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Implementing a Flipped Learning Approach With TPACK in Grades 6 to 9

Mise en œuvre d'une approche d'apprentissage inversée avec TPACK de la 6e à la 9e année

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Abstract

In this design-based study, a flipped learning approach using audio-visual resources as prelearning activities was examined in grades 6, 7, and 9 with four teachers and 65 students over one school year. The purpose of this study was to explore the implementation of a technology-enhanced pedagogy in science, math, and social studies. The implementation was sequenced to provide students who were also learning the English language with an opportunity to practice engaging with curriculum concepts through viewing prelearning videos with language tailored by the teacher and with embedded questions, prior to in-classroom learning activities. The technological, pedagogical, and content knowledge (TPACK) framework was used to inform the instructional design for the flipped learning activities. Monthly teacher-researcher professional learning sessions were held, and data were gathered from teachers' reflections and a student survey. Results indicated that teachers had more class time to support students with enrichment, remediation, small group work, and active learning. Students reported that the prelearning video activities benefited their learning and complemented in-class learning activities. This study serves to inform teachers and schools considering implementation of flipped learning to support students' understanding of content knowledge and English language learning, and researchers studying designs using flipped learning sequences.

Keywords: design-based research, flipped learning, technology-enhanced learning, TPACK

Résumé

Cette étude basée sur une approche d'apprentissage inversé utilise des ressources audiovisuelles comme activités de préapprentissage. Soixante-cinq élèves des classes de 6^{e}, 7e et 9e années et accompagnées de quatre enseignants ont participé à cette expérience. L'objectif de cette étude était d'explorer l'introduction d'une pédagogie enrichie par la technologie dans les domaines des sciences, des mathématiques et des études sociales. La mise en œuvre a été séquencée afin d'offrir aux étudiants qui apprenaient l'anglais l'occasion d'interagir en suivant les concepts du programme scolaire en visionnant des vidéos dont le langage avait été adapté par l'enseignant et qui contenaient des questions intégrées. Il est important de noter que cela se faisait avant les activités d'apprentissage en classe. Le cadre de connaissance technologique, pédagogique et de contenu (TPACK) a été utilisé pour informer la conception pédagogique des activités d'apprentissage inversé. Des sessions mensuelles de formation professionnelle pour les enseignants-chercheurs ont été organisées, et des données ont été recueillies à partir des réflexions des enseignants et d'une enquête auprès des élèves. Les résultats ont indiqué que les enseignants disposaient plus de temps en classe pour soutenir les élèves en matière d'enrichissement, la remédiation, le travail en petits groupes et d'apprentissage actif. Les élèves ont rapporté que les activités de vidéos de préapprentissage leur avaient été bénéfiques et avaient complété les activités d'apprentissage en classe. Cette étude sert à informer les enseignants et les écoles qui envisagent de mettre en œuvre l'apprentissage inversé pour aider les élèves à comprendre la connaissance du contenu et l'apprentissage de l'anglais, ainsi que les chercheurs qui étudient les modèles utilisant des séquences d'apprentissage inversé.

Mots-clés : apprentissage inversé, apprentissage amélioré par la technologie, recherche basée sur la conception, TPACK

Introduction

Flipped learning is a pedagogical approach that integrates technology through prelearning designed to be completed independently by students outside of class time, leveraging video and other mediums, followed by learning activities completed during class time (Brown et al., 2022; Mazur et al., 2015). In this study, flipped learning is defined as (a) out-of-class learning activities that use audio-visual materials to prepare students for classwork, followed by (b) in-class activities that involve group work and the real-world application of concepts students learned from the audio-visual materials (Lo & Hew, 2017). This definition is consistent with that provided by the Flipped Learning Network (2014), a nonprofit online community for educators interested in flipped learning practices.

Flipped learning has been documented as a beneficial approach to support student learning related to self-directedness, autonomy, and agency because of how empowered students are to learn prior to classroom activities (Chao et al., 2015; O'Flaherty & Phillips, 2015). Flipped learning has been associated with increases in English language learning as this method builds students' confidence in learning and can contribute to student achievement (Chuang et al., 2018; Graziano & Hall, 2017; Webb & Doman, 2016). Flipped learning sequences using video to introduce prelearning concepts have been shown to increase motivation, engagement, confidence, and academic achievement for students who are also learning the English language (Graziano & Hall, 2017; Pang, 2022; Webb & Doman, 2016).

Akin to how these unique designs and learning sequences can be achieved, there is increasing demand for meaningful and sustainable technology-enhanced approaches in education. There is much to be learned from examining the prelearning activities that are complementary to in-class activities in a flipped learning approach and the outcomes for students and teachers. This question guided the study: How do teachers and students perceive the implementation of flipped learning with prelearning activities followed by in-class activities?

Literature

Prelearning Activities

Flipped learning has been used across multiple disciplines in kindergarten to Grade 12 (Lee & Choi, 2019), and research has demonstrated that learners benefitted when multimedia was used for prelearning activities (Aidinopoulou & Sampson, 2017; Jong et al., 2019). Mischel (2019) noted that students assigned asynchronous video content for prelearning reported positive feedback, indicating that using videos helped them focus on the important aspects of the topic and that they were more confident of the learning after taking embedded quizzes. Students felt a higher rate of perceived learning readiness when given opportunities to view videos and engage in video lessons before in-class activities (Lee & Choi, 2019; Lo, 2017).

Slemmons et al. (2018) investigated how middle school science students responded to short (< 10 min) versus long (> 10 min) videos, using surveys and quiz results to assess. Students were divided into these two groups and received the same content. At the end of each video, students were assessed on both the content of the video and their attitude towards its length. Students watching the short videos reported a greater degree of engagement, focus, and ability to retain content compared to their peers in the long video group (Slemmons et al., 2018). Designs for prelearning activities in a flipped learning sequence could include assigning short videos for introductory knowledge with surveys or quizzes to help students focus on the topic and develop overall confidence and readiness for the subsequent in-class activities.

Viewing videos as prelearning activities enabled students to understand content, gave them a greater level of autonomy and independence (Muir, 2021; Santikarn & Wichadee, 2018), and enabled them to develop introductory knowledge (Fung, 2020). The implementation of a flipped learning approach provides students with the agency to watch videos, rewatch sections as needed, and focus on areas that need further development (Brown et al., 2022; Sun et al., 2016; Unakorn, 2015). A study by Putri et al. (2019) noted that flipped learning allowed students the opportunity to learn in their own ways and be flexible in managing their time for studying, thus increasing student responsibility for their learning process. Designs for prelearning activities in a flipped learning sequence could include flexible activities to increase autonomy, independence, and agency and prepare students for in-class activities.

In-Class Activities

Teachers need to carefully design the sequence of activities to make the in-class instruction complementary to the prelearning activities (Kinnari-Korpela, 2015; Wiese & Newton, 2013). Using a flipped learning model can help personalize student learning during in-class activities (Muir, 2021; Zupanec et al., 2022). In a study by Winter (2018), average-achieving students in Grade 6 social studies benefited from flipped learning especially when differentiated strategies were used during in-class instruction. In a study comparing traditional and flipped learning approaches in Grade 7, Al-Abdullatif (2020) found that students participating in a flipped classroom approach practiced metacognitive self-regulation learning strategies. Knowing that they would be able to ask questions during class time about their prelearning, the students felt more engaged in classes where flipped learning was used (Bond, 2019).

In a study related to conceptual understanding and competency development, Fisher et al. (2017) asserted that students had more classroom time for critical reflection because the introductory content was provided in advance of the class. Additionally, teachers were able to support a deep understanding of concepts with the in-class activities following the prelearning activities (Fisher et al., 2017). Designs for in-class activities in a flipped learning sequence could include differentiated instruction and opportunities for students to engage in critical reflection and metacognitive learning.

Increased Engagement During In-Class Activities

Putri et al. (2019) reported that the flipped learning method allowed teachers and students to participate in student-centred learning during class time and students engaged with the in-class material more readily than with traditional approaches. In mathematics, for example, researchers argued flipped classroom approaches could improve mathematics achievement (Bhagat et al., 2016; Wei et al., 2020) and provide more opportunities for students to apply their knowledge during in-class activities (Lo, 2017). Additionally, flipped learning has been shown to benefit students in science-based inquiry (Chang & Hwang, 2018), engagement in junior high mathematics (Brown et al., 2022), and active learning in social studies (Mazur et al., 2015).

Flipped learning can also increase interaction between teachers and students during class time (Jong et al., 2019). Students can foster strong connections with each other when in-class activities involve groups with the support of the students' instructor (Brown et al., 2022; Singay, 2020). These academic connections enable students to actively participate in class because of the highly engaging learning environment created with a flipped learning approach (Singay, 2020). Students have opportunities to distill their understanding of concepts being explored by engaging in group discussions with peers and asking them questions (Alfares, 2017; Taqi & Al-Nouh, 2014). Students' responses in Taqi and Al-Nouh's (2014) study reflected this sentiment, as they expressed enjoyment in working in groups with classmates, and many felt their communication skills improved as a result of group work and interactions with peers. Designs for in-class activities in a flipped learning sequence could include student-centred approaches, active learning, interactions between teachers and students, interactions among peers, group work, and opportunities for communicating with peers.

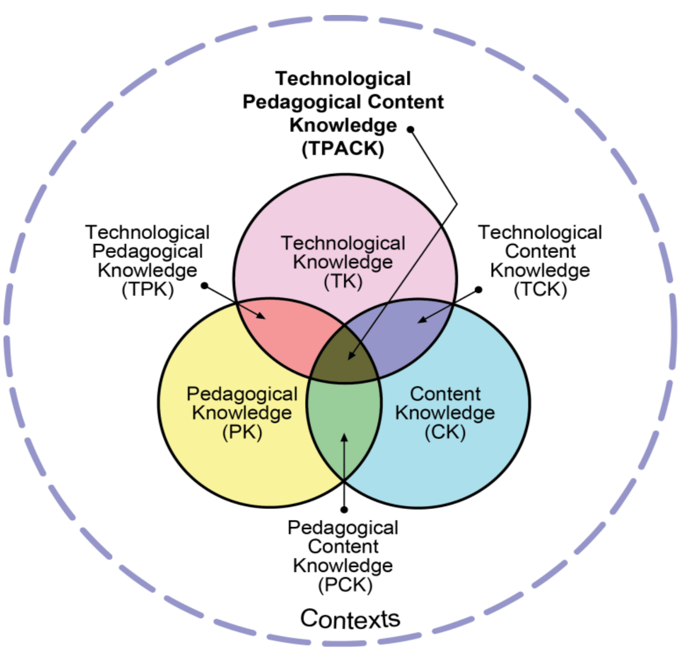
Flipped learning can provide rich opportunities for student engagement with in-class activities that are intentionally designed to follow prelearning activities, such as viewing a content video and completing an embedded practice quiz. Teachers can tailor in-class activities based on the students' engagement with prelearning activities. Overall, once flipped learning sequences are integrated as part of the class proceedings, in-class activities can be responsive to students' learning needs.

Theoretical Framework

The technological pedagogical content knowledge theoretical (TPACK) framework denotes the importance of considering multiple dimensions when designing and integrating technology-enhanced practices in a classroom in order to coalesce areas such as content, pedagogy, and technology (Voogt & McKenney, 2017). The TPACK framework (Mishra & Koehler, 2006) was used in the conceptualization of this design-based research study and informed discussions with the teachers and their reflections when using a flipped learning approach (Voogt & McKenney, 2017). The framework was used to coach and support teachers as they designed and implemented flipped learning with the intent to create more sustainable and engaging practices (Wu et al., 2022). Teachers integrated technology into their teaching by designing flipped learning sequences of prelearning activities and in-class activities with attention to the content knowledge, pedagogical knowledge, and technological knowledge needed for each sequence. The framework supported the preliminary preparation for the teachers in implementing flipped learning as well as the design adjustments made throughout the design-based research study. Using TPACK as a theoretical backdrop helped provide a consistent design frame for dialogue using the three domains and the four subdomains: pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge, as shown in Figure 1.

Figure 1

TPACK Framework



Note. TPACK = technological pedagogical content knowledge. From *Using the TPACK Image*, by M. J. Koehler, 2011 (http://matt-koehler.com/tpack2/using-the-tpack-image/). Copyright 2011 by tpack.org. Reproduced with permission.

Methodology

In this design-based research study (McKenney & Reeves, 2019), a flipped learning intervention was implemented in math, science, and social studies classes in a junior high/middle school that supports students who are learning the English language. This study included professional learning to support teachers in designing and implementing flipped learning sequences and built on an earlier study and design cycles that occurred during the pandemic in two mathematics classes (Brown et al., 2022). During the present study, classes were held at the school site, but teachers, students, and their families were familiar with using technology to access assignments outside class time. Teachers used other pedagogical practices during this timeframe as well, selecting suitable lessons for implementing a flipped learning sequence of prelearning activities followed by in-class activities.

Participants

Classes from grades 6 to 9 were involved in the study with a total of four teachers and 65 students ranging from the age of 10 to 16 years. The teachers who were all new to integrating a flipped learning approach volunteered to participate in a series of monthly literature-based reflective conversations and professional learning sessions to design prelearning activities using a flipped learning approach, that is, using a video and embedded quiz online application (Edpuzzle, https://edpuzzle.com), which linked to Google Classroom (https://classroom.google.com) and the gradebook. In these sessions, teachers worked alongside members of the research team to design flipped learning sequences of in-class activities that would follow the prelearning video and quiz activities.

Data Collection

As part of the design-based research process, teacher participants worked with the research team to determine suitable data collection methods. Data sources included the four teachers' reflections and student surveys. Teachers were invited to respond to questions such as, "How did your prelearning design inform the in-class activities?" and "What could be modified to strengthen the design?", aiding them to articulate strengths and challenges, insights about implementation, and their experiences with their classes. Students were surveyed to ascertain their perceptions of the flipped learning approach, responding to statements using a Likert scale (*4= strongly agree to 1= strongly disagree*). Students also had the opportunity to add comments or provide reasoning for their selections. The surveys were sent to 116 students, with 65 total respondents (56% response rate) across grades 6, 7, and 9 with parent consent and student assent. Teachers used the video/quiz tool in Google Classroom for students as part of the flipped learning approach. In this article, we report on the results of the surveys and the themes that arose from the teachers' reflections.

Data Analysis

For the qualitative data, content analysis was used for the teacher reflections. We created descriptive codes that represented the main ideas in the reflections and then grouped the responses into categories related to similar themes. Two members of the research team completed the initial coding of the reflections, followed by a discussion with all members of the research team. The team members conducted an additional round of coding and compared their codes to establish agreement and intercoder reliability (Miles et al., 2014). A similar process was used for coding the text-based responses from the student survey. We then used the data visualization application Tableau (https://www.tableau.com) to tabulate the data into the frequency of phrase and word responses at a scale of 10:1. This scale helped us cross-reference our own coding and content analysis with that yielded by Tableau and served as a check based on the frequency of responses. For the quantitative survey data, we used descriptive statistical analysis including the frequency and percentage to determine the levels of agreement/disagreement related to the survey questions and the relationship to the research question.

Findings

Student Responses

In the survey, 90.8% of students agreed or strongly agreed that they were satisfied with the flipped learning approach. Survey respondents agreed the videos used in the prelearning activities supported their learning. Additionally, they indicated that the videos were easy to understand, and having the opportunity to view the videos or sections in the videos multiple times was regarded as helpful by most students. Moreover, the prelearning videos and activities helped students come to class prepared with questions. In addition, 92.3% of students agreed or strongly agreed that the learning activities designed for the in-class portion of the flipped learning sequence helped their learning. Just over 15% of student respondents shared that the videos did not help them prepare for asking questions during class time. Table 1 shows the results of the student survey.

Table 1

*Student Survey Responses About Prelearning and In-Class Learning Activities (*N *= 65)*

Survey statement	Student response			
	Strongly agree *n* (%)	Agree *n* (%)	Disagree *n* (%)	Strongly disagree *n* (%)
I am satisfied with the flipped approach used in class.	17 (26.2)	42 (64.6)	5 (7.7)	1 (1.5)
The learning activities in the videos help me understand what I need to learn in class.	20 (30.8)	41 (63.1)	3 (4.6)	1 (1.5)

Survey statement	Student response			
	Strongly agree *n* (%)	Agree *n* (%)	Disagree *n* (%)	Strongly disagree *n* (%)
The learning material in the videos is easy to understand.	20 (30.8)	38 (58.5)	7 (10.8)	0 (0.0)
It is helpful for my learning to view parts of the video more than one time.	29 (44.6)	32 (49.2)	3 (4.6)	1 (1.5)
The videos help me to come to most classes prepared with questions in mind that I seek answers to.	17 (26.2)	38 (58.5)	8 (12.3)	2 (3.1)
The learning activities in the classroom help me understand what I need to learn in class.	22 (33.8)	38 (58.5)	4 (6.2)	1 (1.5)

Most survey respondents (66.2%) indicated that they were very willing or somewhat willing to ask their classmates questions in class, and 76.9% reported a willingness to ask their teacher questions about concepts in class. Most (75.4%) also reported a willingness to offer their opinions and felt comfortable communicating during whole-class discussions. Lastly, 86.1% of respondents indicated a willingness to offer their opinions and said they felt comfortable communicating in a small group discussion. Of note, 9.2% of respondents reported they were very unwilling to ask questions to the teacher or offer their opinions in class discussions. Table 2 shows the student survey results for questions about communications during in-class activities.

Table 2

*Student Survey Responses About Communication During In-Class Activities (*N *= 65)*

Survey statement	Student response			
	Strongly agree *n* (%)	Agree *n* (%)	Disagree *n* (%)	Strongly disagree *n* (%)
I ask my classmates questions in class.	15 (23.1)	28 (43.1)	18 (27.7)	4 (6.2)
I ask the teacher questions about concepts in class.	14 (21.5)	36 (55.4)	9 (13.9)	6 (9.2)
I offer my opinions and feel comfortable communicating in whole-class discussions in class.	12 (18.5)	37 (56.9)	10 (15.4)	6 (9.2)
I offer my opinions and feel comfortable communicating in small group discussions in class.	27 (41.5)	29 (44.6)	6 (9.2)	3 (4.6)

Students provided text responses to open-ended questions, noting the benefits of flipped learning and offering suggestions for improvement. The sample quotations in Table 3 illustrate student perspectives about the benefits of the flipped learning approach, which may not have been garnered from the survey alone. Themes emerged, such as the positivity with which students embraced the flipped learning approach, and this was reflected in statements highlighting how the prelearning and in-class sequences supported their learning. Some respondents also offered suggestions for improving future implementation.

Table 3

Student Survey Quotations: Benefits and Suggestions for Improvement

Student	Quotation
1	"The flip is really useful to me I understand much more when I am watching the videos."
2	"I think this was an easy way to know what experiments we are gonna do in class it helps me to understand what we will be learning."
3	"I am able to focus more when I watch videos and when I can rewatch them."
4	"I find it very helpful and I can always understand any upcoming questions."
5	"Flipped learning could be improved by making the videos shorter and also easy to understand."
6	"I would like to learn about different situations which are still happening around the world like about Palestine, Syria, Yemen and other countries which are suffering."

When using the flipped learning approach, teachers continually reflected and engaged in professional learning with the researchers to discuss ways to design their instruction with Edpuzzle and what information would support the learning sequence. Teachers also maintained a diary of reflections regarding the progress of implementation, adjustments made, and the affordances and constraints of flipped learning, and these reflections were analyzed for common themes. The following themes emerged from the analysis of the teachers' reflections on their experiences with the flipped learning approach: student-centredness, confidence, personalized support, active learning, agency, equity, and literacy.

Teacher Reflections

Student-Centredness

In their reflections, teachers noted a priority for student-centred approaches in developing technological, pedagogical, and content knowledge through designing flipped learning sequences. Student-centredness was viewed as how teachers could use instructional methods, such as the questions in the video and formative assessment segments, to create active engagement for students rather than spending time on factual recall. For example, a teacher reflected on how the prelearning video/quiz data highlighted areas of struggle for students in relation to ionic compounds. The teacher was then able to design the in-class learning activities with opportunities for students to develop a deeper understanding of ionic compounds. The teacher estimated that having access to the prelearning formative assessment data from the video/quiz activities saved time equivalent to at least one class period. The prelearning activities helped students prepare for in-class learning and also supported the teacher in gathering formative video/quiz results for how each student was engaging in the prelearning activities.

Additionally, in the prelearning for each topic area, the teachers thought about and enacted ways in which students could learn content knowledge including key vocabulary and apply them to the in-class activities, which included labs in science or using manipulatives in math-based learning sequences. The self-guided sections were scaffolded so students could understand how the prelearning connected to the learning sequence for the in-class activities to enhance students' understanding of what was being learned, how this learning related to real world contexts, and how they could engage with the material more meaningfully. One teacher noted the option to add customized quiz questions to the videos required technological knowledge so the prelearning activities could also be responsive and align with the learning sequence and in-class activities. For example, trading cards with key vocabulary (i.e., disciplinary literacy) were highlighted in the prelearning videos and then used in class to support understanding as it related to the periodic table and the chemical elements and for math concepts. Teachers' reflections across the disciplines highlighted how this approach required technological, pedagogical, and content knowledge to support a student-centred design.

Confidence

Teachers initially expressed reluctance to use the video/quiz tool for several reasons. First, many teachers had never experienced technology-enhanced teaching practices and discussed how the teaching methods they regularly used did not require technological knowledge. Second, teachers expressed an added layer of pressure to communicate information about the use of the video/quiz tool with parents and keep track of students' permission slips. Finally, teachers thought flipped learning would take more class time to teach students how to use the video/quiz tool effectively, such as demonstrating how to rewatch a video and redo assigned activities. However, as teachers became accustomed to the video/quiz tool, they noted its straightforwardness. Teachers also felt more confident with the flipped learning approach as they found relevant videos which supported the learning sequences and aligned with the content in the program of studies. One teacher noted that, despite feeling "obviously hesitant" to change their methods after six years of teaching, employing the flipped learning approach became simple and ultimately resulted in positive outcomes for students.

While it was still prevalent, the learning curve was less dramatic for students. Teachers quickly observed students' increased confidence when the flipped method was employed. This confidence manifested through students asking deeper questions, communicating their ideas more often with their teacher and classmates, and raising their hands to contribute during in-class discussions. This was especially notable in students who were previously less engaged during classes. For example, one teacher noted that three quiet students who were not particularly strong learners started whispering their answers in class, and their answers became more accurate, possibly because of rewatching videos and taking part in the prelearning activities.

Personalized Support

From a pedagogical perspective, teachers found that implementing a flipped learning approach enabled them to provide more support and accommodations for students, which included grouping students by ability. Teachers also described being able to engage with and help more students in a responsive capacity and attend to individual questions, thus personalizing students' learning. For example, one teacher said they used the embedded formative feedback from students' responses to video/quiz questions to purposefully arrange small groups during the in-class activities. Using the video/quiz features to gather information about students' learning prior to class enabled the teacher to spend more time with targeted groups of students who needed extra support. A similar sentiment was echoed by another teacher who divided students into independent study groups and pulled those who needed extra personalized support based upon the results of their prelearning video/quiz activities. Utilizing the prelearning methods at the beginning of the learning sequence provided more responsive and effective opportunities for personalization in a timely manner from the outset of the learning. By grouping students by ability, teachers reflected that they were able to differentiate and personalize learning during the in-class activities. Teachers reported several ways in which the flipped learning model gave them more time to support student learning in class, which meant that students who were struggling could be more aptly supported.

Active Learning

The prelearning formative assessments embedded in the videos provided rich data and targeted evidence of where students were at in their learning or where they experienced gaps in understanding. Teachers realized that by going over concepts in class after students had watched the video, they did not need to spend as much time providing conceptual information and that students found it easier to understand content. The video/quiz results provided teachers with insights on how to continually adapt and design responsive in-class learning activities.

Teachers speculated that student engagement in the prelearning video/quiz activities created opportunities for students to work with the content more meaningfully during the in-class activities, to expand their understanding of the concepts, themes, vocabulary, and learning processes. As a result, there was more time to design engaging learning activities during in-class time. Teachers described an increase in student engagement during in-class activities and attributed this to increased hands-on time interacting with materials. This was especially apparent during science labs conducted in-class, as students arrived with prelearning activities completed and had more opportunities to work through the final process of their experiments in class. Prior to using the flipped approach, teachers explained that they had to dedicate considerable amounts of lab time to explain the procedures and provide instructions, which left students with limited time to conduct the lab and synthesize the results of their experiments. In addition, teachers perceived that students were more capable of seeing how concepts and topics connected with the added time for experimentation.

Student Agency

Throughout the flipped learning intervention, teachers observed an increase in students' agency and ownership of their learning. *Agency* refers to the students taking more initiative and allowing their interests to guide their learning, and *ownership* refers to the appreciation, sense of autonomy and choice, and increased responsibility over one's learning. In their reflections, teachers noted that these changes in agency and ownership were not immediate and only became evident once students started to become accustomed to the flipped learning sequence. Students were able to view and engage with materials on their own time and learned the value of rewatching sections of the videos or slowing the video down. When looking at the data analytics on the video/quiz tool, teachers also noted that many students would reattempt questions to best grasp concepts, even though the assessments were only formative. Teachers reported that students seemed keen to take part in conversations about content in class and that discussions were richer when using the flipped learning approach. Where teachers would have simply told students answers to questions in, for example, social studies content areas, students seemed eager to research and would seek out information themselves.

Teachers noted that students participated more readily in classroom discussions and that students were excited to share what they learned more than when using traditional approaches. In some content areas, students were able to move their thinking, curiosity, and questioning to reflect higher levels of cognition, which one teacher shared was exemplified in the types of questions asked after the flipped learning approach had taken root. Across math and science, teachers reflected on the in-class activity design and reflected that most students were more apt to explore further from the initial prelearning provided with video/quiz activities. For example, in science, preparation for lab activities and initial simulations were provided for students before they did the actual lab in class. Many students shared that they explored more content by examining online educational resources so they could inquire about each of the labs prior to their in-class lab time.

Equitable Access

When the flipped approach was first introduced, teachers reported having concerns about students' accessibility to the tools needed to complete prelearning video/quiz activities. Given that not all students had access to technology at home, this was perceived as a constraint to adopting the flipped approach and ultimately resulted in issues concerning equity. Considerations pertaining to equitable access are imperative for all student populations, as there may be socioeconomic constraints and familial conceptions about in-class work versus homework. Teachers mitigated this limitation by providing access to technology before school started in the morning, during the lunch hour, and after school. While these strategies made the prelearning activities accessible, two teachers expressed that this solution unfortunately resulted in a disruption of the design of the learning sequences given that students were completing the video/quiz activities at varying stages and not necessarily in advance of the in-class activities. In the context of a flipped classroom, teachers recognized it was necessary to incorporate strategies that helped mitigate the issue of access to devices at home, Internet access, and making time for engaging in prelearning activities at school.

English Literacy

In their reflections, many teachers highlighted a main challenge for several students was their literacy, specifically their writing and reading skills in English. Teachers reported that at times, the wording used in the video/quiz was slightly too hard for their students to understand, but that they were able to mitigate this by either choosing specific questions or by rewording questions to include level-appropriate language. Teachers also observed that encouraging students to turn on closed captions when watching videos was beneficial for student comprehension. Another practice used by teachers to support students' literacy was to create videos which better matched in-class content or use a teacher voiceover to emphasize key terms. Overall, teachers reported that the flipped learning approach and designing learning sequences with prelearning activities with customization of the video/quiz content followed by in-class activities supported students' literacy skills and supported the development of discipline-based vocabulary and concepts.

Discussion

Drawing on one of the recommendations from an earlier flipped learning study with two mathematics classes (Brown et al., 2022), we used the TPACK framework as a design frame to help coalesce content, technology, and pedagogy during the professional learning sessions and conversations with teachers prior to and while using the flipped learning approach. The overall results from the teachers' reflections and student survey indicated both groups were satisfied with implementation of flipped learning. In this section, we discuss our interpretations of the results in response to the guiding question: How do teachers and students perceive the implementation of flipped learning with prelearning activities followed by in-class activities?

The results demonstrate the value of using a theoretical frame, such as TPACK, to design and harness flipped learning sequences with prelearning and in-class activities so that students are confident to ask questions and engage with peers during in-class activities and teachers use responsive teaching and adjust in-class activities to support and personalize students' learning. Using the TPACK framework possibly helped teachers to both work through the initial learning curve as they designed learning activities during the professional learning sessions and become more confident in designing and implementing sequences of complementary prelearning and in-class activities. After implementing flipped learning over one school year, teachers reported that they were more confident in using this approach and more apt to design prelearning activities using the video/quiz tool for conceptual instruction and in-class, student-centred, active learning activities, aligning with suggestions from the literature (Chang & Hwang, 2018; Putri et al., 2019). Students also took some time to become familiar with the approach and shared that after experiencing flipped learning, they were more comfortable communicating in smaller groups and had increased opportunities to collaborate with classmates, which further aligns with the literature (Brown et al., 2022; Singay, 2020).

Teachers perceived an increase in the amount of time that could be dedicated to in-class activities. Time was an important construct to consider as part of our interpretations, which was especially apparent when teachers shared that the use of flipped learning afforded them significant time per lesson where they would have been teaching content if they had not implemented the flipped approach. Initially, teachers were hesitant to implement flipped learning as they thought it would require an increased time commitment. However, after implementation, the teachers' reflections indicated the opposite—that using a flipped learning approach provided more in-class time. This additional time was then used either to work with students who were struggling with the content or to be more visible for the whole class as they engaged in hands-on learning activities such as science labs, small group centres, or building enrichment for students who had mastered the outcomes within the lessons. Thus, the increased classroom time that resulted from using a flipped learning approach can provide students with more time to participate in learning activities in the classroom (Putri et al., 2019).

Across the classes using flipped learning, all four teachers in this study included reflections about the positive impact of using the TPACK design frame. They reported having more time to further personalize learning and provide targeted support for students they may not have been able to engage with previously and for creating greater visibility in the learning process (e.g., student centredness, confidence, personalized support, active learning, student agency, equitable access, and English literacy). As affirmed by Jong et al. (2019), the role of the teacher as facilitator can support more efficient uses of class time and does not rely on teachers to be the bearers of knowledge.

Students perceived an increase in readiness for class, and with this advance preparation, they were able to engage more fully during in-class activities. Technology-enhanced approaches for prelearning activities such as designing flipped learning sequences create a unique learning experience for students that can increase learning readiness (Lee & Choi, 2019; Lo, 2017). In the student survey, respondents expressed that the flipped learning approach supported their learning and helped them prepare for in-class learning and become more active in their own learning across multiple classes and disciplines. Across much of the literature, group work and small group discussions with peers has been shown to be highly beneficial for students to distill their understanding (Alfares, 2017; Taqi & Al-Nouh, 2014). Students also reported they were able to assert their own agency (Brown et al., 2022; Sun et al., 2016; Unakorn, 2015) through rewatching videos and repeating quizzes, followed by engagement during in-class activities by asking questions in class (Bond, 2019).

We recognize that student engagement during in-class activities is not simply a result of implementing a flipped learning approach and could be impacted by many factors including teacher support, the quality of instruction, meaningful connections with peers, and the structure and management of the classroom setting (Pang, 2022), and more. Over 15% of survey respondents indicated that the videos did not always help them prepare for engaging in class by asking questions, and 9.2% of respondents reported they were very unwilling to ask questions or offer their opinions in class discussions, so it is important to also recognize that some students did not perceive flipped learning to result in engagement during class time. More research is needed to identify reasons why a small group of students in this study were unwilling to engage in class discussions and to help address this issue in future.

Although this study has limitations, such as the timeframe (occurring over only one school year) and the small number of teacher and student participants, the findings can be useful for teachers considering the design and implementation of flipped learning sequences. We should also note that during this study, participants were uncertain if classes would be required to move to emergency remote teaching with little notice. Similar to a study with two mathematics classes, we found the flipped learning model can be used during emergency remote teaching (Brown et al., 2022), and this may have been one of the reasons that teachers were willing to participate in the professional learning sessions and the study. In a systematic literature review building on previous empirical studies in mathematics education, Cevikbas and Kaiser (2022) also reported that flipped classroom pedagogy is a promising practice during events such as the pandemic. Science, math, and social studies teachers in our study used a flipped learning approach and described their context as a dynamic and shifting learning environment requiring teachers and students to be ready and agile for unexpected changes in the context.

Conclusion

The insights from this design-based study help illustrate the perceptions of teachers and students involved in an implementation of a flipped learning approach using audio-visual resources as prelearning activities over the course of one school year in grades 6, 7, and 9. The study aimed to explore the perceptions of teachers and students when using a flipped approach to learning using complementary prelearning and in-class activities, specifically in the subjects of science, math, and social studies. The instructional design for the flipped learning activities was informed by the principles of the TPACK framework. The implementation of this approach provided students with an opportunity to practice disciplinary concepts and the English language through tailored videos and embedded questions prior to in-classroom learning activities.

The data collected from teachers' reflections and a student survey revealed several positive outcomes. For example, teachers reported having more class time to support students with enrichment, remediation, and small group work when using the flipped learning approach and identified seven benefits in their reflections, including student-centredness, confidence, personalized support, active learning, student agency, equitable access, and English literacy. Most students expressed that the prelearning video activities enhanced their learning readiness and engagement with the in-class activities. However, there were some students who did not benefit from the prelearning activities, and this underscores the importance of examining the many factors that can impact student engagement when implementing flipped learning. A longitudinal study could provide more insights into student engagement. Overall, this study suggests that implementing a flipped learning approach holds promise in supporting students' understanding of disciplinary concepts and can support students who are also learning the English language. Its findings serve as valuable insight for teachers and schools considering the adoption of this pedagogical approach and can provide a foundation for future implementation research.

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