- 2019 Student Research Symposium -

Effects of Discussion Strategies and Learner Interactions on Performance in Online Mathematics Courses: An Application of Learning Analytics

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Introduction

Problem Statement & Possible Solution

Problem

- High failure rates in college math courses; higher in online math courses

What we know

- In mathematics learning contexts, a few studies found that the use of online discussions helped in
  - decreasing math anxiety
  - increasing achievement outcomes
- Learners performed better in "effectively designed and structured online discussions"

Challenges in Practice & Research

- Instructors seldom design/implement structured online discussions
- Prior studies tended to focus on students' discussion behaviors rather than instructor involvement
- Little research in mathematics learning contexts

Mathematics Learning

+

Instructional Design

+

Online Discussions

Question: What discussion design works best in online math courses?

Research Purposes

For online introductory mathematics courses:

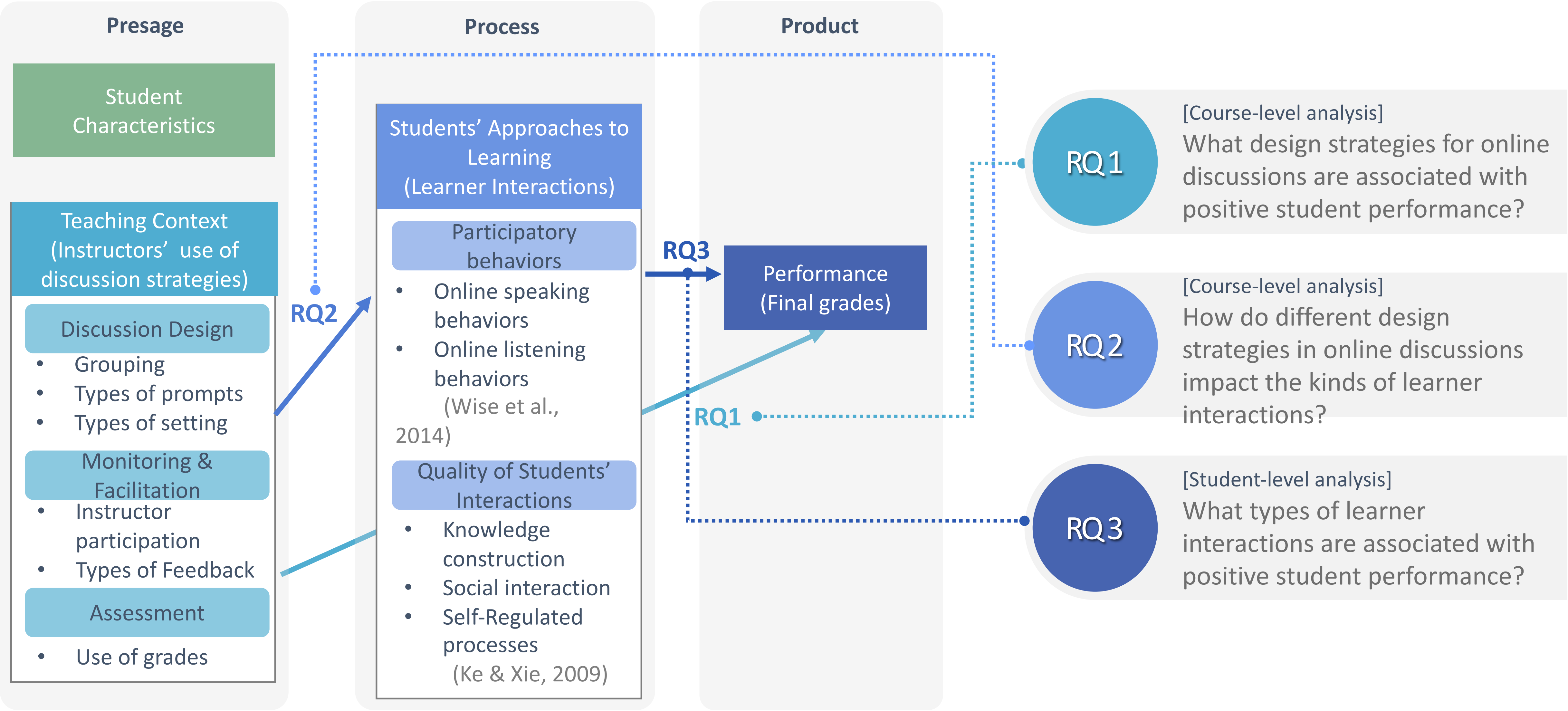
01

Exploring **instructors'** use of discussion strategies that enhance meaningful learner interactions and performance

02

Investigating **learner** behaviors and interaction patterns that lead to better performance

RESEARCH QUESTIONS



*Adopted from Biggs's 3P (Presage-Process-Product) model of teaching and learning

METHODS

Research Context & Sample

Canvas Learning Management System (LMS) used at a public university located in the western U.S.

- Fully online introductory (0 and 1000 levels) math/statistics courses offered between 2011 fall and 2015 summer
- Courses that used online discussions

Sample for the study

Courses

# of courses	# of instructors
N = 72	N = 11

Students

# of students	Unique #
N = 2,869	N = 2,404

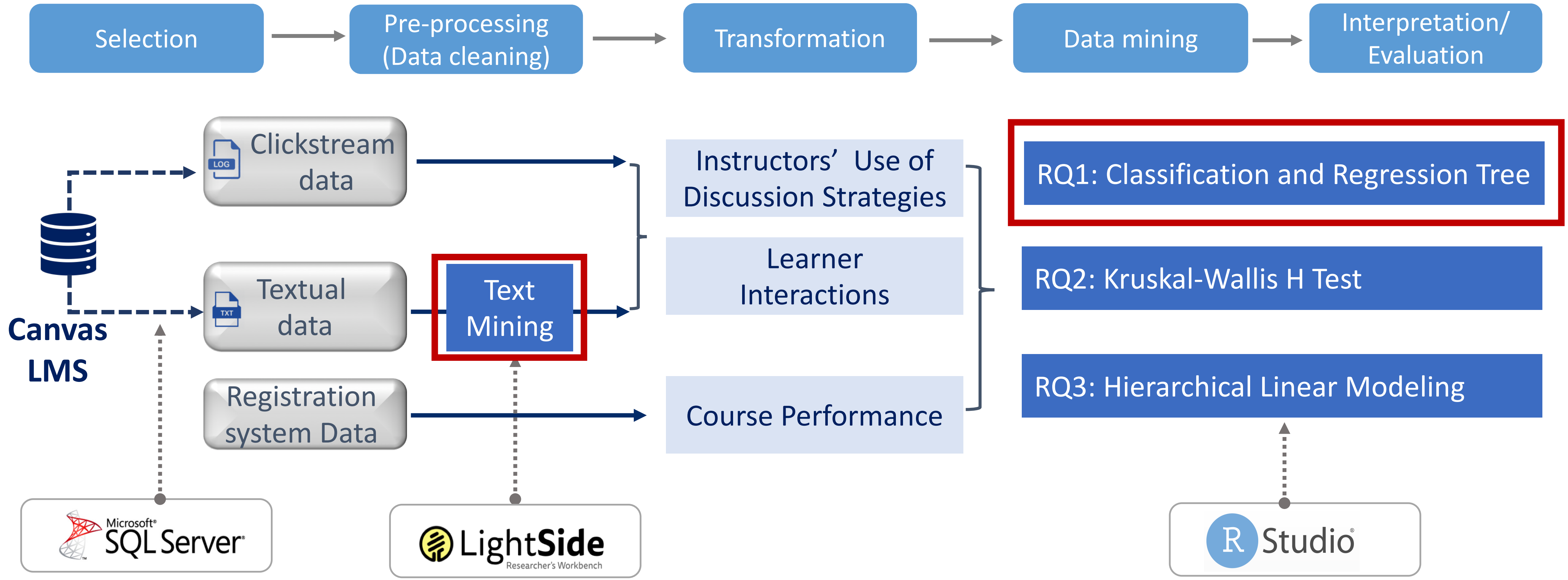
Activities (Discussion topics) (N = 703)

Events/Actions (Discussion messages)

- Instructors: 1,284 messages
- Students : 20,884 messages

METHODS
Workflow & Data Analysis Methods

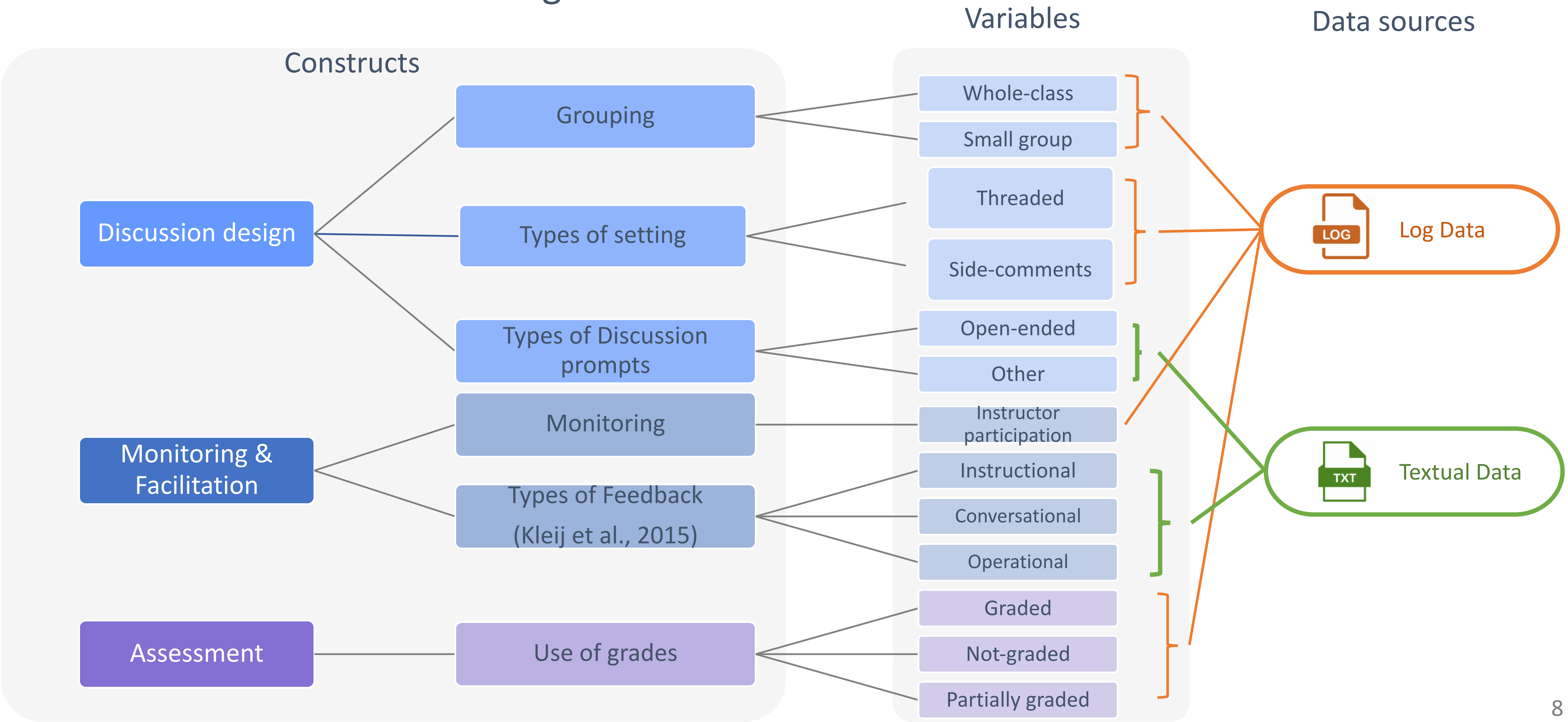
Knowledge Discovery in Databases (KDD) Process



METHODS

Measurement

Instructor’ Use of Discussion Strategies



METHODS

Data Pre-processing (Text mining)

LightSide
Researcher's Workbench

Creating a training dataset

1
- Hand-coded 10% of messages
- IRR: .908 (p = .00)

Feature extractions

2
- Imported the training into LightSIDE
- Unigrams + Bigrams + Trigrams

Building a Model

3
- Four built-in algorithms
  : Naïve Bayes classifier, Logistic regression, Support Vector Machines (SVM), Decision trees

Validity Testing

4
- 10-fold cross-validation
- Confusion matrix
- Accuracy, Kappa values

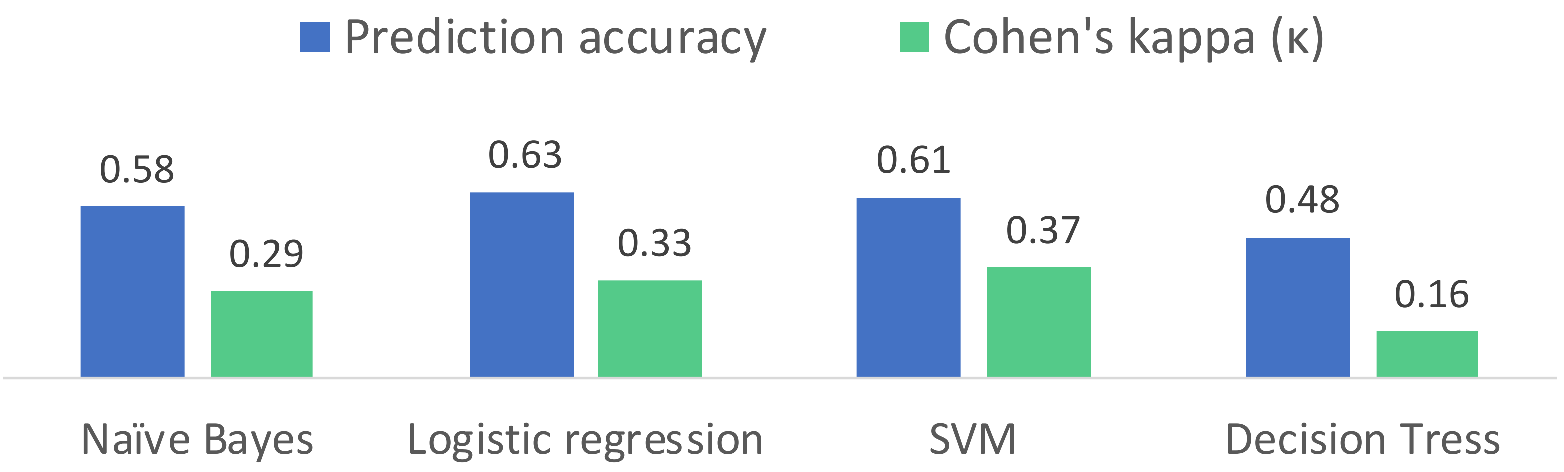
5
- Hand-coded 50% of messages

Replication

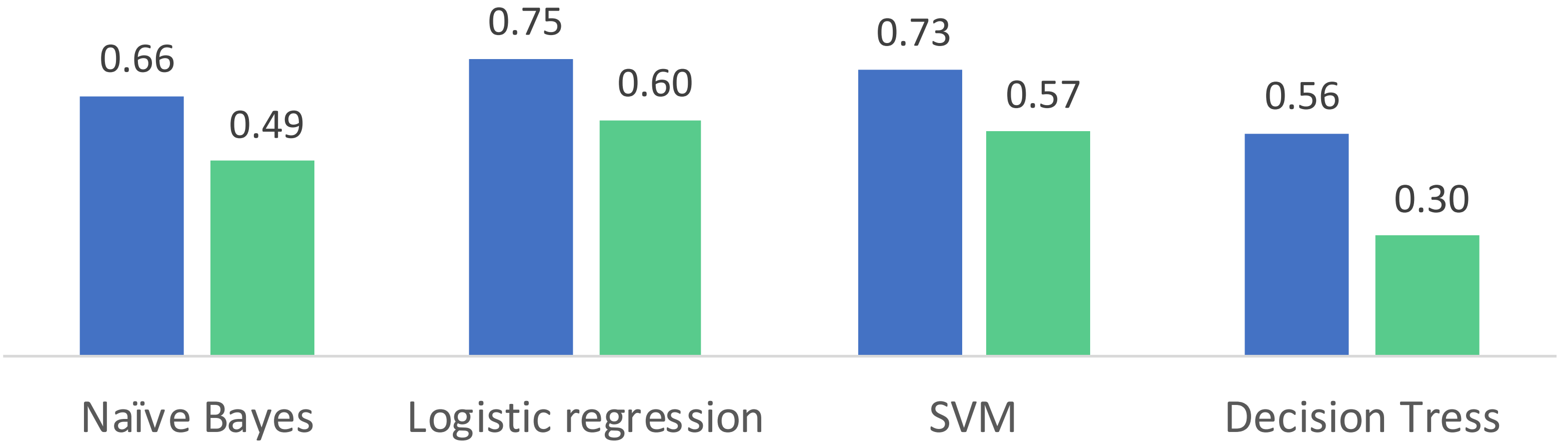
6
- Applied the developed model to the rest of the dataset (50% of the discussion messages)

PRELIMINARY RESULTS
Semi-automated Content Analysis

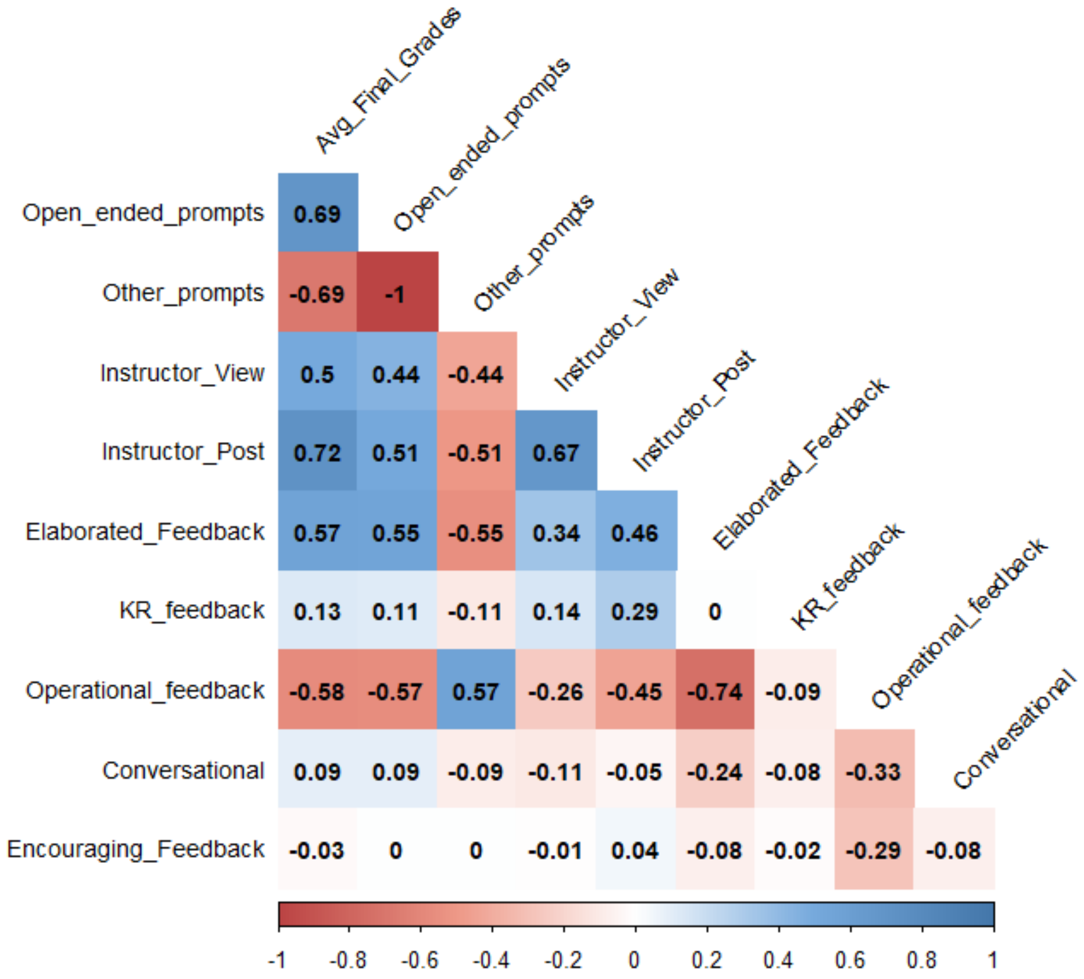
Initial
Prediction Models
(hand-coding: 10% of discussion messages)



Final
Prediction Models
(hand-coding: 50% of discussion messages)



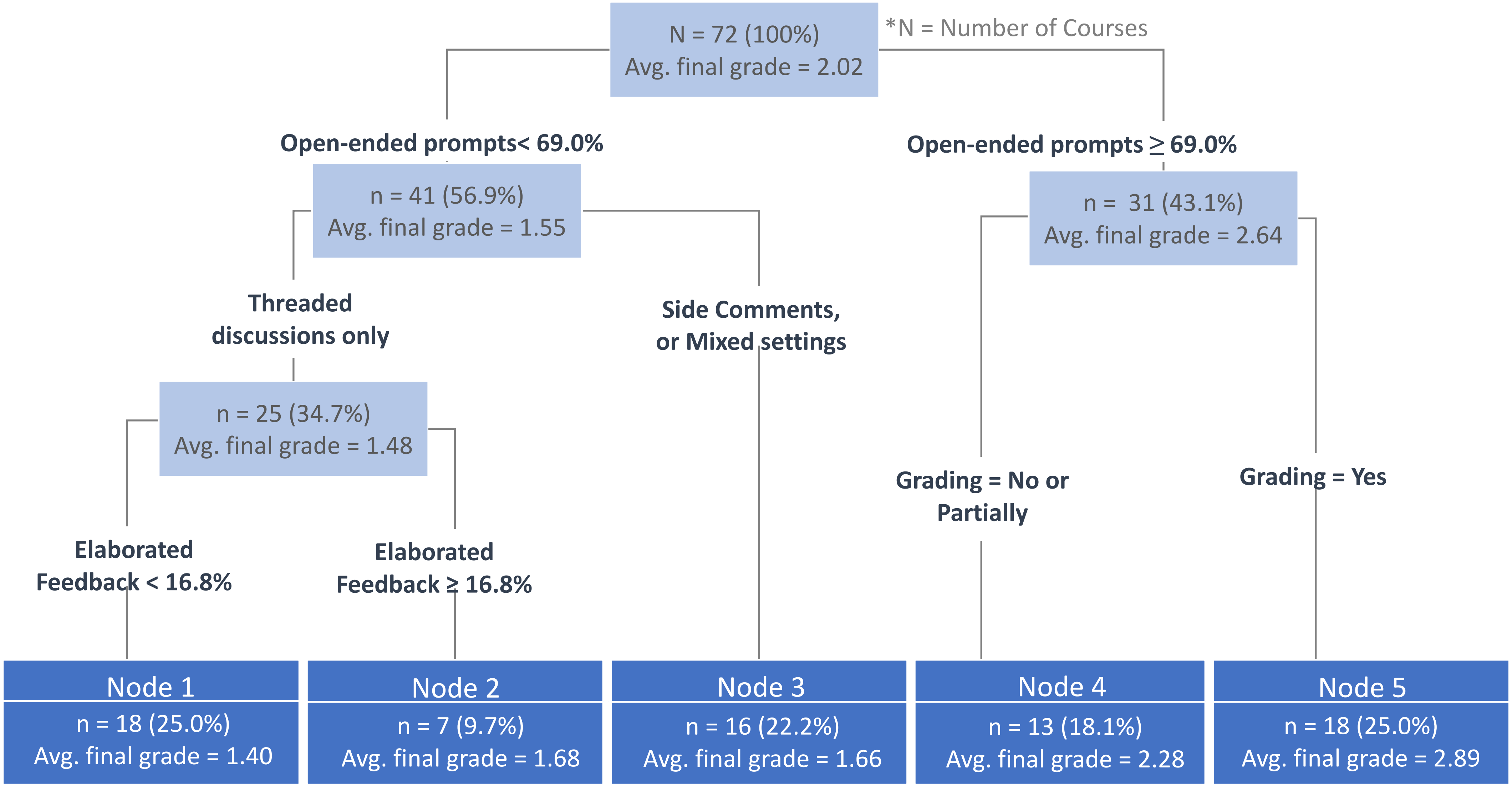
PRELIMINARY RESULTS
Correlation analysis



*Included continuous variables only

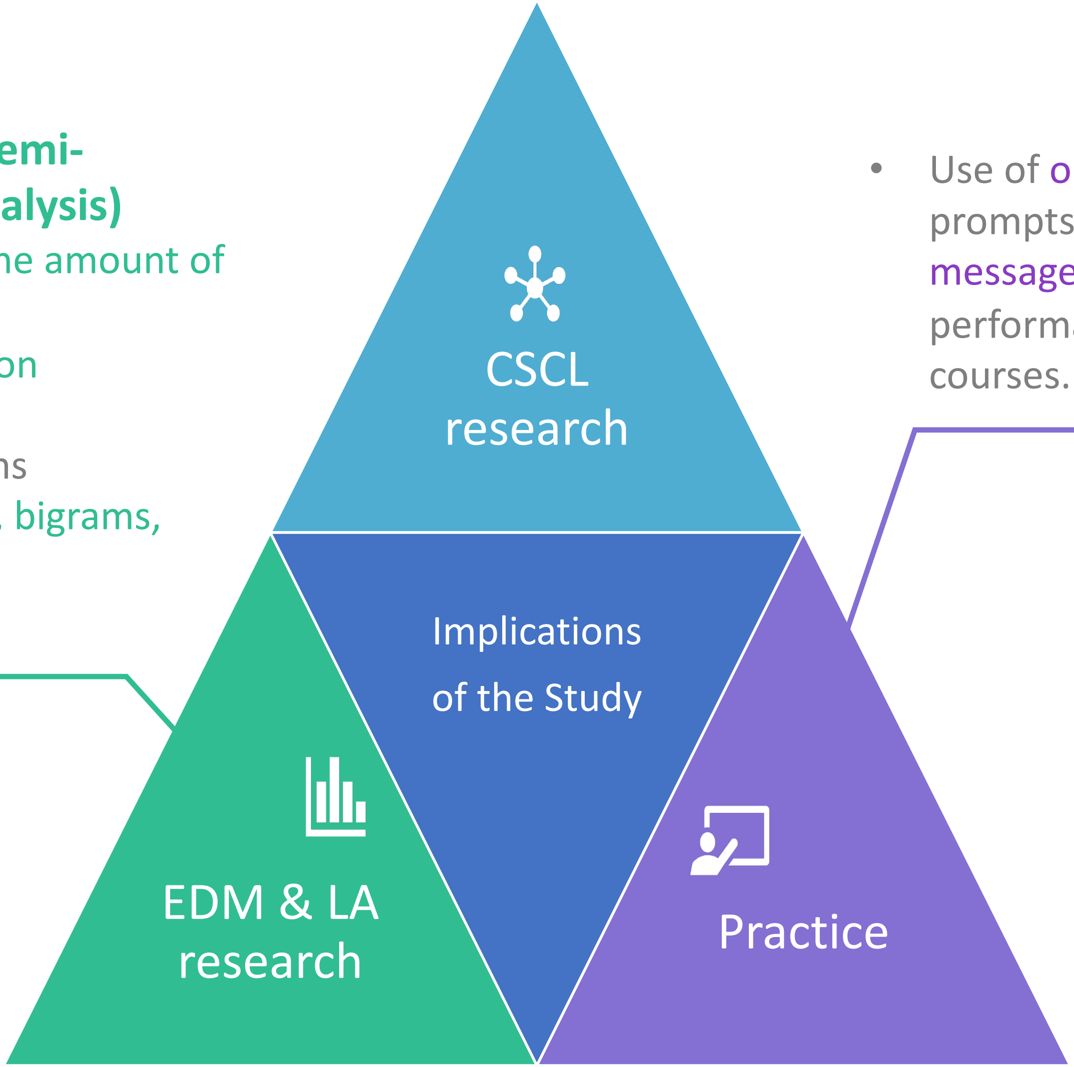
- "Instructors' posts" showed the strongest positive correlation with the students' average final grades (r = .72, p <.05).
- The ratio of "open-ended prompts" (r = .69, p <.05) and the ratio of "elaborated feedback" (r = .57, p <.05) showed the significant and positive correlations with the average final grades.
- The ratio of "other prompts" (r = -.69, p <.05) and the ratio of "operational feedback" (r = -.58, p <.05) showed the significant and negative correlations with the average final grades.

PRELIMINARY RESULTS
RQ1: Classification and Regression Tree (CART)



Lessons Learned & Future Work

- **Text mining (semi-automated analysis)**
- Importance of the amount of hand-coding
- Logistic regression outperformed other algorithms
- Use of unigram, bigrams, trigrams altogether



- Use of open-ended discussion prompts and grading students' messages will lead to better student performance in online mathematics courses.

Future Work

- Validation of the CART analysis results
- RQ2: Statistical Analyses (Kruskal-Wallis H Test)
- RQ3: Hierarchical Linear Modeling (HLM)
- ~~Interpretation and evaluation of the results~~

Thank you

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