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Original Article

A case study of assessing perceptions, experiences, collaborating quality, learning performance, and student satisfaction in a flipped classroom

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Abstract

The flipped classroom is one of the new approaches to learning and innovative teaching methods worldwide. Given the conditions created in the Corona pandemic and the production of the initial content of many courses, a practical experience of holding a flipped class is examined. Accordingly, the present analysis aims at assessing perceptions, experiences, quality of participation, learning performance and student satisfaction with in a flipped classroom. 18 students participated from the field of electrical engineering in this case study. The data were analyzed using statistical methods of one-sample t-test, Pearson correlation, regression coefficient, and SPSS software. The results revealed that students' access to information and resources and teachers' support and motivation significantly affected students' satisfaction. Furthermore, access to information and resources and teacher support and motivation significantly affected student-perceived learning outcomes. Finally, supporting students' participation and collaboration with each other in flipped classroom also had a significant effect on their satisfaction and perceived learning outcomes. The knowledge gained by students during the class had a significant impact on students' satisfaction and perceived learning outcomes.

Keywords

Collaboration, learning performance, student satisfaction, flipped classroom, Corona.

Introduction

Many studies have analyzed the impact of technology evolution on the education sector over time. Under the influence of industry 4.0 developments, education, teaching philosophies, educational models, information resources, teaching-learning methods, and the role of students and educators in conceptualization have significantly changed. Therefore, the personalization of knowledge creation processes and information transfer techniques, methods, and activities have led to more efficiency, accessibility and flexibility [1]. Consequently, those teaching methods will be constantly updated.

The increasing trend of using flipped classroom in higher education, especially its popularity among engineering educators, has led to significant changes in teaching-learning practices [2, 3]. In the past, engineering education was more in favor of traditional educational approaches. However, recent revolutionary advances in information technology and the overall development of the Internet have opened up a whole new field of research in education [4]. For instance, the flipped classrooms engage students in the process of empirical and practical teaching-learning [5]. The flipped classroom is a strategy in that students require to take responsibility for learning and make their own decisions before, in, and after class [6]. Therefore, adopting a flipped

classroom model can be an attractive solution for both instructors and engineering students because engineering education must provide students with several essential learning disciplines to develop effective problem-solving skills and technical knowledge that can manage real-world problems in the workplace [7, 8]. Perhaps the simplest definition of a flipped classroom is that events that traditionally took place inside the classroom now occur outside the classroom and vice versa [9]. A student-centered model that combines unique theories such as constructivism (active and problem-based learning activities) and behaviorism (instructional lectures derived from direct teaching methods), which were once thought to be incompatible. In this model, with the help of technology, asynchronous video lectures and problem-solving exercises are used as homework and active and group problem-solving activities in the classroom. In a way, time is saved for more active learning activities instead of lectures [8, 10, 11, 12, 13, 14]

More flexibility, better in interaction, more professional skills, better student participation and enhanced learning are some of the benefits identified for flipped engineering classroom training [10, 15, 16]. Implementing flipped classrooms in engineering education and technology-related topics encourages educators to create a challenging environment that helps learners engage them in effective discussion and activities and link new knowledge to prior knowledge [2]. It is also a practical guide for educators to provide immediate reflection and feedback to students [2]. While it is possible to interact with students individually to pay more attention to students who have difficulty understanding the subject or doing their homework. On the other hand, talented students will have more freedom to learn independently at their own pace. The flipped classroom deliberately changes the teaching to a learning-oriented model in which students explore specific topics in more depth during classwork.

Researchers have adopted a wide range of studies to evaluate the flipped classroom, for example, in quantitative perspective educators' attitudes toward the flipped classroom [3], participatory and competitive mindset [17], comparison of exam scores, survey, course evaluation, organizational data and system report data [10], self-efficacy and intrinsic motivation [12], satisfaction and perception of students from the flipped classroom [10], students' academic performance [18], performance and perception of students' scientific project [19]. Few studies have argued that flipped learning improves students' professional skills such as lifelong learning, self-regulation, interpersonal communication [10], student learning performance, and motivation. Therefore, further research on students' learning performance in flipped classrooms is also needed. Reviews should include more students' opinions and views to reflect their perceptions of the flipped classroom. One strength of a flipped classroom should be that the student (after reviewing the content and concepts) can come to the classroom with questions about the content or problems in understanding the content and can interact with peer groups and educators during the face-to-face session. By focusing on students' perceptions, these interactions affect the quality of their learning. Instructors are also free to improve or modify pre-lectures or add new material if necessary [20]. Therefore, more studies are needed to assess students' perceptions of flipped classrooms, and student satisfaction. The results of different studies over the past years and the level of student satisfaction in flipped classrooms have been different [21, 22]. COVID-19 and its challenges for the world's educational systems have changed the perception of all academic disciplines, especially student activities in flipped classrooms. This requires more assessments of students' perceptions and satisfaction with flipped classrooms

The present study aims at evaluating perceptions, experiences, quality of participation, learning performance, and students' satisfaction in flipped classrooms. The results of this study can provide recommendations for researchers, educators, and other educational policymakers. The study provides the research-based action plans on achieving practical outcomes in flipped classrooms, which can play an important role, especially given the extensive content generated in the Corona pandemic.

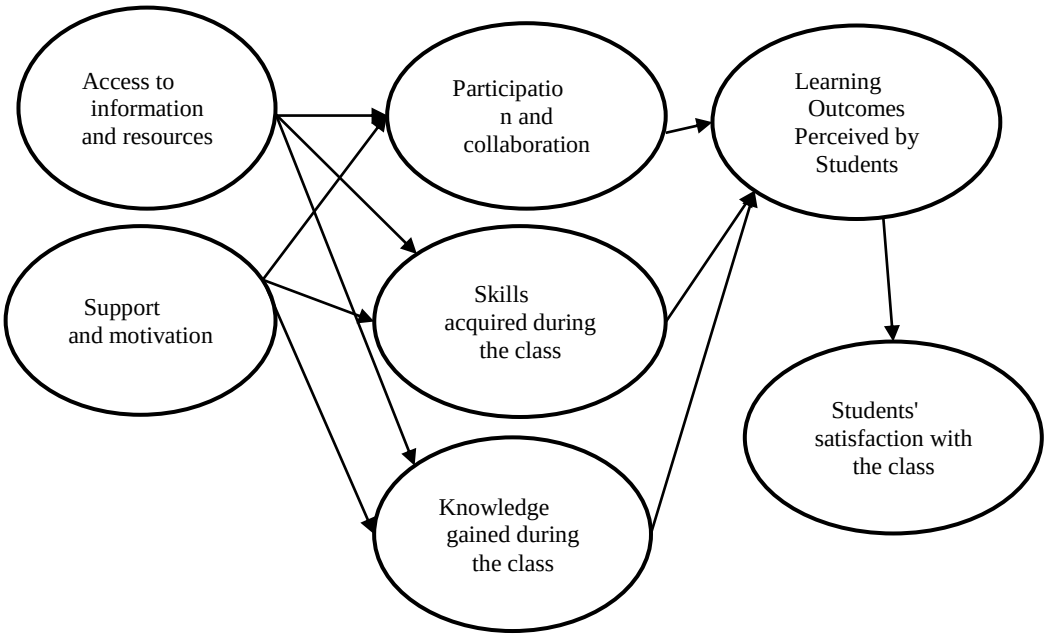
In the next section, we briefly discuss the flipped classrooms research literature, examining perceptions, experiences, participation quality, learning performance, and student satisfaction in flipped classrooms.

Literature Review

Although the concept of flipped classrooms is not new [23]. It has become popular among engineering educators since 2012 [10]. The theoretical foundations used to justify the flipped classrooms are derived from the learner-centered learning literature, which combines behaviorism, cognitivism, social learning theory, constructivism, and relationalism [24].

There are several definitions of flipped learning. In an operational definition, Cheng, Ritzhaupt, and Antonenko (2019) defined the flipped classroom strategy according to Bloom's classification of educational goals in the cognitive domain: "They learn before the class and then engage in interactive and participatory learning activities that facilitate understanding, practice, analysis, evaluation, and creation throughout the class." Despite the considerable diversity, there are some standard and core features in almost all definitions, such as inclusiveness, technology-based, social and interactive nature of activities, collaborative learning, and the learning environment outside and inside the classroom.

Various aspects of flipped classrooms have been evaluated in some literature. For example, Thai, De Wever, and Valcke (2017) stated that the flipped classroom positively affects self-efficacy beliefs and intrinsic motivation and is a promising way to increase students' learning. Putri, Khairil, and Safrida (2022) also noted differences in student motivation to learn through Google's classroom platforms in the reverse classroom. According to Förster, Maur, Weiser, and Winkel (2022), motivational interventions encourage students to acquire knowledge in flipped classroom, to participate regularly and in a timely manner in watching pre-class videos. This helps them benefit from new themes of learning activities in classroom sessions. Ramirez et al. (2022) evaluated how students perceived flipped classrooms and pointed out the usefulness of the course, the elements of the course, and the level of participation in these classes. This result shows that students' perceptions of flipped classrooms affect their performance. Wang and Zhou (2022) research showed that the flipped classroom improves the efficiency and quality of students' learning. Koh (2019) believed that flipped classrooms facilitate learning through access to resources and personal instructors, develop higher-level thinking through problem-solving, and engage students in collaborative learning with peer groups. Latorre-Cosculluela et al. (2021) also described and presented high-level learning experiences through flipped learning before and during education transformation due to the Covid 19 pandemic, to a high degree of student agreement on the benefits and effectiveness of learning designs. It can be useful for developing their future personal and professional skills, including personality building, collaboration, communication, citizenship, critical thinking, and creativity. They noted that the flipped classrooms model allows a combined learning approach in addition to developing 21st-century competencies. In another study, Torres-Martín et al. (2022) acknowledged that the flipped learning and teaching model effectively promotes students' interest, their capacity for independent learning, and personal and collaborative relationships. Al-Samarraie, Shamsuddin and Alzahrani (2020) showed that using the flipped classrooms in different disciplines promotes student participation, metacognition, attitude, performance, understanding, progress, and other learning outcomes.



Research model of the present study

Methodology

The present case study is quantitative and is a practical design and a descriptive survey in terms of method. This research approach can be used to understand an event, an individual, a group or an activity [25]. The data were collected from 18 students from electrical engineering at Shiraz University. Of the 20 questionnaires sent out, 18 students provided usable survey, 100.0% males. Their ages ranged from less than 25 years (66.7%), 26 to 30 years (27.8%), 31 to 40 years (5.6%). Also, there were 55.6% Bachelor and 33.3% MSc, and 11.1% Ph.D. with the marital status of 100.0% Single.

Procedure

The electronic questionnaires were distributed among the students. Participants first read and signed the informed consent and questionnaires. Completed E-questionnaires were collected in one week in may, 2021.

Measures

The following measures were contained in a 29-item questionnaire. We altered some items to make the items more relevant to the context of the university. The scales of "Access to information and resourcess","Support and motivation" and " Participation and collaboration "5-point Likert scale (1=strongly disagree; 5=strongly agree) were adapted from Awidi & Paynter (2019). The reliability of the access to information and resourcess, support and motivation and participation and collaboration was correspondingly found 0.93, 0.88 and 0.91 on Cronbach's α level. The scales of "Skills","Knowledge" and " Students satisfaction"5-point Likert scale (1=strongly disagree; 5=strongly agree) were adapted from Murillo-Zamoranoet al. (2019). The reliability of the skills, knowledge, and Students satisfaction was correspondingly found 0.95, 0.85 and 0.95 on Cronbach's α level. Finally, in order to measure percieved learning outcomes, Lim & Richardson's (2017) 5-point Likert scale (1=strongly disagree; 5=strongly agree) questionnaire was used. The reliability of the percieved learning outcomes was correspondingly

found 0.97 on Cronbach's α level.

Results

Descriptive statistics are presented in Table 1. As Table 1 shows, students were generally satisfied with the flipped class and learning in this class. It is noteworthy that the highest average (3.76) belongs to the quality of participation and collaboration from the students' point of view. To explain the sub-components affecting student satisfaction, all the elements and the average student satisfaction with the flipped class and learning in this class in each item are given Table1.

Table1. Descriptive Statistics

Study variables	N	Minimum	Maximum	Mean	Std. Deviation
AIR (Access to information and resources)	18	1.00	5.00	3.6852	1.35508
SM (Support and motivation)	18	1.00	5.00	3.6111	1.34553
PC (Participation and collaboration)	18	1.25	5.00	3.7639	1.24402
Knowledge (Knowledge gained during the class)	18	1.50	5.00	3.6111	1.23140
SKILL (Skills acquired during the class)	18	1.50	5.00	3.7611	1.23210
PL (Learning Outcomes Perceived by Students)	18	1.00	5.00	3.6190	1.38071
(Students' SS satisfaction with the class)	18	1.00	5.00	3.7037	1.30303
Valid N (listwise)	18				

It should also be noted that according to the number of samples (18 samples), the Shapiro-Wilk test was used to measure normality.

Table 2. Summary of the use of analytical reasoning

Study variables	Normality of data	Test used
AIR (Access to information and resources)	Not approved	One Sample Median Test
SM (Support and motivation)	Not approved	One Sample Median Test
PC (Participation and collaboration)	Not approved	One Sample Median Test
KNOWLEDGE (Knowledge gained during the class)	Not approved	One Sample Median Test
SKILL (Skills acquired during the class)	Not approved	One Sample Median Test
PL (Learning Outcomes Perceived by Students)	Not approved	One Sample Median Test
SS (Students' satisfaction with the class)	Not approved	One Sample Median Test

Table 3. Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
AIR	0.223	18	0.018	0.865	18	0.015
SM	0.190	18	0.085	0.877	18	0.023
PC	0.175	18	0.151	0.875	18	0.021
KNOWLEDGE	0.204	18	0.047	0.889	18	0.037
SKILL	0.179	18	0.133	0.869	18	0.017
PL	0.175	18	0.150	0.876	18	0.022
SS	0.160	18	0.200*	0.877	18	0.023
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

As shown in the Table 2 after analyzing the research variables, the data were not normal and the One Sample Median Test was used for analysis.

Table 4. Statistics

		AIR	SM	PC	KNOWLEDGE	SKILL	PL	SS
N	Valid	18	18	18	18	18	18	18
	Missing	0	0	0	0	0	0	0
Median		4.0000	4.0000	3.8750	3.5000	4.0833	3.9286	4.0000

The normality of the data was not confirmed in 7 variables. One Sample Median Test was used for analysis. Studies have shown that from the perspective of students, the quality of access to information and resources (AIR); Support and Motivation (SM); Partnership and Collaboration (PC); Knowledge gained during the class (KNOWLEDGE); Skills acquired during the class (SKILL); The perceptual learning outcomes (PL) and students' satisfaction with the class (SS) are higher than the standard rank (3) with an average rank of 4.00, 4.00, 3.87, 3.50, 4.08, 3.92 and 4.00, respectively. Also, there was a significant difference at the level of 0.0001 between the mean rank of satisfaction with the quality of access to information and resources (AIR); Support and Motivation (SM); Partnership and Collaboration (PC); Knowledge gained during the class (KNOWLEDGE); Skills acquired during the class (SKILL); Learning Outcomes Perceived by Students (PL) and Student Satisfaction with the Class (SS) and Standard Rank (3). It can be inferred from the quality of Access to Information and Resources (AIR); Support and Motivation (SM); Partnership and Collaboration (PC); Knowledge gained during the class (KNOWLEDGE); Skills acquired during the class (SKILL); Student Perceived Learning Outcomes (PL) and Student Satisfaction with the Class (SS) are in the flipped classroom above the standard rank (3).
Test a few supplementary study questions:

-Did access to information and resources affect students' satisfaction with the student satisfaction in flipped classroom?

Table 5. Coefficients related to the impact of access to information and resources on students' satisfaction with student satisfaction in the flipped classroom [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.360	0.312		1.156	0.265
	AIR	0.907	0.080	0.943	11.388	0.000
a. Dependent Variable: SS						

The regression analysis showed that from students' point of view, their access to information and resources (AIR) had a significant effect on their satisfaction with flipped Classroom (SS) (Sig. 0.000, B = 0.943).

-Did teacher support and motivation in the flipped classroom affect students' satisfaction with the flipped classroom?

Table 6. Coefficients related to the impact of teacher support and motivation on students' satisfaction [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.408	0.311		1.312	0.208
	SM	0.913	0.081	0.943	11.283	0.000
a. Dependent Variable: SS						

The regression analysis showed that from the students' point of view, teacher support and motivation (SM) in the flipped classrooms had a significant effect on student satisfaction with the flipped classroom (SS) (Sig. 0.000, B = 0.943).

-Did access to information and resources affect student-perceived learning outcomes?

Table 7. Coefficients related to the impact of access to information and resources on student-perceived learning outcomes [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.001	0.266		0.002	0.998
	AIR	0.982	0.068	0.964	14.431	0.000
a. Dependent Variable: PL						

The regression analysis showed that from the perspective of students, access to information and resources (AIR) had a significant effect on student-perceived learning outcomes (PL) (Sig. 0.000, B = 0.964).

- Did teacher support and motivation in the flipped classroom affect students' perceived learning outcomes?

Table 8. Coefficients related to the impact of teacher support and motivation on student-perceived learning outcomes [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.006	0.218		0.026	0.980
	SM	1.001	0.057	0.975	17.606	0.000
a. Dependent Variable: PL						

The regression analysis showed that from the students 'point of view, teacher support and motivation (SM) in the flipped classroom had a significant effect on students' perceived learning outcomes (PL) (Sig. 0.000, B = 0.975).

-Did supporting students 'participation and Collaboration with each other in the flipped classroom affect students' satisfaction with the flipped classroom?

Table 9. Coefficients related to the impact of supporting students 'participation and Collaboration with each other on students' satisfaction [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.122	0.250		-0.488	0.632
	PC	1.016	0.063	0.970	16.067	0.000
a. Dependent Variable: SS						

The regression analysis showed that from the students' point of view, supporting students' participation and Collaboration with each other in the flipped classrooms (PC) had a significant effect on students' satisfaction with the flipped classroom (SS) (Sig. 0.000, B = 0.970).

- Did supporting student participation and collaboration with each other in the flipped classroom affect student-perceived learning outcomes?

Table 10. Coefficients related to the impact of supporting students 'participation and collaboration with each other on student-perceived learning outcomes [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.462	0.235		-1.968	0.067
	PC	1.084	0.059	0.977	18.265	0.000
a. Dependent Variable: PL						

The regression analysis showed that from the students' point of view, supporting students' participation and cooperation with each other in the flipped classroom (PC) had a significant effect on students' perceived learning outcomes (PL) (Sig. 0.000, B = 0.977).

- Did the knowledge gained by the students during the class affect the students' satisfaction with the flipped classroom?

Table 11. Coefficients related to the impact of knowledge gained by the students during the class on students' satisfaction [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.399	0.505		0.789	0.441
	KNOWLEDGE	0.915	0.133	0.865	6.893	0.000
a. Dependent Variable: SS						

The regression analysis showed that from the students 'point of view, the knowledge gained by them during the class had a significant effect on students' satisfaction with the flipped classroom (Sig. 0.000, B = 0.865).

- Did the knowledge gained by the students during the class affect the learning outcomes perceived by the students?

Table 12. Coefficients related to the impact of knowledge gained by the students during the class on the learning outcomes perceived by the students [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	0.020	0.489		0.041	0.968
	KNOWLEDGE	0.997	0.128	0.889	7.759	0.000
a. Dependent Variable: PL						

The regression analysis showed that from the students 'point of view, the knowledge gained by them during the class had a significant effect on students' perceived learning outcomes (Sig. 0.000, B = 0.889).

Discussion

In general, the present study examines the students' perspective and measures their satisfaction with the flipped classroom in engineering education. The current study found that when students reflected on their experiences of the flipped classroom, their satisfaction with the classroom was remarkable. In their view, the quality of participation and cooperation was of greater value and importance. This finding has been considered by many researchers as one of the benefits of the flipped classroom [10, 15, 16]. According to Bloom's cognitive classification, student participation in the flipped classroom process facilitates their understanding, application, analysis, evaluation, and creativity [23].

In the following finding, the students' perspectives evaluation showed the quality of Access to Information and Resources (AIR); Support and Motivation (SM); Partnership and Cooperation (PC); KNOWLEDGE gained during the class (KNOWLEDGE); SKILLS acquired during the course (SKILL); student-Perceived Learning outcomes (PL) and Student Satisfaction with the class (SS) in the flipped class were higher than the standard rank (3). As discussed above, these were the primary goals during the flipped classroom. The flipped classroom focuses on designing and using virtual resources to help students adapt their learning, achieve greater transference, provide more practical activities, and encourage more collaborative learning because there is computer-assisted collaborative learning in flipped learning. The flipped

classroom approach leads to the effective development of students' competencies through practical learning, which increases their deep understanding of the subject and achieves meaningful learning. This leads students to acquire higher-level thinking skills, which enable the individual to achieve logical and reflective thinking, as well as innovative, critical and creative thinking. Higher-level thinking skills are enhanced by testing students (knowing how to do, knowing how to be and how to be) to deepen learning compared to superficial understanding, due to their more active participation in achieving learning goals, which improves performance [18].

In questions one and three, a positive and significant effect of access to information and resources on students' satisfaction with the flipped classroom and the learning outcomes was found. During the flipped classroom process, especially before and after class, the more students have access to the resources and information they need, the more positive their perception of academic support and resources will be. This helps students who need more support. The flipped classroom model provides students with meaningful learning experiences that enable them to make connections between new and previous knowledge [26]. As Torres-Martín et al. (2022) noted, the flipped classroom focuses on designing and using virtual resources to help students adapt their learning, achieve more significant transfer, suggest more practical activities, and encourage more collaborative learning. Given that most of the students in our study are from the digital native generation, if students have more access to information, primarily through digital systems, they will be more satisfied with the flipped classroom process. The flipped classroom can access the information and resources needed, the possibility of active and meaningful learning, opportunities for interaction between teacher and student, and stimulating a variety of learning styles [27]. As a result, there will be more satisfaction from students.

The findings of questions two and four had a positive and significant effect on teacher support and motivation in the flipped classroom on students' satisfaction with this class and the learning outcomes perceived by them. Numerous studies have shown that supportive and motivating learning environments significantly impact students' learning outcomes. For example, part of the research of Förster, Maur, Weiser and Winkel (2022) showed that motivational interventions aimed at encouraging students to prepare for class on time play an essential role in gaining knowledge in the reverse classroom. Reeve (2006) also acknowledges that educators who support student independence have a clearer understanding of what is expected from them. This issue also positively affects students' satisfaction in the flipped classroom. Suppose educators reverse most of the learning and interactive activities in the classroom around students' preferences and interests. In that case, they will be more motivated and, as a result, more satisfied with the class. As a result, the learning outcome in such a motivating and supportive environment is expected to improve.

In response to questions five and six, supporting students 'participation and cooperation with each other in the flipped classroom had a positive and significant effect on students' satisfaction with the flipped classroom and the perceived learning outcomes. In the flipped classroom process, if students support and participate in activities together and their satisfaction with the class process, it gives them a deeper understanding of learning topics. A systematic review by O'Flaherty and Phillips (2015) concluded that students' learning potential is enhanced through more active participation and interaction in the inverted classroom, and Wang and Zhou (2022) noted student participation, increased motivation, and enhanced independence. Their research showed that the flipped classroom improves the efficiency and quality of students' learning.

In response to questions seven and eight, the knowledge gained by students during the class had a positive and significant effect on students' satisfaction with the classroom and the learning outcomes perceived by them. Engineering students need to be prepared for the uncertain future, consequently the knowledge gained during flipped classroom processes is crucial. The flipped classroom requires students to be responsible for their learning, the knowledge gained from

each stage promotes students' reflection and communication throughout the learning process [2]. Bezanilla et al. (2019) acknowledged that the flipped classroom develops the personality traits required by 21st-century students, including their learning outcomes, due to the practical combination of communication networks and increasing access to educational resources. In this regard, Tang et al. (2020) pointed to the improvement of learning, attention, and evaluation of student training courses. Wang and Zhou (2022) also mentioned improving the quality of students' understanding during flipped classrooms.

Conclusion

The analysis of our research findings and highlighting students' perceptions, experiences, quality of participation, learning performance, and student satisfaction with the flipped classroom emphasized their motivation and interest in participating more actively in the class. In general, the flipped classroom allows students to learn freely and on time, engage actively with other students, share their understanding of the content with others, and learn many skills. In addition, we noted several times during the research analysis that the flipped classroom has many advantages and that students' perceptions of these classes significantly impact the expected outcomes and outcomes. To conclude, one of the limitations of this study is that this study was conducted in an engineering field at Shiraz University, and its findings cannot be generalized to other fields and universities. Although the present study focused on students' attitudes toward the flipped classroom, it is therefore suggested that educators' and others' attitudes be examined to achieve complementary results.

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