Exploring Relationships between Students’ Discussion Patterns, Emotions, and Learning Outcomes in an Online Mathematics Course

Ji-Eun Lee & Mimi Recker

Utah State University
Instructional Technology and Learning Sciences Department
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Introduction
Background of the study

Online Discussions
- Widely used in higher education settings
- Promote individual and group knowledge construction
- Do not always lead to productive interactions and knowledge construction
- Prior studies have focused on students’ posting behaviors, rather than online speaking & listening behaviors

Students’ Emotions
- Directly or indirectly influence their learning outcomes
- Especially in developmental mathematics courses, students’ negative emotions and anxiety play a significant and negative role in performance
Introduction
Research Purpose and Research Questions

**RQ1**
What online **discussion behaviors** and **emotions** characterize different groups of students? How do these relate to student learning outcomes?

**RQ2**
How does the **content of online discussions** vary within different groups of students? How do these relate to student learning outcomes?

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Canvas LMS

Clickstream data

Online discussion behaviors

Textual data (Content of online discussions)

Students’ emotions

Identifying subgroups of students

Learning outcomes

Data Pre-processing

Text mining

Classification and Regression Tree (CART)

Co-occurrence network analysis

Clickstream data

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Theoretical Framework
Online Discussion Behaviors

- A framework for examining engagement in online discussions (Wise et al., 2013; 2014)

Online Speaking

- Externalizing one’s ideas by posting

Online Listening

- Taking in the externalizations of others (i.e., students’ attend to others’ posts)

Quantity

- Volume of discussion

Breadth

- Distribution throughout the discussion

Intensity

- Multiple contributions to a specific thread
Methods

Research context and participants

- **Canvas LMS** used at a university located in the western U.S.
- **Online developmental math (statistics)** course offered during Summer 2015
- 77 undergraduate students

- **Online Discussions**
  - 11 discussion board threads
  - Participation points were awarded for posting messages (3% of final grades)
  - No required minimum # of postings
  - **387 new messages & 430 replies**
    (a total of 15,176 words)

- Example of the discussion prompt:
  - **Module 6 Discussion**
  
  *Ask and answer questions about Module 6 here. Here’s a great article about probability.....*
Methods

Measure 1: Discussion behaviors

Discussion behaviors

Online Speaking

- quantity
  - Total # of new messages made
  - Average message length (in words)

- breadth
  - Percent of threads with a minimum of one message

Online Listening

- quantity
  - Total # of replies made
  - Total # of views of (any) discussion threads

- breadth
  - Percent of threads read at least once
Methods
Measure 2: Students’ emotions


<table>
<thead>
<tr>
<th>Positive emotions</th>
<th>Negative emotions</th>
<th>Anxiety</th>
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<tbody>
<tr>
<td>% of positive emotion words within a message</td>
<td>% of negative emotion words within a message</td>
<td>% of words related to anxiety within a message</td>
</tr>
<tr>
<td>e.g.) love, nice, thank</td>
<td>e.g.) hurt, ugly, nervous</td>
<td>e.g.) worried, fearful</td>
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Example
Thanks for your help!
- LIWC analysis results for positive emotions = 25.00 \( \frac{1}{4 \text{ words}} \times \frac{\text{positive word ("thanks")}}{\times 100} \),
  for negative emotions = 0.00.
## Methods

### Data analysis

<table>
<thead>
<tr>
<th>Research questions</th>
<th>Data mining techniques</th>
<th>Tools</th>
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<tr>
<td><strong>RQ1.</strong> What online discussion behaviors and emotions characterize different groups of students? How do these relate to student</td>
<td><strong>Text mining</strong></td>
<td>LIWC</td>
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<td><strong>Classification and Regression Tree (CART)</strong></td>
<td>R studio</td>
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<td>• non-parametric decision tree method</td>
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<td><strong>RQ2.</strong> How does the content of online discussions vary within different groups of students? How do these relate to student learning outcomes?</td>
<td><strong>Co-occurrence network analysis</strong></td>
<td>KH Coder</td>
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Results

RQ 1. Online discussion behaviors, emotions and learning outcomes

- Results of the CART analysis predicting student final scores
Results

RQ 2. The content of online discussions and learning outcomes

- Co-occurrence diagram for group 1

**Group 1: Low participators**

- The **lowest average final scores** ($M = 55$, $SD = 28.87$)
- Sparse content network
- **Content not relate to course topics**

- Size of the nodes: Frequency of the words
- Color: Centrality in terms of social network analysis (light blue to white to pink in ascending order of centrality value)
Results

RQ 2. The content of online discussions and learning outcomes

- Co-occurrence diagram for group 3

Group 3: Negative Viewers (n = 14)

- Average final scores ($M = 76.64, SD = 14.68$)
- The highest average level of negative emotions, anxiety, and the # of views
- Used the discussion boards to express concerns or to ask questions
Results

RQ 2. The content of online discussions and learning outcomes

- Co-occurrence diagram for group 6

Group 6: Consistent Participators (n = 26)

- The highest average final scores
  ($M = 92.45$, $SD = 4.55$)
- Showed a higher level of online listening behaviors
- Talked about specific course content
Conclusion

Discussion Behaviors
- The most important variable in terms of predicting students’ learning outcomes were related to students’ online listening behaviors

Students’ Emotions
- Results showed that negative emotions (but not positive or anxious) also played an important role.

Discussion Content
- The lower performing subgroups did not appear to talk about course content.
- The highest performing subgroup, however, discussed specific course topics.
Key Citations


Thank you
Questions / Comments?

Ji-Eun Lee | jieun.lee@aggiemail.usu.edu
Instructional Technology and Learning Sciences Department
Utah State University

Dr. Mimi Recker | mimi.recker@usu.edu
Instructional Technology and Learning Sciences Department
Utah State University