Instructional Efficiency in Asynchronous Online Discussions

Emily Faulconer  
*Embry-Riddle Aeronautical University*, faulcone@erau.edu

Darryl Chamberlain  
*Embry-Riddle Aeronautical University*, chambd17@erau.edu

Beverly Wood  
*Embry-Riddle Aeronautical University*, woodb14@erau.edu

Follow this and additional works at: https://commons.erau.edu/publication

Part of the Educational Methods Commons, Higher Education Commons, and the Online and Distance Education Commons

Scholarly Commons Citation

This Presentation without Video is brought to you for free and open access by Scholarly Commons. It has been accepted for inclusion in Publications by an authorized administrator of Scholarly Commons. For more information, please contact commons@erau.edu.
Instructional Efficiency in Asynchronous Online Discussions

Emily Faulconer, Ph.D.
Darryl Chamberlain, Ph.D.
Beverly Wood, Ph.D.
Embry-Riddle Aeronautical University
Asynchronous online course offerings are increasing.

+ “No Significant Difference” in student grades

- Higher withdrawal rate
Understanding student persistence in online learning is complex.

- Institutional Characteristics
- Student Expectations & Satisfaction
- External/Environmental Factors
- Learner Characteristics & Skills
- Internal Personal Factors
- Engagement
- Psychological Attributes
- Cost/Benefit
  - Attrition vs. Persistence

Before Course → During Course
Learning tasks in online courses demand working memory resources – cognitive load.

**Intrinsic load:** amount of mental processing required to understand the task
- task complexity
- element interactivity
- task environment

**Extraneous load:** working memory load experienced as learners interact with learning materials
- Material presentation (split attention, redundancy, etc.)

**Germane load:** work required to create a new knowledge schema
Cognitive load influences persistence and satisfaction in online courses.

<table>
<thead>
<tr>
<th>Cognitive Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intrinsic Load</td>
</tr>
<tr>
<td>Extraneous Load</td>
</tr>
<tr>
<td>Germane Load</td>
</tr>
</tbody>
</table>
Asynchronous online classes often use discussions to establish a learning community.

- Idea exchange
- Content focus
- Critical thinking
- Peer feedback
- Problem solving
- Collaboration
Learners & instructors project their personality into the community through social presence.

- Affective responses
- Interactive communication
- Cohesive responses
Teaching presence may reduce extraneous load and improve persistence.

Design
Direction
Facilitation

Social and Cognitive Interactions
Students’ cognitive presence in online courses can be predicted by social & teaching presence.

**Triggering event**
- Puzzlement
- Clarification

**Exploration**
- Agreement/Divergence
- Information Sharing
- Leap to Conclusions
- Personal Narration
- Opinion

**Integration**
- Building On
- Creating Solutions
- Justified Hypothesis
- Supported Agreement/Divergence

**Resolution**
- Wrap-Up
- Thought Experiment
- Apply, Test, Defend
This study was designed as a quantitative descriptive case study.

RQ1: Are student social & cognitive presences and instructor social & teaching presences consistent throughout a course (module-to-module)? Section to section?

RQ2: What factors predominate within each presence?

RQ3: What tasks in asynchronous online discussions influenced cognitive load?

(variables measured, not manipulated or controlled)


- **Survey data**: NASA-TLX
  - 476 Pop, 67 Resp (14% response rate)
- **LMS data**:
  - final course grade, discussion scores (476 total)
  - Discussion transcripts (29, 12, 27, 23 = 91 total)
Mentimeter for RQ1
We identified 5 discrete tasks involved in engaging in asynchronous online discussions.

- Understanding expectations
- Crafting initial post
- Reading posts
- Creating reply posts
- Integrating instructor feedback
Discussion transcripts were coded for community of inquiry presences.

<table>
<thead>
<tr>
<th>Student Social Presence</th>
<th>Student Cognitive Presence</th>
<th>Instructor Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Affective Responses:</strong> Emotion, expressions, humor, or personal information.</td>
<td><strong>Triggering Event:</strong> Asking a content question or clarifying content.</td>
<td><strong>Facilitating Discourse:</strong> Encouraging consensus and student contribution.</td>
</tr>
<tr>
<td><strong>Interactive Responses:</strong> Responses between individuals.</td>
<td><strong>Exploration:</strong> Low-level arguments like (dis)-agreeing without substance, sharing facts, stating content opinions, and content-related stories.</td>
<td><strong>Instructional Design &amp; Organization:</strong> Setting expectations, establishing netiquette, and macro-level comments about course and content.</td>
</tr>
<tr>
<td><strong>Cohesive Responses:</strong> Responses to the class in general or purely social functions.</td>
<td><strong>Integration:</strong> High-level arguments like building on a previous statement, (dis)agreement with reasoning, &amp; making conclusions.</td>
<td><strong>Direct Instruction:</strong> Responses that focus on student learning of discussion concepts.</td>
</tr>
<tr>
<td><strong>Resolution:</strong> Highest-level arguments like synthesis of information and drawing a conclusion with reasoning.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Presence Density acts as a standardization to compare categories without over-representation of verbose responses.

General Formula: \( \text{Presence Density} = \frac{\text{Category}(\text{text units})}{\text{Form}(\text{number of words})} \times 1000 \)

In our case: \( \text{Presence Density} = \frac{\text{Subpresence}(\# \text{ of sentences})}{\text{Discussion}(\# \text{ of words})} \times 1000 \)

We can then compare the PDs by % of density for each presence.
RQ1: All modules/cohorts analyzed [Social]?

Social Presence Density % All Cohorts

Social Presence Density % Cohort 1

Social Presence Density % Cohort 2

Social Presence Density % Cohort 3

Social Presence Density % Cohort 4
RQ1: All modules/cohorts analyzed [Cognitive]?
RQ1: All modules/cohorts analyzed [Instructor]?

Teaching Presence Density % All

Teaching Presence Density % Cohort 1

Teaching Presence Density % Cohort 2

Teaching Presence Density % Cohort 3

Teaching Presence Density % Cohort 4
RQ2: Predominate Student Social Factors

<table>
<thead>
<tr>
<th>Natural Expression (24%)</th>
<th>Vocatives (23%)</th>
<th>Expressing Appreciation (16%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing insights and thoughts, including specific advice.</td>
<td>Use of names and/or official titles.</td>
<td>Complimenting, expressing appreciation, praise, encouragement.</td>
</tr>
<tr>
<td>“Last week, I’ve anticipated this application coming and I have a video to share...”</td>
<td>[name]</td>
<td>“I enjoyed your discussion piece on ambient pressure...”</td>
</tr>
<tr>
<td>“About the example ..., reminds me of a physics demonstration that I've done in class.”</td>
<td></td>
<td>“That's a pretty good description and example of linear momentum.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Sharing (19%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharing information such as thoughts, experiences, or personal values, (focus is on thought or story, not content or content-related opinion); introducing topic of discussion.</td>
</tr>
<tr>
<td>“This weekend I decided to flex my nerd bones and watched the episode of “Star Trek” where Data performed an experiment...”</td>
</tr>
</tbody>
</table>
Mentimeter for RQ2
RQ2: Predominate Student Cognitive Factors

<table>
<thead>
<tr>
<th>Information Sharing (60%)</th>
<th>Personal Narrative (9%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stating a fact, policy, rule; brainstorming; sharing resources.</td>
<td>Telling a story or relating an incident (e.g. describing practices at their job), relevant to content.</td>
</tr>
<tr>
<td>“Sugar is a solid in it's natural form, until it is added into a cup of boiling hot liquid.”</td>
<td>“In my aircraft, the MV-22, we don't really have much of a radar system.”</td>
</tr>
<tr>
<td>“The transfer of heat is broken down into three methods: conduction, convection, and radiation.”</td>
<td>“For us on the V-22, we constantly monitor the power output of the engines because...”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Opinion (9%)</th>
<th>Clarification (6%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stating a belief, personal view, attitude (related to content) with insufficient evidence to conclude as factual.</td>
<td>Expressing clarification and restating for clarity.</td>
</tr>
<tr>
<td>“In my humble opinion, this Law is the first law for a reason.”</td>
<td>“In other words, speed and magnitude of the aircraft.”</td>
</tr>
<tr>
<td>“In my perspective, vectors are vital to daily flight operations.”</td>
<td>“To make a complicated answer short, we don't autorotate, nor do we really glide.”</td>
</tr>
</tbody>
</table>
### RQ2: Predominate Instructor Factors

<table>
<thead>
<tr>
<th>Encouraging (24%)</th>
<th>Resources (23%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledge, reinforce, encourage student contribution.</td>
<td>Providing resources to further understanding and support learning.</td>
</tr>
<tr>
<td>“Please see the list below and address the corrections as needed.”</td>
<td>“Here, [formula] is the weight density of the fluid,”</td>
</tr>
<tr>
<td>“Thank you for your reply.”</td>
<td>“Please, watch this Khan Academy video and comment on it, or ask questions, or answer the questions of your peers.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expectation-setting (14%)</th>
<th>Questioning (11%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishing parameters and expectations (including feedback outside of content-focus).</td>
<td>Questioning content or responses.</td>
</tr>
<tr>
<td>“I would like to see more details about the information that you can derive from this topic.”</td>
<td>Which of them are vectors, and which are scalars?</td>
</tr>
<tr>
<td>“This external sources must be included in the references at the end of your writing.”</td>
<td>Feedback (11%)</td>
</tr>
<tr>
<td>Confirm student understanding through feedback, offering recommendations (content-related).</td>
<td>“CONCEPT EXPRESSED NOT CLEAR: Then you will take that mass and times it by the desired acceleration.”</td>
</tr>
</tbody>
</table>
Try to rank the discrete tasks from most cognitive load to least cognitive load.

<table>
<thead>
<tr>
<th>Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓  Understanding expectations</td>
</tr>
<tr>
<td>✓  Crafting initial post</td>
</tr>
<tr>
<td>✓  Reading posts</td>
</tr>
<tr>
<td>✓  Creating reply posts</td>
</tr>
<tr>
<td>✓  Integrating instructor feedback</td>
</tr>
</tbody>
</table>

To vote, go to [www.menti.com](http://www.menti.com) and use the code 2482 8413 or QR code below.
Instructional efficiency is a measure of the effects of instructional conditions on student learning.

Calculation from Van Gog & Paas, 2008

\[ E = \frac{1}{n} \sum_{i=1}^{n} \frac{Z_i(P_{test}) - Z_i(E_{test})}{\sqrt{2}} \]

*E* is Instructional Efficiency

*n* is number of participants in each group

\( Z_i(P_{test}) \) is the standardized test performance for student *i*

\( Z_i(E_{test}) \) is the standardized test mental effort for student *i*

The Instructional Efficiency standardizes the performances and mental efforts, then calculates the difference between the standardized performance and each mental effort score.

A large, negative *E* suggests the specific mental effort is far higher than expected and may be a source of extraneous cognitive load.
Instructional efficiency is normally measured by participant, but we modified the calculation for anonymous data.

\[ E = \frac{\sum_{i=1}^{n} Z_i(E_{\text{test}})}{n\sqrt{2}} \]

*E* is Instructional Efficiency  
*n* is number of participants in each group  
*Z_i(E_{\text{test}})* is the standardized test mental effort [scale 1-10] for student *i*

Our *E* describes the average standardized score per cognitive load item by category of task.
### Results

<table>
<thead>
<tr>
<th>Activity</th>
<th>Mental Demand</th>
<th>Temporal Demand</th>
<th>Performance</th>
<th>Effort</th>
<th>Frustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding what is expected</td>
<td>0.241</td>
<td>0.138</td>
<td>0.089</td>
<td>0.248</td>
<td>0.026</td>
</tr>
<tr>
<td>Crafting your initial discussion post</td>
<td>0.349</td>
<td>0.245</td>
<td>0.201</td>
<td>0.201</td>
<td>0.154</td>
</tr>
<tr>
<td>Critically reading posts from your instructor and peers</td>
<td>-0.280</td>
<td>-0.191</td>
<td>-0.015</td>
<td>-0.208</td>
<td>-0.060</td>
</tr>
<tr>
<td>Creating reply posts</td>
<td>-0.171</td>
<td>-0.099</td>
<td>0.021</td>
<td>-0.068</td>
<td>-0.020</td>
</tr>
<tr>
<td>Integrating instructor feedback into future discussion posts</td>
<td>-0.146</td>
<td>-0.099</td>
<td>-0.305</td>
<td>-0.179</td>
<td>-0.097</td>
</tr>
</tbody>
</table>

A positive average standardized rating scaled for error suggests the extraneous cognitive load is higher for this item compared to others.
RQ1: Are student social presences, student cognitive presences, and instructor presences in modules and cohorts consistent throughout a course?

- Student presences are NOT consistent throughout a course but ARE fairly consistent across cohorts.
- Instructor presences are NOT consistent.

RQ2: What factors predominate within each presence?

- **Student Social:** NE (24%), V (23%), SS (19%), EAP (16%)
- **Student Cognitive:** IS (60%), PN (9%), OP (9%), CL (6%)
- **Teaching:** ENC (34%), RS (15%), ES (14%), Q (11%), F (11%)

RQ3: What tasks in asynchronous online discussions influenced cognitive load?

- Crafting your initial discussion post
- Understanding what is expected
As with any study, there are limitations.

- Nonresponse error
- Voluntary, un-incentivized survey
- Low response rate
- Time limitations for data collection
  limited scope
Planned Intervention: Support Community of Inquiry in asynchronous discussions while mitigating impacts to cognitive load.

- **Persistence**
- **Performance**
- **Perspectives**

**Learner in Asynchronous Learning Environment**

**“Traditional” Online Discussion**

- Redesigned prompts
- Redesigned rubrics
- Faculty professional development

**Col-CL Model for Online Discussions**

**Variables Measured**
- Social Presence
- Teaching Presence
- Cognitive Presence
- Cognitive Load
- Demographics (moderating)
Cognitive load mitigation strategies & community of inquiry framework are not discipline-specific.
Questions?

faulcone@erau.edu

chambd17@erau.edu

woodb14@erau.edu
Mentimeter for questions
Evaluate Sessions and Win!

- Navigate to specific session to evaluate
- Select “Evaluate Session” on session details screen
  - Complete session evaluation*

*Each session evaluation completed (limited to one per person per session) = one contest entry. **Five (5) $25 gift cards** will be awarded.