

Research Design Framework

Study Title: The Impact of Actor-Network Theory on Student Learning Outcomes in Online College Algebra Courses

Author Name(s): Oscar Villalobos

Abstract from the Study

This study explores the application of Actor-Network Theory (ANT) to understand and enhance student engagement, learning outcomes, and retention rates in online higher education College Algebra courses. Utilizing a social constructivist approach, this research investigates the dynamic interactions between human actors (students, instructors, tutors) and non-human actors (Canvas, MyLab Math, educational videos). The study aims to identify how these interactions influence educational outcomes and develop strategies to improve student support and reduce attrition rates. The research employs a mixed-methods approach, combining quantitative data from surveys, usage statistics, and performance metrics with qualitative insights from open-ended survey questions and interviews. Data will be collected over a 16-week semester, with analysis extending into the following semester to prepare for subsequent implementation. Key findings are expected to reveal the impact of digital tools on student engagement and learning outcomes, providing actionable insights for educators and researchers. The anticipated outcomes include enhanced student engagement, improved learning outcomes, and reduced attrition rates. By applying ANT, this study will contribute to the ongoing research on the integration of technology in higher education and offer practical recommendations for improving online learning environments across all fields of study.

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Research main topic of inquiry or Questions

This study explores how Actor-Network Theory (ANT) can be implemented to understand and improve the effectiveness, student engagement, and student retention of online College Algebra courses in higher education.

Subtopic(s) of inquiry or Sub-Questions

- How do the interactions between human actors (students, instructors, tutors) and non-human actors (Canvas, MyLab Math, educational videos) influence student engagement and learning outcomes in online College Algebra courses?
- How can understanding the dynamic relationships within these actor-networks provide strategies to enhance student support and reduce attrition rates (the rate at which students drop out) in online College Algebra courses?

Main Literature in Support of Conducting this Study

1. Article 1: Introducing Actor-Network Theory Via the Engineering Sophomore Year

Annotation: This conference paper by Tsai et al. (2015) found that sophomore engineering student success is heavily influenced by their interactions with instructors (educators), peers (learners), textbooks, and digital tools. Tsai et al. emphasize the importance of understanding these complex networks through Actor Network Theory (ANT) to improve retention and success rates. It also highlights the need for curricular and institutional changes to better support students and demonstrates how Actor-Network Theory provides a thorough framework for analyzing these educational environments.

Reference: Tsai, J., Kotys-Schwartz, D., & Knight, D. (2015). Introducing actor–network theory via the engineering sophomore year. *2015 ASEE Annual Conference and Exposition Proceedings*. <https://doi.org/10.18260/p.24358>

2. Article 2: How Actor-Network Theory Travels and Changes in Engineering Education: A Narrative Literature Review

Annotation: This paper examined how ANT has been adapted and used in engineering education research (EER). It identified three primary roles of ANT in EER: as a philosophical underpinning, a theoretical framework, and as course content. The study found that ANT has been translated in the context of EER to emphasize ethical analysis, moral agency for non-humans (still considered actors), and the interactions between human and non-human actors. It also noted that EER researchers have adapted ANT by incorporating elements from various sources, leading to unique interpretations and applications within the field. Although relatable to STEM, not quite applicable to higher education, but application nonetheless.

Reference: Bezerra Rodrigues, R. A., Seniuk Cicek, J., Zacharias, K., & Paul, J. (2022). How actor-network theory travels and changes in engineering education: A narrative literature review. *2022 ASEE Annual Conference & Exposition Proceedings*. <https://doi.org/10.18260/1-2--41682>

3. Article 3: Tracing translation of an education policy initiative (Maths Mastery) into primary school teachers' classroom practices: an actor-network theory ethnography

Annotation: The thesis by Unsworth explores how their *Maths Mastery* policy initiative was integrated into primary school teachers' classroom practices using ANT. Key findings include the processes of problematisation (challenging existing practices to

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

create a need for change), interessement (forming new ties to the Maths Mastery approach while weakening old ones), enrolment (adopting the policy widely within the school), and mobilisation (sustaining new practices in the classroom). The study highlights the dynamic interactions between various actors that facilitated the successful implementation of the policy. Too long to have read completely and jumped through sections using the Table of Contents. Definitions taken directly from there for simplicity.

Reference: Unsworth, R. (2023, January 1). *Tracing Translation of an education policy initiative (Maths Mastery) into Primary School Teachers' classroom practices: An actor-network theory ethnography*. Theses. <https://etheses.dur.ac.uk/15110/>

4. Article 4: Bringing Critical Mathematics Education and Actor–Network Theory to a Statistics Course in Mathematics Teacher Education: Actants for Articulating Complexity in Student Teachers' Foregrounds

Annotation: Article 4 by Odmo et al. explores how Critical Mathematics Education (CME) and ANT can be integrated into a statistics course for student teachers – a key subject I am interested in, student teachers...the teachers of tomorrow, literally. The study highlights the complexity student teachers face when shifting from an instrumental view of statistics to a critical perspective, particularly within the context of climate change as noted by the article. Key findings include the identification of various actants such as the curriculum, social justice, democracy, and source critique that shape student teachers' foregrounds and their understanding of CME. The study emphasizes the need for teacher education to actively discuss this complexity, enabling future teachers to navigate and integrate CME into their practice effectively. A great paper, much complex than I was expecting as so far our papers involve bigger topics that I am interested in such as politics, social justice, not that I don't find them interesting, I do, but my focus in personal research is programming integration, but I can now see that these issues that have risen really do climb up the administrative ladder. Intimidating.

Reference: Ödmo, M., Chronaki, A., & Bjorklund Boistrup, L. (2023). Bringing critical mathematics education and actor–network theory to a statistics course in mathematics teacher education: Actants for articulating complexity in student teachers' foregrounds. *Education Sciences*, 13(12), 1201. <https://doi.org/10.3390/educsci13121201>

5. **Article 5:** Applying actor–network theory to identify factors contributing to nonpersistence of African American students in STEM majors

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Annotation: Minority students was a topic I had encountered while in a pro dev session at work, and similarly, this paper explores the reasons behind the high attrition rates of African American students in STEM fields at predominantly White institutions (PWIs). The study uses ANT to examine the interactions between students, professors, peers, institutional environments, and societal factors. Key findings reveal that weak relationships with professors, lack of supportive peer networks, an unwelcoming institutional environment, and societal stereotypes contribute significantly to the students' decisions to leave STEM majors. These factors create a complex network of challenges that undermine the students' persistence and success in STEM disciplines. Overall amazing paper, one of my favorites thus far as it's directly applicable to my focus.

Reference: Green, A. M., Brand, B. R., & Glasson, G. E. (2018). Applying actor–network theory to identify factors contributing to nonpersistence of African American students in STEM majors. *Science Education*, 103(2), 241–263. <https://doi.org/10.1002/sce.21487>

6. **Article 6:** Technology for teaching and learning in higher education contexts: activity theory and actor network theory analytical perspectives

Annotation: Mlitwa explores how Activity Theory (AT) and ANT can be used to analyze the adoption and use of technology in higher education – great article as now ANT directly correlates to my research. The study found that AT is useful for examining the practical applications of technology but tends to view technology as a neutral tool, which can be limiting. ANT, on the other hand, supports the critical view of technology as value-burdened and emphasizes its contextual embeddedness, making it more effective for understanding the socio-technical interactions in educational environments. This article recommends combining AT and ANT to develop a comprehensive framework for analyzing e-learning and Learning Management Systems (LMSs) in higher education!!!

Reference: Mlitwa, N. (2007). Technology for teaching and learning in higher education contexts: Activity theory and actor network theory analytical perspectives. *International Journal of Education and Development using ICT*, 3(4), 54-70.

7. **Article 7:** Using actor-network theory to understand the process of information systems curriculum innovation

Annotation: Tatnall examines how ANT can be applied to understand curriculum changes in the field of Information Systems (IS) and is quite interesting as its applications can be to other curricula and or fields. The study uses the adoption of the programming language Visual Basic (VB) by an Australian university in the 1990s as a case study. Key findings include the identification of various human (academics, students, employers) and non-human (computers, programming languages, university

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

infrastructure) actors involved in the curriculum innovation process. The study demonstrates that ANT is effective in explaining the complex interactions and associations that drive curriculum changes, making it relevant for understanding similar innovations in various educational contexts such as the implementation of programming, such as VBA into mathematics courses in higher education.

Reference: Tatnall, A. D. (2010). Using actor-network theory to understand the process of Information Systems Curriculum Innovation. *Education and Information Technologies*, 15(4), 239–254. <https://doi.org/10.1007/s10639-010-9137-5>

8. **Article 8:** Using Actor-Network Theory to Analyze the Construction of the Failure Concept in a K-12 ICT Integration Program

Annotation: Elgali explores the integration of information and communication technologies (ICT) in Israeli K-12 education and the discourse around its perceived failure. By applying ANT, the study compares the national ICT program with a local municipal program - identifying significant differences in actor networks that contribute to the failure narrative. Key findings reveal that non-profit organizations, the role of parents, information flow, teachers' perceptions of technology, and the absence of assessment measures in the national program contribute to its perceived failure. They also suggest that understanding these networks can provide insights for improving ICT integration in education.

Reference: Elgali, Z., & Kalman, Y. M. (2010). Using actor-network theory to analyze the construction of the failure concept in a K-12 ICT integration program. In *Proceedings of the Chain Conference in Instructional Technologies Research 2010: Learning in the Technologies Era, The Open University of Israel, Ra'anana, Israel*.

9. **Article 9:** Still w(AI)ting for the automation of teaching: An exploration of machine learning in Swedish primary education using Actor-Network Theory

Annotation: Sperling et al. examine the use of an AI-based teaching aid, AI Engine, in Swedish primary schools. Using ANT, the study found that while the AI Engine has the potential to personalize and automate teaching, it often requires compensatory actions by human actors (teachers and students) to address its shortcomings – similar to my experience while attempting to use it to solve a problem in class, College Algebra, Fall 2023. Teachers had to intervene frequently to correct errors and provide additional support to each student (taking away from class time), highlighting the AI Engine's limitations and the complex interplay between human and non-human actors in the classroom. The study highlights the ongoing negotiation and adaptation required for integrating AI technologies into education effectively – personally seen, similarly and personally.

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Reference: Sperling, K., Stenliden, L., Nissen, J., & Heintz, F. (2022). Still w(AI)ting for the automation of teaching: An exploration of machine learning in Swedish primary education using actor-network theory. *European Journal of Education*, 57(4), 584–600. <https://doi.org/10.1111/ejed.12526>

10. Article 10: Beyond the player: A user-centered approach to analyzing digital games and players using actor-network theory

Annotation: Due to limiting factors and applications of papers directly implemented into my topic – I had to explore out, but it still applies as seen by Hung. Hung’s article using ANT states it can be used to analyze the sociotechnical networks of adolescents playing online games in different contexts. Key findings include the identification of network assemblages that consist of various human and non-human actors, such as gaming hardware, social settings, and online interactions, which influence players' experiences and behaviors. Although not directly applicable – this allowed me to consider actors not seen before as the ones mentioned above. Hung’s study emphasizes the importance of understanding multiple actor networks and their translations to see how gaming fits into the broader context of players' lives and social interactions. It concludes that recognizing these complex networks helps avoid overgeneralizing about "games" and "players," highlighting the diversity in gaming experiences. Applicability can be switched from “gaming” to “higher education” and boom, I see what we potentially have here.

Reference: Hung, A. C. (2016). Beyond the player: A user-centered approach to analyzing digital games and players using actor-network theory. *E-Learning and Digital Media*, 13(5–6), 227–243. <https://doi.org/10.1177/2042753017691655>

11. Article 11: Live Online Education Efficiency Mediators From the Actor Network Theory Perspective

Annotation: This article explores the factors influencing the quality of live online education sessions (synchronous) through the lens of ANT. The study identifies both human actors (educators, participants, event organizers, external experts) and non-human actors (hardware, primary and supportive software, virtual environment) that mediate the efficiency of online education. Key findings include the significant impact of educators' skills, emotions, and preparation on session success, the critical role of technology in facilitating or hindering learning, and the influence of participants' behavior and expectations. The research highlights the complex interplay between these actors and provides practical recommendations for improving online educational practices. Behavior, expectations, emotions, and preparation all key players not considered prior, similar to Article 10.

Reference: Czahajda, R., Čairović, N., & Černko, M. (2022). Live online education efficiency mediators from the actor network theory perspective. *Frontiers in Education*, 7. <https://doi.org/10.3389/feduc.2022.859783>

12. Article 12: Technologies for learning? An actor-network theory critique of ‘affordances’ in research on mobile learning

Annotation: Article 12 explores how the concept of affordances (*the potential actions or uses that an object or environment offers to an actor, often highlighting the relationship between the object's properties and the actor's capabilities.*) is used to position mobile devices as learning technologies. The study with ANT as a lens, critiques the term 'affordances' for its inconsistency and lack of analytical clarity. It identifies how this term, despite its problems, is prevalent in mobile learning research and influences how these devices are perceived in educational contexts – I have to come back to this one. The authors argue for a more critical approach to understanding the role of mobile devices in learning, emphasizing the need to move beyond simplistic assertions of 'anytime, anywhere' learning. Major professor states mobile learning not directly applicable to my research, but may offer some future insight.

Reference: Wright, S., & Parchoma, G. (2011). Technologies for learning? an actor-network theory critique of “affordances” in research on Mobile Learning. *Research in Learning Technology*, 19(3). <https://doi.org/10.3402/rlt.v19i3.17113>

13. **Article 13:** Factors Determining the Balance between Online and Face-to-Face Teaching: An Analysis Using Actor-Network Theory

Annotation: This one explores how online resources have been implemented in a first-year accounting course at Victoria University using ANT. The study identifies both human (students, lecturers, administrators) and non-human actors (Blackboard, computers, university policy) that influence the balance between online and face-to-face teaching. Key findings highlight the varied perspectives of different actors, the challenges of integrating technology, and the importance of achieving an optimal balance to enhance student learning experiences – with the study emphasizing that both technological and human factors must be considered to effectively implement blended learning approaches.

Reference: Wong, L., & Tatnall, A. (2010). Factors determining the balance between online and face-to-face teaching: An analysis using actor-network theory. *Interdisciplinary Journal of Information, Knowledge, and Management*, 5, 167–176. <https://doi.org/10.28945/1152>

14. Article 14: Accountability Practices in Adult Education: Insights from Actor-Network Theory

Annotation: Fenwick explores how accountability mechanisms in adult education are created and their effects using ANT. The study also explores various accountability practices in workplace learning, professional education, literacy tutoring, and public pedagogy which then go on to highlight the complexities and contradictions in these processes. Key findings indicate that accountability mechanisms are not simply oppressive but contain spaces for resistance and non-calculable actions. The paper suggests that ANT can offer valuable insights into the dynamic and multifaceted nature of accountability in adult education, providing a more nuanced understanding of these mechanisms. General overall, not quite applicable.

Reference: Fenwick, T. (2010). Accountability Practices in Adult Education: Insights from actor—network theory. *Studies in the Education of Adults*, 42(2), 170–185.
<https://doi.org/10.1080/02660830.2010.11661596>

15. Article 15: From Classroom Learning to E-learning: An Actor-Network Perspective

Annotation: Article 15 examines the transition from traditional classroom-based learning to an e-learning environment for educating Norwegian athletic judges. Using ANT, the study highlights the challenges and complexities involved in implementing a Learning Management System (LMS) in this context. Key findings include issues with communication, project delays, and the need for continuous adaptation and negotiation among various human and non-human actors – which then go on to emphasize the importance of understanding the socio-technical environment to successfully transition to e-learning. Although post-Covid everyone is mostly gone e-learning as this was published in 2010 we can see a pre-perspective that may shed new insight.

Reference: Hustad, E., & Arntzen, A. A. B. (2010). From Classroom Learning to E-learning: An Actor-Network Perspective.

16. Article 16: Performing Actor-Network Theory in the Post-Secondary Classroom

Annotation: Quinlan et al. explore and analyze the challenges and innovative methods of teaching the ANT framework to undergraduate sociology students (quite meta isn't it). The authors propose a creative pedagogical approach by "performing" ANT in the classroom, using a theatrical method to teach Annemarie Mol's "The Body Multiple" as I had presented during my PPT, quite the awesome study by Mol. The study found that this innovative method successfully engaged students and made the complex concepts of ANT more accessible and understandable by going outside the textbook. It highlights

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

the effectiveness of using performance-based techniques to teach non-conventional and innovative sociological theories, although performance-based in a math course can be seen as application-based, we may have something here.

Reference: Quinlan, A., Quinlan, E., & Nelson, D. (2013). Performing actor-network theory in the post-secondary classroom. *Social and Professional Applications of Actor-Network Theory for Technology Development*, 56–66. <https://doi.org/10.4018/978-1-4666-2166-4.ch005>

17. Article 17: Socioscientific issues via controversy mapping: bringing actor-network theory into the science classroom with digital technology

Annotation: Elam et al. explore the integration of ANT into science education through controversy mapping, a mapping inspired by ANT. *Controversy mapping is a method that uses digital tools to visualize and analyze the complex networks of relationships and interactions surrounding argumentative issues. It helps reveal different perspectives, interests, and power dynamics, enhancing understanding of the controversy.* The study was conducted in a Swedish upper secondary school and aimed to address how digital tools can help students engage with socioscientific issues (SSI). Key findings include the successful reconfiguration of citizenship training, the enhancement of interdisciplinary teaching, and the promotion of digital literacy. They went on to demonstrate that controversy mapping allows students to explore the complexity of scientific controversies and develop critical thinking skills by visualizing and analyzing different perspectives using digital technology. Phew. Tired.

Reference: Elam, M., Solli, A., & Mäkitalo, Å. (2018). Socioscientific issues via controversy mapping: Bringing actor-network theory into the science classroom with Digital Technology. *Discourse: Studies in the Cultural Politics of Education*, 40(1), 61–77. <https://doi.org/10.1080/01596306.2018.1549704>

General Theoretical Framework Supporting Method

The theoretical framework I used for this study is supported by Actor-Network Theory (ANT), which suggests that both human and non-human actors interact within a network, shaping outcomes through their dynamic relationships. This study adopts a social constructivist approach - acknowledging that while an objective world exists, our understanding of it is shaped by the interactions and agreements within a network of actors – with perspectives changing as seen through Mol's famous study. This framework influences the methods by focusing on how the interactions between students, instructors, tutors, and digital tools impact student engagement and learning outcomes in online College Algebra courses. By understanding these networks this study aims to develop strategies to enhance student support and reduce attrition rates. This will then demonstrate the relevance and applicability of qualitative methods in capturing the complexities of these interactions.

Study goals

- The primary goal of this study is to understand how the interactions between human actors (students, instructors, tutors) and non-human actors (Canvas, MyLab Math, educational videos) influence student engagement and learning outcomes in online College Algebra courses through the lens of Actor-Network Theory (ANT). Additionally, the study aims to develop strategies to enhance student support and reduce attrition rates (the rate at which students drop out) by analyzing these dynamic relationships within the actor-networks.
- I am seeking to help the following:
 - Educators: The study will provide valuable insights into designing and implementing effective technology-enhanced teaching methods for online mathematics courses.
 - Researchers. The study contributes to the ongoing research and application of ANT in educational settings.
- We will focus on the challenges associated with effectively integrating technology into online College Algebra courses. By applying ANT, the study seeks to find how interactions between various actors impact student engagement and learning outcomes. The expected outcomes include:
 - Improved Student Engagement - This will be analyzed through qualitative participation metrics (activity/time spent) and student feedback (surveys).
 - Enhanced Learning Outcomes - Reflected in students' performance metrics (Canvas and MyLab Math), indicating better understanding and retention of course material due to the effective use of digital tools.
 - Reduced Attrition Rates - Shown by lower dropout rates which may have to be studied at least one additional semester after Fall 2024.

Delimitations

- Courses - This study is confined to online College Algebra courses that utilize Canvas and MyLab Math, which may limit the generalizability of the findings to other courses or educational settings.
- Focus on Interactions - The study emphasizes the interactions between students, instructors, tutors, and digital tools, which may not capture the broader impact of other factors such as institutional policies or external educational trends.

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Setting

Describes the setting where the population exists in local and contextual framing

Broad contextual framing

We will be focused on higher education. Higher education has the freedom to implement technology as opposed to K-12, for the most part. Ever-changing teaching methods allow for ways to tackle student engagement, student success, and student motivation.

Local contextual framing

The specific focus is on online College Algebra courses at a community college, which utilizes Canvas and MyLab Math for instruction. This setting is best for examining how these digital tools impact student engagement, student motivation, and learning outcomes. The community college environment provides an applicable environment for exploring the effectiveness of these technologies in supporting student success, motivation, and retention.

Physical or virtual setting of the study

The research will be conducted in a fully online environment, leveraging the college's Learning Management System (Canvas) and MyLab Math. Surveys and feedback will be collected using Qualtrics.

Participants

The participants in this study are the students, instructors, and tutors involved in the online College Algebra courses. These individuals are well-suited to provide insights into the interactions between human and non-human actors within the online course.

Population in focus

The study will have to include a mixed methods approach like Dr. Lee's assignments through both of our courses. Qualitative for student feedback and quantitative for performance and activity metrics. Gathering both quantitative data (such as usage statistics and performance metrics) and qualitative insights, and surveys, to gain a thorough understanding of the impacts of Canvas and MyLab Math on student engagement, motivation, and learning outcomes.

Projected Data Collection Methods

Type of quantitative approach (if appropriate)

The quantitative approach will include surveys administered at the end of each module, with a total of 16 modules in the 16-week Fall 2024 course. Additionally, usage data will be collected through Canvas and MyLab Math (MLM). Performance metrics, such as grades and completion rates for assignments and exams, will also be analyzed.

Type of qualitative approach (if appropriate)

The qualitative approach will include open-ended survey questions, student feedback, and interviews with selected students, instructors, and tutors to gain deeper insights into their experiences and interactions within the course.

Research Instrumentation

- Surveys:
 - Regular Module Weeks - Surveys will be administered at the end of each module to gather data on student engagement, understanding of the material, and perceptions of the digital tools used.
 - Exam Weeks - During exam weeks (three exams and a final exam), surveys will be incorporated into the exam, consisting of questions that do not count towards the exam score but gather insights into students' experiences and preparation for exams.
- Usage Data: Collected through Canvas and MyLab Math, including time spent on the platform, frequency of access, and interaction with course materials.
- Performance Metrics: Analysis of grades, assignment completion rates, and exam scores to measure learning outcomes and the impact of digital tools on student performance.
- Interviews: Conducted with a sample of students (challenging to do all – unless use Zoom to get some to join if time constraints), instructors, and tutors to gather qualitative data on their experiences and interactions within the online course.

Length of study and reason for length

The study will be conducted over one semester (Fall 2024), with data collection spanning the entire 16-week period. This duration is necessary to capture a comprehensive view of student engagement, learning outcomes, and interactions across different modules and assessments.

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

The subsequent semester will be used to analyze the collected data and prepare for implementation in the following Fall semester.

Projected Data Analysis Methods

Quantitative analysis (if appropriate)

For the quantitative analysis, we will use descriptive statistics and statistical tests to analyze the data.

Descriptive Statistics: We will summarize the survey responses, usage data, and performance metrics using measures such as mean, median, standard deviation, and frequency distributions. This will help us understand the central tendencies and variability of the data collected from both the intervention group (using ANT-informed tools) and the control group (not using ANT-informed tools).

Independent t-tests: To compare the mean scores of the intervention group and the control group on key outcomes such as student engagement, learning outcomes, and attrition rates. The independent t-tests are appropriate for determining whether there are statistically significant differences between the two groups.

Regression Analysis: To identify the predictors of student engagement, learning outcomes, and attrition rates by examining the relationship between various independent variables (e.g., tool usage, demographic factors are a major one too!). This will help in understanding the impact of specific factors on student success.

Qualitative analysis methods (if appropriate)

For the qualitative analysis, we will use thematic analysis to identify, analyze, and report patterns (themes) within the qualitative data collected from open-ended survey questions and interviews. This approach is suitable because it allows for a detailed examination of the participants' experiences and perceptions, providing deeper insights into the interactions between human and non-human actors in the online learning environment. Thematic analysis involves coding the data, searching for themes, reviewing themes, defining and naming themes, and producing the final report. May need assistance from a data scientist, perhaps.

Credibility and Trustworthiness

- To mitigate the threat of selection bias, since we are dealing with one class where students are already registered, we will use statistical controls for characteristics to ensure that any differences between groups are accounted for based on observable factors.
- To address the maturation threat, where changes in students' attitudes or performance over time might influence outcomes independently of the digital tools, we will collect data over one semester to capture meaningful changes while minimizing natural

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

maturation effects, we can also consider having surveys done every other week (every other exam)

- To handle attrition, where different dropout rates between groups could bias the results, we will monitor and report attrition rates and use statistical methods to handle missing data and make inferences, ensuring the completeness and reliability of our findings.

Projected Audience for the Research Outcomes

Educators: Insights, findings, and practical recommendations will be shared through workshops, webinars, and professional development sessions aimed at educators.

Academic Journals/Researchers: The findings will be targeted toward academic journals focused on educational technology and higher education, such as the AMATYC and IEEE Xplore. The research will contribute to the academics of ANT applications in educational settings.

Higher Education Institutions: The results will be provided to administrators to inform decisions on technology integration and support systems in online learning environments - aiming to improve student engagement, retention, and overall learning outcomes.

Timeline

Give a timeline for when you expect to do each research activity starting with completion of research framework and IRB approval all the way through write up and publication. The following is a beginning, but don't feel limited to the components included in the following table. You also will not necessarily use all data collection methods or need to do data analysis if you do not collect a particular type, so adjust the table as needed adding or subtracting row.

<i>Action</i>	<i>Date Begins</i>	<i>Expected Completion Date</i>	<i>Date Due</i>	<i>Responsible Person(s)</i>	<i>Approval needed</i>
Research framework	7/22/2024	8/22/2024	8/23/2024	Oscar Villalobos	Kinshuk
Full methods with instruments	7/23/2024	8/23/2024	8/24/2024	Oscar Villalobos	Kinshuk
Letter of support from Data Collection Site	9/23/2024	9/24/2024	9/25/2024	Oscar Villalobos	Kinshuk
NIH certificates from Team	9/24/2024	9/25/2024	9/26/2024	Oscar Villalobos	Kinshuk
IRB Completion	9/25/2024	9/26/2024	9/27/2024	Oscar Villalobos	Kinshuk
Literature Review	7/22/2024	7/1/2018	7/15/2018	Oscar Villalobos	Kinshuk
IRB Approval	8/1/2018	9/15/2018	Varies	Oscar Villalobos	IRB
Data Collection – Survey	8/15/2024	8/16/2024	12/16/2024	Oscar Villalobos	Kinshuk
Data Collection – Interviews	8/15/2024	8/16/2024	12/16/2024	Oscar Villalobos	Kinshuk
Data Cleaning and Organization	12/16/2024	2/16/2025	2/17/2025	Oscar Villalobos	Kinshuk
Data analysis – survey	8/15/2024	8/16/2024	12/16/2024	Oscar Villalobos	Kinshuk
Data analysis - interviews	8/15/2024	8/16/2024	12/16/2024		Kinshuk
Data analysis – thematic generation	8/15/2024	8/16/2024	12/16/2024	Oscar Villalobos	Kinshuk
Write up findings for (dissertation, article, chapter, script, etc.)	12/17/2024	2/17/2025	2/18/2025	Oscar Villalobos	Kinshuk
Submit article, etc.	2/28/2025	3/1/2025	3/2/2025	Oscar Villalobos	Kinshuk

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Submit IRB Conclusion/Extension Paperwork	3/2/2025	3/3/2025	3/4/2025	Oscar Villalobos	Kinshuk
---	----------	----------	----------	------------------	---------

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

References

- Bezerra Rodrigues, R. A., Seniuk Cicek, J., Zacharias, K., & Paul, J. (2022). How actor-network theory travels and changes in engineering education: A narrative literature review. *2022 ASEE Annual Conference & Exposition Proceedings*. <https://doi.org/10.18260/1-2--41682>
- Czahajda, R., Čairović, N., & Černko, M. (2022). Live online education efficiency mediators from the actor network theory perspective. *Frontiers in Education*, 7. <https://doi.org/10.3389/feduc.2022.859783>
- Elam, M., Solli, A., & Mäkitalo, Å. (2018). Socioscientific issues via controversy mapping: Bringing actor-network theory into the science classroom with Digital Technology. *Discourse: Studies in the Cultural Politics of Education*, 40(1), 61–77. <https://doi.org/10.1080/01596306.2018.1549704>
- Fenwick, T. (2010). Accountability Practices in Adult Education: Insights from actor—network theory. *Studies in the Education of Adults*, 42(2), 170–185. <https://doi.org/10.1080/02660830.2010.11661596>
- Green, A. M., Brand, B. R., & Glasson, G. E. (2018). Applying actor–network theory to identify factors contributing to nonpersistence of African American students in STEM majors. *Science Education*, 103(2), 241–263. <https://doi.org/10.1002/sce.21487>
- Hung, A. C. (2016). Beyond the player: A user-centered approach to analyzing digital games and players using actor-network theory. *E-Learning and Digital Media*, 13(5–6), 227–243. <https://doi.org/10.1177/2042753017691655>
- Quinlan, A., Quinlan, E., & Nelson, D. (2013). Performing actor-network theory in the post-secondary classroom. *Social and Professional Applications of Actor-Network Theory for Technology Development*, 56–66. <https://doi.org/10.4018/978-1-4666-2166-4.ch005>
- Sperling, K., Stenliden, L., Nissen, J., & Heintz, F. (2022). Still w(AI)ting for the automation of teaching: An exploration of machine learning in Swedish primary education using actor-network theory. *European Journal of Education*, 57(4), 584–600. <https://doi.org/10.1111/ejed.12526>
- Tatnall, A. D. (2010). Using actor-network theory to understand the process of Information Systems Curriculum Innovation. *Education and Information Technologies*, 15(4), 239–254. <https://doi.org/10.1007/s10639-010-9137-5>
- Tsai, J., Kotys-Schwartz, D., & Knight, D. (2015). Introducing actor–network theory via the engineering sophomore year. *2015 ASEE Annual Conference and Exposition Proceedings*. <https://doi.org/10.18260/p.24358>
- This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.*

- Unsworth, R. (2023, January 1). *Tracing Translation of an education policy initiative (Maths Mastery) into Primary School Teachers' classroom practices: An actor-network theory ethnography*. Theses. <https://etheses.dur.ac.uk/15110/>
- Wong, L., & Tatnall, A. (2010). Factors determining the balance between online and face-to-face teaching: An analysis using actor-network theory. *Interdisciplinary Journal of Information, Knowledge, and Management*, 5, 167–176. <https://doi.org/10.28945/1152>
- Wright, S., & Parchoma, G. (2011). Technologies for learning? an actor-network theory critique of “affordances” in research on Mobile Learning. *Research in Learning Technology*, 19(3). <https://doi.org/10.3402/rlt.v19i3.17113>
- Ödmo, M., Chronaki, A., & Bjorklund Boistrup, L. (2023). Bringing critical mathematics education and actor–network theory to a statistics course in mathematics teacher education: Actants for articulating complexity in student teachers' foregrounds. *Education Sciences*, 13(12), 1201. <https://doi.org/10.3390/educsci13121201>

Appendices

Appendix A.

Likert Scale Survey for Regular Module Weeks

Q1: How engaged did you feel with the course material this week?

- 1 (Not engaged at all)
- 2 (Slightly engaged)
- 3 (Moderately engaged)
- 4 (Very engaged)
- 5 (Extremely engaged)

Q2: How useful did you find Canvas for this module?

- 1 (Not useful at all)
- 2 (Slightly useful)
- 3 (Moderately useful)
- 4 (Very useful)
- 5 (Extremely useful)

Q3: How useful did you find MyLab Math for this module?

- 1 (Not useful at all)
- 2 (Slightly useful)
- 3 (Moderately useful)
- 4 (Very useful)
- 5 (Extremely useful)

Q4: How clear were the instructional materials and resources provided?

- 1 (Not clear at all)
- 2 (Slightly clear)
- 3 (Moderately clear)
- 4 (Very clear)
- 5 (Extremely clear)

Q5: How confident do you feel about your understanding of the topics covered this week?

- 1 (Not confident at all)
- 2 (Slightly confident)
- 3 (Moderately confident)
- 4 (Very confident)
- 5 (Extremely confident)

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Q6: How likely are you to use the digital tools and resources provided (e.g., lecture videos recorded in Canvas, MyLab Math) in future modules?

- 1 (Not likely at all)
- 2 (Slightly likely)
- 3 (Moderately likely)
- 4 (Very likely)
- 5 (Extremely likely)

Open-Ended Questions for Regular Module Weeks:

Q7: What aspects of the digital tools (Canvas, MyLab Math) did you find most helpful in this week's module? Please explain why.

Q8: Were there any challenges you faced with the digital tools or course materials this week? How did you address them, or what support would have helped?

[Appendix B.](#)

Likert Scale Survey for Exam Weeks

Q1: How prepared did you feel for this exam?

- 1 (Not prepared at all)
- 2 (Slightly prepared)
- 3 (Moderately prepared)
- 4 (Very prepared)
- 5 (Extremely prepared)

Q2: How helpful were the review materials and resources in preparing for this exam?

- 1 (Not helpful at all)
- 2 (Slightly helpful)
- 3 (Moderately helpful)
- 4 (Very helpful)
- 5 (Extremely helpful)

Q3: How effectively did Canvas support your exam preparation?

- 1 (Not effective at all)
- 2 (Slightly effective)
- 3 (Moderately effective)
- 4 (Very effective)
- 5 (Extremely effective)

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

Q4: How effectively did MyLab Math support your exam preparation?

- 1 (Not effective at all)
- 2 (Slightly effective)
- 3 (Moderately effective)
- 4 (Very effective)
- 5 (Extremely effective)

Q5: How clear were the exam instructions and questions?

- 1 (Not clear at all)
- 2 (Slightly clear)
- 3 (Moderately clear)
- 4 (Very clear)
- 5 (Extremely clear)

Q6: How likely are you to seek additional support (e.g., tutor sessions) based on your exam experience?

- 1 (Not likely at all)
- 2 (Slightly likely)
- 3 (Moderately likely)
- 4 (Very likely)
- 5 (Extremely likely)

Open-Ended Questions for Exam Weeks

Q7: What specific resources or strategies did you find most helpful in preparing for this exam? Please elaborate on why they were effective.

Q8: Were there any difficulties you encountered during your exam preparation? How could the provided resources or support be improved to help you better prepare for future exams?

[Appendix C. Semi-structured interview questions \(if exists\)](#)

[Appendix D. Researcher field notes schema \(if exists\)](#)

[Appendix E. Researcher checklist \(if exists\)](#)

[Appendix F. Other documents \(if needed\)](#)

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.

This framework in part comes from Ravitch, Sharon M.; Carl, Nicole C. Mittenfelner (2015-09-16). Qualitative Research: Bridging the Conceptual, Theoretical, and Methodological (p. 50). SAGE Publications. Kindle Edition Some comes from Dr. Scott Warren's experience and is original, so avoid lifting parts without attribution.