The Effects of Flipped Classroom Teaching Method on Science Students' Higher Order Thinking Skills, Engagement and Satisfaction

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ABSTRACT

This study employs a quasi-experimental research design to examine the impact of flipped classrooms on students' higher-order thinking skills (HOTS), engagement, and satisfaction in a science setting at a public secondary school in the Petaling Perdana district, Malaysia. The research involved two Form Four classrooms: an experimental group experiencing the flipped classroom model and a control group taught traditionally. The instruments used in the research included a HOTS paper-and-pencil test administered as a post-test assessment and 5-point Likert scale questionnaires designed to evaluate student engagement and satisfaction. The study found that students in the experimental group showed significant improvements in HOTS, engagement, and satisfaction compared to those in the traditional classroom model. Furthermore, a positive relationship between engagement and satisfaction in the flipped classroom was observed. These findings underscore the potential advantages of the flipped classroom approach for teaching and learning. By integrating face-to-face instruction with online resources, the flipped classroom encourages active student participation and fosters a more engaging learning environment. This study offers valuable insights for educators looking to develop effective flipped classroom modules and strategies, highlighting the model's ability to enhance student learning outcomes and overall educational experience. The results suggest that implementing flipped classrooms can be a viable strategy for educators seeking to address the limitations of traditional teaching methods and better support student learning in today's technologically advanced educational landscape.

Keywords: Flipped classroom; Effect; Higher order thinking skills; Engagement; Satisfaction

INTRODUCTION

In today's era of technological advancement and the proliferation of online educational resources, educational institutions are increasingly integrating technology into teaching methodologies (Harahap & Manurung, 2019). This shift marks a transition from traditional teacher-centered approaches to more student-centered learning, where students actively engage in the classroom rather than passively receiving information. Such changes address challenges in traditional classroom pacing, where some students struggle to absorb information quickly or lack the foundational knowledge to grasp new concepts easily (Alsowat, 2016). In response, scholars, educators, and policymakers have long advocated for innovative learning models, such as the flipped classroom, to address these issues (Grazzados, 2015).

The flipped classroom is a cooperative learning strategy that enhances student engagement and encourages

social constructivism, creating a more effective learning atmosphere. It leverages technology, such as tablets and smartphones, to integrate traditional and digital education (Capone et al., 2017), promoting active participation and personalized learning opportunities. In Malaysia, flipped learning aligns with the Malaysia Education Blueprint as a strategic method for implementing technology-based learning environments. Although more institutions are beginning to adopt this model to maximize student potential, as seen in recent studies (Nadarajan et al., 2023; Majid, 2024; Kiang & Yunus, 2021), Wasriep (2019) noted limited research on flipped classrooms in Malaysia, highlighting its nascent implementation. While this approach may increase engagement and communication skills, challenges such as adapting to new routines and ensuring access to technology persist.

Against this backdrop, the present study aims to investigate the effectiveness of the flipped classroom approach in high school science education in Malaysia. By examining its impact on student engagement, higher-order thinking skills, and satisfaction, this research seeks to contribute to the ongoing discourse on innovative educational methodologies and support informed decision-making in educational institutions.

PROBLEM STATEMENT

Despite the promising potential of the flipped classroom model to enhance student engagement and learning outcomes, its implementation in secondary or high schools remains underexplored and inconsistent. Research by Tague and Czocher (2016) showed that flipped classrooms increase student engagement, particularly in cooperative problem-solving. However, challenges persist, such as students' potential misunderstandings of course material connections, impacting their comprehension and integration of concepts. Meanwhile, Wessling and Roller (n.d.) found that students studying heat transfer in a flipped classroom expressed dissatisfaction with the approach, revealing that student acceptance and satisfaction can vary and may not always align with their preferences or learning styles. In the Malaysian context, the implementation of the flipped classroom in Malaysia has faced significant challenges that have hindered its effectiveness for students. Jain et al. (2023) highlighted difficulties encountered by teachers in a Malaysian international school, noting that limited training and workshops resulted in insufficient guidance, which impeded the achievement of educational goals. These findings suggest that despite the potential benefits of the flipped classroom model, its current implementation may not adequately support student learning and engagement. Concerns about students struggling to adapt to the routine of this approach (Muniandy & Ping, 2023), feeling overwhelmed by homework, and the likelihood of encountering issues related to access to technology and internet connectivity (Taspolat, et al, 2021) have also been highlighted. Uncovering and addressing issues such as these is crucial for maximizing the effectiveness of flipped classroom and ensuring equitable access to quality education. Against this backdrop, the present study aspires to furnish a meticulous, well-structured investigation, aimed at elucidating the true effectiveness of the flipped classroom approach within the domain of science education, particularly in high school settings in Malaysia.

RESEARCH OBJECTIVES

Based on the problem highlighted, this study was carried out with the following objectives in mind:

1. to compare students' Higher Order Thinking Skills in science subject between flipped classroom and traditional classroom.
2. to compare students' engagement before and after the flipped classroom.
3. to determine the level of students' satisfaction towards flipped classroom.
4. to find out if there are any relationships between students' engagement, and satisfaction towards flipped classroom.

LITERATURE REVIEW

The Flipped Classroom

The flipped classroom runs by shifting in-class content to homework and vice versa (Ali & Saberg, 2016). In a flipped classroom, students first engage with learning materials, such as pre-recorded videos, readings, and online material, outside of the classroom before coming to class. The face-to-face classroom time is then used for interactive and collaborative activities, shifted the role of instructor from being a lecturer to a facilitator and guide. This constructivist approach makes learners become active inside the classroom and benefits their academic performance, engagement, and satisfaction. Traditionally, teachers spend the whole time of their lesson just introducing basic concepts, explaining ideas, asking students to read, giving boring lectures that show the teacher 's dominant. However, in the present 21st century learning environment that emphasizes on student's ability to be independent, and to engage in thinking via exploration of ideas, using class valuable time to help students apply the knowledge they gained through online lectures and videos is paramount importance. Thus, traditional learning had been improvised by splitting into two, "at home" and "during class". The unpredicted COVID-19 forced education to be more flexible which promotes flipped classroom more even in the post-pandemic.

Students' Higher Order Thinking Skills (HOTS)

Higher Order Thinking Skills (HOTS) refers to thinking at a higher level instead of simply remembering facts or retelling something heard to others (Pratama & Retnawati, 2018). It involves cognitive processes that would allow students to apply knowledge in new situations, analyze information critically, and create new ideas or solutions. HOTS are essential for fostering a deeper understanding and preparing students for real-world challenges. The flipped classroom model promotes HOTS by engaging students with content before class through videos or readings. Heo and Chun (2018), for instance, found that class preparation activities, such as previewing lecture videos, positively impact HOTS by increasing students' metacognitive awareness of their knowledge gaps. Engaging with content before class also enable students to participate in higher-order thinking activities during class as students engage more deeply with the subject matter, examine diverse viewpoints, and critically evaluate information during group projects (McLean et al., 2016; Riza & Setyarini, 2020). Class time in a flipped classroom is often dedicated to cooperative learning activities that encourage students to participate in five types of behaviors which include problem analysis or understanding, individually working on problems, comparing individual work, interacting with peers, and interacting with the instructor (Karabulut-Ilgu et al., 2018; Zainuddin & Halili, 2016).

Research by Annan et al. (2019) supports these findings, demonstrating that the flipped learning approach effectively enhances students' HOTS by enabling them to enter the classroom with foundational Lower Order Thinking Skills (LOTS) gained from pre-class video content. This preparation allows students to participate actively in discussions and group work, facilitated by the instructor, promoting student-centered learning and a deeper understanding of the content. By focusing on higher-order tasks during class, the flipped classroom model empowers students to make informed decisions and apply their learning to real-world scenarios, thereby cultivating critical thinking and problem-solving skills essential for academic success.

The flipped model empowers students to take charge of their learning, increasing engagement, autonomy, and motivation (McLaughlin et al., 2013). Personalized learning allows students to learn at their own pace, focusing on challenging concepts and supporting the development of HOTS. With foundational knowledge acquired beforehand, students can apply what they've learned in real-time, reinforcing their understanding and enhancing critical thinking skills. Teachers in a flipped classroom act as facilitators, guiding students through higher order thinking exercises and providing support as they explore and analyse concepts. Overall, the flipped classroom model creates an environment conducive to developing HOTS by promoting active

engagement, collaboration, and the meaningful application of knowledge.

Student Engagement

Student engagement is defined as the active involvement, participation, and commitment of students in their learning process, both inside and outside the classroom, encompassing behavioral, emotional, and cognitive aspects (Yılmaz & Banyard, 2020). It reflects students' motivation to learn, their willingness to communicate and collaborate with peers, and their attentiveness during lessons. Engaged students demonstrate a genuine interest in learning, actively contribute to discussions and assignments, and take proactive approaches to understanding and mastering content (Choi & Brochu, 2020).

Research by Alsowat (2016) indicates that the flipped classroom increases student engagement, leading to higher achievement and better preparedness for 21st-century learning. The flipped classroom model enhances student engagement in behavioral and cognitive dimensions more effectively than traditional learning (Lo & Hew, 2021). High behavioral engagement in flipped classrooms stems from pre-class activities that students must complete, keeping them engaged through Learning Management Systems (LMS) even when not physically present with the teacher. This approach provides teachers with additional time for interactive learning, allowing for more personalized feedback, making students feel more connected (Strohmyer, 2016). Additionally, peer interaction in the flipped classroom fosters valuable exchanges as students teach each other (Bond, 2020).

Cognitive engagement in the flipped classroom promotes positive self-regulation among students. Kong (2014) noted that while it takes time for students to adjust, they gradually develop independent learning skills and self-reflection. Students learn the technology required for the flipped classroom, gaining greater independence in their studies. Gasmi (2018) supported that the flipped model positively impacts cognitive engagement and growth, with students transitioning from easier to more challenging tasks and participating actively in debates that require higher-order thinking skills. Cognitive engagement also reinforces self-efficacy, with students in flipped classes exhibiting greater confidence in applying their knowledge compared to those in traditional settings (Lo & Hew, 2021).

In the context of the flipped classroom, student engagement is crucial for an effective learning experience. This model shifts focus from passive listening to active participation, encouraging students to engage with course materials before class for deeper understanding and more meaningful discussions during face-to-face sessions (Dixson, 2015). The interactive nature of the flipped classroom fosters engagement through collaborative activities, problem-solving tasks, and peer interactions (Chwilkowska-Kubala, 2024). Factors influencing engagement in the flipped classroom include student motivation, quality of teacher support and feedback, relevance of course content, and opportunities for student leadership (Choi & Brochu, 2020). Engaged students are more likely to take charge of their learning, exhibit higher levels of critical thinking, and achieve improved academic outcomes (Tuljannah & Ayuningtias, 2020). Ultimately, engagement leads to a deeper understanding of the material and a desire to explore topics further, creating a dynamic and effective learning environment.

Student Satisfaction

Satisfaction is defined as the experience of happiness felt when we fulfil our needs and desires (Saif, 2014). In the context of flipped classroom, students could show positive or negative satisfaction regarding the challenges they faced. Alsowat (2016), on the other hand, reported student satisfaction in the context of positive attitude toward the teaching and learning activities and experiences. These positive feedbacks on flipped classroom were also supported by Nouri (2016) whereby from a total of 240 respondents, 180 (75%) expressed positive satisfaction which are mainly contributed to the use of video that provides flexibility and mobility given by the flipped classroom. Educational video is the crucial tool for this learning before

students enter the class. Uses of this video brings advantages in which the students will extrinsically and intrinsically motivated, have self-efficacy and positive attitude for learning (Bui & Thi, 2021). In addition, using video in flipped classroom also encourages learners to make inventive research. However, there are certain criteria for the video provided to be considered. The recommendations are pointed out by Brame (2016) as follows: –

Consideration	Description
Keep each video brief	Multiple videos for a lesson, each is less than 6 minutes. Longer video makes student's mind wandering
Use conversational language	Use "I" and "you" in the video to creates a sense of social partnership between student and teacher.
Use guiding questions	Guiding questions could increase student's germane cognitive load, reduce extraneous cognitive load, and improve student self-assessment.
Filled video with interactive questions	Teacher could interact virtually when the students watch the video within LMS, comment section or Google Form.

Table 1 Video Consideration in the Flipped Classroom

Secondly, Nouri (2016) also mentioned that student satisfaction in flipped classroom is guided by self-paced learning. The students mentioned that the function of pause, rewind and fast forward function in watching videos is beneficial for them that could be obtain from flipped classroom approach. In addition, they could do more studying on their own spare time, have more responsibility for their learning and experience stronger peer-collaboration in the self-paced learning. Yu and Zhu (2016) identified that students undoubtedly freedom access to the knowledge in flipped model could enhance their confidence and positive emotions that leads to their satisfaction. By preparing the students before the class, they could have self-controlled activities outside classes. As a result, students would make extra effort to internalize the knowledge before class, which helps them to construct the mental schemas. This mental scheme that they had developed before the real class could prepare them to learn more complicated knowledge. In fact, Alsowat's (2016) study found that students felt satisfied with flipped classroom experience because they have the control and freedom of choosing what and how to learn. This satisfaction encouraged them to have creative thinking, pushed students forward to participate, engage, and have meaningful learning.

Lastly, there were also reports by students who felt supported learning processes offered by flipped classroom was what led to satisfaction in learning (Nouri, 2016). For instance, the use of Learning Management System (LMS) contributes appear to elevate student's motivation to learn where the teacher will keep interacting with the student in their self-paced learning. Ugwoke et al (2018) claimed LMS use in flipped classroom reduces the distance between a lecturer and his students, and also between students and other students. The process directly improved the learning outcomes of the students. Not only can flipped classrooms via LMS develop students' interest in learning, but also learners' needs to obtain new knowledge from the teacher are met through proper channels. These bring out students' satisfaction towards flipped classroom. In other words, the channel allows learners to interact, encounter, and actively process problems which promotes learning (Adind et al., 2020). The use of LMS during flipped is also encouraged by Talan and Gulsecen (2019); the students in their research sample were satisfied with the implementation method. In addition to requesting other subsequent lessons be designed like the first lesson they had over LMS, the students also pledged to recommend lessons using the LMS platform to others.

METHODOLOGY

Research Design

This study utilized a quasi-experimental research design to quantitatively assess the impact of the flipped

classroom on students' higher-order thinking skills (HOTS), engagement, and satisfaction in a science classroom. Since students are typically grouped into classes in a school setting, this design allowed for a comparison between the HOTS and engagement levels of students in a flipped classroom and those in a traditional classroom without needing to reassign students. This approach avoided disruption to students' learning and social dynamics (Shadish, Cook, & Campbell, 2002). Additionally, the quasi-experimental design addressed ethical concerns about randomly assigning students to different instructional methods, allowing the researcher to evaluate the flipped classroom's impact while ensuring equitable educational opportunities for all students, consistent with ethical standards in educational research (Creswell, 2014). Data were collected using several instruments: a pre-test in HOTS administered to both the experimental and control groups to establish baseline equivalence, a post-test to measure differences in HOTS at the study's conclusion, and a survey questionnaire given to the experimental group to assess changes in student engagement and satisfaction with the flipped classroom approach.

Population and Sample

The study was conducted with a total of ten Form Four classes taking science as a core elective subject. Sampling for the study was non-random, with the main criterion being science classes where students had comparable abilities. Two classes were selected: one as the experimental group, which received the flipped classroom treatment, and the other as the control group. The experimental group (4SK1) consisted of 36 students, while the control group (4SK3) had 42 students. At the request of the study, both classes were taught by the same teacher, who was also the researcher, to maintain consistency in instruction. The experimental group experienced flipped instruction, whereas the control group continued with traditional teaching methods..

Research Instruments

There were two instruments in this research, namely a paper and pencil test tapping into the students' higher order thinking skills (HOTS) and a questionnaire to gauge students' engagement and satisfaction towards flipped classroom. Detailed explanation of the instruments are as follows:

1. Higher Order Thinking Skills (HOTS) Test

The higher-order thinking skills (HOTS) test was designed to assess students' abilities to analyze, evaluate, and create, based on Bloom's Taxonomy. The test focused on Chapter 11: Force and Motion, which was taught to both the experimental and control groups over approximately 3-4 weeks, following the school lesson schedule. The test items were vetted by science teachers at the school to ensure content validity and relevance. The table of specifications was carefully designed to cover all lessons in the chapter and assess higher-order thinking skills. Although the test included both higher-order thinking skills (HOTS) and lower-order thinking skills (LOTS) items, data collection for the study focused on HOTS. The test consisted of eight questions targeting analysis, evaluation, and creation, with a total of 40 marks and an allocated time of 1 hour and 30 minutes..

2. Questionnaire on Student Engagement and Satisfaction

In addition to the higher-order thinking skills (HOTS) test, the research utilized a questionnaire to gauge student engagement and satisfaction in the flipped classroom setting. This questionnaire, adapted from Alsowat's (2016) research, was designed to evaluate the impact of flipped learning on students in a Form 4 science classroom. The questionnaire measured student engagement across three dimensions: affective, behavioral, and cognitive engagement. It also assessed overall student satisfaction with the flipped classroom approach.

Certain adjustments were made to tailor the questionnaire to the specific goals of this research. The questionnaire comprised three sections: Section A, Section B, and Section C. Section A collected respondents' demographic information, while Sections B and C focused on student engagement and satisfaction, respectively. The questionnaire was administered only to the experimental group, allowing for pre- and post-intervention comparisons to understand how flipped learning influenced students' engagement and satisfaction.

Validation of Instruments

The validity of the research instruments was assessed by identified experts to ensure their effectiveness. The study utilized two main instruments: a paper-and-pencil test and a questionnaire. Separate validation processes were carried out for each to ensure their reliability. For the test, after its development, three expert science teachers at the school were engaged to evaluate the test items and provide constructive feedback. Their consensus was specifically sought regarding the items' ability to effectively measure higher-order thinking skills, such as analyzing, evaluating, and creating.

The process for validating the questionnaire items was different. Two experts in educational psychology were consulted to review the items, which underwent back-to-back translation. Their expertise ensured that the questionnaire accurately represented the dimensions being measured, focusing on student engagement and satisfaction.

Pilot Study

A pilot study was conducted to ensure the reliability of the items in the engagement and satisfaction scales of the questionnaire. A class of students with similar characteristics to those in the actual study was selected to respond to the questionnaire for pilot purposes. The pilot results are shown in Table 2. Both alpha values exceed the general rule of thumb threshold of 0.70, indicating good reliability (Crossman, 2019). Thus, the questionnaire items were deemed reliable for measuring student engagement and satisfaction.

Dimension	Cronbach' Alpha Value
Engagement Scale	0.807
Satisfaction Scale	0.961

Table 2 Cronbach Alpha Value

DATA ANALYSIS AND FINDINGS

Students' HOTS in Science (Flipped vs. Traditional Classrooms)

To compare students' higher order thinking skills (HOTS) in science subject between flipped classroom (experimental group) and traditional classroom (control group), an independent sample t-test was conducted, and the result is shown in Table 3.

	Class	N	Mean	Std. Deviation	t	df	Sig.(2-tailed)
Analyze	Experimental	36	8.78	3.313	7.814	63.599	.000
	Control	42	3.55	2.452			
Evaluate	Experimental	36	6	2.683	3.649	67.699	0.001
	Control	42	3.95	2.197			

Create	Experimental	36	4.89	2.846	1.449	74.177	0.152
	Control	42	3.95	2.845			
Total	Experimental	36	19.67	6.99	5.632	67.455	.000
	Control	42	11.45	5.688			

Table 3 The Result of Post-Administration of HOTS Test

As seen in Table 3, there were statistically significant differences between the mean scores of the two groups in the HOTS test; analyze (t value = 7.814, df = 63.599, sig = .000), evaluate (t value = 3.649, df = 67.699, sig = .001) and total grade (t value = 5.632, df = 67.445, sig = .000). There is only one domain that showed statistically no significant difference which is create (t value = 1.449, df = 74.117, sig = .152).

The findings of this study are in line with those of Lee et al's (2017) which clearly demonstrated the advantages of the flipped classroom model on students' HOTS. By adopting the flipped learning approach, educators can allocate classroom time towards practical application and advanced levels of learning instead of focusing on lecturing and tasks that involve lower order thinking skills (LOTS). During the treatment, the researcher gave a video that will provide early information before the students enter the classroom. This will allow LOTS understanding and give extra time for HOTS learning during flipped classroom, that explains the findings of this research.

Also, similar to Khan and Rashmi's (2018) study, students were seen to have entered the classroom with LOTS knowledge during the treatment. By watching a video prior to the lesson, and the content of which was brought forward or embedded as teacher-controlled activities in the classroom such as discussions and group work did promote student-centered and HOTS learning. In return, understanding of the science content and general performance of the students improved. These findings suggest that flipped learning has the potential to serve as an alternative method for developing students' higher-order thinking skills, a crucial requirement in twenty-first-century education. D'Alessio et al. (2019) further added that flipped classrooms also have a positive impact on students' analytical and synthesis skills, confirming McLean's (2016) findings of flipped classroom holding the potential for achieving significant educational benefits beyond the modest grade improvements observed in previous studies.

Student engagement before and after the flipped classroom

To compare student engagement before and after the flipped classroom, paired sample t-test was conducted to see if there was a significant increase in student engagement after implementing the flipped classroom. Table 4 showed the result of this comparison:

	Treatment	**Mean**	**N**	**Std. Deviation**	**t**	**df**	**Sig. (2-tailed)**
Engagement	Pre	3.47515	36	0.42804	-3.5	35	0.001
	Post	3.89766	36	0.58512			

Table 4 The Difference Between Pre- and Post-Administration of the Engagement Scale

As seen in Table 4, there was statistically significant difference between the mean scores of the pre and post administration of the engagement scale in favor of the post administration (t value = -3.500, df = 35 and Sig.(2-tailed) = .001). Since the Sig.(2-tailed) is less than .05, it can be examined that there is a significant difference in students' engagement before and after the flipped classroom. Students' engagement in the flipped classroom is higher compared to the traditional classroom. The finding of this study is in agreement with that of Lo and Hew (2021); flipped classroom appears to catalyze student engagement in the classroom, spurring students' interaction and attention/participation with and among each other compared to the

interactions in the traditional classroom. A current study by Ng (2023) also explains that the flipped classroom could cater for three dimensions of student engagement. This includes behavioral engagement (e.g., task completion of the pre-class activities and in classroom discussion), cognitive engagement (e.g., increase understanding of subject matter, apply knowledge to practice and preference for challenges) and emotional engagement (e.g., yield a mixed picture for feelings and satisfaction). It was consistent with the findings of Riddle and Gier (2019) that the flipped classroom model can significantly enhance students' engagement and active participation in classroom activities. By involving themselves in various ways, students can not only contribute to and participate in meaningful discussions, but also exchange innovative ideas with their peers and work together to solve complex problems, thereby fostering a sense of shared learning and intellectual growth within the flipped classroom environment (Lo & Hew, 2021).

The level of students' satisfaction towards flipped classroom

To determine the impact of the flipped classroom on students' satisfaction, descriptive analysis was conducted on the ratings that students made on sixteen items in the satisfaction scale as seen in Table 5:

No	Item	Mean	Std. Deviation
1	The flipped learning responses to purposes, objectives, and learning activities in the classroom.	4.17	0.737
2	The flipped learning helps in my science learning.	4.17	0.811
3	The flipped classroom has suitable tools for supporting my learning.	4.06	0.754
4	The flipped learning encourages me to have creative thinking and evaluation.	4.03	0.774
5	I am satisfied with the content and topics of the learning materials.	4.22	0.722
6	I am satisfied with the format and structure of the learning materials.	4	0.756
7	I am satisfied with the integration of technology and multimedia resources.	4.08	0.806
8	I am satisfied with the control and freedom of choosing what and how to learn.	4.25	0.77
9	The flipped learning gives control over my study.	3.92	0.937
10	The use of the flipped learning reduces the feeling of boring and tension.	4	0.926
11	The flipped approach to science learning will remain useful in the future.	4.14	0.798
12	The use of the flipped approach to learning is easy and applicable.	4.08	0.77
13	The use of the flipped learning helps me to develop useful skills.	4.06	0.826
14	The flipped learning reduces time required to learn.	4	0.793
15	I enjoy learning science using the flipped learning.	4.03	0.878
16	Overall, I am satisfied with the flipped science classroom learning experience.	4.36	0.798
	Overall Mean	**4.01**	**0.639**

Table 5 The Mean of Students Satisfaction Towards Flipped Classroom

The overall mean score of students' satisfaction was (M=4.01, SD=.639). All items were high, ranging from 4.00 to 4.36. Students were most satisfied with the flipped classroom because of the control and freedom of choosing what and how to learn (M=4.25, SD=.770) and with the content and topics of the learning materials (M=4.22, SD=.722) during flipped classroom. Only one item is rated under the mean of four which is the flipped learning gives control over my study (M=3.92, SD = .397). In conclusion, students were satisfied with the implementation of flipped classroom.

These findings of the student satisfaction confirmed the importance of shifting from the conventional teaching strategies to a more effective teaching paradigm of the flipped classroom which involved student centered in the learning process. There are reports in numerous studies on the high level of students' satisfaction toward the flipped classroom experience (Martinez & Ruiz, 2020; Annan et al, 2019; Rizhaupt & Sommer, 2018; Chen et al, 2018: Alsowat, 2016; Nouri, 2016), suggesting that using the flipped approach to teaching is one of the ways forward to promoting better learning and understanding.

The key explanation for the results of this study is "I am satisfied with the control and freedom to choose what and how I learn" on the satisfaction questions. In a study by Martinez and Ruiz (2020), it was found that learners "really like" the flipped model because of the learner-centered benefits, such as learners moving at their own pace, more time available for more engaging activities in class, and it being easier for learners who miss class to attend class. When the researcher conducted the funky classroom for this study, students were given 4-5 days before class to complete assignments. On these days, students are able to complete the assignments on their own time, which leads to them being satisfied and able to work at their own pace. The freedom to decide their own learning is in line with Yu and Zhu (2016), who found that students' undoubtedly free access to knowledge in the flipped classroom can boost their self-confidence and positive emotions, leading to their satisfaction.

In addition, students showed high satisfaction on the item "I am satisfied with the integration of technology and multimedia resources"." The flipped teaching method, which integrates technology to a high degree, also increases students' satisfaction with this method. This was confirmed by Annan et al. (2019). The flipped model showed high student satisfaction with the video provided by the instructors before entering the classroom. The materials provided before class "give students the opportunity to have a little fun and learn at the same time." Murillo et al. (2019) also believe that students' overall satisfaction with the instructor, module, and teaching method increases with the flipped method. This is because students can engage with online course content as often as they want, where they want, and how they want, which allows for greater flexibility in knowledge acquisition.

Finally, the student also expressed satisfaction with the flipped classroom because "flipped learning encourages me to think creatively and evaluate." Flipped classroom activities allow students to show creativity and resourcefulness. During the treatment, the researcher conducted an activity that required the experimental group to build a parachute with very few materials. Observation showed that most of the students were able to complete the task on time and properly, unlike in the traditional classroom. Tien (2020) agreed with the paper about the impact of flipped classroom on students' creativity. Flipped learning can increase the artistic value of work and make students recognize and compare the advantages and weaknesses of their own work and the work of others. Students can often express their appreciation through this model and highlight the ability to promote students' thinking in science class. In summary, the use of flipped learning in student activities can effectively stimulate thinking and creativity.

Relationship between student engagement and satisfaction towards flipped classroom.

To determine the relationship between engagement and satisfaction during flipped classroom, Pearson correlation test was used as illustrated in Table 6:

Variables		Satisfaction
Engagement	Pearson Correlation	.696**
	Sig. (2-tailed)	.000

Table 6 The Correlation Between Students' Engagement and Satisfaction in Flipped Classroom

Table 6 shows the correlation of the two variables. The results found that r = 696 and alpha = .000 which is less than 0.05. This means that there is a significantly moderate positive relationship between engagement and satisfaction level after the flipped classroom. In other words, as engagement level increases, satisfaction level also increases.

The findings of this study on the positive relationship between student engagement and satisfaction were confirmed by Fisher et al. (2021). This direct correlation between engagement and satisfaction is likely due to the active learning environment of the flipped classroom. The indicators in the scale developed to capture the construct of flipped learning indicate how flipped learning engages students. By engaging and motivating them and providing them with an enjoyable learning experience, you help ensure that they understand the material well and take ownership of their learning, which increases satisfaction. Students are most satisfied when they have an enjoyable learning experience through the integration of technology and are in control of their learning, which helps them achieve a good understanding of the course material.

Murillo et al. (2019) also agree on the positive relationship between student engagement and satisfaction in the flipped classroom. From the research findings, student interaction, such as their ability to work effectively in groups, actively listen to others' opinions, and engage in self-directed learning, is improved, thus improving overall student satisfaction in the flipped classroom. This significant finding is consistent with research that has consistently highlighted the positive relationship between student engagement and overall satisfaction. By promoting this flipped method, students are not only better able to collaborate and learn from their peers, but also experience a greater sense of fulfillment and satisfaction in their academic endeavors.

CONCLUSION

This study underscores the significant positive impact of the flipped classroom model on students' higher-order thinking skills (HOTS), engagement, and satisfaction within the context of science education. Students in flipped classrooms demonstrated superior HOTS compared to those in traditional settings, as the model encourages independent pre-class preparation and active in-class participation. This approach enables students to tackle complex problems and engage in creative tasks, fostering intellectual growth and a deeper understanding of the subject matter. The dynamic environment of the flipped classroom promotes critical thinking, analysis, and creativity, making it a valuable strategy for enhancing students' learning experiences.

Additionally, the study showed that the flipped classroom significantly boosts student engagement across behavioral, cognitive, and emotional dimensions. Students reported higher levels of enjoyment and involvement due to the interactive and collaborative nature of flipped learning. This model fosters active participation and meaningful peer interactions, cultivating a supportive learning environment that empowers students to take ownership of their education. The learner-centered approach of the flipped classroom, which offers students the freedom to choose their learning paths and integrates technology and multimedia resources, aligns with their preferences for autonomy and flexibility. This alignment leads to increased motivation and satisfaction, underscoring the importance of engaging and interactive classrooms for improving academic experiences and outcomes. Overall, the study advocates for the integration of the flipped classroom

approach in science education as an effective strategy for promoting higher-order thinking, engagement, and satisfaction, while also providing a foundation for future research and pedagogical advancements.

IMPLICATION AND RECOMMENDATION

The study's findings demonstrate that the flipped classroom positively impacts students' HOTS, engagement, and satisfaction in science education. This model aligns with students' preferences for independent learning, allowing them to choose how and what to learn, which has been well-received. These findings can guide educational policymakers and the Ministry of Education Malaysia in integrating the flipped classroom into the curriculum. To facilitate this integration, comprehensive guidelines and professional development for teachers should be provided, encouraging the adoption of student-centered activities, collaborative learning, and technology-enhanced instruction. The flipped classroom promotes HOTS by fostering critical thinking, problem-solving, and analytical reasoning, while enhancing engagement through interactive learning environments and peer interactions. This shift from teacher-centered instruction to student-centered learning transforms teachers into facilitators of students' learning journeys.

To enhance student learning experiences, integrating the flipped classroom approach into science curricula is highly recommended. This model allows students to develop a strong conceptual foundation through pre-class activities and reinforces their understanding in interactive classroom settings. For effective implementation, educational institutions should provide comprehensive professional development for educators, equipping them with the necessary pedagogical skills and technological expertise to create engaging flipped classroom lessons. Teachers should also assess which topics are best suited for the flipped approach and design specific modules with high-quality pre-class content, such as instructional videos and interactive materials, to optimize learning outcomes. Furthermore, further research is essential to conduct comparative studies between the flipped classroom and other pedagogical approaches to evaluate their relative effectiveness in science education. This research should explore factors contributing to the success of the flipped classroom, such as students' aptitude, learning styles, and cognitive strategies, to better understand its impact on student performance and outcomes. Overall, these findings are significant for informing educational policies, guiding instructional practices, and advancing educational theories and future research on flipped classroom implementation.

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