Instructional Efficiency in Asynchronous Online Discussions

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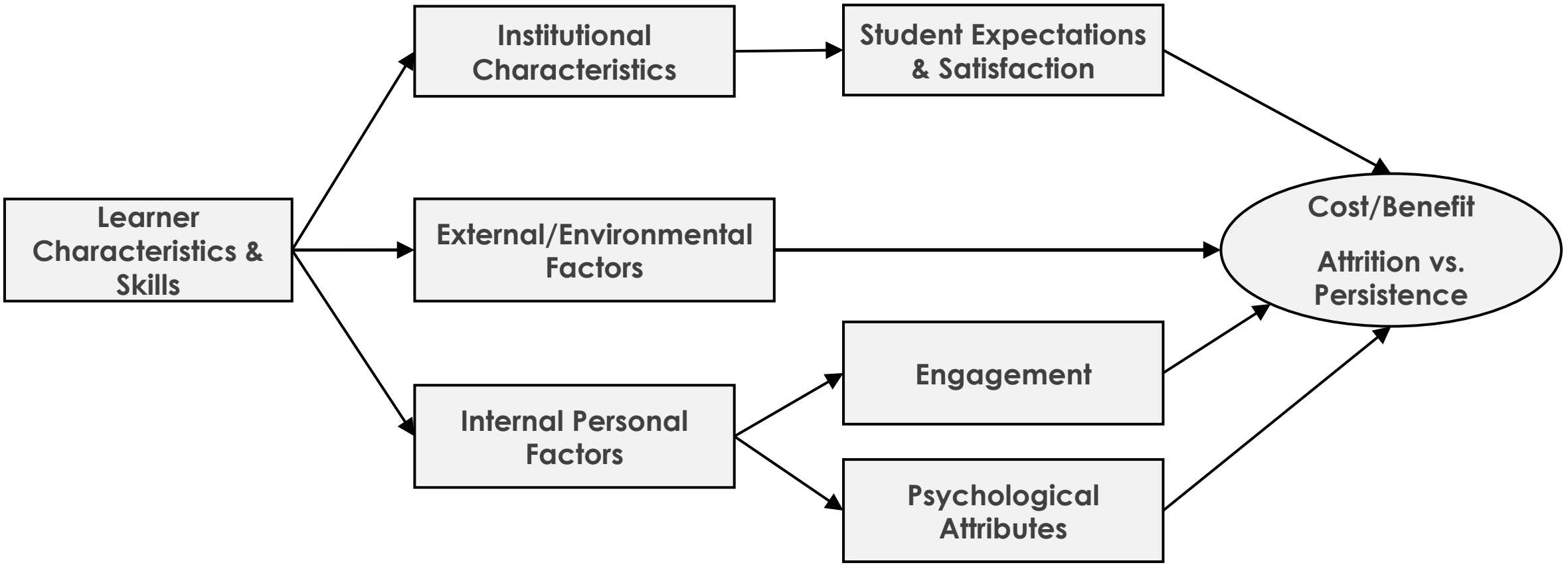
Asynchronous online course offerings are increasing.

+	"No Significant Difference" in student grades
-	Higher withdrawal rate

Understanding student persistence in online learning is complex.



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.

Cognitive Load		
Intrinsic Load	Extraneous Load	Germane Load

Asynchronous online classes often use discussions to establish a learning community.

- Idea exchange
- Content focus
- Critical thinking
- Peer feedback
- Problem solving
- Collaboration

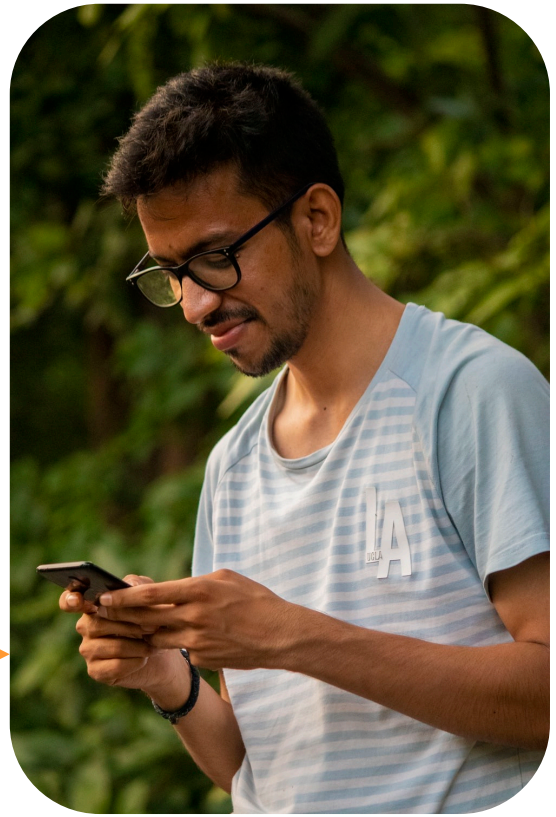
Learners & instructors project their personality into the community through social presence.

Affective responses

Interactive communication

Cohesive responses

Peer Support Hypothesis



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?

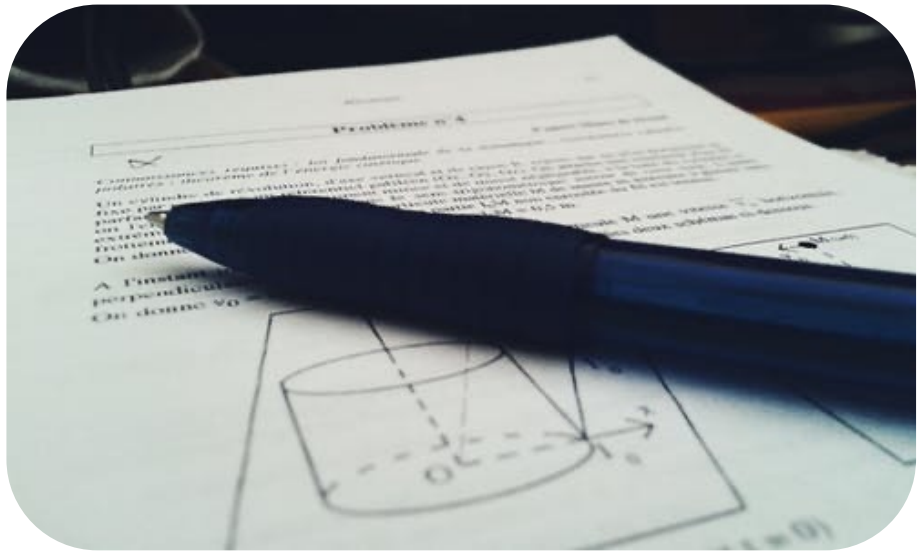
RQ2: What factors predominate within each presence?

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

(variables measured, not manipulated or controlled)

Population: Introductory Physics sections Oct 2020 – Jan 2021

- **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)



Discussion transcripts were coded for community of inquiry presences.

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

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

Presence Density acts as a standardization to compare categories without over-representation of verbose responses.

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

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

We can then compare the PDs by % of density for each presence.

How do you think Student Social Presence was distributed?

Guess the average percentage of each social presence below.

Affective Responses (Emotion, expressions, humor, or personal information)

Interactive Responses (Responses between individuals)

Cohesive Responses (Responses to the class in general or purely social functions)

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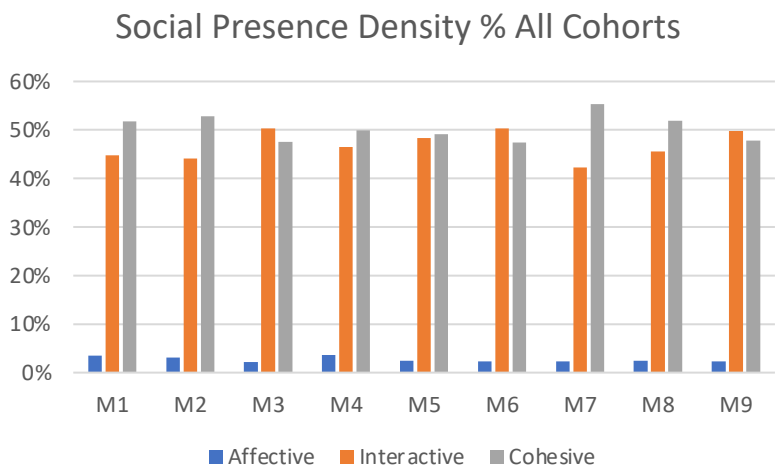
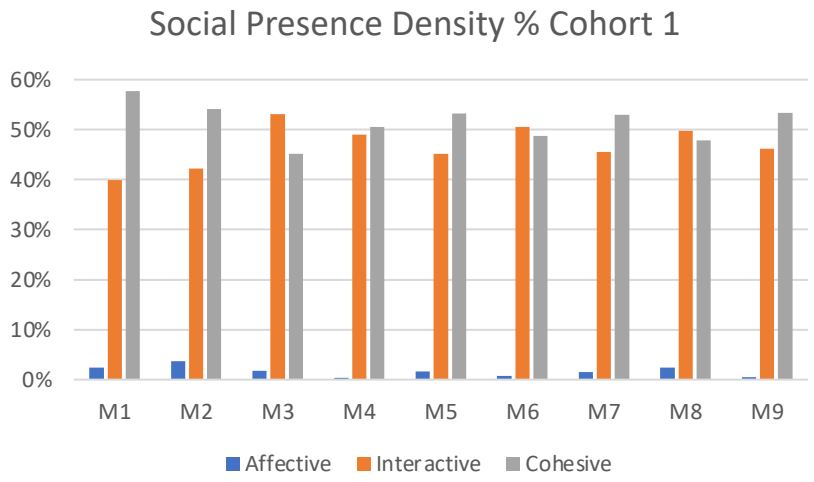
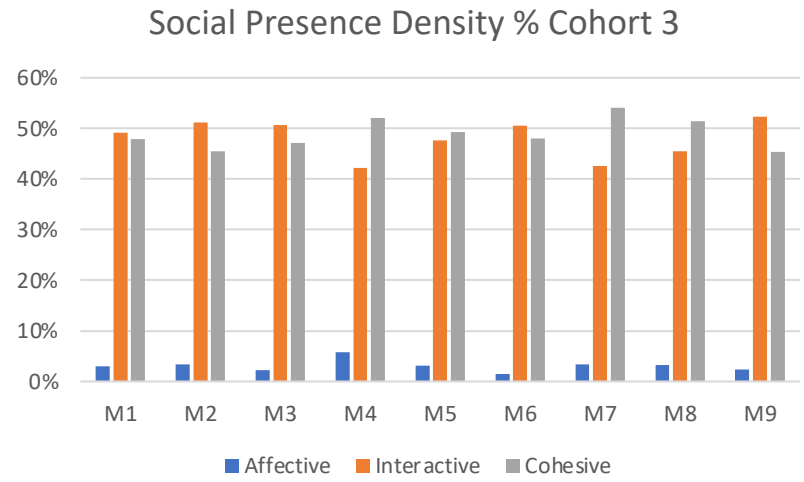
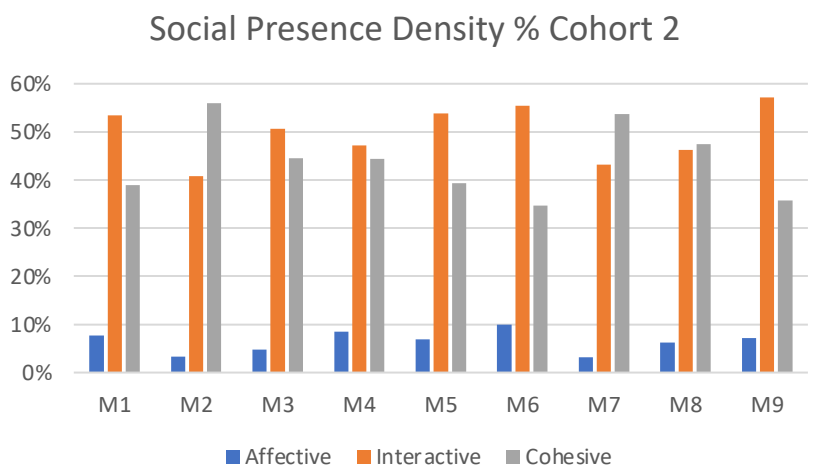
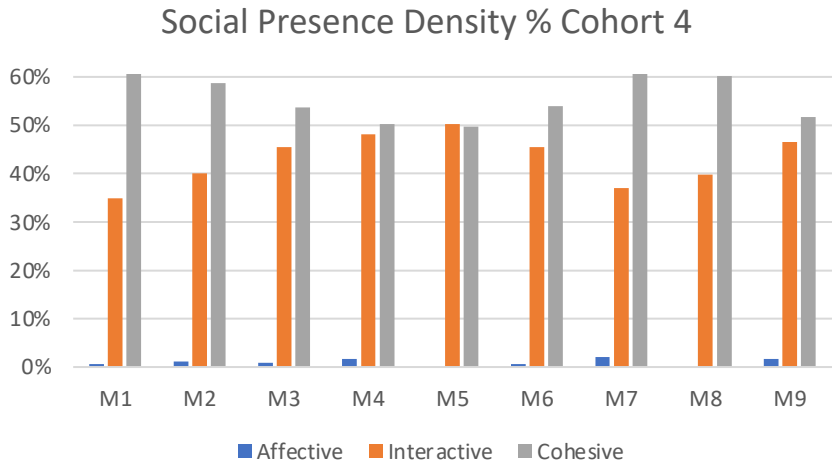
RQ1: All modules/cohorts analyzed [Social]?











How do you think Student Cognitive Presence was distributed?

Guess the average percentage of each social presence below.

Triggering Event (Asking a question)

Exploration (Low-level arguments sharing facts)

Integration (High-level arguments like agreement with reasoning)

Resolution (Highest-level arguments like synthesis)

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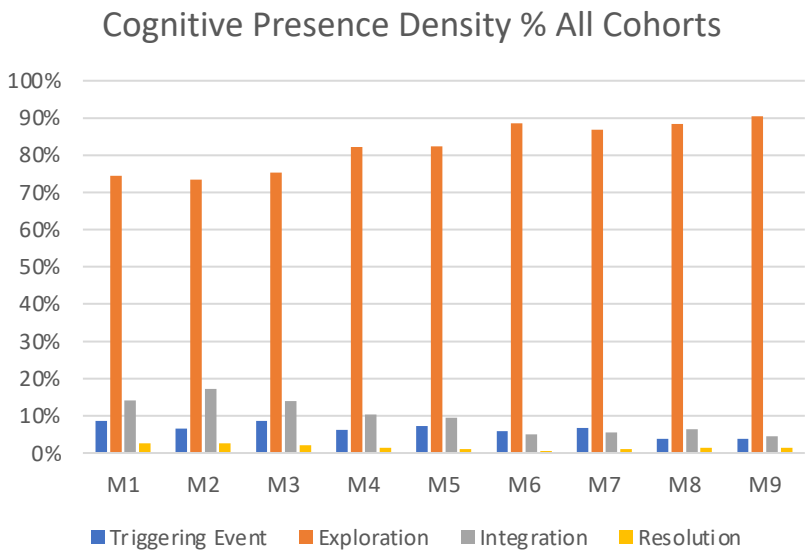
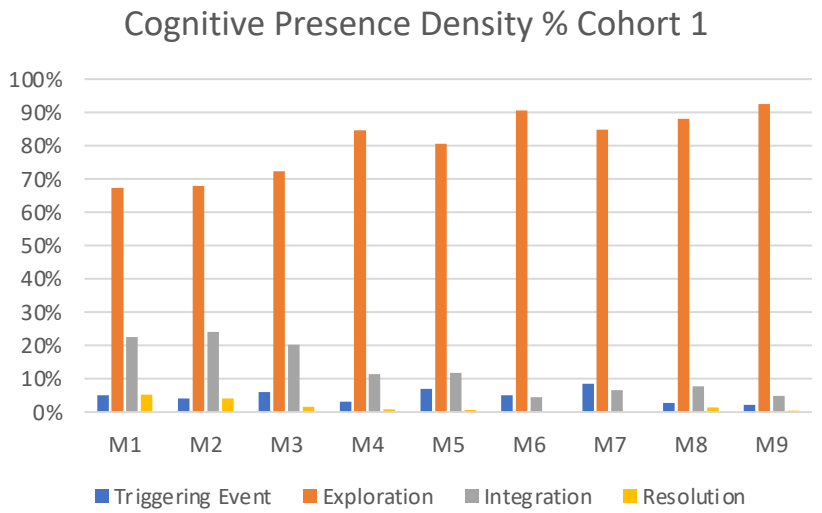
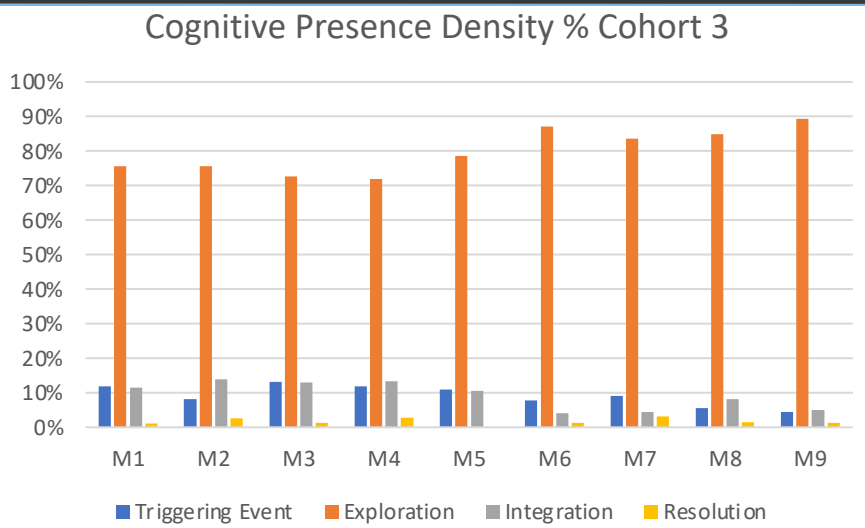
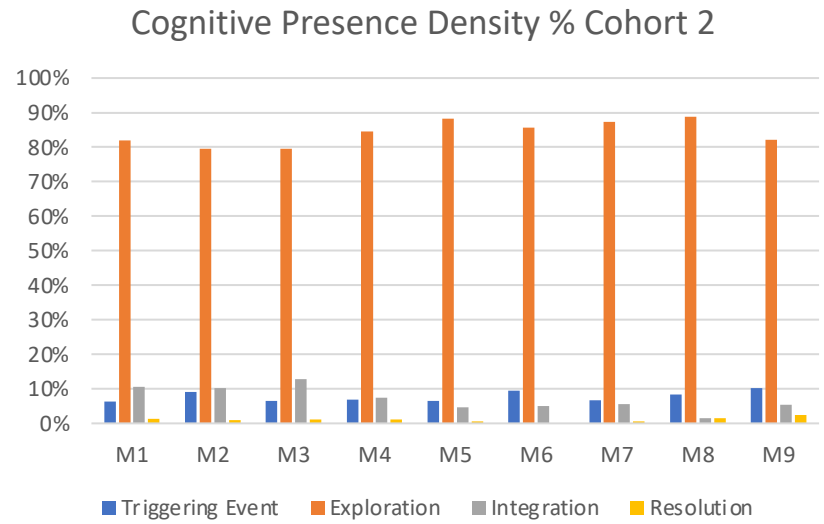
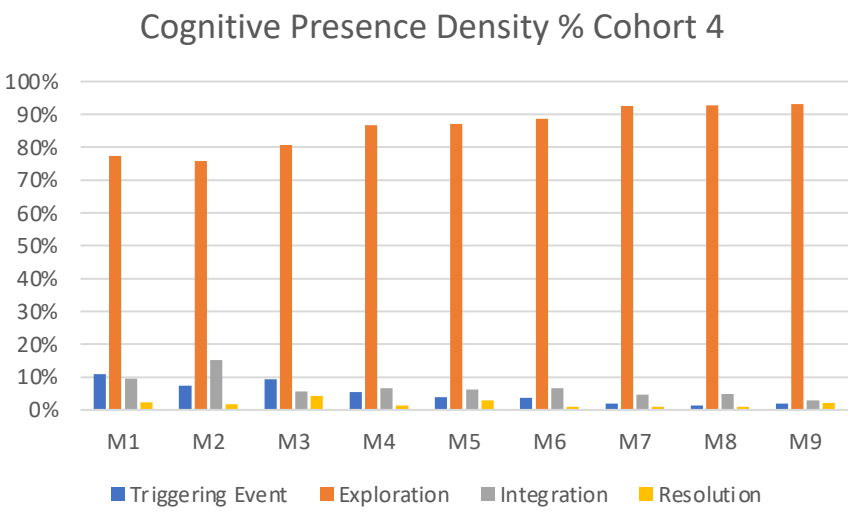
RQ1: All modules/cohorts analyzed [Cognitive]?



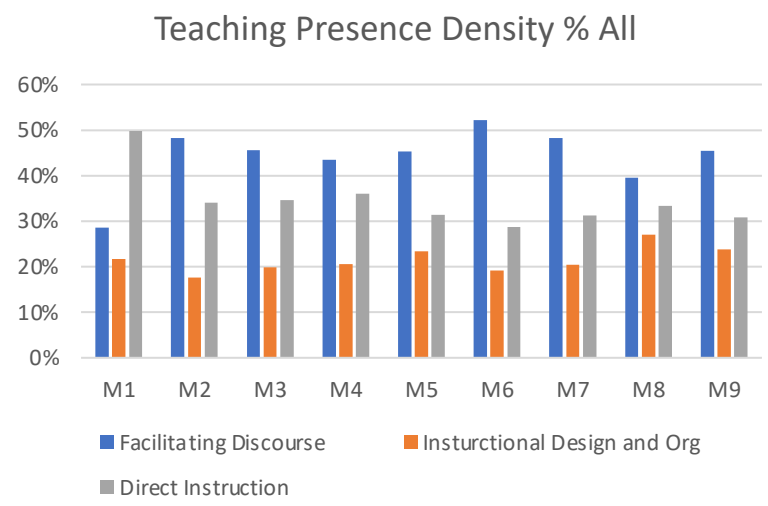


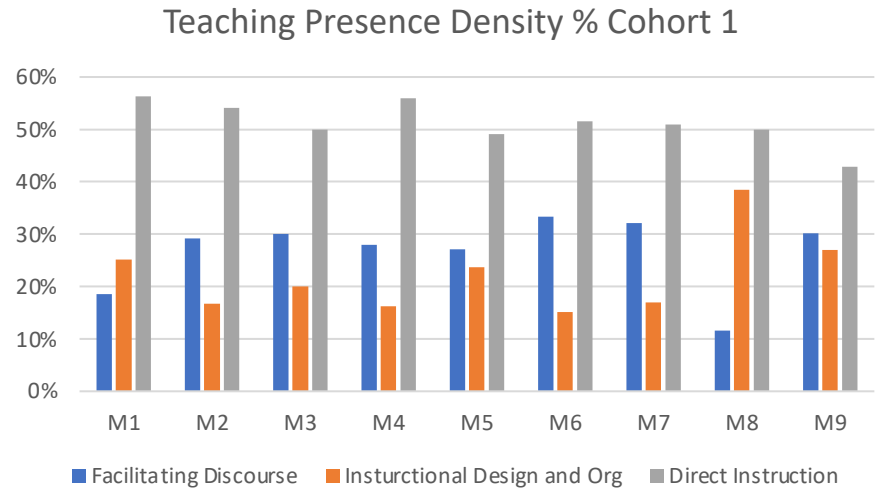


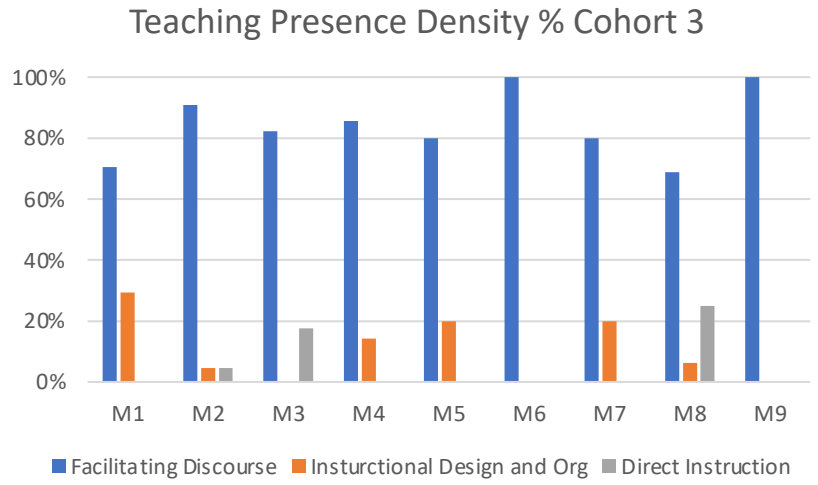


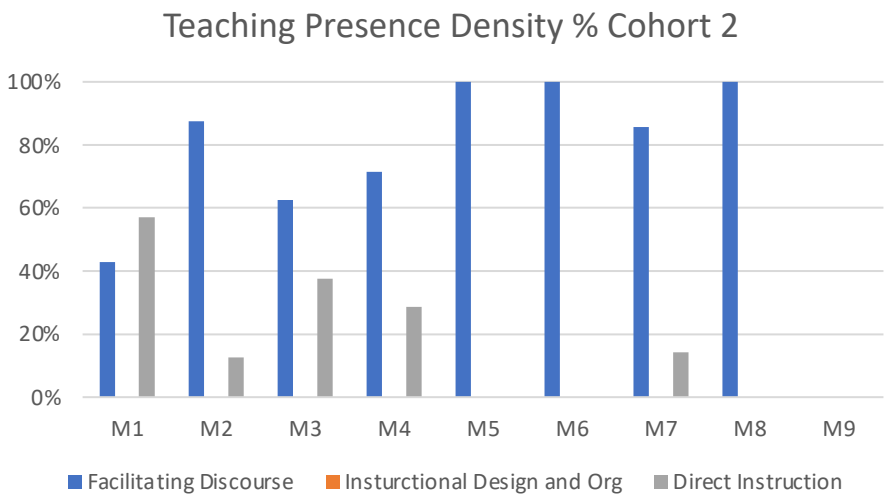


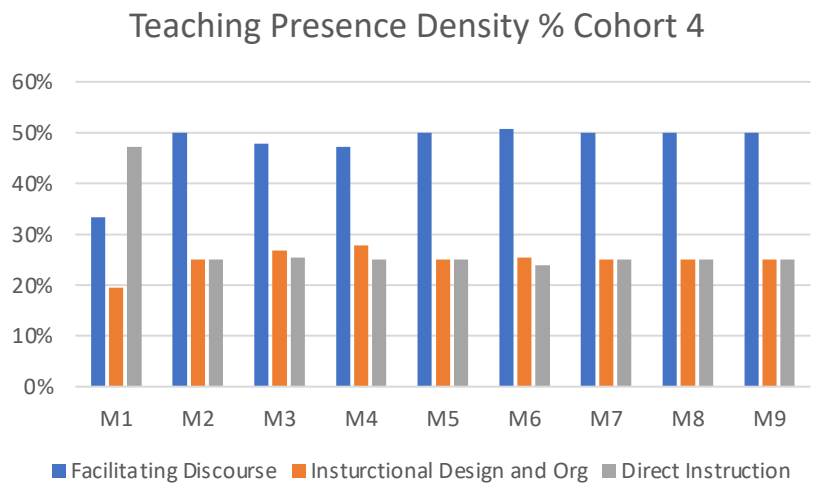
RQ1: All modules/cohorts analyzed [Instructor]?











RQ2: Predominant Student Social Factors

Natural Expression (24%)
Sharing insights and thoughts, including specific advice.

"Last week, I've anticipated this application coming and I have a video to share…"

"About the example …, reminds me of a physics demonstration that I've done in class."

Vocatives (23%)
Use of names and/or official titles.

[name]

Social Sharing (19%)
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.

"This weekend I decided to flex my nerd bones and watched the episode of "Star Trek" where Data performed an experiment…"

Expressing Appreciation (16%)
Complimenting, expressing appreciation, praise, encouragement.

"I enjoyed your discussion piece on ambient pressure…"

"That's a pretty good description and example of linear momentum."

RQ2: Predominant Student Cognitive Factors

Information Sharing (60%)
Stating a fact, policy, rule; brainstorming; sharing resources.

"Sugar is a solid in it's natural form, until it is added into a cup of boiling hot liquid."

"The transfer of heat is broken down into three methods: conduction, convection, and radiation."

Personal Narrative (9%)
Telling a story or relating an incident (e.g. describing practices at their job), relevant to content.

"In my aircraft, the MV-22, we don't really have much of a radar system."

"For us on the V-22, we constantly monitor the power output of the engines because…"

Opinion (9%)
Stating a belief, personal view, attitude (related to content) with insufficient evidence to conclude as factual.

"In my humble opinion, this Law is the first law for a reason."

"In my perspective, vectors are vital to daily flight operations."

Clarification (6%)
Expressing clarification and restating for clarity.

"In other words, speed and magnitude of the aircraft."

"To make a complicated answer short, we don't autorotate, nor do we really glide."

RQ2: Predominant Instructor Factors

Encouraging (24%)
Acknowledge, reinforce, encourage student contribution.

"Please see the list below and address the corrections as needed."

"Thank you for your reply."

Resources (23%)
Providing resources to further understanding and support learning.

"Here, [formula] is the weight density of the fluid,"

"Please, watch this Khan Academy video and comment on it, or ask questions, or answer the questions of your peers."

Expectation-setting (14%)
Establishing parameters and expectations (including feedback outside of content-focus).

"I would like to see more details about the information that you can derive from this topic."

"This external sources must be included in the references at the end of your writing."

Questioning (11%)
Questioning content or responses.

Which of them are vectors, and which are scalars?

Feedback (11%)
Confirm student understanding through feedback, offering recommendations (content-related).

"CONCEPT EXPRESSED NOT CLEAR: Then you will take that mass and times it by the desired acceleration."

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.

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

E is Instructional Efficiency
n is number of participants in each group
$Z_i(E_{test})$ 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.

Try to rank the discrete tasks from most cognitive load to least cognitive load.

✓	Understanding expectations
✓	Crafting initial post
✓	Reading posts
✓	Creating reply posts
✓	Integrating instructor feedback

To vote, go to www.menti.com and use the code #### #### or QR code below.

Results

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

A positive average standardized rating scaled for error suggests the extraneous cognitive load is higher for this item compared to others.

In Review …

RQ1: *Are student social presences, student cognitive presences, and instructor presences in modules and cohorts consistent throughout a course?*

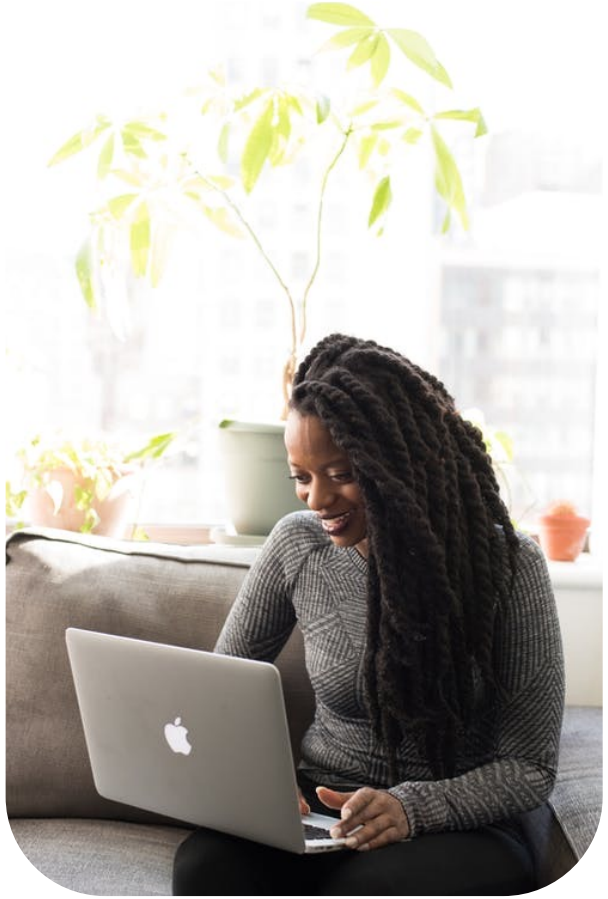
- Student presences are NOT consistent throughout a course but ARE fairly consistent across cohorts.
- Instructor presences are NOT consistent.

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?*

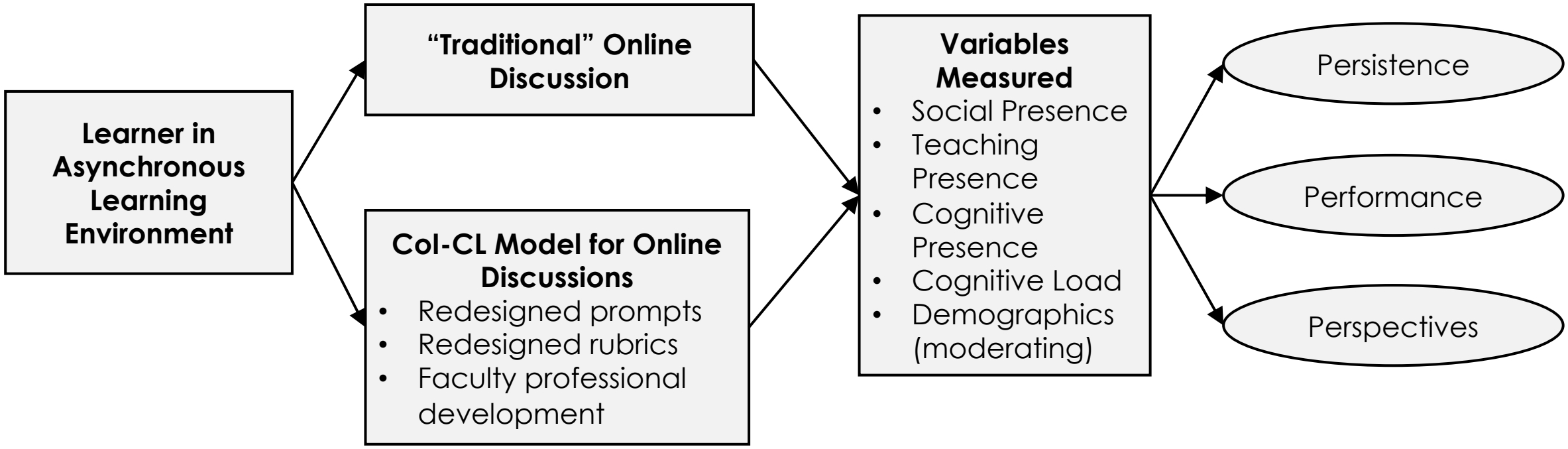
- Crafting your initial discussion post
- Understanding what is expected



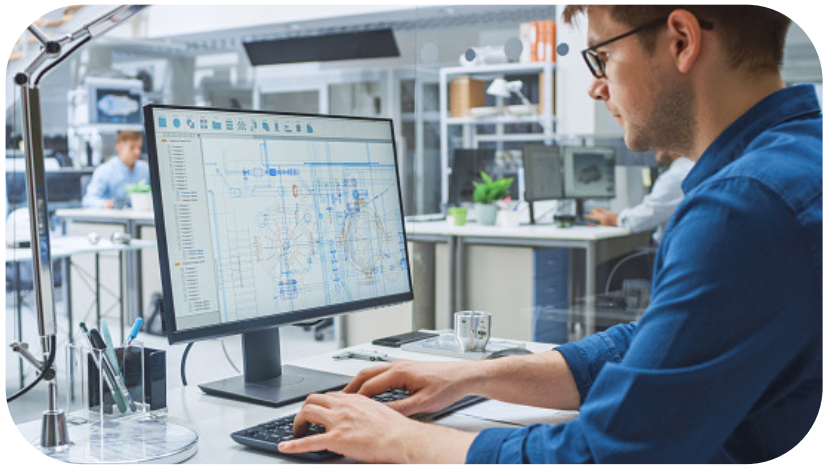
As with any study, there are limitations.

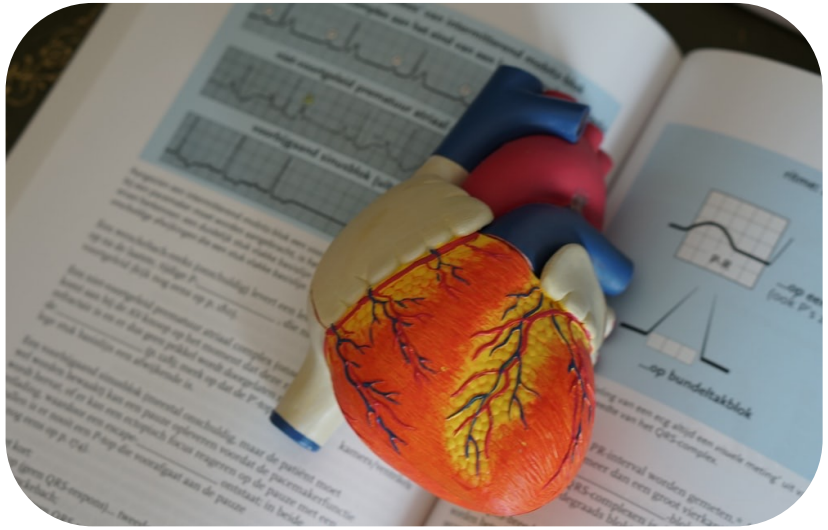
- Nonresponse error
- Voluntary, un-incentivized survey
- Low response rate
- Time limitations for data collection limited scope

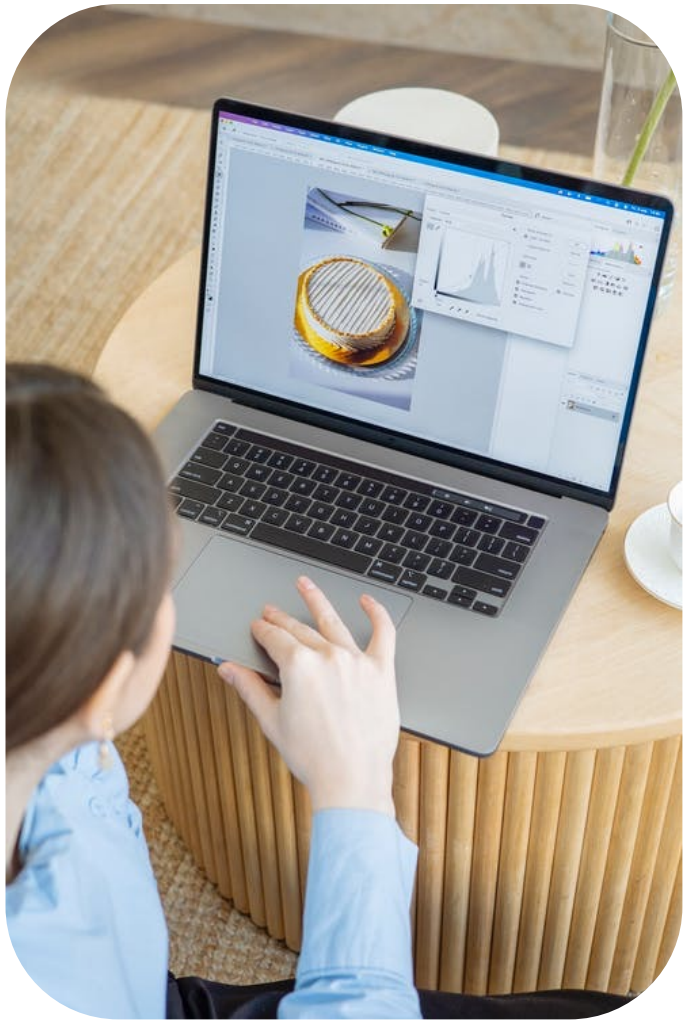
Planned Intervention: Support Community of Inquiry in asynchronous discussions while mitigating impacts to cognitive load.



Cognitive load mitigation strategies & community of inquiry framework are not discipline-specific.







Questions?

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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.