>Total</td>
<td>21,578</td>
<td>5,163</td>
<td>4,159</td>
<td>2,114</td>
<td>254</td>
<td>14,318</td>
</tr>
</tbody>
</table>
Undergraduate Research Impact on College Outcomes

Comparing outcomes of similar students and accounting for confounding factors, the study finds that UR experience is significantly related to most outcomes of interest: final GPA, the probability of graduation, transfer, and departure; and time to transfer and departure. The effects differ by frequency of UR participation.

First, students who participate in undergraduate research activities show better academic performance than similar non-participants. On average, UR experience is associated with a 0.43-point increase in the final cumulative GPA, all else equal. The results improve with each frequency level: participation in UR one time corresponds to a 0.34 point increase in GPA, participating twice leads to half a point rise in this outcome, and participating three or more times is associated with a 0.7-point increase in the final cumulative GPA.

Second, UR participation leads to a higher probability of graduation (19 pp.) and university transfer (11 pp.), and a lower probability of departure (22 pp.) as compared to similar nonparticipants. This general difference increases with each frequency level of UR experience. To illustrate, the predicted probability of graduation increases from 12 pp. for one-time experience, to 23 pp. for participating twice, and to 37 pp. for experiencing UR activities three or more times. The probability of departure drops with higher frequency of UR experience.

Finally, accounting for time to departure, UR students are found to be less likely to drop-out in any term than non-UR students (the hazard for departure decreases by 58%). In similar models, UR participants are found to progress to transfer slower than nonparticipants (hazard decreases by 19%); it happens due to participants tending to earn more credits and obtain a credential prior to transferring. The effect sizes grow with an increase in frequency of UR experiences. There is no evidence that UR participation affects time to graduation.

### The Impact of Undergraduate Research on Student Outcomes: Findings

<table>
<thead>
<tr>
<th>Increase in GPA (points)</th>
<th>Change in predicted probability of:</th>
<th>Decrease in the hazard for:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Graduation</td>
<td>Transfer</td>
</tr>
<tr>
<td>Overall UR</td>
<td>0.43</td>
<td>19 pp.</td>
</tr>
<tr>
<td>UR – once</td>
<td>0.34</td>
<td>12 pp.</td>
</tr>
<tr>
<td>UR – twice</td>
<td>0.51</td>
<td>23 pp.</td>
</tr>
<tr>
<td>UR – 3+ times</td>
<td>0.70</td>
<td>37 pp.</td>
</tr>
</tbody>
</table>

### The study details

**Design:** Examining the impact of undergraduate research (UR), this study continues a large-scale TBR’s investigation of the effect of high impact practices (HIP) on the following student outcomes: probability of graduation, transfer, and student departure; time to completion, transfer, and departure; and academic performance. Similarly to the prior study on service learning effects, this project tracked the 2017 cohort of first-time freshmen at 13 TBR community colleges over 9 semesters in order to observe their UR experiences and compare outcomes of similar students who did and did not participate in undergraduate research. The study examined both the general effect of undergraduate research participation and the impact of frequency of undergraduate research experiences.

**Key issue:** The key issue for the effect identification is that selection into HIP participation is not random: students either opt to participate or do so to meet the program requirements. As a result, the effect of UR experiences is confounded by student characteristics: better outcomes could be the result of better preparation or background factors in addition to the impact of HIP. To address this self-selection issue, the study used propensity score weighting to compare college outcomes of similar students. Machine learning was used to estimate the propensity to participate in UR. In doubly robust estimators, the following groups of variables were used in propensity score weighting and as control variables: student background characteristics, key academic variables, financial aid, and institutional factors.

**Methods:** Propensity Score Weighting, Logistic and OLS regression, Event History Analysis.
Study design

Questions, methods, data
Motivation & design

Objectives:
- Estimate effect of undergraduate research participation
- Dissect effect by frequency

Outcomes:
- Graduation, transfer, GPA, departure

Sample:
- 2017 freshmen cohort tracked over 9 terms

Data sources:
- TBR, NSC, THEC
Research questions

Does participation in undergraduate research impact:

- Likelihood of graduation, transfer & departure?
- Academic performance?
- Progression to graduation, transfer & departure?

Do effects differ by frequency of participation?
Key issue: Selection

Participants & non-participants are systematically different

Participants may:

- be better prepared
- come from different backgrounds
- have higher motivation

Some differences affect both participation & outcomes

- Better preparation $\rightarrow$ better outcomes
Addressing selection bias

Compare students who are similar.

Attribute difference in outcomes to participation.

Use appropriate methods:

- Create balanced data sets via propensity scores.
- Add controls to minimize bias further.
- Use appropriate regression techniques.
Factors accounted for

Demographics
- Age, gender, race/ethnicity groups, resident status, Pell-eligible

Academic factors
- ACT score, HS GPA, diploma type, learning support, TN Promise, attempted credits, attendance, delay, TTP, major groups

Financial aid
- Grant amount: Pell, TN Promise, TN Lottery, TSAA

College of enrollment
Methodology

Approach:

- Machine learning for propensity scores
- Weight on inverse probability of participation
- Logistic & OLS regression, EHA

Binary analysis:

- Did or did not participate?

Frequency analysis:

- How many times?
Weighting on 33 treatment predictors

- Lottery Amount
- White
- ACT composite score
- Black
- Attempted credits
- First term
- High school GPA
- TN Promise
- High school diploma type
- Tennessee Transfer Pathway
- Major Group 1
- Enrollment status
- Age
- Major Group 5
- Degree intent: Undeclared
- Learning Support
- Pell ever
- Major Group 6
- Hispanic
- Degree intent: Transfer
- Asian
- Pell Amount
- Resident Status
- Other Race
- Promise Amount
- Gender: Female
- Major Group 7
- Degree intent: Terminal
- Major Group 1
- TSAA Amount
- Major Group 2
- Other Race

○ Before Adjustment
● After Adjustment
Undergraduate research participants

Sample, time frame, descriptives
2017 cohort tracked through summer 2020

FTF Cohort: 21,578

Undergrad Research: Yes or No

Graduated: 5,163

Transferred to university *: 4,159

Still enrolled **: 254

Can't see any more: 14,318

* 2,316 students both graduated and transferred
** in spring or summer 2020
### Undergraduate research participation

#### Participations:

- Undergraduate research: 3,197
- Once: 1,843
- Twice: 727
- 3+ times: 627

#### Term Participation:

<table>
<thead>
<tr>
<th>Term</th>
<th>Term 1 (Fa '17)</th>
<th>Term 2</th>
<th>Term 3</th>
<th>Term 4</th>
<th>Term 5</th>
<th>Term 6</th>
<th>Term 7</th>
<th>Term 8 (Sp '20)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23.1</td>
<td>32.3</td>
<td>1.9</td>
<td>15.0</td>
<td>16.8</td>
<td>1.8</td>
<td>5.3</td>
<td>3.8</td>
</tr>
</tbody>
</table>

(Percent of all terms of observation)
## Undergraduate research by demographics

<table>
<thead>
<tr>
<th></th>
<th>Participants</th>
<th>Non-participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(percent of the group's total)</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>0.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Black</td>
<td>8.3</td>
<td>19.6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.4</td>
<td>6.5</td>
</tr>
<tr>
<td>White</td>
<td>82.5</td>
<td>67.8</td>
</tr>
<tr>
<td>Other</td>
<td>3.9</td>
<td>4.5</td>
</tr>
<tr>
<td>Male</td>
<td>42.4</td>
<td>44.2</td>
</tr>
<tr>
<td>Female</td>
<td>57.6</td>
<td>55.8</td>
</tr>
<tr>
<td>Traditional age</td>
<td>95.4</td>
<td>91.9</td>
</tr>
<tr>
<td>Adult</td>
<td>4.6</td>
<td>8.1</td>
</tr>
<tr>
<td>non-Pell</td>
<td>40.8</td>
<td>34.6</td>
</tr>
<tr>
<td>Pell</td>
<td>59.2</td>
<td>65.4</td>
</tr>
</tbody>
</table>

Stat. significant difference: Participants vs. Non-participants
Undergraduate research by academic factors

<table>
<thead>
<tr>
<th></th>
<th>Participants</th>
<th>Non-participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>High school GPA</td>
<td>3.23</td>
<td>2.99</td>
</tr>
<tr>
<td>ACT score</td>
<td>20.2</td>
<td>18.9</td>
</tr>
<tr>
<td>Non-learning support</td>
<td>41.7%</td>
<td>34.9%</td>
</tr>
<tr>
<td>Learning support</td>
<td>58.3%</td>
<td>65.1%</td>
</tr>
<tr>
<td>Non-Promise</td>
<td>28.7%</td>
<td>38.3%</td>
</tr>
<tr>
<td>Promise</td>
<td>71.4%</td>
<td>61.7%</td>
</tr>
<tr>
<td>Final GPA</td>
<td>2.66</td>
<td>2.22</td>
</tr>
<tr>
<td>Average credits earned</td>
<td>46.8</td>
<td>30.4</td>
</tr>
</tbody>
</table>

Stat. significant difference:
Participants vs. Non-participants
<table>
<thead>
<tr>
<th>Major</th>
<th>Participation Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberal Arts and Sciences</td>
<td>77.6%</td>
</tr>
<tr>
<td>Registered Nursing</td>
<td>5.4%</td>
</tr>
<tr>
<td>Education, General</td>
<td>4.5%</td>
</tr>
<tr>
<td>Business Administration</td>
<td>3.4%</td>
</tr>
<tr>
<td>Computer &amp; Information Sciences</td>
<td>1.8%</td>
</tr>
<tr>
<td>Criminal Justice and Corrections</td>
<td>1.2%</td>
</tr>
<tr>
<td>Health Professions</td>
<td>1.1%</td>
</tr>
<tr>
<td>Human Development</td>
<td>0.8%</td>
</tr>
<tr>
<td>Industrial Production Technologies</td>
<td>0.7%</td>
</tr>
<tr>
<td>Allied Health Diagnostic</td>
<td>0.7%</td>
</tr>
<tr>
<td>Electrical Engineering Technologies</td>
<td>0.4%</td>
</tr>
</tbody>
</table>
Outcomes by UR participation

Legend
Participants
Non-participants

Cohort
3,197
18,381

Graduated
38.2%
21.5%

Graduated after transfer
1.3%
0.9%

Transferred
28.3%
17.7%

Transferred after graduation
18.1%
8.4%

Still enrolled
1.50%
1.1%

Dropped out
51.4%
69.0%
Findings from the quantitative analyses

Academic performance, graduation, transfer, departure
How should the findings be interpreted?

Outcomes for students who are similar in:

- Likelihood of undergraduate research participation
- Control variables

Averaged outcomes at the population level

Results that are unlikely to be due to chance alone
Increase in GPA for UR participants

On average, participants’ GPA is .43 points higher
## Predicted probability of graduation

<table>
<thead>
<tr>
<th></th>
<th>Average non-participant</th>
<th>Average UR participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergrad. research</td>
<td>.19</td>
<td>.38</td>
</tr>
<tr>
<td>UR – once</td>
<td>.16</td>
<td>.28</td>
</tr>
<tr>
<td>UR – twice</td>
<td>.16</td>
<td>.39</td>
</tr>
<tr>
<td>UR – 3+ times</td>
<td>.16</td>
<td>.53</td>
</tr>
</tbody>
</table>
Predicted increase in probability of graduation

Participants are 19 pp more likely to graduate
Progression to graduation

No evidence that participants graduate faster
## Predicted probability of transfer

<table>
<thead>
<tr>
<th></th>
<th>Average non-participant</th>
<th>Average UR participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergrad. research</td>
<td>.16</td>
<td>.27</td>
</tr>
<tr>
<td>UR – once</td>
<td>.14</td>
<td>.22</td>
</tr>
<tr>
<td>UR – twice</td>
<td>.14</td>
<td>.25</td>
</tr>
<tr>
<td>UR – 3+ times</td>
<td>.14</td>
<td>.37</td>
</tr>
</tbody>
</table>
Predicted increase in probability of transfer

Participants are 11 pp more likely to transfer
Probability of transfer by ACT score

- Undergraduate Research Participants
- Non-participants

Pr(Transfer) vs. ACT composite score
Progression to transfer

Participants are 19% less likely to transfer faster.
## Predicted probability of departure

<table>
<thead>
<tr>
<th></th>
<th>Average non-participant</th>
<th>Average UR participant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergrad. research</td>
<td>.72</td>
<td>.50</td>
</tr>
<tr>
<td>UR – once</td>
<td>.76</td>
<td>.61</td>
</tr>
<tr>
<td>UR – twice</td>
<td>.76</td>
<td>.50</td>
</tr>
<tr>
<td>UR – 3+ times</td>
<td>.76</td>
<td>.36</td>
</tr>
</tbody>
</table>
Predicted decrease in probability of departure

Participants are 22 pp less likely to stop out
Probability of departure by ACT score

- Undergraduate Research Participants
- Non-participants

Pr(Departure) vs. ACT composite score

Pr(Departure) ranges from 0.1 to 0.9.

ACT composite score ranges from 10 to 30.
Progression to departure

The graph shows the progression to departure with two lines:
- **Non-participants** (dashed blue line)
- **Participants** (solid red line)

The y-axis represents probability, ranging from 0.2 to 1.0, and the x-axis represents terms of enrollment, ranging from 0 to 10.

The graph indicates the probability of progression to departure over time for both non-participants and participants.
Progression to departure by frequency

- 0 times
- Once
- Twice
- 3+ times
1 - .42 = .58

Participants are 58% less likely to depart faster.
<table>
<thead>
<tr>
<th>Undergraduate research</th>
<th>Increase in GPA</th>
<th>Change in predicted probability:</th>
<th>Decrease in the hazard:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Graduation</td>
<td>Transfer</td>
</tr>
<tr>
<td>UR - once</td>
<td>0.34</td>
<td>12 pp.</td>
<td>8 pp.</td>
</tr>
<tr>
<td>UR - twice</td>
<td>0.51</td>
<td>23 pp.</td>
<td>11 pp.</td>
</tr>
<tr>
<td>UR - 3+ times</td>
<td>0.70</td>
<td>37 pp.</td>
<td>23 pp.</td>
</tr>
</tbody>
</table>
Key takeaways

Undergraduate research participation:

- Higher probability of graduation & transfer
- Higher GPA
- Lower likelihood of student departure

Results improve with an increase in frequency.

Effect sizes are substantial.