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

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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?

Canvas LMS

Clickstream data
Online discussion behaviors

Textual data (Content of online discussions)
Students’ emotions

Identifying subgroups of students

Learning outcomes

online developmental math course

Data Pre-processing → Text mining → Classification and Regression Tree (CART) → Co-occurrence network analysis
A framework for examining engagement in online discussions (Wise et al., 2013; 2014)

- **Quantity**
  - Volume of discussion

- **Breadth**
  - Distribution throughout the discussion

- **Intensity**
  - Multiple contributions to a specific thread

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**Online Speaking**
Externalizing one’s ideas by posting

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

- **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>
</tr>
</thead>
<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>
</tr>
</tbody>
</table>

- Example
  Thanks for your help!
  - LIWC analysis results for positive emotions = 25.00 \( \left( \frac{1 \text{ positive word ("thanks")}}{4 \text{ words}} \right) \times 100 \),
  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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<tbody>
<tr>
<td><strong>RQ1.</strong> What <em>online discussion behaviors and emotions</em> characterize different groups of students? <strong>How do these relate to student</strong></td>
<td><strong>Text mining</strong></td>
<td>LIWC</td>
</tr>
<tr>
<td></td>
<td><strong>Classification and Regression Tree (CART)</strong></td>
<td><a href="http://liwc.wpengine.com">http://liwc.wpengine.com</a></td>
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<td></td>
<td>• non-parametric decision tree method</td>
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<td><strong>RQ2.</strong> How does <em>the content of online discussions</em> vary within different groups of students? <strong>How do these relate to student learning outcomes?</strong></td>
<td><strong>Co-occurrence network analysis</strong></td>
<td>KH Coder</td>
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<td><a href="http://khc.sourceforge.net">http://khc.sourceforge.net</a></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
<table>
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<tr>
<th>Discussion Behaviors</th>
<th>The most important variable in terms of predicting students’ learning outcomes were related to <strong>students’ online listening behaviors</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ Emotions</td>
<td>Results showed that <strong>negative emotions</strong> (but not positive or anxious) also played an important role.</td>
</tr>
</tbody>
</table>
| 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?

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