Journal of Inclusive Methodology and Technology in Learning and Teaching
ISSN 2785-5104
Anno4 n.2(2024)

Taking Care Of Training For Special Education Teachers Through A Flipped Learning Approach

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Abstract: Flipped learning, a widely used pedagogical strategy, lacks extensive research regarding its efficacy in the context of preparing special education teachers. Candidates in special education participated actively in interactive, flipped learning sessions prior to attending classes for a specialized math methods course. During class, they engaged in lesson planning and additional activities. The researchers employed various research methodologies to evaluate the effectiveness of these learning sessions on student performance and engagement. Their findings revealed positive correlations between student achievement and the flipped lessons across all assessment tasks. The vast majority of students acknowledged the benefits of flipped learning in assisting them in attaining the course objectives. Students largely credited their academic progress to the flipped lessons, as they provided them with the opportunity to interact with course materials at their own pace and utilize class time for more substantial review and extension activities under the guidance of the instructor.

Keywords: Flipped Learning, Special Education, Teacher Preparation, Engagement, Active Learning.

1. Introduction

For decades, students in higher education sectors have engaged in blended learning environments where they learn content outside the classroom (i.e., through reading text or watching videos) and reinforce or extend that content within the classroom through discussion or activities (Ent, 2016). This approach to teaching is also known as *flipped learning*, defined by the Flipped Learning Network (2014): Flipped learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guided students as they apply concepts and engage creatively in the subject matter. Flipped learning includes four pillars: F (flexible environment); L (learning culture); I (intentional content); and P (professional educator), which guide the instructor. Throughout all of these pillars, the teacher must be reflective and flexible in their practice to support diverse learning needs. By moving direct instruction outside the classroom, the classroom becomes a more student-centered environment with rich opportunities for learning. While flipped learning does not require the use of technology, there are many tools on the market that can help facilitate this approach in the college classroom. In the present study, we explore how student engagement with flipped video content impacts the learning of pre-service special education teachers. There is an emerging body of literature exploring the benefits of flipped learning. Much of this research is perceptions-based and/or focuses on different strategies to successfully implement flipped learning (Corona & De Giuseppe, 2016; DeLozier & Rhodes, 2016; Jenkins et al., 2017; Milman, 2012; Song, Jong, Chang, & Chen, 2017). In one study, student questionnaire responses indicated flipped learning promoted student involvement, self-efficacy, and self-directed learning (Chyr, Shen, Chiang, Lin, & Tsai, 2017). In a teacher preparation course, student- reported benefits of flipped learning included increased motivation and enthusiasm for content and more student-to-student interaction during the in-class activities (Graziano, 2017). Pedagogically, flipped learning allows instructors to differentiate instruction by providing self- paced lessons for mastery learning with immediate feedback and increased opportunities for discourse, collaboration, and cooperative learning (Altemueller & Lindquist, 2017).

Though perceptions of flipped learning are often positive, few researchers have actually measured academic achievement in a flipped learning environment (Altemueller & Lindquist, 2017). Gopalan and Klann (2017) compared a combination of flipped learning and modified team-based learning with more traditional lecture-based instruction. These researchers found the flipped learning group had higher exam scores. Similarly, Al- Zahrani (2015) conducted a quasi- experimental group design comparing a lecture-based class to a flipped classroom and found significant differences in measures of students' creative thinking on a final assessment in favor of the flipped classroom structure. In both of the aforementioned studies, the researchers' in-class activities for flipped learning consisted of extensive peer-peer interaction, while the in-class activities in the control groups were predominantly lecture-based. It presents a challenge to ascertain whether the educational advantages were primarily associated with the flipped content, the in-class activities, or a synergistic combination of both.

DeLozier and Rhodes (2016) suggest learning outcomes in any teaching structure are most impacted by the cognitive processes of the learner.

The authors present a persuasive argument advocating for a more targeted approach to researching flipped learning. They suggest that the focus should be on specific instructional components such as video lectures, quizzing games, and student-led discussions, rather than the entire flipped structure. By doing so, researchers can gain a better understanding of which practices result in academic gains. The existing body of literature on flipped learning in higher education shows promise; however, there is a need for further research that establishes a connection between flipped learning and learning outcomes. This need is especially noted in classrooms for teacher preparation programs (Graziano, 2017). In our search, we did not find any studies examining the impact of flipped learning on achievement in special education teacher preparation courses in Italy (our research context). The purpose of this study is to explore how engagement with flipped video content impacts student learning. Our research extends the existing body of literature by connecting learner perceptions to academic outcomes associated with flipped learning within an unexplored area – special education teacher preparation. The subsequent inquiries steered our investigation:

- To what degree does the involvement with flipped learning videos correspond to the exhibition of mathematical knowledge for teaching by special education teacher candidates?
- How do special education teacher candidates perceive the efficacy of flipped learning in a math methods course for undergraduate special education students?

2. Research Structure: Methodology, Participants, Context, Analysis of Variables and Activities

We have taken a pragmatic approach to this research, electing to utilize multiple methods for collecting, analyzing, and interpreting our data. Specifically, we utilized a partially-mixed parallel convergent design (Creswell & Plano Clark, 2017) with qualitative and quantitative results mixed during the interpretation stage of the research after conducting separate qualitative and quantitative analyses. A pragmatic approach allows the freedom to select methods that are the best fit for each research question (Felizer, 2010), acknowledging that the combination of qualitative and quantitative approaches mitigates some of the limitations and provides a better understanding of the problem than either approach alone.

Participants were recruited over two semesters from five sections of an undergraduate special education mathematics methods course at a large Italian public university. Of the 106 total students enrolled in these sections, 88 students (83%) agreed to participate. Typical of population demographics for special education majors at our institution, our participants were primarily female (89%).

We employed video "educational modules" as an integral component of a flipped learning framework - an instructional methodology that incorporates the direct dissemination of content outside of the classroom, in order to optimize engagement with the material during in-class sessions under the guidance of an expert (i.e., the instructor). The learning modules were developed as a substitute for the original course textbook. Feedback obtained from students in previous semesters indicated that they either did not read the textbook or encountered challenges in comprehending the mathematical approaches presented in textual format. Other reasons for flipping the course included the need for more time to apply content through lesson planning with the additional factors for flipping the course encompassed the requirement for more time to implement content via lesson planning under the guidance of the instructor, and to offer personalized assistance during group activities to teach and reinforce collaborative work habits. To manage the individual learning space, we utilized a free tool, EDpuzzle (EDpuzzle Inc., 2019), to post video learning lessons with embedded questions and prompts. The quantity of embedded cues varied based on the content and duration of the video. On average, each video contained 2.5 multiple-choice questions (range = 0-10) and 4.4 open answer responses (range = 0-9). Additionally, seven math-focused lessons included accompanying worksheets to facilitate individual practice, which necessitated students to demonstrate their calculations or create mathematical representations. To incorporate these prompts, we utilized the comments feature in EDpuzzle, which allowed us to pause the video and direct students to specific questions on the worksheet. EDpuzzle possesses built-in accountability features that enable instructors to monitor students' video watching habits, review their responses to questions/prompts, and track the number of times they re-watched specific segments. Another advantage of this tool is its ability to enhance engagement by preventing students from fast forwarding through the video and automatically pausing the video if they attempt to navigate away from the webpage. While student accuracy on the embedded questions and prompts was not utilized for summative assessment in the course, the completion of the learning lessons constituted 15% of their final course grade, serving as an additional measure of accountability. We designed learning lessons utilizing principles of Mayer's (2009) cognitive theory of multimedia learning, which builds off existing cognitive theories for learning to address how people learn with a combination of words, text, and narration. Researchers have found videos created using these principles, known as Content Acquisition Podcasts (CAPs), to be effective in developing foundational knowledge of special education teacher candidates in areas such as early literacy (Carlisle, Newman Thomas, & McCathren, 2016) and positive behavior supports (Kennedy & Newman Thomas, 2012). The 25 video learning lessons utilized in this study adhered to the principles of multimedia learning, much like CAPs. However, these lessons possessed greater breadth of content and thus, were longer in duration (with a median length of 12 minutes and a range of 5 to 26 minutes). Additionally, these lessons incorporated embedded questions and prompts to aid students in their individual learning process. Multiple choice questions integrated into the videos were automatically graded, providing immediate feedback to students as they watched. Although embedded open-answer questions were not automatically graded, instructors included qualitative feedback that was displayed to students upon submission of their responses.

With our first research question, we explored how engagement with flipped learning videos relates to special education teacher candidates' demonstration of mathematical knowledge for teaching. We utilized quantitative data sources to run a series of simultaneous multiple regression analyses within SPSS to determine if engagement habits with the flipped videos predicted student achievement as measured by performance on five different summative assessments aligned with the course outcomes.

As regards the independent variables of our research scheme, the subsequent variables were assessed through the process of replicating information collected within the EDpuzzle platform into a spreadsheet.

Word count: the summative total of words written on open-answer questions integrated throughout all 25 learning lessons was determined. These questions primarily encouraged reflection or necessitated an explanation of mathematical reasoning. This measure was utilized as an estimation of the duration of engagement, with the assumption that students who wrote more would have spent a greater amount of time interacting with the video content.

Accuracy: the cumulative accuracy of multiple-choice questions in various learning lessons, determined by dividing the total number of correct answers by the total number of attempted questions, was used as an approximation of the quality of student engagement. It was assumed that students who paid more attention to the video would have higher accuracy on the questions directly related to the video.

In the multiple regression analysis, these two variables were initially entered together as a group to evaluate their impact on each outcome variable. If either variable did not significantly contribute to the model, it was removed and a simple regression analysis was conducted using only the contributing variable.

From the perspective of the analysis of the dependent variables of our research, we initially took into account that in the mathematics methods course, there were a total of five distinct summative assignments that were aligned with the course outcomes. In order to ensure uniformity, all of these assessments were evaluated using meticulous rubrics. After the conclusion of the semester, a sample of 10% from each of the aforementioned five assignments were regraded and scrutinized to confirm their reliability. We thoroughly examined any minor inconsistencies within the sub-scores and ultimately reached a unanimous consensus on the overall scores.

Reflection on an Explicit Instruction Video: The teacher candidates designed an explicit instruction lesson and taught it in a virtual learning classroom, which was recorded on video for the purpose of reflection. They utilized video tagging software, which provided reflective prompts aligned with course outcomes, to identify the strengths and areas of improvement in their instruction.

Midterm Application Exam: Teacher candidates completed an open-answer take-home exam that included application questions related to the domains of math knowledge and pedagogical knowledge.

Lesson Observation Reflective Report: Prospective educators observed a mathematics lesson in a K-12 classroom that included at least one student with an Individualized Education Program (IEP). Utilizing a visual tool for recording information, they submitted a written reflective report about their observations and the alignment between what they witnessed and the mathematical knowledge for teaching they acquired throughout the course.

Co-Teaching Video Reflection: Teacher candidates designed a co- taught lesson on a mathematical topic of their choice and were video recorded when they taught it to their peers during class. They utilized video tagging software (given reflective prompts aligned to course outcomes) to identify strengths and areas of improvement related to their instruction.

Final Application Exam: Teacher candidates completed an open- answer take-home exam that included application problems focused on math strategies and pedagogy.

Given the sample size and the exploratory nature of this study, we opted to conduct separate multiple regression analyses instead of employing a single multivariate regression analysis. This approach also facilitated our investigation into the specific summative assignments that may have been influenced by engagement with the learning lessons. To address the second research inquiry, which pertains to the perspectives of special education teacher candidates regarding the efficacy of flipped learning in an undergraduate special education math methods course, an examination of two unidentified sources of teacher candidate feedback was conducted. One of these sources consisted of a midterm feedback survey, in which teacher candidates were requested to provide responses to a series of open-ended questions: (a) *What specific aspects of the course/instruction have FACILITATED the development of your knowledge and skills in providing math instruction to students with disabilities?*; and (b) *What specific aspects of the course/instruction have been a BARRIER to the development of your knowledge and skills in providing math instruction to students with disabilities?* On this survey, we did not explicitly ask about the flipped learning structure or videos because we wanted to see if any teacher candidates would bring this up on their own. A second feedback source was an end of course survey asking candidates to rate the helpfulness of the flipped "learning lesson" videos on a Likert-scale of 1-5 (1 = not helpful; 5 - extremely helpful) followed by an open answer prompt asking students to describe the most effective aspects of the learning lessons and add any additional feedback about the flipped learning structure. We summarized descriptive results from the Likert-scale ratings and utilized open coding and axial coding (Strauss & Corbin, 1999) to identify themes and sub-themes from the open answer responses.

3. Results

Our analyses have unveiled a predominantly advantageous effect of a flipped structure on the acquisition and exhibition of mathematical pedagogical knowledge by teacher candidates. Teacher candidates' descriptive and qualitative data have furnished valuable insights that enhance our comprehension of the consequences inferred from our regression analyses.

We performed simultaneous multiple linear regressions in order to forecast academic achievement for each of the five summative course assignments based on cumulative accuracy and word count, which are measures of engagement, for the learning lesson videos. Prior to executing the regressions, we analyzed our data to: (a) exclude any outliers, which are data points that exceed 1.5 times the interquartile range from the mean; (b) verify that our residuals exhibited a normal distribution; and (c) assess whether there was any multicollinearity between the two independent variables. Descriptive statistics for all variables can be found in Table 1.

Table 1. Descriptive statistics for independent variables

Variable	*N*	Min	Max	*M*	*SD*
Word count	88	624	4681	2315.45	735.74
Accuracy	88	72.92	97.48	89.63	4.16
Explicit Instruction Video Reflection*	86	22.50	30.00	27.97	1.75
Midterm*	83	14.50	25.00	20.85	2.45
Lesson Observation Report*	87	33.00	40.00	37.09	1.75
Co-Teaching Video Reflection*	86	22.50	30.00	27.49	1.78
Final Exam*	86	34.00	49.50	43.60	3.97

* dependent variables with outliers removed

The results of the multiple regression analysis indicated that only accuracy was a significant predictor of performance for the outcome variable, Explicit Instruction Reflection. Therefore, a simple linear regression analysis was conducted to examine the relationship between learning lesson accuracy and achievement on this summative assignment (Table 2). The results of the regression analysis were found to be significant, F(1, 84) = 18.58, p < .001, with an R2 of .181. On average, a one percentage point increase in overall accuracy on the learning lessons was associated with an increase of .18 points (out of 30) on this assignment. Accuracy accounted for approximately 18% of the variance in scores. Similarly, for two other summative assignments, the results of the multiple regression analysis indicated that only accuracy was a significant predictor.

Accuracy predicted performance on the *Observation Report*, $F(1, 85) = 16.50$, $p < .001$, with an R^2 of .163 (explaining about 16% of the variance). A one percent increase in accuracy generally produced an increase of

points (out of 40) on this assignment. Accuracy was also a significant predictor for performance on the *Final Exam*, $F(1, 84) = 12.10$, $p = .001$, with an R^2 of .126

(explaining about 13% of the variance). For this assignment, an increase of one percent on accuracy resulted in an increase of .34 points (out of 50) on average.

For the other two assignments, multiple regression results indicate the combination of word count and accuracy positively predicted performance. For the outcome variable, *Midterm*, both accuracy and word count significantly predicted performance on the assessment, F(2, 80) = 21.85, $p < .001$, with an R^2 of .353. On average, for every percentage point increase in overall accuracy on the learning lessons, there was an increase of .24 points (out of 25) on the midterm, and for every additional word written, there was an increase of .001 points. Accuracy and Word Count together accounted for about 35% of the score variance on this assignment. The combination of accuracy and word count predicted achievement on the final summative assessment, *Co-teaching Lesson Reflection*, as well, F(2, 83) = 10.05, $p < .001$, with an R^2 of .195. On average, a one-point increase in overall accuracy resulted in a

.10-point increase (out of 30) on the assignment, and for every additional word written there was a .001-point increase.

These variables together account for approximately 20% of the variance on this assignment.

Table 2. Results of the simple and multiple regression analysis by dependent variable

Models by Variable	*F*	*Df*	*p*	R^2	*t*	*p*	*B*
EI Video Reflection							
Overall model	18.58	1, 84	<.001	.181			
Accuracy					4.31	<.001	.179
Midterm							
Overall model	21.85	2, 80	<.001	.353			
Word count					2.60	.011	.001
Accuracy					3.89	<.001	.236
Lesson Observation Report							
Overall model	16.50	1, 85	<.001	.163			
Accuracy					4.06	<.001	.169
Co-Teaching Video Reflection							
Overall model	10.05	2, 83	<.001	.195			
Word count					2.45	.016	.001
Accuracy					1.99	.050	.098
Final Exam							
Overall model	12.10	1, 84	.001	.126			
Accuracy					3.48	.001	.339

For the second research inquiry, we endeavored to gain a better comprehension of the specific components of the flipped videos, or any other elements of the course, that may have played a role in promoting the advancement of mathematical knowledge for teaching. To achieve this, we meticulously analyzed the feedback provided by students on the optional midterm and final course surveys. Out of the pool of participants, a total of fifty students responded to the first open-ended question on the midterm feedback, which inquired about the factors that facilitated their learning in the course. Interestingly, although we did not explicitly mention flipped learning in the formulation of the question, all fifty responses highlighted flipped learning as a significant facilitator. One student stated: "*The structure* of *the class has facilitated the development of my knowledge and skills because before class I am able to learn the content, then at the beginning of class with the entrance tickets I get immediate feedback of what I know and what I don't know and then in class we review and that helps me to understand more deeply and gives me the opportunity to ask questions".*

Another wrote: *The learning lessons offer tremendous assistance. I appreciate the presence of embedded questions, which greatly facilitate the identification of essential information. In the event of confusion, I possess the capability to revisit and re-listen to the particular segment, thereby enhancing comprehension. Moreover, the class discussions prove invaluable, as they serve as a comprehensive debriefing session.*

The learning lessons provide a wealth of knowledge, and the combination of your lecture, classroom activities, and discussions effectively consolidates understanding.

Students responses about flipped learning tended to acknowledge both the videos and the in-class activities as facilitators of their learning.

On the Likert-scale survey at the end of the semester, 73 of the 77 responders (95%) rated the videos as *helpful* (n = 14) or *extremely helpful* (n = 59). Two students (3%) rated the videos as *neutral*, and two students rated them as *somewhat not helpful*. No students rated the learning lessons as *not helpful*. Student responses on the open answer questions on the midterm and final surveys gave some insight into which aspects of flipped instruction they perceived as most effective in facilitating their learning of course outcomes. Of the 108 total comments across survey questions that mentioned flipped learning, 25 responses (23%) mentioned out of class activities that went along with the learning lesson videos. Most of these (19%) mentioned the worksheets that went with the math strategy videos. Four responses also mentioned the PDF notes pages (slide images from the video with lines to take notes), which were posted for all 25 videos. Additionally, 26% of responses to open answer questions mentioned specific features of *EDpuzzle* as a facilitator of their learning. Embedded questions as checks for understanding (11%) and the ability to pause and re-watch sections of the video to work at their own pace (11%) were the most commonly liked features. Students also mentioned how the platform was easy to use and that they liked how there were mechanisms built into the program that would pause the video if they tried to multi- task with another internet tab.

Teacher candidates also commented on the in-class aspect of flipped learning on the surveys. Most of these students (40%) described the combination of the videos with the in-class activities (i.e., the entire flipped learning structure) as a facilitator of their learning. One student wrote, "I believe that I get more out of this class because the class time is spent discussing and collaborating with my peers." Another student commented on the benefits of multiple perspectives during class: *I think being able to discuss the concepts with our group members at our table is also very helpful because we get to hear* *another person's perspective if we are not understanding the "teacher language" - they might have it understood in simpler terms.*

The most commonly reported activities observed in the classroom by students included engaging in class discussions, participating in group work, playing review games and activities, and seeking clarification from the instructor regarding the course content. While the majority of student feedback regarding flipped learning was positive, there were some criticisms. Out of the seven responses received for the midterm question on barriers to learning, six mentioned some aspect of flipped learning as a barrier (the other barrier was the difficulty and volume of course content). Furthermore, when asked about the helpfulness of the learning lessons at the end of the semester, seven responses provided suggestions or considerations to enhance the flipped learning experience. Three teacher candidates mentioned that they just do not like the idea of a flipped learning structure without giving any rationale other than preference. The most useful responses criticizing flipped learning in the course were the ones that provided rationales for any barriers presented. Two such responses indicated some frustration for having to wait to have questions answered until class time, two indicated some of the learning lessons were too long, and one mentioned there were not enough examples in the videos. The last comment is contrary to what many other teacher candidates described. It is also important to note, most students who described barriers to the flipped videos or structure, noted facilitators as well. Solely critical feedback represented less than 5% of the total responses.

4. Discussion

Flipping some aspect of a higher education course is not a new idea (Ent, 2016). Many professors assign readings, videos, or other activities for students to prepare for class. The course in the present study is unique in that all of the direct instruction is flipped and the video learning lessons use a research-based framework (i.e., Multimedia Learning; Mayer, 2009) to carefully craft the lectures in a way that enhances the cognitive aspects of learning. Our quantitative analysis focused on the impact of the out-of-class learning lessons on demonstration of course outcomes. The student feedback indicates a convergence of our quantitative and qualitative data sources – students noted the academic benefit of the learning lessons and their engagement on those learning lessons predicted achievement. Our regression models indicate teacher candidate engagement with learning lessons only accounted for between 15-35% of performance on summative assignments though, so clearly additional factors contributed to their learning.

The distributions of scores for all course assignments exhibited a negative skew, owing to the fact that students tended to perform well on said assignments. Consequently, we were uncertain as to whether a significant predictive relationship between video engagement and achievement would be discovered. In the case of two assignments, achievement was significantly predicted by word count and accuracy, while in the case of three assignments, only accuracy was found to predict achievement. Though the R^2 values were fairly small, our results indicate increased engagement with the video learning lessons did impact student learning. This is somewhat contrary to the supposition of DeLozier and Rhodes (2016) who suggest video instruction is not responsible for student learning. Nonetheless, engagement with the videos is likely not the only factor that contributes to achievement. Qualitative information gathered from the experiences of special education teacher candidates provides us with insights about other instructional factors that may have contributed to their learning.

One of the pillars of flipped learning (Flipped Learning Network, 2014) is *intentional content* – the instructor must decide what content should be taught directly and what content students should explore on their own. Once decided, the instructor either needs to find or create that content. As DeLozier and Rhodes (2016) and Zhou (2023) suggest, flipped learning involves more than assigning videos to view outside of class; we must also consider the way in which content is presented and the learner's cognitive engagement with the task. The learning lessons used for our course leverage multimedia learning principles (e.g., energetic and conversational narration, signaling and image builds to illustrate mathematical strategies; Mayer, 2009) and elements of explicit instruction (e.g., modeling, scaffolding, visual representations, opportunities to respond with immediate feedback; Archer & Hughes, 2011) to engage learners' cognitive processes as they are prompted to reflect and think deeply about the content. In their open- answer responses, students specifically commented on the quality of presentation of the content and the incorporated explicit instruction elements as a facilitator of their learning. Though our learning lessons were effective in their current form, we recommend instructors review flipped content periodically to catch errors, reduce length, evaluate for inclusion of new research, or to include clearer examples.

Before we flipped this course, students read the textbook for background knowledge before coming to class to do the practice activities. These activities are now embedded within our learning lessons. Our original (i.e., non-flipped) approach reduced the time allotted for collaborative work during class and it also lacked an element of accountability and formative assessment because instructors had no way of monitoring individual student work outside of classroom. There are a variety of tools on the market to implement flipped content that address the barriers of more traditional structures. We selected *EDpuzzle* specifically because of features that allow us to easily skim through student responses to gauge their understanding to help guide and differentiate our in-class activities. We used the gradebook feature in the platform as an additional accountability measure to verify teacher candidates watched and responded to embedded questions in the video on time. Regardless of the tool selected, instructors should ensure students have sufficient understanding of their expectations and of the tool functionality.

In-class activities. Given the students' feedback on the midterm and final course surveys, engagement within the in-class extension activities is likely another factor that contributed to academic gains on the course outcomes. Teacher candidates specifically mentioned review games, discussions, group work, hands-on activities, and the ability to have questions answered in class as helping solidify their understanding of the content from the flipped videos. In-class engagement is also likely to be related to out-of-class engagement because the extension activities are planned so they build off the explicit instruction from the video. This type of engagement is harder to measure, particularly for collaborative activities, however, our qualitative data collected from students in our course suggest these activities may contribute to the learning process as well. We are currently brainstorming ways to collect data about performance on specific in-class extension activities to include measures of in-class engagement as in independent variable in a future regression model.

Within-student factors. Other factors that likely contribute to performance on course assignments may have more to do with skills and characteristics of the learner than with the teacher's instruction. Self-regulated learning plays a significant role in how students attend to both in and out of class activities for flipped learning (Sun, Xie, & Anderman, 2017). This type of learning requires self-motivation and good work habits. In a study by Fisher, Ross, LaFerriere, and Maritz (2017), students themselves recognized the need for a self-directed approach to learning so they did not fall behind on the content. Finally, given the well-established impact of math knowledge, confidence, and self-efficacy on achievement (Pajares & Kranzler, 1995), these individual student factors are also likely to impact teacher candidate performance on these summative assignments, regardless of the quality of the instruction. Individual factors such as these should also be considered in a future regression model.

5. Conclusion

The results of our study echo the benefits noted by other researchers of flipped learning in higher education coursework including increased motivation, engagement, and perceived learning (Altemueller & Lindquist, 2017; Ianniello et al, 2023) and increased opportunities for active learning (DeLozier & Rhodes, 2016). In the realm of special education teacher preparation courses, the significance of these benefits cannot be understated. Students in these courses require dedicated class time to cultivate performance-based skills in teaching, all the while receiving expert feedback. Additionally, they must also acquire knowledge that is specific to the content they are teaching. Our extensive findings and experience have led us to propose several recommendations for the implementation of these benefits in other teacher preparation courses. One notable recommendation involves the utilization of technology tools to ensure accountability and engagement in flipped learning. A prime example of such a tool is EDpuzzle. This particular tool enabled professors to hold students responsible for their learning outside of the classroom. By requiring students to respond to questions and document their completion of videos, their performance in these activities contributed towards their overall course grade. Moreover, this tool fostered engagement among students by incorporating various interactive elements such as open-ended and multiple-choice questions, as well as the inclusion of embedded links and worksheets within the learning modules. Additional recommendations for flipped learning include taking time to record quality videos that utilize elements of explicit instruction (Archer & Hughes, 2011) and research-supported multimedia principles (Mayer, 2009) to address the cognitive demands of learning. The video length is another important consideration. Students within our study mentioned longer videos were less engaging. We therefore recommend keeping videos as concise as possible, remembering that the longer the video, the more embedded questions and opportunities to reflect should be included to maintain the learners' attention. Finally, instructors should build a climate of self- directed learning. We started the semester by explaining a rationale for using flipped learning and provided multiple opportunities for self-monitoring and reflection on their learning throughout the semester. Flipped learning benefited teacher candidates within our mathematics special education teacher preparation course. Students in this course differentiated foundational knowledge based on their own individual needs allowing the instructor to review, clarify, and expand upon concepts learned within the learning modules, which is the premise behind flipped learning (Ent, 2016). The instructor was able to address common misconceptions among the group during class time and any individual difficulties with the content could be addressed during office hours. This structure allowed class time to be used for lesson planning and opportunities to practice teaching with instructor and peer feedback. In teacher preparation programs, course content needs to be aligned with state standards for teacher licensure, so consistency across course sections is essential. Given our success with this model, in our department, flipped video learning lessons have become the curriculum that all instructors of this course share, which provides instructional consistency for the foundational content knowledge needed for student success in future semesters and in their teaching careers.

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