



# Comparison of the Experiences of Female and Male Students in Laboratories



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Reference: <https://www.acs.org/education/policies/middle-and-high-school-chemistry/laboratory/laboratory-experience.html>

# Motivation & Background

- **Marshman et al. (2018)**

Physics self-efficacy in introductory courses – female vs male students

- **Sokoloff et al. (2007)**

Traditional physics labs - unengaging and tedious

- **Kalman et al. (2020)**

Labatorials - labs and tutorials vs conceptual understanding and engagement.

# Research Questions

## **For Female and Male Students:**

- Social interactions in laboratories vs the learning experience?
- Elements of laboratories vs a satisfying experience?
- Laboratories vs students' perspectives on physics?
- Self-efficacy involvement vs laboratories?
- Laboratories vs conceptual understanding?

# What Are Laboratorials?

## Key Features:

- Collaborative problem solving
- Experiments-Worksheets
- Emphasis on reasoning rather than procedure



3 female & 2 male students

Reference: <https://freerangestock.com/photos/147854/group-of-students-doing-science.html>



3 male & 2 female students

Reference: [https://www.freepik.com/premium-ai-image/group-students-working-together-science-project-using-lab-equipment-sharing-ideas\\_318563444.htm](https://www.freepik.com/premium-ai-image/group-students-working-together-science-project-using-lab-equipment-sharing-ideas_318563444.htm)

**Methodology**

**Mixed-Methods Design**

**QUANTITATIVE**

**QUALITATIVE**

Data Collection  
Data Analysis

Data Collection  
Data Analysis

**Results compared, integrated  
& interpreted**

# Qualitative Findings

## Interviews

### Different Engagement Styles:

#### Female Students:

- Discussion oriented
- Collaborative
- Concept-driven
- More likely to seek help

*"Girls actually talk to each other more and ask help from each other more often."*

#### Male Students:

- Independent
- Task-focused
- Math/procedure-driven
- More likely to work alone

*"Guys normally would rather try to figure it out by themselves."*

# Qualitative Findings

## Interviews

**Major Themes** - Female students repeatedly described:

- **Collaboration** - Supportive discussions

*"Everyone was so supportive... and because of that, I was very confident."*

- **Psychological Safety** - Shared struggles and encouragement from peers

*"That feeling of security helps."*

- **Self-Efficacy** - Increased confidence

Confidence developed socially.

## Qualitative Findings

## Observed Interaction Patterns

### Female Students

- High levels of interaction from the beginning
- Frequently engaged in collaborative discussion
- Strong engagement with peers
- Active apparatus manipulation, particularly in mixed-gender groups

### Male Students

- More likely to take leadership roles
- Greater tendency to work independently
- Strong interest in apparatus manipulation and computations
- Interaction increased over time

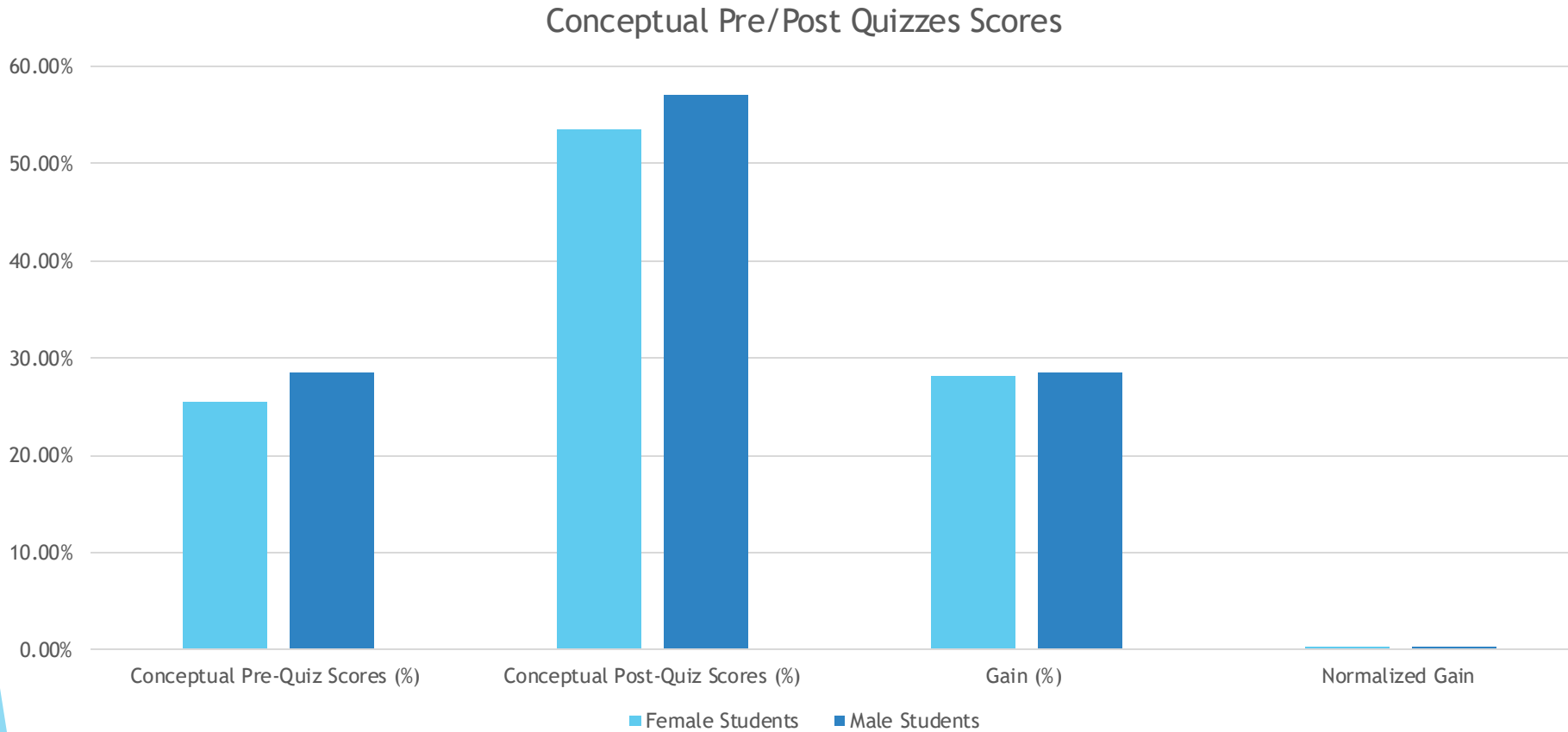
**Collaborative Interactions**



**Psychological Safety & Confidence**

# Quantitative Findings

# Conceptual Learning Outcomes



**N = 86-87 students**

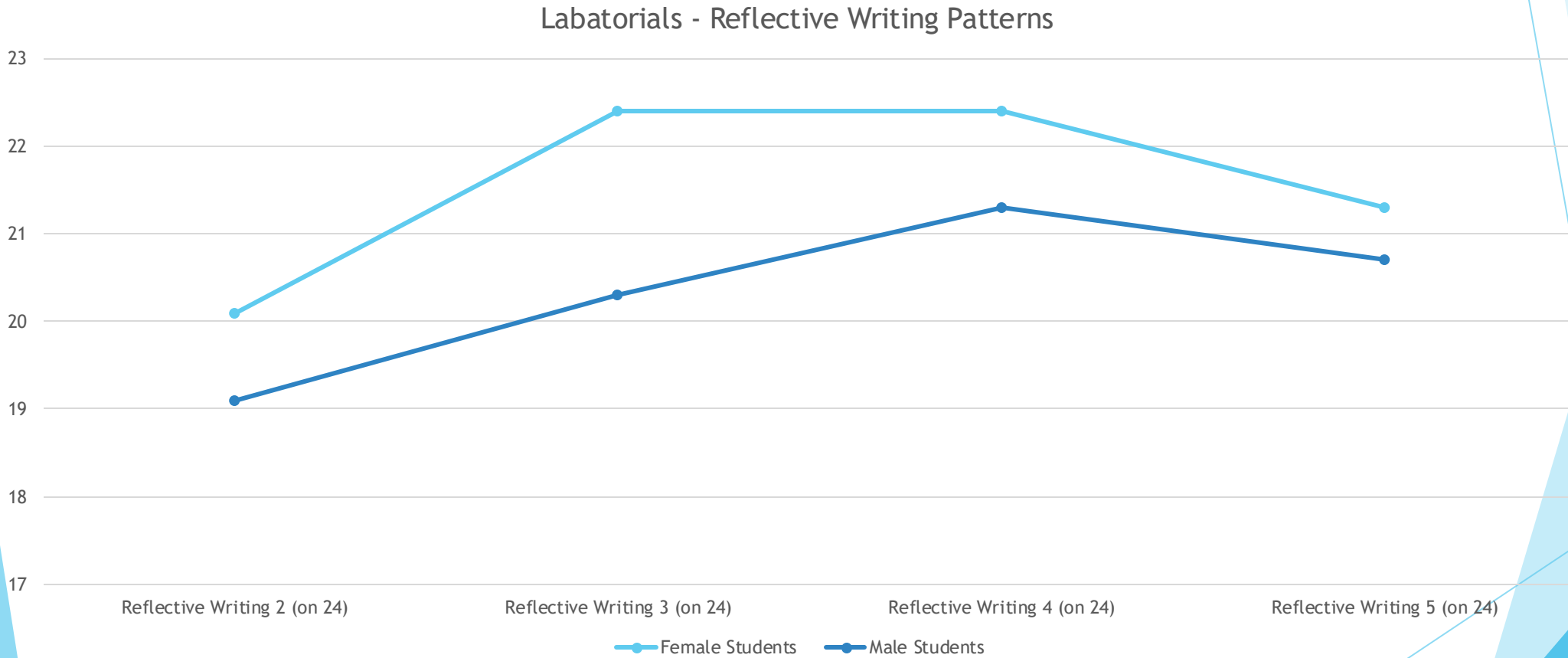
## Normalized Gains

- Female Students:  $g = 0.38$
- Male Students:  $g = 0.40$

**Figure 1:** Conceptual pre/post Quizzes scores

# Quantitative Findings

# Course Performance



**Figure 2:** Reflective Writing Patterns

# Quantitative Findings

# Course Performance

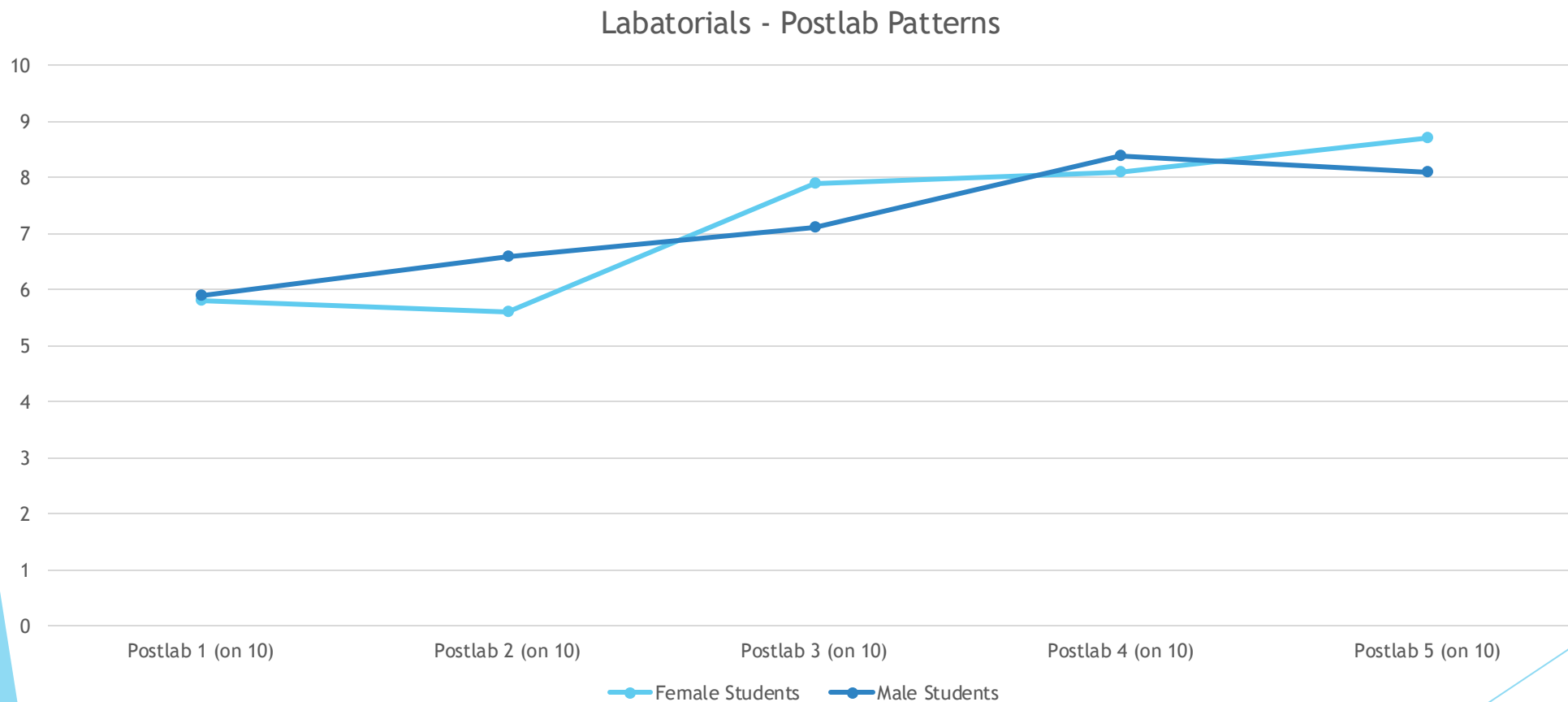


Figure 3: Postlab Patterns

# Quantitative Findings

# Course Performance

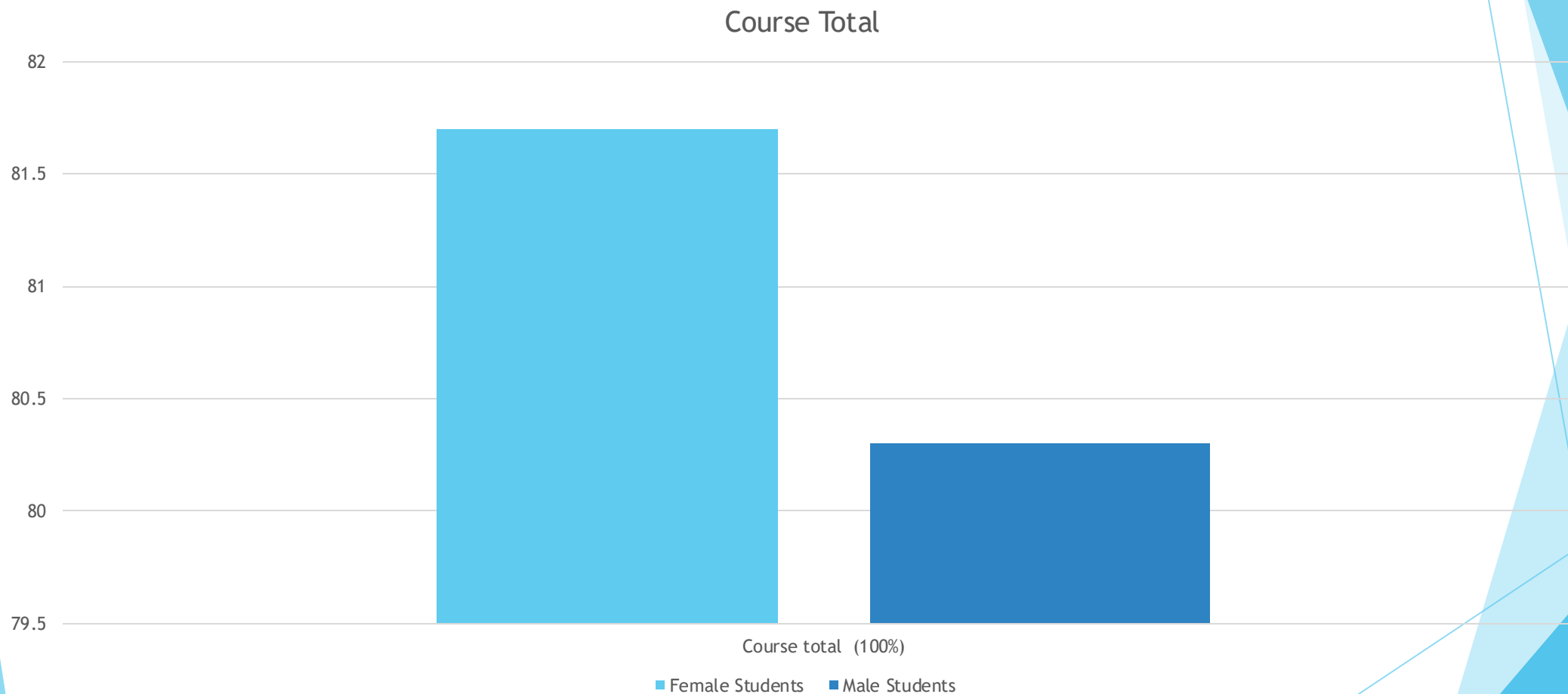
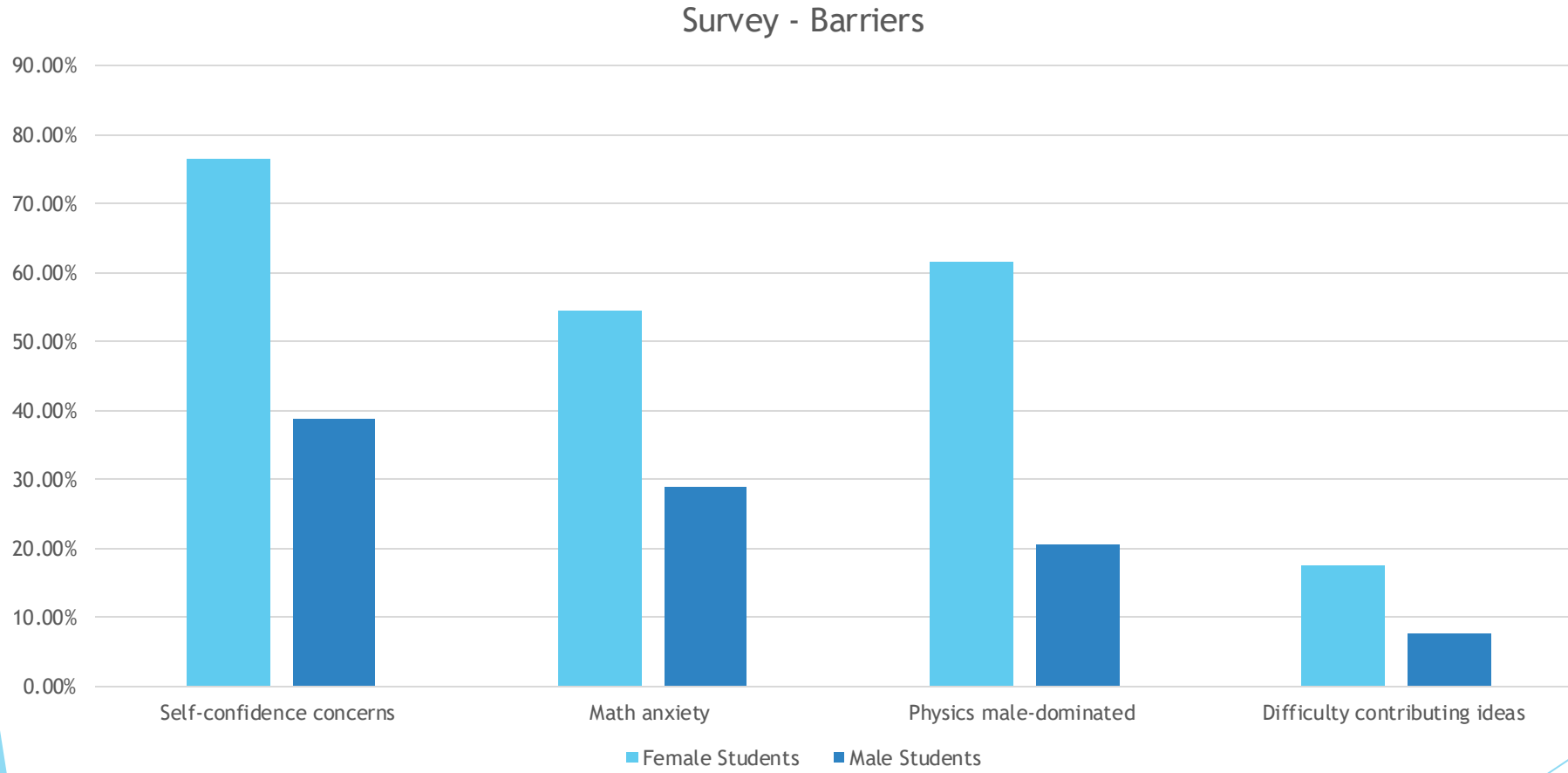


Figure 4: Course Total Scores

# Quantitative Findings

## Survey



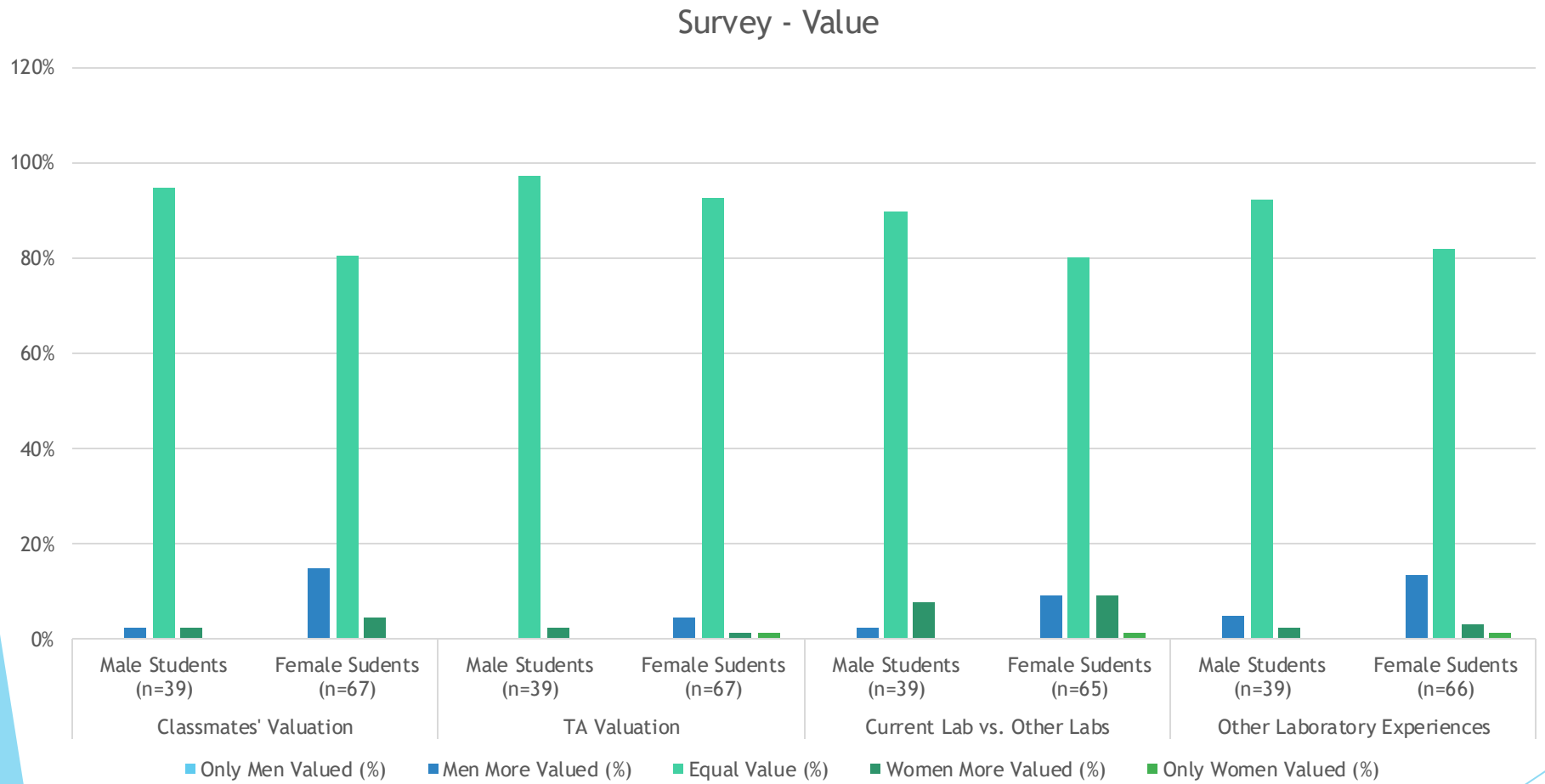
Female students reported substantially more challenges.

**Yet... Learning outcomes remained equivalent.**

Figure 5a: Survey - Barriers

# Quantitative Findings

# Survey

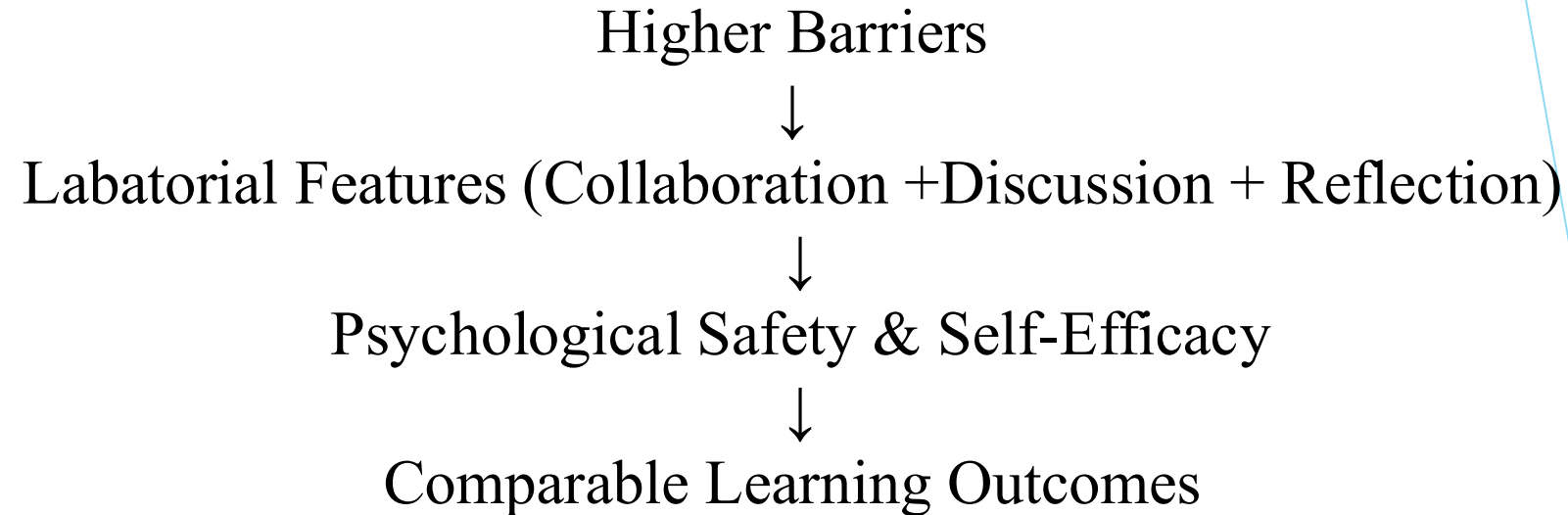


**High perception of equity and inclusivity.**

**Figure 5b: Survey – Contributions' Value**

## Integrated Discussion

## Mixed-Methods Interpretation



The collaborative structure of labatorials may help mitigate barriers commonly associated with introductory physics environments.

# Future Work

## Future Work

- Longitudinal tracking of confidence and retention
- Investigation of group composition effects

# Summary

## Main Findings

- Female students reported lower confidence and higher anxiety
- Female students outperformed male students in reflective writing
- Female students achieved learning gains equal to male students
- Students perceived laboratorials as equitable and supportive

**Questions?**