ASSESSING STUDENTS’ EMOTIONAL STATES: AN APPROACH TO IDENTIFY LECTURES THAT PROVIDE AN ENHANCED LEARNING EXPERIENCE

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PRESENTATION OVERVIEW

- Background
- Motivation
- Methodology
- Case Study
- Results
- Conclusions
- Future Work
EMOTIONS IN THE CLASSROOM

Research Motivation

Munoz, Tucker 2014

http://www.engr.psu.edu/datalab/
How can we identify lectures that offer an enhanced learning experience?

**Literature Review**

Munoz, Tucker 2014 http://www.engr.psu.edu/datalab/
EMOTIONS IN THE CLASSROOM

<table>
<thead>
<tr>
<th>Emotional State</th>
<th>Learning Gains Impact</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement/Interest</td>
<td>Positive</td>
<td>[21, 7]</td>
</tr>
<tr>
<td>Frustration</td>
<td>Negative</td>
<td>[25, 9]</td>
</tr>
<tr>
<td>Boredom</td>
<td>Negative</td>
<td>[26]</td>
</tr>
<tr>
<td>Confusion</td>
<td>Positive</td>
<td>[9, 25, 27]</td>
</tr>
<tr>
<td>Delight</td>
<td>Positive</td>
<td>[9]</td>
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</table>

students experience positive mental states while minimizing those mental states associated with negative connotations.
STUDENTS’ UNDERSTANDING OF LECTURE MATERIAL

Limitations in understanding the root causes of poor students’ performance

Existing Assessment Techniques

Data Mining Lectures

SRTEs
Hypothesis: Students’ emotional states are correlated with the lecture characteristics (lecture style and lecture content) - towards individually customized learning
METHODOLOGY: QUANTIFYING STUDENTS EMOTIONAL STATES TOWARDS LECTURES

<table>
<thead>
<tr>
<th>Experimental Setting</th>
<th>Data Capturing</th>
<th>Data Analysis</th>
<th>Optimal Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Setting</td>
<td>Data Capturing</td>
<td>Data Analysis</td>
<td>Optimal Lectures</td>
</tr>
<tr>
<td>LECTURE</td>
<td>Background</td>
<td>Attitude</td>
<td>$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Methodology

Munoz, Tucker 2014
http://www.engr.psu.edu/datalab/
EXPERIMENTAL SETTING

Experimental Setting

- Students from various fields (degree, habits of study, class participation, interest and area of expertise)
- A Likert scale (1 to 5)
- Lecture composed by various lessons.
- Survey asking students about emotional states during lecture
## DATA CAPTURING

### Experimental Setting

### Data Capturing

### Data Analysis

### Optimal Lectures

<table>
<thead>
<tr>
<th>Forms</th>
<th>Background</th>
<th>Emotional states</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Degree sought</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Class level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Habits of study</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Areas of interest</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Areas of expertise</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td><strong>Background</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Attitude</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Methodology**

Munoz, Tucker 2014  
http://www.engr.psu.edu/datalab/
Correlation analysis from self-reported survey

<table>
<thead>
<tr>
<th>r</th>
<th>Type of relationship</th>
<th>Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>± [0.0 to 0.2]</td>
<td>Weak or no relationship</td>
<td></td>
</tr>
<tr>
<td>± [0.2 to 0.4]</td>
<td>Weak relationship</td>
<td></td>
</tr>
<tr>
<td>± [0.4 to 0.6]</td>
<td>Moderate relationship</td>
<td></td>
</tr>
<tr>
<td>± [0.6 to 0.8]</td>
<td>Strong relationship</td>
<td></td>
</tr>
<tr>
<td>± [0.8 to 1.0]</td>
<td>Very strong relationship</td>
<td></td>
</tr>
</tbody>
</table>

\[ r = \frac{\Sigma_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\Sigma_{i=1}^{n}(X_i - \bar{X})^2 \Sigma_{i=1}^{n}(Y_i - \bar{Y})^2}} \]

- **r**: Sample size
- **X_i**: Value of \( i \)th observation from sample X, \( i: 1 \) to \( n \)
- **\bar{X}**: Average value of all observations from sample X
- **Y_i**: Value of \( i \)th observation from sample Y, \( i: 1 \) to \( n \)
- **\bar{Y}**: Average value of all observations from sample Y
Value path graphs

- Value paths range from 1 to 5
- Emotions categorized as negative will be normalized to have 5 as more desirable and 1 as less desirable
- Positive emotions and negative emotions are directly compared
CASE STUDY: EMOTIONAL STATES IN THE CLASSROOM
Participants Selection

- 22 students from different fields
- Lecture of five short video-lectures
- 5 – 7 minutes per video

Lecture Selection

- 10 video-lectures
  - List A (5 videos)
  - List B (5 videos)

The videos were retrieved from the “Big Think” channel in YouTube.
RESULTS: CORRELATIONS AMONG EMOTIONAL STATES

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>ENG</th>
<th>BOR</th>
<th>INT</th>
<th>FRU</th>
<th>DEL</th>
<th>CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG</td>
<td>-0.74</td>
<td>0.74</td>
<td>-0.45</td>
<td>0.61</td>
<td>-0.36</td>
<td></td>
</tr>
<tr>
<td>BOR</td>
<td>-0.74</td>
<td>-0.71</td>
<td>0.42</td>
<td>-0.54</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td>0.74</td>
<td>-0.71</td>
<td>-0.43</td>
<td>0.65</td>
<td>-0.38</td>
<td></td>
</tr>
<tr>
<td>FRU</td>
<td>-0.45</td>
<td>0.42</td>
<td>-0.43</td>
<td></td>
<td>-0.29</td>
<td>0.43</td>
</tr>
<tr>
<td>DEL</td>
<td>0.61</td>
<td>-0.54</td>
<td>0.65</td>
<td>-0.29</td>
<td></td>
<td>-0.27</td>
</tr>
<tr>
<td>CON</td>
<td>-0.36</td>
<td>0.54</td>
<td>-0.38</td>
<td>0.43</td>
<td></td>
<td>-0.27</td>
</tr>
</tbody>
</table>

Interesting insights

- ENG is strongly positively associated to INT (0.74) and DEL (0.61), which are usually defined as positive mental states.
- ENG, is strongly negatively associated to BOR (-0.74), moderately negatively related to FRU (-0.45), and weakly negatively associated to CON (-0.36).
- In addition, CON is weakly (-0.36, -0.38, and -0.27) or moderately associated (0.54 and 0.43) to all other mental states.

Emotional states included

Engagement (ENG)
Boredom (BOR)
Interest (INT)
Frustration (FRU)
Delight (DEL)
Confusion (CON)
RESULTS: EMOTIONAL STATES AND PERCEPTUAL FACTORS

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>ENG</th>
<th>BOR</th>
<th>INT</th>
<th>FRU</th>
<th>DEL</th>
<th>CON</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIF</td>
<td>-0.07</td>
<td>0.01</td>
<td>-0.11</td>
<td>0.13</td>
<td>0.05</td>
<td>0.35</td>
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<tr>
<td>BAC</td>
<td>0.44</td>
<td>-0.45</td>
<td>0.50</td>
<td>-0.16</td>
<td>0.36</td>
<td>-0.21</td>
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<tr>
<td>UND</td>
<td>0.51</td>
<td>-0.54</td>
<td>0.61</td>
<td>-0.40</td>
<td>0.36</td>
<td>-0.53</td>
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<tr>
<td>STY</td>
<td>0.77</td>
<td>-0.77</td>
<td>0.68</td>
<td>-0.51</td>
<td>0.55</td>
<td>-0.50</td>
</tr>
</tbody>
</table>

Interesting insights

• The level of perceived difficulty was not significantly correlated with the reported emotional states except for confusion in which a weak relationship was found (0.35).

• Background of the student is not significantly associated to the frustration reported. However, this statement cannot be generalizable for other settings in which more field-specific lectures are presented.

• Teaching style to engage students is correlated to all the emotions reported.

Perceptual factors included

• Perceived difficulty (DIF)
• Background (BAC)
• Understanding (UND)
• Teaching style (STY)
RESULTS: CORRELATIONS AMONG PERCEPTUAL FACTORS

Perceptual factors included

- Perceived difficulty (DIF)
- Background (BAC)
- Understanding (UND)
- Teaching style (STY)

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>DIF</th>
<th>BAC</th>
<th>UND</th>
<th>STY</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIF</td>
<td></td>
<td>0.06</td>
<td>-0.24</td>
<td>-0.01</td>
</tr>
<tr>
<td>BAC</td>
<td>0.06</td>
<td></td>
<td>0.27</td>
<td>0.32</td>
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<tr>
<td>UND</td>
<td>-0.24</td>
<td>0.27</td>
<td></td>
<td>0.53</td>
</tr>
<tr>
<td>STY</td>
<td>-0.01</td>
<td>0.32</td>
<td>0.53</td>
<td></td>
</tr>
</tbody>
</table>

Interesting insights

- The reported understanding level (UND) is moderately correlated with the perception of the ability of the speaker to engage the audience, STY (0.53).
- Perceived difficulty (DIF) was not significantly correlated to neither background (BAC) nor speaker style (STY).
RESULTS: VALUE PATH GRAPHS

Value Path Graph (Set of lectures A)

- Lectures A4 and A5 are non-dominated video-lectures.
- A1, A2, and A3, are considered to be dominated video-lectures.

Value Path Graph (Set of lectures B)

- Lectures B1 and B5 are non-dominated video-lectures.
- B2, B3, and B4, are considered to be dominated video-lectures.
### Lecture Related Metrics
- Like/View (L/V)
- Like/Dislike (L/D)
- Subscriptions/View (S/V)
- Share/View (H/V)

### Results and Insights
- The ratio S/V was moderately correlated to ENG, BOR, INT, and FRU, and weakly correlated to DEL and CON.

<table>
<thead>
<tr>
<th></th>
<th>ENG</th>
<th>BOR</th>
<th>INT</th>
<th>FRU</th>
<th>DEL</th>
<th>CON</th>
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</thead>
<tbody>
<tr>
<td><strong>L/V</strong></td>
<td>-0.10</td>
<td>0.18</td>
<td>-0.06</td>
<td>-0.29</td>
<td>0.10</td>
<td>-0.09</td>
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<tr>
<td><strong>L/D</strong></td>
<td>0.35</td>
<td>-0.33</td>
<td>0.36</td>
<td>-0.25</td>
<td>0.32</td>
<td>-0.14</td>
</tr>
<tr>
<td><strong>S/V</strong></td>
<td>0.53</td>
<td>-0.53</td>
<td>0.55</td>
<td>-0.43</td>
<td>0.33</td>
<td>-0.25</td>
</tr>
<tr>
<td><strong>H/V</strong></td>
<td>0.08</td>
<td>0.00</td>
<td>0.13</td>
<td>-0.48</td>
<td>0.05</td>
<td>-0.04</td>
</tr>
</tbody>
</table>
CONCLUSIONS

Positive Engagement • Interest • Delight Positively correlated (r > 0.6)

Positive Boredom • Frustration • Confusion Positively correlated (r > 0.4)

Engagement and boredom are strongly negatively correlated (r = -0.74)

Confusion has the weakest correlations

Munoz, Tucker 2014 http://www.engr.psu.edu/datalab/
## FUTURE WORK

### Current and future work

- Capture emotional states automatically (non-invasive sensors)

### Potential applications

Identify factors influencing student’s emotional states and early advice

Team matching

Evaluate teaching methods and lecture structure

Determine optimum length of a lecture or topic
Acknowledgement & References

Contributors:
• D.A.T.A. Lab: David Munoz, Conrad Tucker

References


QUESTIONS