How Teachers Influence Student Adoption and Effectiveness of a Recommendation System for Algebra

Walter Leite, Amber Hatch, Huan Kuang, Catherine Cavanaugh, & Wanli Xing

VIRTUAL LEARNING LAB

COLLEGE OF EDUCATION
UNIVERSITY OF FLORIDA

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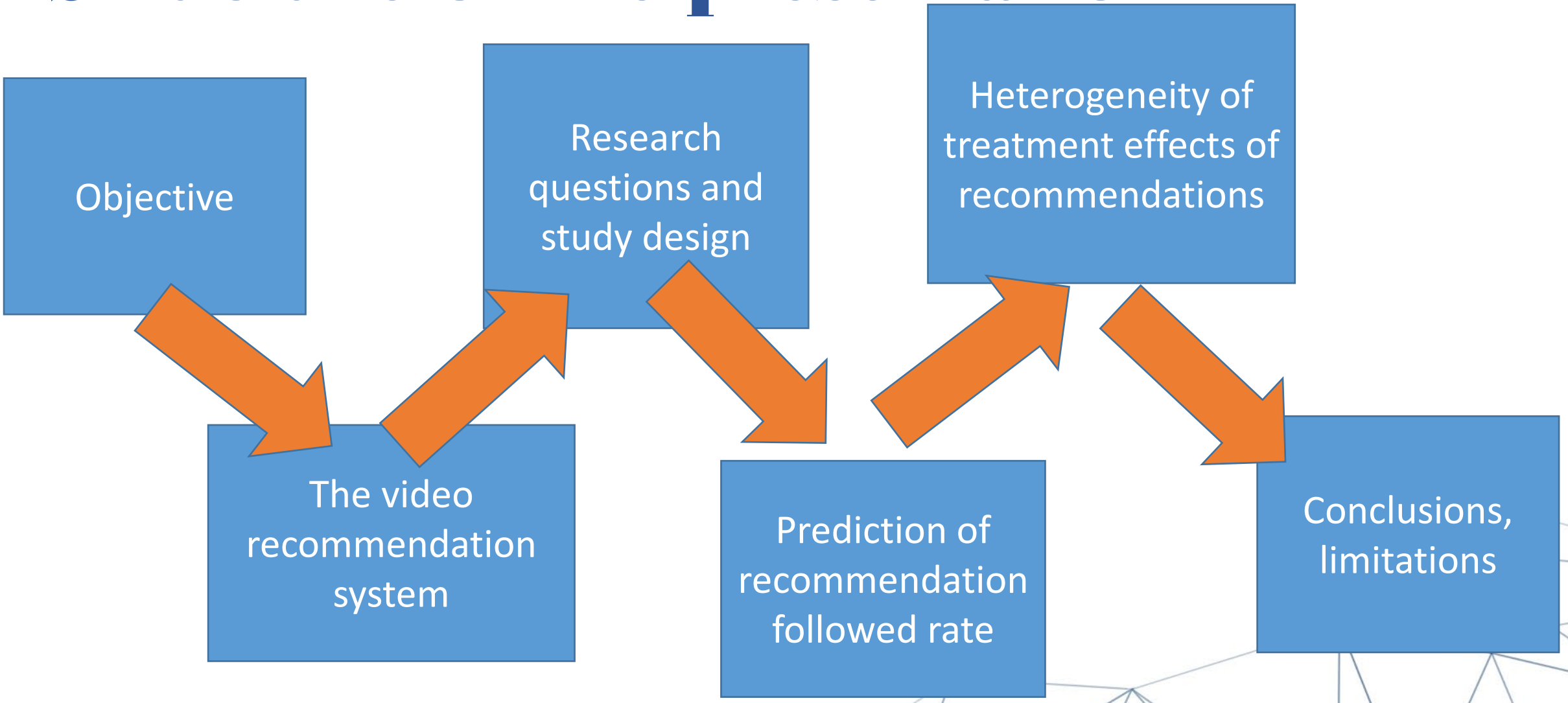
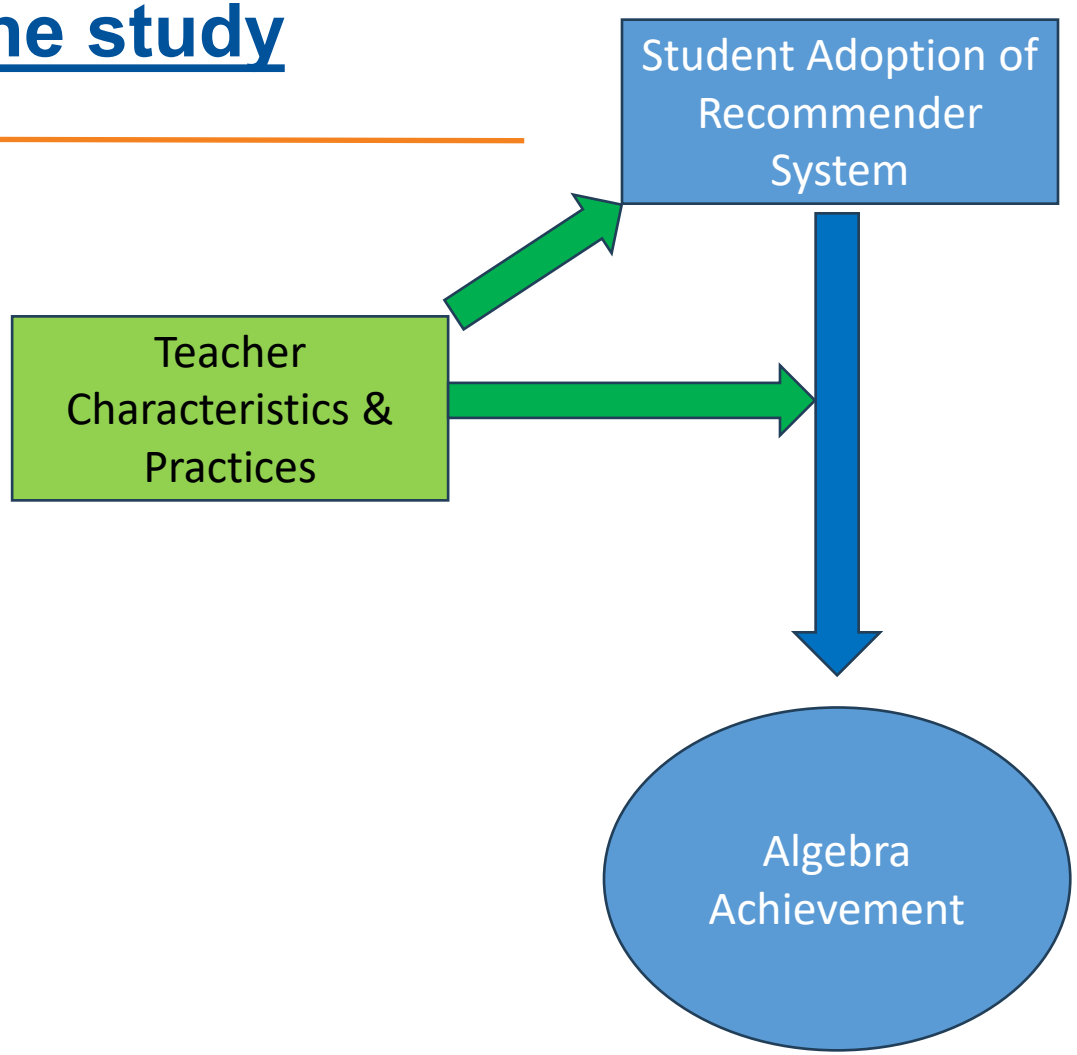
Structure of the presentation

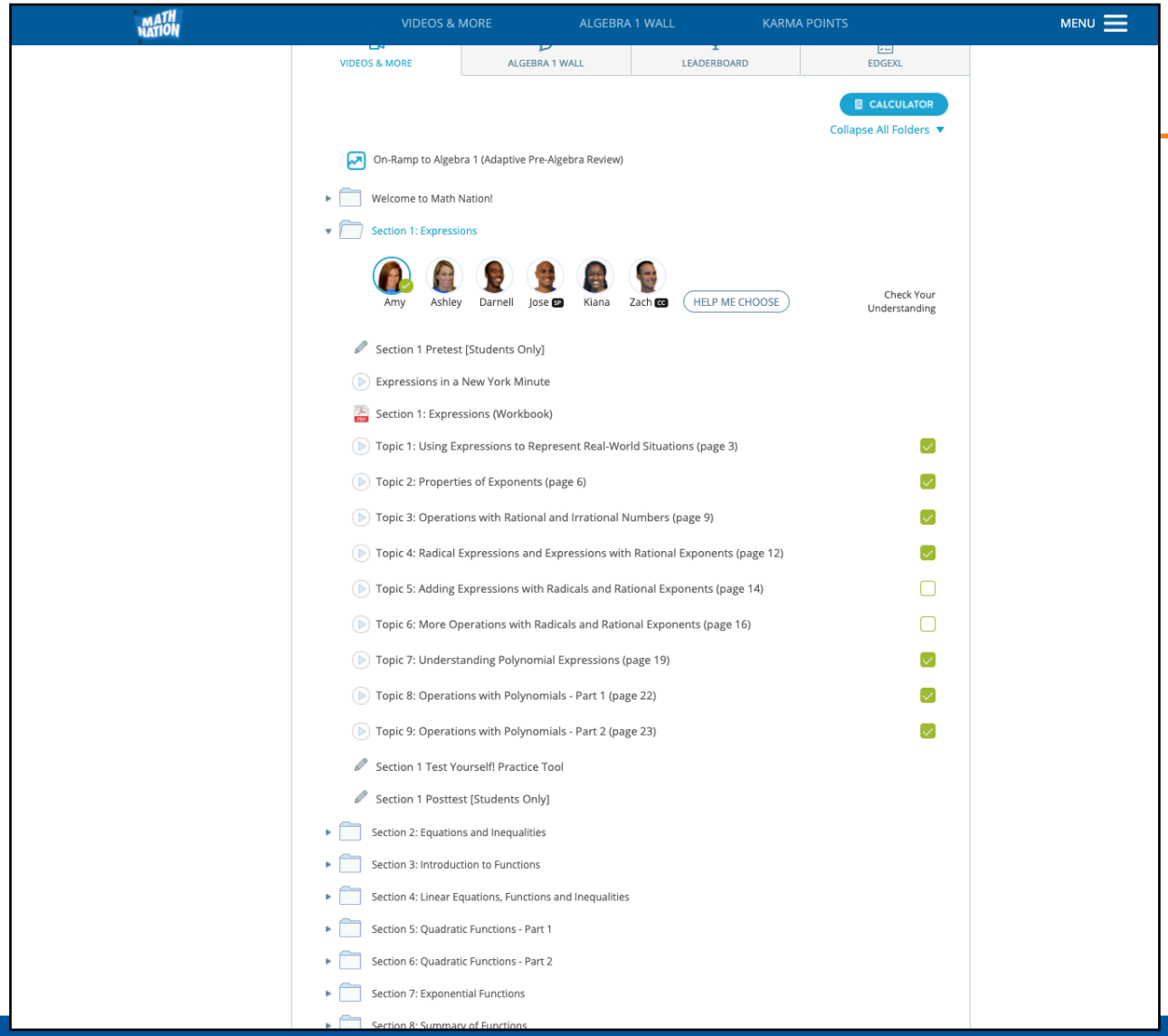


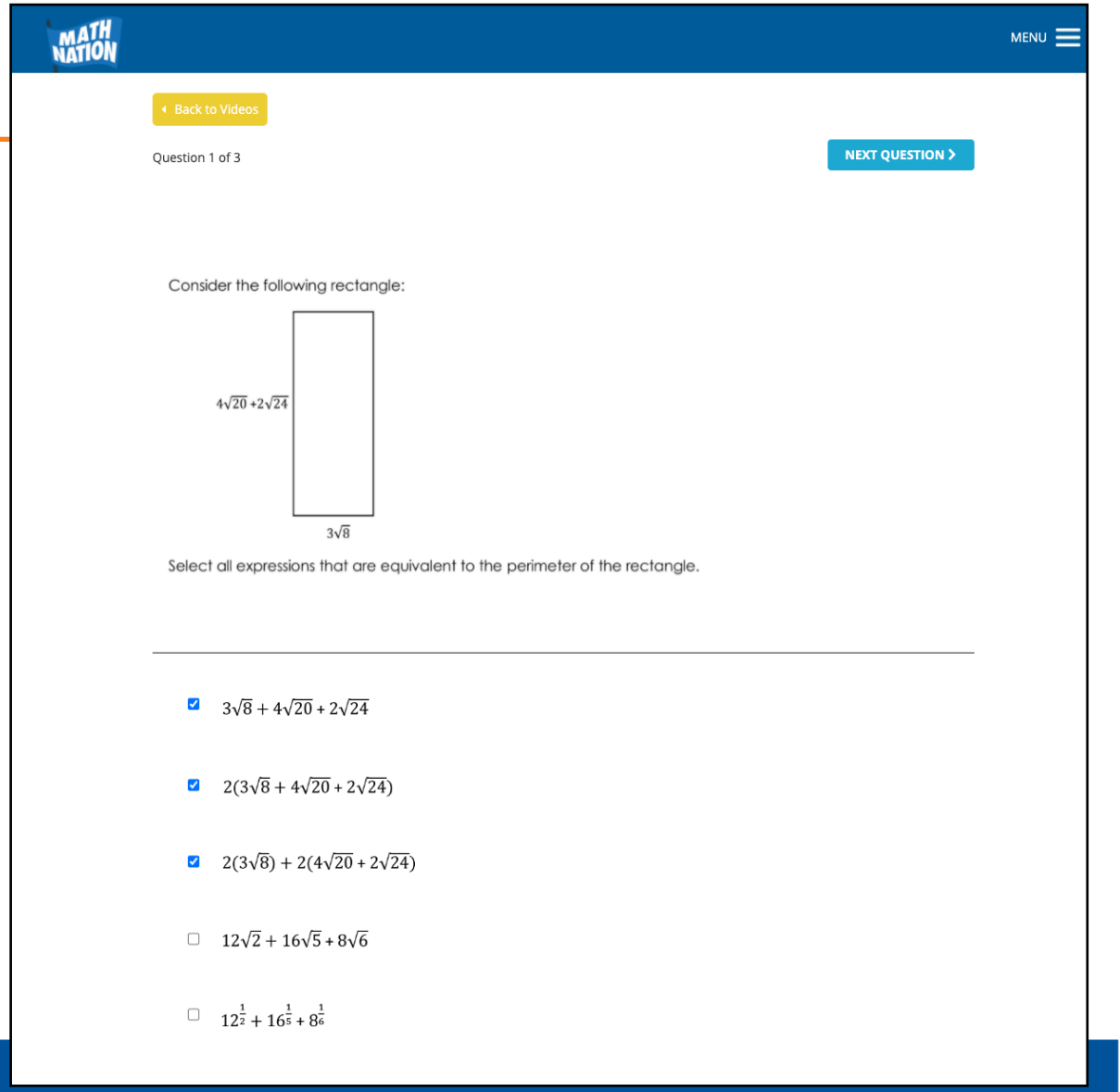
Objective of the study

- This study examined the relationships between teacher characteristics and practices and student adoption and effects of a video recommendation system embedded within a virtual learning environment (VLE), Math Nation.



Context: Math Nation





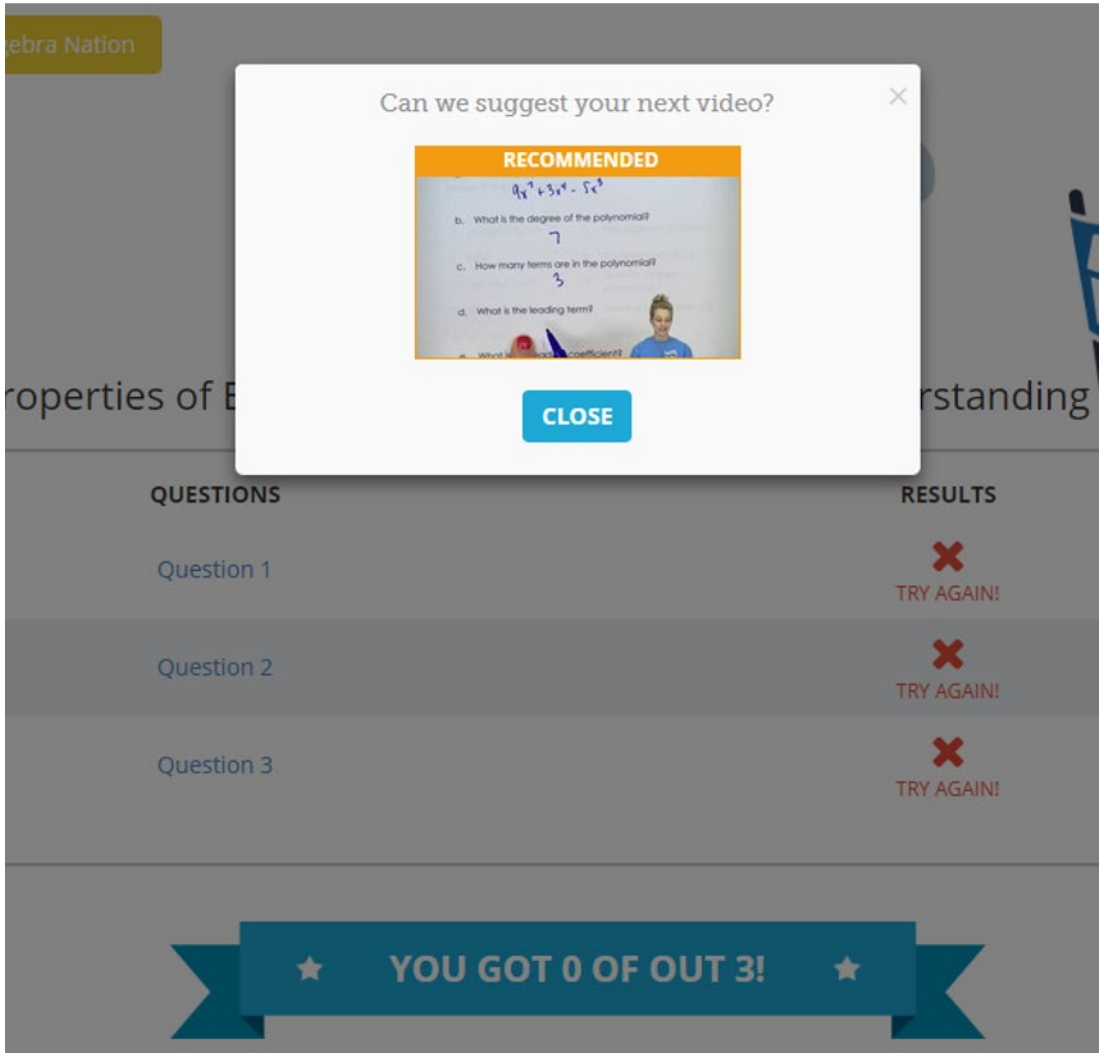
Video Recommendation System

Provide students with a personalized video recommendation that takes into account their current **knowledge** as well as their **engagement** with the system.

Additional information:

https://doi.org/10.1145/3491140.3528275
https://doi.org/10.1145/3506860.3506906

Video Recommendation Screen in Math Nation



Related Theories

Effectiveness of advanced learning technologies to increase student achievement depends on teachers' experience and fidelity of implementation (Wijekumar et al., 2016, Anderson et al., 1995; Kulik & Fletcher, 2016).

Related theories:

- The technology acceptance model (TAM) (Davis et al., 1989)
- Technological Pedagogical Content Knowledge (TPACK) model (Koehler & Mishra, 2009)
- Digital literacy (Mac Callum et al., 2014).
- Technology orchestration in the classroom (Prieto et al., 2011)

Research Questions

1. What is the relationship between teacher characteristics and practices with a VLE and student adoption of a video recommendation system?

2. How do teacher characteristics and practices with a VLE explain heterogeneity of effects of the video recommendation system on student achievement?

Study Design: Secondary data analysis of a large experimental study.

- **Sample:**
  - 2,936 students of 52 teachers
  - 6th to 11th grades
  - Conducted from January to June 2021
  - Algebra 1 or Algebra 1 Honors classes

- **Measures:**

  Three teacher surveys:
  - February survey aligned with technology orchestration theory;
  - April survey contained the Mathematics Teaching Efficacy Belief Instrument (MTEBI) (Huinker & Enochs, 1995)
  - May survey asked about challenges during the year, including the COVID-19 pandemic

- **Student variables:**

  Outcomes:
  - RQ1: Recommendation followed rate
  - RQ2: Post-test score

  Treatment: Video recommendation type

  Covariates: pre-test score, engagement, course type, absent days, gender, ethnicity, free or reduced lunch, days enrolled, percent remote, special ed eligibility, cluster membership

Surveys and code are available at: https://osf.io/h5tpn/

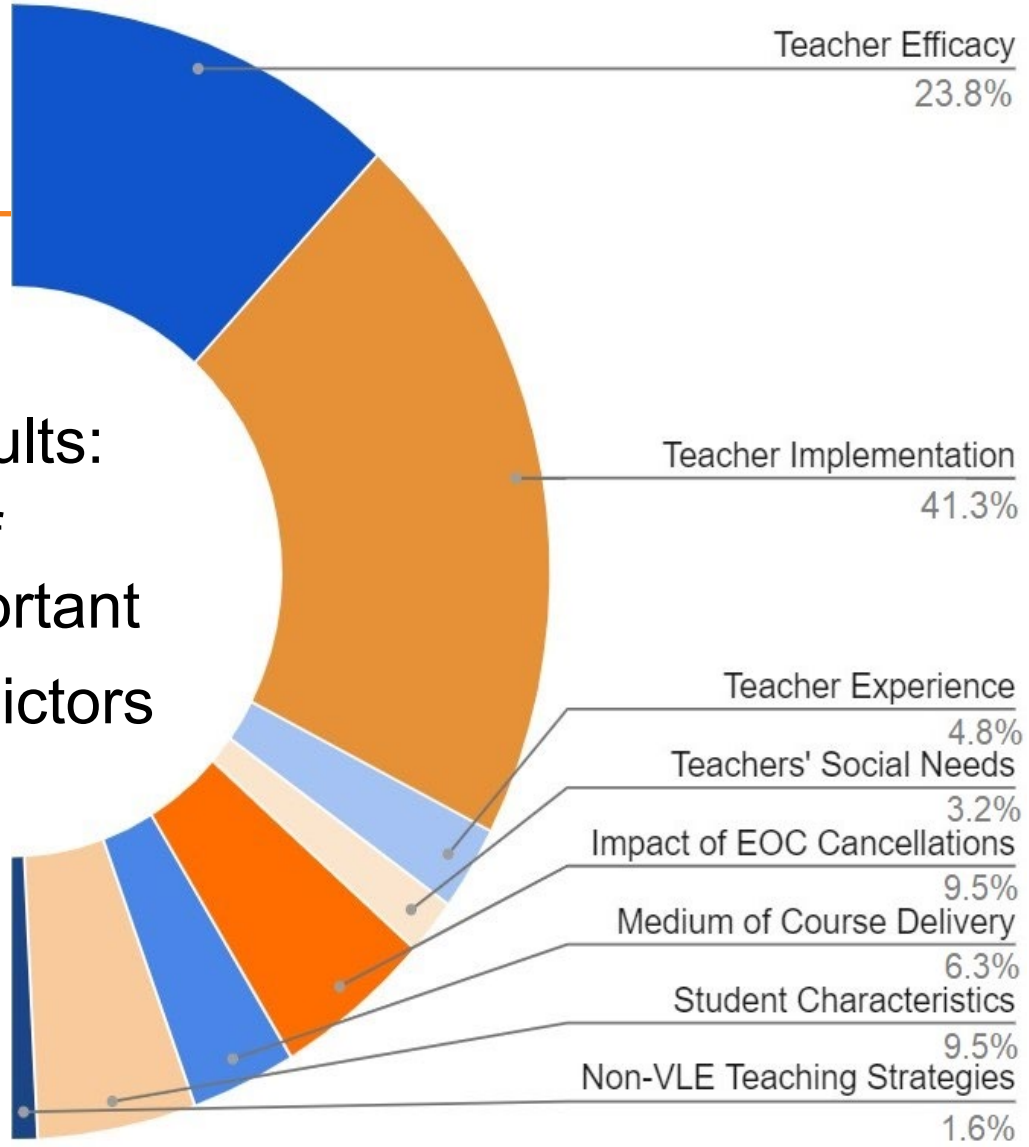
RQ1: Prediction of recommendation followed rate

- Analysis:

- Random forest algorithm implemented by the *ranger* package (Wright & Ziegler, 2017)
- 216 predictors: all teacher survey variables and student variables
- 50% of the data for training, sampling 15 variables per iteration of 10,000 trees.
- Variable importance was estimated using the remaining 50% of the data using permutation importance, with *p* values obtained with the Altman et al. (2010) method.
- Thematic analysis to identify common themes among survey items of above-the-average permutation importance.

Results:

% of important predictors



RQ2: Heterogeneity of treatment effects

- generic machine learning inference (GenericML) method (Chernozhukov et al.; 2020), implemented by the GenericML package (Welz et al., 2022)

1. With 50% training data and multiple ML methods, estimate conditional average treatment effects (CATEs).
2. With test data, use OLS regression to obtain best linear predictor (BLP), estimate ATE, and test heterogeneity.
3. Obtain five group average treatment effects (GATES) from quintiles of the CATE distribution
4. Classification analysis (CLAN): Calculate predictor mean scores for each of the 5 groups.
5. Rank the standardized absolute differences in predictor means between Group 5 and Group1.
6. Thematic analysis to understand the differences between teacher factors between Groups 5 and 1.

- Results: Group average treatment effects (GATES)

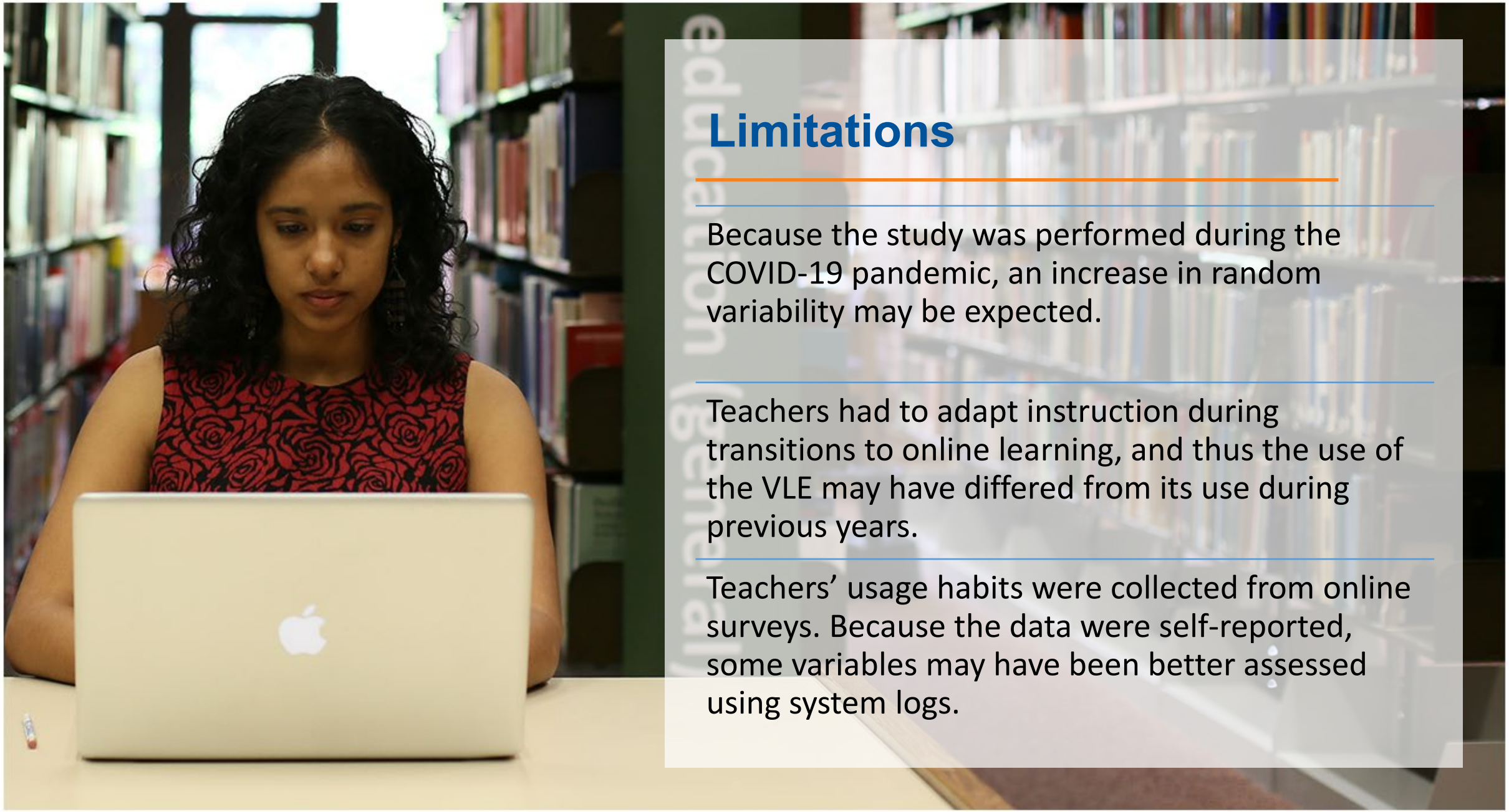
	Estimate	Lower C.I.	Upper C.I.	*p*-value
Group 1	-0.562	-0.640	-0.484	0.000
Group 2	-0.178	-0.256	-0.101	0.000
Group 3	0.000	-0.076	0.077	0.999
Group 4	0.208	0.131	0.285	0.000
Group 5	0.544	0.467	0.620	0.000
Group 5 – Group 1	1.098	0.989	1.207	0.000

RQ 2 Results: *Teacher Characteristics Organized According to their Students' Achievement Group*

Teachers of students who benefitted the most	Teachers of students who benefited the least
Used Algebra Nation videos 3 – 4 times weekly	Engaged in daily use of Algebra Nation
Used videos more than other features	Used assessments most and often daily
Spent more time in Algebra Nation overall	Had unmet social and professional development needs
Monitored students on the teacher dashboard	Struggled to engage students
Spent more time on classroom planning	Had larger class sizes
Made positive appraisals of own teaching ability	Made negative appraisals of own teaching ability
Believed achievement was a direct result of their teaching	Reported more COVID-19-related challenges

Conclusions

- Student adoption of the video recommendations is related to teacher fidelity of use, frequency of student monitoring, and experience with the VLE.
- There were several differences in strategies for orchestrating the VLE between teachers with students in the most affected (Group 5) and least affected (Group 1) groups by the treatment video recommendations.
- Effective PD should engage teachers in increasing their experience using the VLE in ways students are most likely to benefit.



Limitations

Because the study was performed during the COVID-19 pandemic, an increase in random variability may be expected.

Teachers had to adapt instruction during transitions to online learning, and thus the use of the VLE may have differed from its use during previous years.

Teachers' usage habits were collected from online surveys. Because the data were self-reported, some variables may have been better assessed using system logs.


Thank you!
More information and contact:
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